

National Clinical Guideline Centre

Chronic obstructive pulmonary disease: Management of chronic obstructive pulmonary disease in adults in primary and secondary care

Update guideline

NICE's original guidance on COPD was published in 2004. It was updated in 2010, 2018 and 2019.

See the NICE website for the [guideline recommendations](#) and the [evidence reviews for the 2018 and 2019 updates](#).

This document preserves evidence reviews and committee discussions for areas of the guideline that were not updated in 2018 or 2019.

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Contents

Preface

1 Introduction	22
1.1 Definition of chronic obstructive pulmonary disease	22
1.2 Clinical context	22
1.2.1 Prevalence	23
1.2.2 Mortality	24
1.2.3 Morbidity	25
1.2.4 Comorbidities	27
1.2.5 Economic Impact	27
1.3 Original guideline aims	29
1.4 Patient choice	29
1.5 Underlying guideline principles	29
1.6 Structure of the original guideline	30
1.7 Updating a NICE guideline	31
1.8 Update aim	31
1.9 Scope	32
1.10 Audience	32
1.11 Involvement of people with COPD	32
1.12 Guideline limitations	33
1.13 Other work relevant to the guideline	33
2 Methodology	36
2.1 The process of guideline development (for a partial update)	36
2.1.1 Identifying areas of existing guidance that need updating	36
2.1.2 Developing evidence based questions	36
2.1.3 Developing the review protocol	36

2.1.4 Searching for the evidence.....	37
2.1.5 Appraising the evidence.....	38
2.1.6 Undertaking new health economic analysis	38
2.1.7 Distilling and synthesising the evidence and developing recommendations.....	38
2.1.8 Agreeing the recommendations.....	39
2.1.9 Structuring of the updated sections of the guideline.....	39
2.1.10 Writing the guideline	40
2.2 Re-run evidence	41
2.3 Disclaimer.....	41
2.4 Funding.....	41
3 Hierarchy of evidence and grading of recommendations.....	41
4 Glossary of terms.....	42
5 Summary of key priorities for implementation, algorithms and audit criteria	51
5.1 Key priorities for implementation.....	51
5.2 Algorithms.....	54
5.3 Suggested audit criteria for implementation.....	58
6 Diagnosing COPD	62
6.1 Introduction	62
6.2 Symptoms.....	62
6.3 Signs	64
6.4 Spirometry.....	65
6.4.1 Performing Spirometry.....	65
6.4.2 Interpreting Spirometry	70
6.5 Differential diagnosis.....	75
6.6 Further investigations	75
6.7 Reversibility testing.....	77
6.8 Assessment of severity and prognostic factors.....	82

6.8.1 Multidimensional assessment.....	82
6.9 Assessment and classification of severity of airflow obstruction	87
6.10 Identification of early disease	88
6.11 Referral for specialist advice	90
7 Managing Stable COPD	92
7.1 Introduction	92
7.2 Smoking Cessation	93
7.2.1 Benefits of stopping smoking.....	94
7.2.2 Smoking cessation therapy	94
7.3 Inhaled therapy	97
7.3.1 Short-acting beta ₂ agonists (SABA).....	98
7.3.2 Short-acting beta ₂ agonists (SABA) and short-acting muscarinic antagonists (SAMA)	99
7.3.3 Long-acting beta ₂ agonists (LABA).....	101
7.3.4 Long-acting anticholinergics (long-acting antimuscarinics or LAMA)	108
7.3.5 Inhaled corticosteroids (ICS).....	126
7.3.6 Inhaled combination therapy.....	132
7.3.6.1 Long-acting beta ₂ agonists (LABA) and inhaled corticosteroids (ICS).....	134
7.3.6.2 Long-acting beta ₂ agonists (LABA) and inhaled corticosteroids (ICS) and long-acting muscarinic antagonist (LAMA)	162
7.3.6.3 Long-acting beta ₂ agonists (LABA) and long-acting muscarinic antagonist (LAMA).....	180
7.3.6.4 Long-acting muscarinic antagonists (LAMA) + Inhaled Corticosteroids (ICS)	196
7.3.6.5 Health economic modelling for inhaled combination therapy	197
7.3.6.6 Evidence discussion for inhaled combination therapy.....	200
7.3.7 Delivery systems used to treat patients with stable COPD	207
7.4 Oral therapy	215
7.4.1 Oral corticosteroids.....	215
7.4.2 Oral theophylline.....	217

7.4.3 Oral phosphodiesterase type 4 inhibitors	222
7.4.4 Oral mucolytics.....	222
7.4.5 Oral anti-oxidant therapy	232
7.4.6 Anti-tussive therapy	234
7.4.7 Oral prophylactic antibiotic therapy	235
7.5 Combined oral and inhaled therapy.....	236
7.5.1 Beta ₂ agonists and theophylline	236
7.5.2 Anticholinergics and theophylline.....	238
7.6 Oxygen.....	241
7.6.1 Long term oxygen therapy (LTOT).....	243
7.6.2 Ambulatory oxygen therapy	247
7.6.3 Short burst oxygen therapy.....	250
7.7 Non-invasive ventilation	251
7.8 Management of pulmonary hypertension and cor pulmonale.....	254
7.8.1 Diagnosis of pulmonary hypertension and cor pulmonale	255
7.8.2 Treatment of cor pulmonale	258
7.9 Pulmonary rehabilitation	260
7.9.1 Benefits of pulmonary rehabilitation	261
7.9.2 Course content, setting and duration	264
7.9.3 Referral criteria	267
7.9.4 Repeat programmes	268
7.9.5 Timing of rehabilitation programmes.....	269
7.10 Vaccination and anti-viral therapy	284
7.11 Lung surgery	291
7.12 Alpha-1 antitrypsin replacement therapy.....	300
7.13 Multidisciplinary management	302
7.13.1 Respiratory nurse specialists.....	303

7.13.2	<i>Physiotherapy</i>	305
7.13.3	<i>Identifying and managing anxiety and depression</i>	309
7.13.4	<i>Nutritional factors</i>	317
7.13.5	<i>Palliative care</i>	325
7.13.6	<i>Assessment for occupational therapy</i>	333
7.13.7	<i>Social services</i>	335
7.13.8	<i>Advice on travel</i>	336
7.13.9	<i>Education</i>	339
7.13.10	<i>Self-management</i>	341
7.14	Fitness for general surgery	346
7.15	Follow-up of patients with COPD	347
8	Management of exacerbations of COPD	351
8.1	Introduction	351
8.2	Definition of an exacerbation	351
8.3	Consequences of having an exacerbation	351
8.4	Causes of an exacerbation	354
8.5	Symptoms of an exacerbation	356
8.6	Differential diagnosis of an exacerbation	357
8.7	Assessment of the severity of an exacerbation	357
8.8	Assessment of need for hospital treatment	358
8.9	Investigation of an exacerbation	360
8.10	Hospital-at-home and assisted discharge schemes	361
8.11	Pharmacological management	366
8.11.1	<i>Inhaled bronchodilators</i>	366
8.11.2	<i>Delivery systems for inhaled therapy during exacerbations</i>	366
8.11.3	<i>Systemic corticosteroids</i>	370
8.11.4	<i>Antibiotics</i>	374

8.11.5	<i>Theophylline and other methylxanthines</i>	379
8.11.6	<i>Respiratory stimulants</i>	380
8.12	Oxygen therapy during exacerbations of COPD.....	382
8.13	Non invasive ventilation (NIV) and COPD exacerbations.....	386
8.14	Invasive ventilation and intensive care.....	389
8.15	Respiratory physiotherapy and exacerbations.....	392
8.16	Monitoring recovery from an exacerbation.....	394
8.17	Discharge planning.....	395
9	AUDIT CRITERIA	397
10	Areas for Future Research	403
10.1	General Points.....	403
10.2	Specific points.....	404
10.2.1	<i>Pharmacological Management</i>	404
10.2.2	<i>Adjunctive therapies</i>	405
10.1.3	<i>Patient focused strategies</i>	405
10.3	NEW 2010 UPDATE Future research recommendations.....	406
11	Appendix A Details of questions and literature searches	410
12	Appendix B Cost effectiveness of opportunistic case finding in primary care	431
13	Appendix C Educational packages	454
14	Appendix D Economic costs of COPD to the NHS	455
15	Appendix E Searching for health economics evidence	459
16	Appendix F Evidence tables	462
17	Appendices for NEW 2010 update	463
18	Appendix G NEW 2010 update Scope	464
19	Appendix H NEW 2010 update PICO questions	473
20	Appendix I NEW 2010 update research protocols	476

COPD (update)

21 Appendix J NEW 2010 update literature searches	497
22 Appendix K NEW 2010 deleted sections from original guideline	531
23 Appendix L NEW 2010 update criteria for selecting high-priority research recommendations.....	559
24 Appendix M NEW 2010 update cost effectiveness modelling.....	561
25 Appendix N NEW 2010 COPD update GDG declarations of interest register	609
26 Appendix O NEW 2010 COPD update forest plots	613
27 Reference List	626

NOTE: the evidence tables are in separate files.

Preface to original guideline

COPD is common but for many years it was largely ignored on the (false) grounds that little could be done. However in the last 10 years there has been a surge in research interest and several new treatment options. The first Guidelines on the Management of COPD (published by the British Thoracic Society in Jan 1997) led to significant improvements in the recognition and care of COPD. Since then new treatment possibilities including long-acting bronchodilator drugs, respiratory rehabilitation services, and non-invasive ventilation in respiratory failure, have meant that a revision is overdue.

The guideline was commissioned from NICE and the scope for the project was developed by National Collaborating Centre with input from all the stakeholders registered with NICE. The agreed final project scope advises that since it is aimed at the NHS, the guideline should concentrate on the health aspects of COPD. However it should also include the need for support from other agencies including social services, and should set out the interface with such services but not discuss their detailed provision.

There are other national and international guidelines for COPD but this is the first to systematically bring together and examine all the evidence in the published literature. The systematic nature of the approach provides an explicit audit trail of what has and has not been identified and how it was treated. Because the project scope was so wide ranging, even with an extremely hard working and dedicated team, it has not been possible to examine every paper on every question. Pragmatic choices have had to be made. Thus we searched first for the best quality research studies and if several were found that provided a strong evidence base, we did not continue to search for papers of lesser quality. The searching for, and systematic critical appraisal of, studies has been done using standard techniques and all searches will be available to future researchers. We believe it is unlikely that important papers have been missed either by the technical team in their searches or by the expertise of the guideline groups.

The guideline had to cover all aspects of the disease so that local care pathways could be defined using the document. Where there were gaps between the evidence, these have been filled with best practice recommendations based on a formal consensus of the experts on our guideline groups.

In each section of the document the level of supporting evidence is made clear on the understanding that the stronger the evidence the greater likelihood that the recommendations based on it are sound. However the reader should not equate level of evidence with strength of recommendation - some of the most important recommendations with greatest consequences for the health service or for people with COPD have been made by group consensus because there was inadequate evidence. This is what the experts believe to be best practice i.e. what they would recommend for their patients or relatives.

While the detail of local implementation of this guideline may vary (according to local facilities and geography), the main aims ought to be common across England and Wales and if adopted should lead to better standards of care and thus better outcomes from this often distressing condition. But implementation will depend on both clinicians and managers working together to ensure that resources and patient needs are matched. COPD is a common disease with many different facets to management that varies with the stages of disease and with individual patient circumstance. The evidence of the last 6 years since the first British guideline is that it is possible to work together and to improve care.

There are some recommendations that either may seem to challenge the international COPD guidelines or may rankle with individual clinicians. Our guideline group believe their recommendations to be the best advice for patient care – and hope that any who disagree will feel challenged to produce and publish evidence to either confirm or refute what this guideline sets out.

It is therefore a pleasure to welcome you to this Guideline on the management of COPD. We hope that all those involved in health care (those that commission care, those that deliver care, and the patient and carer groups) ensure that these guidelines are used and to that end we commend the audit/implementation criteria set out in the final section as ways of measuring the implementation process. Those with COPD deserve no less.

Dr Mike Pearson

Director, National Collaborating Centre - Chronic Conditions

Preface to NEW 2010 update guideline

It is over six years since the original NICE COPD guideline was published, and it is essential to note that this 2010 version is only a partial update, concentrating on specific issues relating to diagnosis, clinical assessment, the management of stable disease with inhaled therapies, and the timing of pulmonary rehabilitation. Other important aspects such as the management of acute exacerbations were specifically excluded from the scope of the guideline revision. Whilst the Guideline Development Group have gone to great lengths to make as obvious as possible which parts of the guideline are new and which are not, it is important to emphasise that many of the 2004 recommendations (for example those relating to smoking cessation and the crucial role of multidisciplinary teams) remain just as important and relevant now as they did when the original guideline was produced. Indeed many of the 2004 recommendations still remain key priorities for implementation.

The revision of the section on diagnosis has provided an opportunity to ensure that the classification of severity of airflow obstruction is now in line with other international guidelines. It was always difficult to rationalise why, for example, a patient with “severe” airflow obstruction in North America had it classified as only “moderate” in the U.K. This welcome realignment will lead to some patients having their severity stage re-classified; such patients will need reassurance that their actual clinical condition and need for appropriate therapy remain unchanged.

A recurring theme of the guideline update is the emphasis on the clinical features of the disease and not over-reliance on spirometry. Many of the new recommendations for treatment are based on the persistence of symptoms (including exacerbations) and not on arbitrary levels of lung function. The guideline emphasises that the realigned gradation of spirometric impairment refers purely to the degree of airflow obstruction and not the clinical severity of the disease, for which a far more comprehensive assessment needs to be made. There is an important research recommendation that simple and practical multi-dimensional assessment tools (some of which were in development during the period of the guideline production) need to be assessed and validated in primary care settings.

A major component of the guideline revision is the new section relating to inhaled therapies. A number of complex inter-locking recommendations are all summarised in a novel clinical algorithm which is intended to provide clarity regarding the clinical and cost-effective use of these drugs. In addition to these new recommendations about pharmacological therapy, there is also an important new recommendation relating to the use of pulmonary rehabilitation following hospitalisation for an acute exacerbation.

This full version of the guideline provides all the evidence, carefully evaluated, on which the update has been based. It is inevitable that not everyone will agree with all of the recommendations. Nevertheless,

COPD (update)

taken in conjunction with the research recommendations and the key priorities for implementation, they do provide a sound basis for reassessing the management of people with COPD and ensuring continuing improvements in the standards of care that our patients deserve.

Michael Rudolf,

Chair, NICE COPD Guideline Development Group.

1 Introduction

1.1 Definition of chronic obstructive pulmonary disease

Chronic obstructive pulmonary disease (COPD) is characterised by airflow obstruction. The airflow obstruction is usually progressive, not fully reversible and does not change markedly over several months. The disease is predominantly caused by smoking.

- Airflow obstruction is defined as a reduced post-bronchodilator FEV₁/FVC ratio (where FEV₁ is forced expiratory volume in 1 second and FVC is forced vital capacity), such that FEV₁/FVC is less than 0.7.
- If FEV₁ is \geq 80% predicted normal, a diagnosis of COPD should only be made in the presence of respiratory symptoms e.g. breathlessness or cough.
- The airflow obstruction is due to a combination of airway and parenchymal damage.
- The damage is the result of chronic inflammation that differs from that seen in asthma and which is usually the result of tobacco smoke.
- Significant airflow obstruction may be present before the individual is aware of it.
- COPD produces symptoms, disability and impaired quality of life which may respond to pharmacological and other therapies that have limited or no impact on the airflow obstruction.
- COPD is now the preferred term for the conditions in patients with airflow obstruction who were previously diagnosed as having chronic bronchitis or emphysema.
- Other factors, particularly occupational exposures, may also contribute to the development of COPD.

There is no single diagnostic test for COPD. Making a diagnosis relies on clinical judgement based on a combination of history, physical examination and confirmation of the presence of airflow obstruction using spirometry. These issues are discussed in more detail in the diagnosis section (Section 6).

1.2 Clinical context

An estimated three million people are affected by COPD in the UK. About 900,000 have been diagnosed with COPD and an estimated two million people have COPD which remains undiagnosed¹. The symptoms of the disease usually develop insidiously, making it difficult to determine the incidence of the disease. Most patients are not diagnosed until they are in their fifties.

1.2.1 Prevalence

[This section was updated in 2010]

Because it is defined by airflow obstruction, questionnaire surveys cannot be used to identify patients with COPD. In the last 20 years, only one national study has measured airway function in patients aged 18-65 in the UK. Overall 10% men and 11% women had an abnormally low FEV₁². A postal study³ with hospital assessment in Manchester in patients aged 45 and over suggested prevalence of non-reversible chronic airflow obstruction in 11%. Half of these individuals had not previously been diagnosed.

In a primary care population aged 45 and over in the UK, screened opportunistically, the prevalence of an abnormal FEV₁ and respiratory symptoms was around 9%⁴. Prevalence increases with increasing age⁵ and there are significant geographic variations in the prevalence of COPD.

Unlike many other common chronic diseases the prevalence of COPD has not declined in recent years. Prevalence rates appear to be increasing steadily in women but have reached a plateau in men⁶.

The rate of COPD in the population is estimated at between 2% and 4%, representing between 982,000 and 1.96 million people in England¹. The diagnosed prevalence of COPD is 1.5% of the population in 2007/08 according to the Quality Outcome Framework (QOF) statistical bulletin¹.

Approximately 835,000 people in England have been diagnosed with COPD in 2008-9⁷. However it is currently estimated that over 3 million people have the disease and that an estimated 2 million have undiagnosed COPD, among whom it is considered that 5.5% will have COPD at the mild end of the spectrum⁸

Estimates of the prevalence of COPD in the UK vary widely, depending on the criteria that are used. Data from the Quality and Outcomes Framework (QOF)⁹ for GPs suggest that the majority of general practices can produce a register of patients with COPD amounting to 710,000 people on COPD, although these registers may be incomplete.

COPD is closely associated with levels of deprivation - rates of COPD are higher in more deprived communities^{1,10}.

Estimates based on pre-bronchodilator lung function measurements, as reported from the HSE 2001 data set, are likely to represent an overestimate of the prevalence of COPD in the population. This overestimate will be more evident in the mild and moderate severity stages, with little difference in estimates for prevalence in the severe and very severe COPD groups.

1.2.2 Mortality

[This section was updated in 2010]

It is difficult to be certain of the true mortality rate due to COPD. Some patients die with the disease rather than because of it. Others will die of causes related to COPD, but their death may be certified as being due to these complications¹¹. Analysis of trends in death rates is also complicated by changes in the diagnostic labels.

Chronic obstructive lung disease, mainly chronic obstructive pulmonary disease, is the third largest cause of respiratory death, accounting for more than one fifth (23%) of all respiratory deaths¹².

COPD accounts for approximately 30,000 deaths each year in the UK, with more than 90% of these occurring in the over 65 age group in 2004^{1,10,12-14}. The rate of mortality for respiratory disease in the UK is almost double the European average. The Health Development Agency estimated in 2004 that around 85% of COPD related deaths could be attributed to smoking.

In men, age standardized mortality rates from COPD have fallen progressively since the 1970s, but in women there has been a small but progressive increase⁶. All cause mortality is increased in patients with COPD¹⁵.

The inpatient mortality rate in 2008 was 7.7% compared with 7.5% in 2003¹⁶. The overall mortality rate at 90 days was 13.9% in 2008 indicating a reduction from 15.5% in 2003. Of those patients dying within 90 days of admission, fewer succumbed from COPD or its consequences in 2008 (65%) compared to 2003 (71%). Mortality varies between hospitals and is higher in those with fewer respiratory consultants and in those serving more deprived communities. It is thought that up to 25% of patients die within a year^{1,17,18}.

Mortality from COPD in England shows a strong urban rural gradient with high mortality rates in the large conurbations in the North of England¹⁹. Mortality reflects social inequalities with men aged 20-64 employed in unskilled manual occupations being 14 times more likely to die from chronic obstructive pulmonary disease than those in professional occupations¹². People in urban and deprived areas are more likely to be at risk²⁰.

Cause of death was recorded as COPD in 65% of those who died, a reduction from the 71% observed in 2003¹⁶. Information on COPD deaths from death certificates significantly under-estimate the burden of disease^{16,21}.

COPD is an important co-morbidity in those dying from other smoking related diseases, most commonly ischaemic heart disease and lung cancer^{12,22}. COPD is the fifth leading cause of death in the UK and fourth worldwide^{21,23}. Moreover, due to an aging population, increases in its prevalence and mortality are expected in the coming decades. COPD is set to become the third leading cause of death worldwide by the year 2020, surpassed only by heart disease and stroke²⁴.

Five year survival from diagnosis is 78% in men and 72% in women with clinically mild disease defined as not requiring continuous drug therapy, but falls to 30% in men and 24% in women with severe disease defined as requiring oxygen or nebulised therapy. The mean age of death of patients with severe COPD is 74.2 years compared with 77.2 years in patients with mild disease and 78.3 years in individuals who did not have COPD¹⁵.

1.2.3 Morbidity

[This section was updated in 2010]

An average general practice in the UK which cares for about 7,000 people will have up to 200 people with COPD on its practice list, for many of whom the condition will be undiagnosed. This equates to around 1.4 million consultations with GPs each year, up to four times more than the number of consultations for angina¹. COPD patients admitted to hospital are frequent users of primary care in the 12 months prior to their admission.

Three quarters (74%) of admitted patients make contact with their general practice in the month before admission and nearly a third (31%) have 3 or more contacts in those 4 weeks. Although patients make a median of 12 contacts with general practice in the 12 months prior to the audited admission, and have a median of 3 exacerbations, 51% have no contact with out-of-hours services¹⁶.

The National COPD Audit 2008 patient survey noted that the majority (83%) of patients report frequent exacerbation of their COPD. Two thirds (68%) of patients reported a respiratory infection or flu-like symptoms in the month prior to admission, about half (57%) noticed a change in colour/volume of phlegm before admission, often 2-5 days before (46%), but with one quarter (26%) having noticed this 6 or more days before. Although 25% of patients admitted with COPD said this was their first admission, 60% had also been admitted to hospital with COPD in the previous 12 months¹⁶.

Although only a small proportion of people with COPD are admitted to hospital each year, one in eight (130,000) emergency admissions to hospital is for COPD, making it the second largest cause of emergency admission in the UK, and one of the most costly inpatient conditions treated by the National Health Service (NHS)²¹. Respiratory disease accounts for 5.2 million bed days, nearly 10% of all hospital

COPD (update)

bed days. One fifth (21%) of bed days used for respiratory disease treatment are due to chronic obstructive lung disease, such that COPD accounts for more than one million 'bed days' each year in hospitals in the UK^{10,12}.

COPD is the most common reason for emergency admission to hospital due to respiratory disease, accounting for the most finished consultant episodes of care (80% of them in those aged over 60 years of age) and is second only to pneumonia in total bed-days per year¹³. About 30% of patients admitted with COPD for the first time will be readmitted within three months¹².

Admission rates have risen in all age groups since 1994 except in the under 45s. The highest rises have occurred in the over 85s in which rates have almost doubled from 1994 to 2005.

www.laia.ac.uk/copd1994-2005.html

Rates of admission to hospital vary by up to five times in different parts of England, reflecting differences in the prevalence of COPD as well as wide variations in the quality of care that is provided in the community¹. Risk of hospital admission for the disease varies greatly between regions and within regions.

COPD admissions also show some seasonality and are more common in the winter months²⁵.

The median length of stay in 2008 was 5 days (interquartile range 3-10 days) compared with 6 days in 2003. There has been an increase from 26% to 34% in the proportion of patients having a shorter stay of at most 3 days since 2003. The readmission rate in 2008 was 33%, increased from 31% in 2003. The median time to readmission was 38 days.

There has been an increase in the proportion of admissions that are female so that COPD is now a disease of equal importance in both men and women. The mean age of admissions in 2008 was 73 years for men (increased from 72 years in 2003), and 72 years for women.

90% of patients still live at home, 36% on their own. 39% of patients received some form of personal care at home, whether paid or unpaid. The median % predicted forced expiratory volume in 1 second (FEV₁) for those patients with spirometry recorded in the last 5 years was 38%. 67% of recorded Medical Research Council (MRC) dyspnoea scores are Grade 4-5 in the steady state prior to admission the number of current smokers was 33% in 2008 compared with 41% in 2003¹⁶.

1.2.4 Comorbidities

[This section was updated in 2010]

COPD coexists with other diseases that share tobacco smoking as a risk factor, of which the most common are heart disease and lung cancer²⁶.

Advances in the understanding of COPD have stressed the importance of co-morbidities²⁷. COPD increases the risk for lung cancer, and a recent meta-analysis found a strong inverse relationship between level of lung function and risk of lung cancer. For the same marginal decrease in FEV₁, adjusted for smoking, women were twice as likely as men to develop lung cancer^{28,29}.

The National COPD audit showed a very high level of co-morbidity, the association with cardiovascular disease being particularly strong. 51% of the patients had been admitted for COPD within the preceding 24 months¹⁶.

The cost and complexity of care escalates with the number of co-morbid conditions³⁰. There is a high

1.2.5 Economic impact

[This section was updated in 2010]

The total annual cost of COPD to the NHS in 2000-1 was estimated to be £491,652,000 for direct costs only and £982,000,000 including indirect costs (See Section 14).

Broken down by disease severity according to guidelines at that time, the cost p.a. was

- Mild £149.68
- Moderate £307.74
- Severe £1,307.10

The average cost per patient p.a. was £819.42, of which 54.3% was due to inpatient hospitalisation, 18.6% for treatment, 16.4% for GP and specialist visits, 5.7% for accident and emergency visits and unscheduled contacts with the GP or specialist and 5% for laboratory tests³³.

COPD (update)

The Chief Medical Officer has reported COPD accounts for more than £800 million in direct health care costs¹⁰. The direct cost of COPD to the UK healthcare system has been estimated to be between £810-£930m to a year³⁴. More than half of these costs relate to the provision of care in hospital. COPD is among the most costly inpatient conditions treated by the NHS.

The indirect costs of COPD are substantial with an impact on annual productivity amounting to an estimated 24 million lost working days per annum^{1,10,35}. There is little UK data available to quantify other indirect costs such as carer time and inability to carry out non-occupationally related activities¹³.

Assuming the above estimates for the 'cost of caring' is referring to the NHS cost and not the societal cost associated with informal carers, recent DH analysis has estimated the direct cost associated with COPD by disease severity.

GOLD Stage I ($FEV_1 \geq 80\%$ predicted): £120 - £130

GOLD Stage II (FEV_1 50% to 79% predicted): £270 - £290

GOLD Stage III (FEV_1 30% to 49% predicted): £910 - £980

GOLD Stage IV ($FEV_1 \leq 30\%$ predicted): £3,000 - £3,200

(see section 6.9, table 6.7)

The estimated cost of an acute episode (exacerbation) in 2004, using the severity classification at that time, ranges from:

- £8 to £15 for a person with mild COPD
- £23 to £95 for a person with mild to moderate COPD
- £1,400 to £1,600 for a person with severe COPD¹⁰

As well as these costs, it has been estimated that 21.9 million working days were lost in 1994-5. In a recent survey of a random sample of patients with COPD 44% were below retirement age and 24% reported that they were completely prevented from working by their disease. A further 9% were limited in their ability to work and patients' carers also missed time from work³³.

The symptoms of the disease usually develop insidiously, making it difficult to determine the incidence of the disease. Most patients are not diagnosed until they are in their fifties.

1.3 Original guideline aims

This guideline offers best practice advice on the identification and care of patients with COPD. It aims to define the symptoms, signs and investigations required to establish a diagnosis of COPD. It also aims to define the factors that are necessary to assess its severity, provide prognostic information and guide best management. It gives guidance on the pharmacological and non-pharmacological treatment of patients with stable COPD, and on the management of exacerbations. The interface with surgery and intensive therapy units (ITU) are also discussed.

1.4 Patient choice

Whenever recommendations are made, it is recognised that informed patient choice is important in determining whether or not an individual patient chooses to undergo the investigation or accept treatment that is recommended.

1.5 Underlying guideline principles

The main principles behind the development of this guideline were that it should:

- Consider all issues that are important in the management of people with COPD
- Use published evidence wherever this is available
- Be useful and usable to all professionals
- Take full account of the perspective of the person with COPD and their carers
- Indicate areas of uncertainty or controversy needing further research.

1.6 Structure of the original guideline

The document is divided into sections, which cover a set of related topics. For each topic the layout is similar.

The **background** to the topic is provided in one or two paragraphs that simply set the recommendations in context.

Then the **evidence statements** are given and these summarise the evidence, which is detailed in the **evidence tables**. In addition there is an evidence statement about the health economic evidence where this is available. These evidence statements and tables aim to provide context and aid the reader's understanding of why each recommendation was made.

The evidence statements are followed by **consensus statements** agreed by the guideline development group. These statements have been made when there is a lack of evidence or where the guideline development group felt that there were important issues which needed commenting on but which lay beyond or outside the current evidence base.

The main **recommendations** follow. These are graded to indicate the strength of the evidence behind the recommendation.

1.7 Updating a NICE guideline

The National Clinical Guideline Centre for Acute and Chronic Conditions (NCGC-ACC) undertook a review for update three years after publication of the original COPD guideline in concordance with the NICE Guidelines Manual 2007³⁶. Literature searches (based upon the original guideline searches) were re-run.

New evidence that had implications for changing recommendations was ascertained. This review of the evidence and the views of healthcare professionals and patients led to NICE commissioning an 18 month partial update of the COPD guideline. The remit and scope of the update are available in appendix G.

The guideline update 2010 has attempted to maintain, as far as possible, the structure and content of the original NICE COPD guideline 2004. Superseded sections have been removed to an appendix K and new sections have been clearly marked and inserted. GRADE methodology was used to assess the quality of clinical research studies for the first time in a NICE update guideline.

Sections and recommendations from the 2004 guideline which have remained unchanged have maintained the old hierarchy of evidence and recommendation grading system in use at that time.

The development of this evidence-based clinical guideline (partial update) draws upon the methods described by the NICE Guidelines Manual³⁶ specifically developed by the NCGC-ACC for each acute and chronic condition guideline.

1.8 Update aim

The aim of the NCGC-ACC is to provide a user-friendly, clinical, evidence-based guideline for the National Health Service (NHS) in England and Wales that:

- Offers best clinical advice for the management and treatment of COPD in adults in primary and secondary care

- Is based on best published clinical and economics evidence, alongside expert interpretation

- Takes into account patient choice and informed decision-making

- Defines the major components of NHS care provision for COPD

- Details areas of uncertainty or controversy requiring further research

- Provides a choice of guideline versions for different audiences.

1.9 Scope

The guideline was developed in accordance with the partial update scope, which detailed the remit of the guideline originating from the Department of Health and specified those aspects of COPD care to be included and excluded.

Prior to the commencement of the guideline development, the scope was subjected to stakeholder consultation in accordance with processes established by NICE in the guidelines manual³⁷. The full update scope is shown in appendix G.

1.10 Audience

The guideline is intended for use by the following people or organisations:

- All healthcare professionals

- People with COPD and their carers

- Patient support groups

- Commissioning organisations

- Service providers.

1.11 Involvement of people with COPD

The NCGC-ACC was keen to ensure the views and preferences of people with COPD and their carers informed all stages of the guideline. This was achieved by:

- Having a person with COPD as a patient representative on the guideline development group (GDG)

- Consulting with the Patient and Public Involvement Programme (PPIP) housed within NICE during the pre-development (scoping) and final validation stages of the guideline.

- Inclusion of patient groups as registered stakeholders for the guideline.

- Securing patient organisation representation from the British Lung Foundation on the guideline development group.

1.12 Guideline limitations

These include:

NICE clinical guidelines usually do not cover issues of service delivery, organisation or provision (unless specified in the remit from the Department of Health).

NICE is primarily concerned with Health Services and so recommendations are not provided for Social Services and the voluntary sector. However, the guideline may address important issues related to the interface of NHS clinicians with these sectors.

Generally, the guideline does not cover rare, complex, complicated or unusual conditions.

It is not possible in the development of a clinical guideline to complete extensive systematic literature review of all pharmacological toxicity. NICE expect the guidelines to be read alongside the Summaries of Product Characteristics.

The guideline usually makes recommendations within medication licence indications. Exceptionally, where there was clear supporting evidence, recommendations, outside the licensed indications have been included. As far as possible where this is the case it is indicated.

1.13 Other work relevant to the guideline

Related NICE guidance:

National Institute for Clinical Excellence. Guidance on the use of zanamivir, amantadine and oseltamivir for the treatment of influenza. NICE technology appraisal guidance. TA58, 2003. This guidance has been replaced by TA168 Influenza - zanamivir, amantadine and oseltamivir (review).

National Collaborating Centre for Acute Care. Nutrition support in adults: Oral nutrition support, enteral tube feeding and parenteral nutrition. National Clinical Guideline Number 32. London: National Collaborating Centre for Acute Care. 2006. <http://guidance.nice.org.uk/CG32>

National Institute for Health and Clinical Excellence. Obesity: the prevention, identification, assessment and management of overweight and obesity in adults and children. NICE clinical guideline 43 (2006). <http://www.guidance.nice.org.uk/CG43>

National Institute for Health and Clinical Excellence. Anxiety (amended): management of anxiety (panic disorder, with or without agoraphobia, and generalised anxiety disorder) in adults in primary, secondary and community care. NICE clinical guideline 22 (2007). <http://www.guidance.nice.org.uk/CG22>

National Institute for Health and Clinical Excellence. Varenicline for smoking cessation. TA 123 (2007). Clinical Introduction. <http://www.guidance.nice.org.uk/TA123>

National Institute for Health and Clinical Excellence. Influenza (prophylaxis) - amantadine, oseltamivir and zanamivir. TA 158 (2008). <http://guidance.nice.org.uk/TA158>

COPD (update)

National Institute for Health and Clinical Excellence. Smoking cessation services: guidance. London: UK: National Institute for Health and Clinical Excellence. PH 10 (2008). <http://guidance.nice.org.uk/PH10>

National Institute for Health and Clinical Excellence. Influenza - zanamivir, amantadine and oseltamivir (review). 2009. <http://guidance.nice.org.uk/TA168>

National Institute for Health and Clinical Excellence. Depression: the treatment and management of depression in adults (update). London: UK: National Institute for Health and Clinical Excellence. 2009. <http://guidance.nice.org.uk/CG90>

National Institute for Health and Clinical Excellence. Depression in adults with a chronic physical health problem: treatment and management. NICE clinical guideline 91 (2009). <http://www.nice.org.uk/guidance/CG91>

The developer's role and remit is summarised below:

**National Clinical Guidelines
Centre for Acute and Chronic
Conditions (NCGC-ACC)**

The NCGC-ACC was set up in 2009 and is housed within the Royal College of Physicians (RCP). The NCGC-ACC undertakes commissions received from the National Institute for Health and Clinical Excellence (NICE).

NCGC-ACC Technical Team

The technical team met approximately two weeks before each GDG meeting and comprised the following members: GDG chair, GDG clinical advisor, Information Scientist, Research Fellow, Health Economist and Project Manager.

**Guideline Development
Group**

The GDG met monthly and comprised a multi disciplinary team of health professionals and a person with COPD, who were supported by the technical team. The GDG membership details including patient representation and professional groups are detailed in the GDG membership table at the front of this guideline.

**Guideline Project Executive
(PE)**

The PE was involved in overseeing all phases of the guideline. It also reviewed the quality of the guideline and compliance with the DH remit and NICE scope. The PE comprised of: NCGC-ACC Clinical Director; NCGC-ACC Operations Director; NICE Commissioning Manager; Technical Team.

Formal consensus

At the end of the guideline development process the GDG met to review and agree the guideline recommendations.

2 Methodology

2.1 The process of guideline development (for a partial update)

The basic steps in the process of producing a guideline update are:

- Identifying areas of existing guidance that need updating
- Developing clinical questions
- Developing the review protocol
- Systematically searching for the evidence
- Critically appraising the evidence
- Undertaking new health economic analysis
- Distilling and synthesising the evidence and writing recommendations
- Agreeing the recommendations
- Structuring and writing the guideline
- Updating the guideline.

2.1.1 Identifying areas of existing guidance that need updating

The NCGC-ACC conducted a preliminary search for new evidence using the search strategies from the original guideline. The views of healthcare professionals and patients were also sought to identify any change in practice or additional relevant published evidence. Key areas that would directly result in changes to recommendations were highlighted for updating.

2.1.2 Developing evidence based questions

The technical team drafted a series of clinical questions that covered the guideline scope. The GDG and Project Executive refined and approved these questions, which are shown in appendix H.

2.1.3 Developing the review protocol

For each clinical question, the Information Scientist and the Research Fellow (with input from the technical team) prepared a review protocol. This protocol explained how the review was to be carried out (see table 2.1), in order to formulate a plan of how to review the evidence, limit the introduction of bias, and for the purpose of reproducibility. A health economic literature review protocol was also developed. All review protocols can be found in appendix I.

Table 2.1 Components of the review protocol

Component	Description
Review question	The review question as agreed by the GDG.
Objectives	Short description; for example 'To estimate the effects and cost effectiveness of...' or 'To estimate the diagnostic accuracy of...'
Criteria for considering studies for the review	Using the PICO (population, intervention, comparison and outcome) framework. Including the study designs selected.
How the information will be searched	The sources to be searched and any limits that will be applied to the search strategies; for example, publication date, study design, language. (Searches should not necessarily be restricted to RCTs.)
The review strategy	The methods that will be used to review the evidence, outlining exceptions and subgroups. Indicate if meta-analysis will be used.

2.1.4 Searching for the evidence

The Information Scientist developed a search strategy for each question. Key words for the search were identified by the GDG. A separate health economic search strategy was developed looking for economic studies in COPD. Papers that were published in peer-reviewed journals (including e-publications ahead print where identified) were considered as evidence by the GDG. Conference paper abstracts and non-English language papers were excluded from the searches. Where it was deemed appropriate and where there was lack of evidence in the literature on an area of clinical importance, the GDG decided to initiate a 'call for evidence' asking all registered stakeholders to submit any relevant unpublished evidence. Where this occurred this is detailed within the guideline write-up.

Each clinical question dictated the appropriate study design that was prioritised in the search strategy but the strategy was not limited solely to these study types. The research fellow or health economist identified relevant titles and abstracts for each clinical question from the search results and full papers were obtained. Exclusion lists were generated for each question together with the rationale for the exclusion. The exclusion lists were presented to the GDG. See appendices I and J for review protocols and literature search details.

2.1.5 Appraising the evidence

The research fellow or health economist, as appropriate, critically appraised the full papers. In general, no formal contact was made with authors. However there were ad hoc occasions when this was required in order to clarify specific details. Critical appraisal checklists were compiled for each full paper.

For non-observational studies, where possible this included meta-analysis of data and synthesis of data into a GRADE 'evidence profile'. The evidence profile shows for each outcome an overall assessment of both the quality of the evidence as a whole (low, moderate or high), as well as an estimate of the size of effect. For observational and qualitative studies, a narrative summary (evidence statements) was written summarising the results.

For economic studies, an economic 'evidence profile' was constructed. The economic evidence profile shows, for each economic study, an assessment of applicability (directly applicable, partially applicable or not applicable) and methodological quality (minor limitations, potentially serious limitations, very serious limitations) with footnotes indicating the reasons for the assessment. It also shows incremental costs, incremental outcomes (e.g. QALYs) and the incremental cost-effectiveness ratio from the primary analysis, as well as information about the assessment of uncertainty in the analysis. In this guideline results are presented for the comparison specified in the clinical question irrespective of whether or not the comparison was 'appropriate' in the analysis being reviewed (that is where an intervention is compared with the next most expensive non-dominated option – a clinical strategy is said to 'dominate' the alternatives when it is both more effective and less costly). Footnotes indicated if a comparison was 'inappropriate' in the analysis.

A research fellows or health economist, as appropriate, undertook the critical appraisal and data extraction. The evidence was considered carefully by the GDG for accuracy and completeness.

All procedures are fully compliant with the NICE methodology as detailed in the 'Guideline Development Methods – Information for National Collaborating Centres and Guideline Developers' Manual³⁶.

2.1.6 Undertaking new health economic analysis

Priority areas for new health economics modelling were agreed by the GDG after the formation of the clinical questions and consideration of available health economic evidence.

The Health Economist performed supplemental literature searches to obtain additional data for modelling. Assumptions, data and structures of the models were explained to and agreed by the GDG members during meetings, and they commented on subsequent revisions. See appendix M for details of the modelling undertaken for the guideline.

2.1.7 Distilling and synthesising the evidence and developing recommendations

The evidence from each full paper was distilled into an evidence table and synthesised into an evidence

profile and evidence statements before being presented to the GDG. The results of health economic modelling undertaken for the guideline were also presented to the GDG. This evidence was then reviewed by the GDG and used as a basis upon which to formulate recommendations.

Evidence tables are available at <http://guidance.nice.org.uk/CG101/EvidenceTables/pdf/English>.

2.1.8 Agreeing the recommendations

The GDG employed formal consensus techniques to:

- Ensure that the recommendations reflected the evidence-base
- Approve recommendations based on lesser evidence or extrapolations from other situations
- Reach consensus recommendations where the evidence was inadequate
- Debate areas of disagreement and finalise recommendations.

The GDG also reached agreement on the following:

- Recommendations as key priorities for implementation
- Future research recommendations
- Algorithms

In prioritising key priorities for implementation, the GDG took into account the following criteria:

- High clinical impact
- High impact on reducing variation in practice
- More efficient use of NHS resources
- Allowing the patient to reach critical points in the care pathway more quickly.

2.1.9 Structuring of the updated sections of the guideline

The guideline is divided into sections for ease of reading. For each section the layout is similar and contains:

Clinical introduction

This sets a succinct background and describes the current clinical context. It includes which section of the original guideline has been updated and why, and what the existing guideline recommends.

Methodological introduction

This section outlines the a priori agreement of the GDG in relation to the inclusion and exclusion criteria together with the outcomes of interest.

GRADE Evidence profiles and forest plots

The GRADE evidence profiles provide a synthesis of the evidence-base, the quality and describe what the evidence showed in relation to the outcomes of interest (including effect sizes). Forest plots showing meta-analysis results are also provided for outcomes where appropriate.

Evidence statements

Provide a bottom-line narrative summary.

Health economics

Presents, where appropriate, an overview of the cost effectiveness evidence-base, or any economic modelling.

From evidence to recommendations

This section sets out the Guideline Development Group (GDG) decision-making rationale providing a clear and explicit audit trail from the evidence to the evolution of the recommendations.

Recommendations

Provides stand-alone, action-orientated recommendations and details which of the original guideline recommendations have been amended or deleted and any new recommendations that have been added. Unlike the original guideline, recommendations made in this partial update are no longer graded on the strength of evidence, in keeping with the guidelines manual 2009.

Evidence tables

The evidence tables are not published as part of the full guideline but are available on-line. These describe comprehensive details of the primary evidence that was considered during the writing of each section.

2.1.10 Writing the guideline

The first draft version of the guideline was drawn up by the technical team in accordance with the decisions of the GDG, incorporating contributions from individual GDG members in their expert areas and edited for consistency of style and terminology. The guideline was then submitted for a formal public and stakeholder consultation prior to publication. The registered stakeholders for this guideline are detailed on the NICE website www.nice.org.uk. Editorial responsibility for the full guideline rests with the GDG.

The original guideline evidence tables from February 2004 are available at http://thorax.bmj.com/content/59/suppl_1

The following versions of the guideline are available:

Full version:	Details the recommendations, the supporting evidence base and the expert considerations of the GDG. Published by the NCGC-ACC. Available from http://guidance.nice.org.uk/CG101/Guidance/pdf/English
NICE version:	Documents the recommendations without any supporting evidence. Available from http://guidance.nice.org.uk/CG101/NICEGuidance/pdf/English http://guidance.nice.org.uk/CG101/NICEGuidance/doc/English
"Quick reference guide":	An abridged version. Available from http://guidance.nice.org.uk/CG101/QuickRefGuide/pdf/English
"Understanding NICE guidance":	A lay version of the guideline recommendations. Available from http://guidance.nice.org.uk/CG101/PublicInfo/pdf/English

2.2 Re-run evidence

Literature searches were repeated for all of the evidence based questions at the end of the GDG development process allowing any relevant papers published up until 20th August 2009 to be considered. Future guideline updates will consider evidence published after this cut-off date. Further updates will take place in concordance with the specifications outlined in the NICE guidelines manual.

2.3 Disclaimer

Healthcare providers need to use clinical judgement, knowledge and expertise when deciding whether it is appropriate to apply guidelines. The recommendations cited here are a guide and may not be appropriate for use in all situations. The decision to adopt any of the recommendations cited here must be made by the practitioner in light of individual patient circumstances, the wishes of the patient, clinical expertise and resources.

The NCGC-ACC disclaims any responsibility for damages arising out of the use or non-use of these guidelines and the literature used in support of these guidelines.

2.4 Funding

The NCGC-ACC was commissioned by NICE to undertake the work on this guideline.

3 Hierarchy of evidence and grading of recommendations

Please note the hierarchy of evidence and grading of recommendations was used for the original COPD guideline and hence still stands for those areas not covered by the 2010 COPD update.

Each recommendation has been allocated a grading which directly reflects the hierarchy of evidence upon which it is based. Please note that the hierarchy of evidence and the recommendation grading relate to the strength of the literature **not** to clinical importance.

The grading is as follows:

<u>Hierarchy of Evidence</u>		<u>Grading of Recommendations</u>	
la	Evidence from systematic reviews or meta-analysis of randomised controlled trials	A	Based on hierarchy I evidence
lb	Evidence from at least one randomised controlled trial		
IIa	Evidence from at least one controlled study without randomisation	B	Based on hierarchy II evidence or extrapolated from hierarchy I evidence
IIb	Evidence from at least one other type of quasi experimental study		
III	Evidence from non experimental descriptive studies, such as comparative studies, correlation studies and case control studies	C	Based on hierarchy III evidence or extrapolated from hierarchy I or II evidence
IV	Evidence from expert committee reports or opinions and/or clinical experience of respected authorities	D	Directly based on hierarchy IV evidence or extrapolated from hierarchy I, II or III evidence.
DS	Evidence from diagnostic studies	DS	Evidence from diagnostic studies
NICE	Evidence from NICE guidelines or Health Technology Appraisal programme	NICE	Evidence from NICE guidelines or Health Technology Appraisal programme
HSC	Evidence from Health Service Circulars	HSC	Evidence from Health Service Circulars

4 Glossary of terms

Term	Definition
ACBT	Active Cycle of Breathing Technique
ACCP	American College of Chest Physicians
ACE inhibitor	Angiotensin-Converting Enzyme inhibitor
ADL	Activities of Daily Living
Ads	Advanced Directives
Adverse event	Usually in relation to treatment and sometimes known as side-effects. Adverse events are any event that is not to the benefit of the person.
Allied health professionals	Healthcare professionals, other than doctors and nurses, directly involved in the provision of healthcare. (Also known as professions allied to medicine or PAMs.)
Anticholinergic drugs	Anticholinergic drugs are also referred to as muscarinic antagonists e.g. short-acting muscarinic antagonist (SAMA) in the update guideline
Appraisal of evidence	Formal assessment of the quality of research evidence and its relevance to the clinical question or guideline under consideration, according to predetermined criteria.
ARDS	Acute Respiratory Distress Syndrome
ARF	Acute Respiratory Failure
ARR	Adjusted risk ratio
ASA Scoring System	American Society of Anaesthesiologists
ATBC	Alpha-Tocopherol and Beta-Carotene Supplementation
ATS	American Thoracic Society
AUC	Area under the curve
BD	Bronchodilator
BMI	Body Mass Index
BORG	Tool for measuring dyspnoea or the state of being short of breath
BTS	British Thoracic Society
Case-control study (CCT)	A study that starts with the identification of a group of individuals sharing the same characteristics and a suitable comparison (control) group. All participants

Term	Definition
	are then assessed with respect to things that happened to them in the past.
CEN	European Committee for Standardization
CES-D	Centre for Epidemiological Studies Depression Scale
CI	Confidence Interval
CLD	Chronic Lung Disease
Clinical audit	A systematic process for setting and monitoring standards of clinical care.
Clinical effectiveness	How well a drug, treatment or package of care works to produce good outcomes for patients?
Clinician	A health care professional providing patient care, e.g. doctor, nurse, physiotherapist.
CMC	Clinically Meaningful Change
CNS	Clinical Nurse Specialist
Cochrane Library	The Cochrane Library consists of a regularly updated collection of evidence-based medicine databases including the Cochrane Database of Systematic Reviews. The Cochrane Library is available on CD-ROM and the Internet.
Cochrane review	Reviews of randomised controlled trials prepared by the Cochrane Collaboration.
Cohort study	A cohort study takes a group of patients, follows them forward in time and measures their outcome (e.g. disease or mortality rates). Patient subgroups are identified from the information collected, and these groups are compared with respect to outcome.
Concordance	Concordance is a concept reflecting agreement between clinicians and patient on the best course of managing a disease, and adherence to that course until alternatives are agreed on and adopted.
COPD	Chronic Obstructive Pulmonary Disease
COPM	Canadian Occupational Performance Measure
Cost-effectiveness	Comparative analysis of the costs and health benefits of a treatment or care pathway.
CRG	Consensus Reference Group

Term	Definition
CRQ / CRDQ	Chronic Respiratory Diseases Questionnaire
CT scan	Computed Tomography
CXR	Chest X-Ray
Dco	Diffusing Capacity of Carbon Dioxide
DDD	Defined Daily Dosage
Diagnostic study	Any research study aimed at evaluating the utility of a diagnostic procedure.
DLCO	Carbon Monoxide Diffusing Capacity
DPI	Dry Powdered Inhaler
DPTC	Disabled Person's Tax Credit
ECCS	European Coal & Steel Community
ECG	Electrocardiogram
ERS	European Respiratory Society
Evidence table	A table summarising the results of a collection of studies which, taken together, represent the evidence supporting a particular recommendation or series of recommendations in a guideline.
Evidence-based	The process of systematically finding, appraising, and using research findings as the basis for clinical decisions.
Experimental study	A research study designed to test if a treatment or intervention has an effect on the course or outcome of a condition or disease.
FET	Forced Expiratory Time
FEV ₁	Forced Expiratory Volume in 1 second
FFM	Fat Free Mass Index
FFM _{PIBW}	Fat-Free Mass as a Percentage of Ideal Body Weight
FVC	Forced Vital Capacity
GDG	Guidelines Development Group
GI	Gastrointestinal

Term	Definition
GOLD	Global Initiative for Chronic Obstructive Lung Disease
Grade of recommendation	A code (e.g. A, B, C) linked to a guideline recommendation, indicating the strength of the evidence supporting that recommendation.
HADS	Hospital Anxiety and Depression Scale
HAM-D	Hamilton Depression Rating Scale
Health technology	Health technologies include medicines, medical devices, diagnostic techniques, surgical procedures, health promotion and other therapeutic interventions.
Health Technology Appraisal (HTA)	A focused review of evidence around a newly emerging health technology, produced by NICE.
Hierarchy of evidence	An established hierarchy of study types, based on the degree of certainty that can be attributed to the conclusions of a well-conducted study. Well-conducted randomised controlled trials (RCTs) are at the top of this hierarchy. (Several large statistically significant RCTs which are in agreement represent stronger evidence than say one small RCT.) Well-conducted studies of patients' views and experiences would appear at a lower level in the hierarchy of evidence.
HR	Hazard Ratio
HRQL	Health Related Quality of Life
IBW	Ideal Body Weight
ICS	Inhaled corticosteroid
ICU	Intensive Care Unit
ILI	Influenza Like Illness
IPPV	Intermittent Positive Pressure Ventilation
IQR	Inter Quartile range
IRR	Incident Rate Ratio
ITT	Intention to Treat Analysis
ITU	Intensive Care Unit
KPa	Kilopascal – A unit of pressure
LABA	Long-acting beta ₂ agonist

Term	Definition
LAMA	Long-acting muscarinic antagonist
LCADL	London Chest Activity of Daily Living scale
Level of evidence	A code (e.g. 1a, 1b) linked to an individual study, indicating where it fits into the hierarchy of evidence and how well it has adhered to recognised research principles.
Literature review	A process of collecting, reading and assessing the quality of published (and unpublished) articles on a given topic.
LTOT	Long Term Oxygen Therapy
LVRS	Lung Volume Reduction Surgery
Meta-analysis	A statistical technique for combining (pooling) the results of a number of studies that address the same question to produce a summary result.
MID	Minimally important difference
MRADL	Manchester Respiratory Activities of Daily Living
MRC	Medical Research Council
MRI	Magnetic Resonance Imaging
Muscarinic antagonist drugs	Muscarinic antagonists e.g. long-acting muscarinic antagonists (LAMA) are also referred to as Anticholinergic drugs in the original guideline.
MV	Mechanical Ventilation
NAC	N-acetylcysteine
NCC-CC	The National Collaborating Centre for Chronic Conditions. Set up in 2000 to undertake commissions from the National Institute for Clinical Excellence to develop clinical guidelines for the National Health Service
NCEPOD	National Confidential Enquiry into Perioperative Deaths
NICE	National Institute for Clinical Excellence
NIV	Non Invasive Ventilation
NNT	Number Needed to Treat
Non-experimental study	A study based on participants selected on the basis of their availability, with no attempt having been made to avoid problems of bias.

Term	Definition
NRT	Nicotine Replacement Therapy
NSF	National Service Framework
OR	Odds Ratio
Palliative care	Care aimed at alleviating symptoms, pain and distress, and hence improving quality of life, rather than at curing or slowing progression of a disease or condition. It is often associated with, but is actually not limited to, the end of life
PaCO ₂	Arterial Carbon Dioxide Tension
PEF	Peak Expiratory Flow
Pemax	Maximal Expiratory Pressure
PEP	Positive Expiratory Pressure
PIBW	Percent Ideal Body Weight
PICO	Population, intervention, comparison, outcome
Pimax	Maximum Inspiratory Pressure
Placebo	A pill, medicine, or other treatment that has no physiological effect and is used as a dummy treatment.
pMDI	Patient Administered Metered Dose Inhalers
Ppa	Pulmonary Artery Pressure
Prevalence	The proportion of a population of people who are experiencing a condition or disease at a given time.
Prospective study	A study in which people are entered into the research and then followed up over a period of time with future events recorded as they happen.
P-value	P values indicate whether an effect can be regarded as statistically significant or not. By convention, where the value of P is below 0.05 the result is seen as statistically significant. Where the value of P is 0.001 or less, the result is seen as highly statistically significant.
Quality-Adjusted Life Year (QALY)	A measure of health outcome
Quasi experimental study	This is a study in which the treatment comparison groups are not assigned by

Term	Definition
	randomisation.
Randomised controlled trial (RCT)	A trial in which people are randomly assigned to two (or more) groups: one (the experimental group) receiving the treatment that is being tested, and the other (the comparison or control group) receiving an alternative treatment, a placebo (dummy treatment) or no treatment. The two groups are followed up to compare differences in outcomes to see how effective the experimental treatment was.
RCP	Royal College of Physicians
RD	Risk Difference
RR	Risk Ratio
RV	Residual Volume
SABA	Short-acting beta ₂ agonist
SAMA	Short-acting muscarinic antagonist
SaO ₂	Oxygen saturation – The % of oxygen present in the haemoglobin present in arterial blood
SEK	Swedish Krona unit of monetary currency
SGRQ	St George's Respiratory Questionnaire
SIGN	Scottish Intercollegiate Guidelines Network
Six MD / 6MWT	Six minute distance or six minute walking test – 6MD / 6MWT
SMD	Standard Mean Difference
Stakeholder	Any national organisation, including patient and carers' groups, healthcare professionals and commercial companies with an interest in the guideline under development.
Systematic review	Research that summarises the evidence on a clearly formulated question using systematic and explicit methods to identify, select and appraise relevant primary studies, and to extract, collate and report their findings. By following this process it becomes a proper piece of research. It may or may not use statistical meta-analysis.
TAG	Technology Appraisal Guidance
TDI	Transition Dyspnoea Index

Term	Definition
TLC	Total Lung Capacity
T _l CO	Transfer Factor for Carbon Monoxide
TNF-	Tumour Necrosis Factor – alpha
Trial of treatment	A planned period during which a patient receives a treatment to find out if it will be of benefit to them as individuals.
TSF	Triceps Skin Fold
VAS	Visual Analogue Scale
VC	Vital Capacity
VMT	Ventilatory Muscle Training
VO ₂	Oxygen Uptake
WMD	Weight Mean Difference

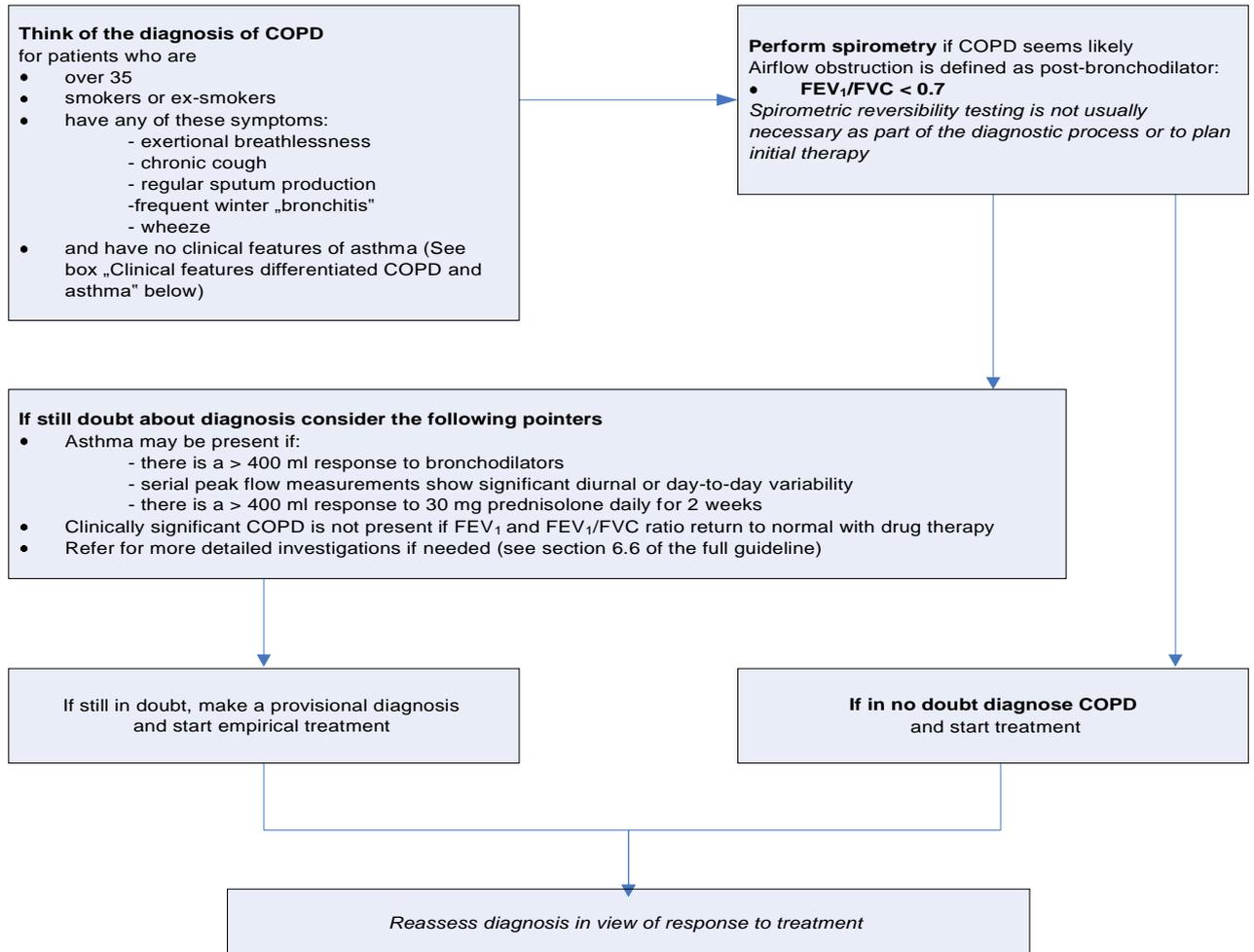
5 Summary of key priorities for implementation, algorithms and audit criteria

This section was removed when the guideline was updated in 2018.

5.2 Algorithms

Algorithm 1: Diagnosing COPD

Definition of chronic obstructive pulmonary disease (COPD)
 COPD is characterised by airflow obstruction. The airflow obstruction is usually progressive, not fully reversible and does not change markedly over several months. The disease is predominantly caused by smoking.

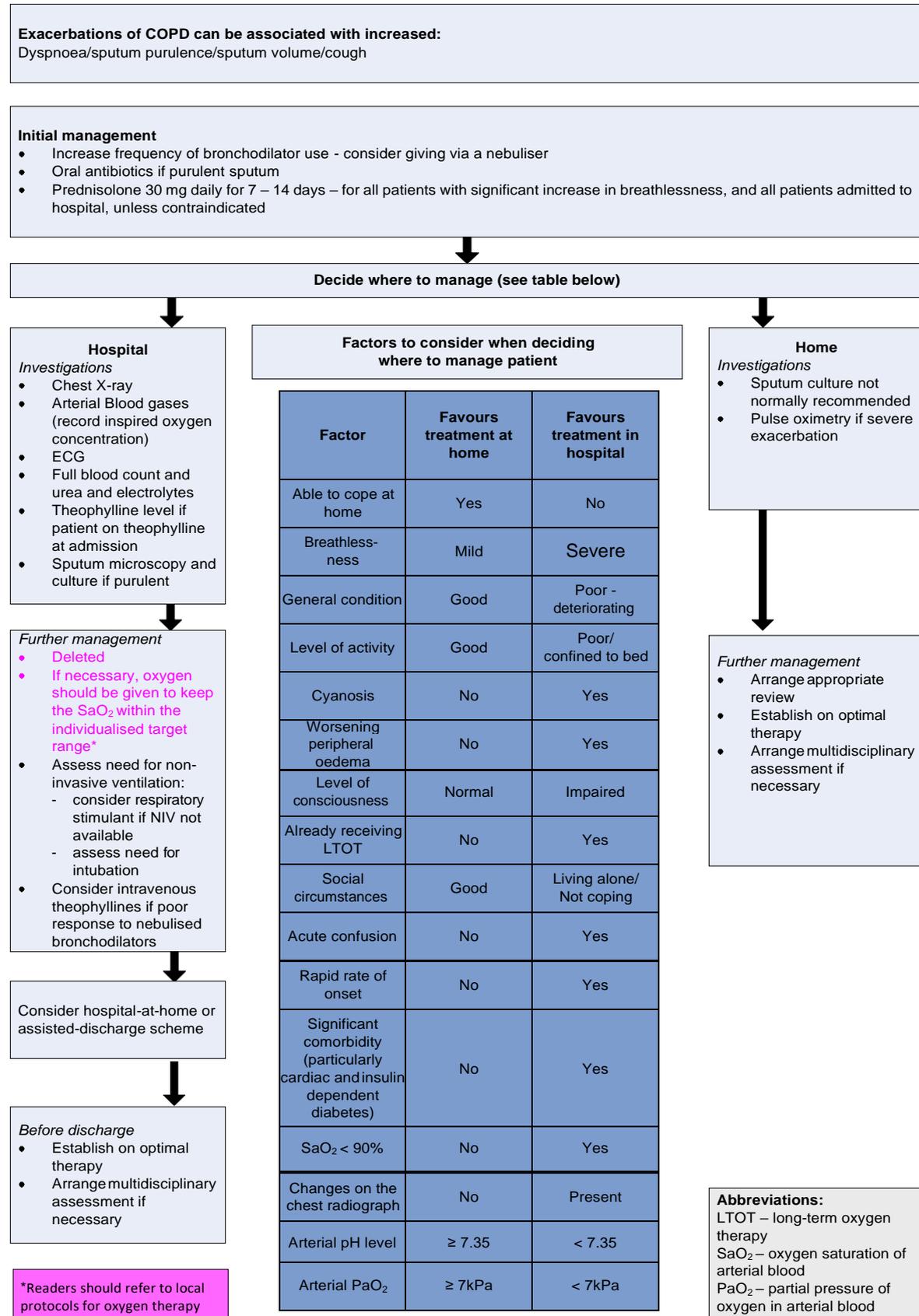


Clinical features differentiating COPD and asthma		
	COPD	Asthma
Smoker or ex-smoker	Nearly all	Possibly
Symptoms under age 35	Rare	Often
Chronic productive cough	Common	Uncommon
Breathlessness	Persistent and progressive	Variable
Night- time waking with breathlessness and or wheeze	Uncommon	Common
Significant diurnal or day-to-day variability of symptoms	Uncommon	Common

COPD (update)

Algorithms 2 and 2a were replaced in the 2018 and 2019 updates. See www.nice.org.uk/guidance/ng115 for the updated visual summary.

Algorithm 3: Managing exacerbations of COPD



COPD (update)

5.3 Suggested audit criteria for implementation

This section was removed in the 2018 update.

COPD (update)

COPD (update)

Please note that this area has been reviewed in 2018, please follow the link on the front page for the evidence review.

6 Diagnosing COPD

6.1 Introduction

The diagnosis of COPD depends on thinking of it as a cause of breathlessness or cough. The diagnosis is suspected on the basis of symptoms and signs and supported by spirometry.

A multidimensional assessment is important (taking into account symptoms such as breathlessness, exercise limitation and exacerbations). The principal differential diagnosis is asthma, and this can usually be distinguished on clinical grounds.

COPD is a heterogeneous disease that affects different patients in different ways. Assessment of the clinical features that are present in an individual helps guide appropriate management.

Spirometry can be used to assess the severity of airflow limitation and together with other investigations it can help predict the prognosis. Any tabulation of spirometry is purely a way of documenting airflow obstruction and should not be indicative of the overall severity of the disease. Different guidelines have previously had varying ways of grading severity of airflow obstruction (section 6.9, table 6.7).

6.2 Symptoms

In the early stages COPD may produce minimal or no symptoms¹¹ and as the disease progresses the symptoms in individual patients vary. IV

Individual patients rank the importance of different symptoms differently; however, in general, breathlessness is the symptom which causes them most concern. IV

Individual symptoms in isolation are not useful in excluding or making the diagnosis of COPD. IV

COPD (update)

Recommendations

The current recommendations can be found at www.nice.org.uk/guidance/ng115.

6.3 Signs

Individual clinical signs are not helpful in making a diagnosis of COPD and in some patients there may be no abnormal physical signs.

The following signs may be present:

- hyperinflated chest
- wheeze or quiet breath sounds
- pursed lip breathing
- use of accessory muscles
- paradoxical movement of lower ribs
- reduced crico-sternal distance
- reduced cardiac dullness on percussion
- peripheral oedema
- cyanosis
- raised JVP
- cachexia.

6.4 Spirometry

This section was updated in 2010

6.4.1 Performing Spirometry

Demonstration of the presence of airflow obstruction is critical to making the diagnosis of COPD. Spirometry is the only accurate method of measuring the airflow obstruction in patients with COPD. Peak expiratory flow measurement may significantly underestimate the severity of the airflow limitation. All hospitals have access to spirometry and many primary care practices now have a spirometer.

GDG consensus statements

Spirometry is fundamental to making a diagnosis of COPD and a confident diagnosis of COPD can only be made with spirometry.	IV
A diagnosis of airflow obstruction can be made if the $FEV_1/FVC < 0.7$ (i.e. 70%) and $FEV_1 < 80%$ predicted.	IV
In individual patients peak expiratory flow (PEF) rates have not been validated for the diagnosis of COPD and a normal PEF rate does not exclude significant airflow obstruction ³⁹ .	IV
Spirometry is a poor predictor of disability and quality of life in COPD ⁴⁰ .	IV
Spirometry predicts prognosis in COPD ^{41,42} .	IV
Spirometry contributes to the assessment of the severity of COPD.	IV
Spirometry alone cannot separate asthma from COPD.	IV
Changes in the flow volume loop may give additional information about mild airflow obstruction.	IV
Measurement of the slow vital capacity may allow the assessment of airflow obstruction in patients who are unable to perform a forced manoeuvre to full exhalation.	IV

Clinical Introduction

Current clinical practice in primary care in the UK has been driven by the Quality Outcome Framework (QOF) which initially advocated bronchodilator reversibility testing (i.e. measurement of both pre and post-bronchodilator values (see section 6.7)) as a diagnostic tool. The 2009 QOF⁹ requires the diagnosis to be confirmed by post bronchodilator spirometry. The 2004 COPD guideline did not specify whether spirometry measurements should be made pre or post bronchodilator. This was identified as an area for clarification in the 2010 partial update.

The GDG posed the following question:

DIAG1: How does post bronchodilator FEV₁ (forced expiratory volume in one second) compare with pre bronchodilator FEV₁ in terms of: a) sensitivity / specificity of FEV₁ for diagnosis; b) classification of severity of disease?

The literature was searched from 2003-20/8/09 for studies that compared pre and post bronchodilator (BD) FEV₁ values to a clinical diagnosis of COPD (based on symptoms). Very few papers defined COPD in this way; i.e. without including FEV₁ as part of the definition of COPD. Several studies were excluded because pre and post BD FEV₁ values were compared to identify COPD defined according to GOLD criteria (post bronchodilator FEV₁/FVC < 0.70). By definition, post bronchodilator FEV₁ would correlate better with a definition of COPD that is based on post bronchodilator FEV₁.

Two studies^{43,44} were identified that addressed this issue.

The PLATINO study⁴³ was a cross sectional study of adults in Latin America defined as either at low risk or high risk for COPD (based on questionnaires and medical histories). The low risk group (N=1895) lacked significant exposures, cough, dyspnoea, wheezing and did not refer a medical diagnosis of asthma or COPD. The remaining participants (N=3288) were considered as having a high risk for COPD. The study compared pre bronchodilator (BD) with post BD FEV₁ to identify people with COPD defined as either an FEV₁/FVC < 0.70 or an FEV₁/FVC < 5th percentile. This study was included because it compared the FEV₁ measures in a high and low risk group. It should be noted that there is no accepted gold standard diagnostic test for COPD against which to compare the FEV₁ indices.

It was unclear if the assessors were blinded to whether the FEV₁ measurements were pre or post BD. The pre and post BD FEV₁ measurements were performed close together and all patients received both FEV₁ measurements (pre and post bronchodilator).

A case series study⁴⁴ assessed the utility of reversibility testing in people with a clinical diagnosis and symptoms compatible with non-asthmatic COPD (N=660). People whose FEV₁ improved post BD by > ten percent of their predicted FEV₁ were excluded. This study was included because it measured FEV₁ pre and post bronchodilator and calculated an interclass correlation coefficient, giving some indication of repeatability of the pre and post bronchodilator measurements.

There were no studies comparing pre with post BD FEV₁ to classify the severity of COPD.

Evidence summary

Prevalence of COPD: Pre versus post bronchodilator FEV₁

In the PLATINO study⁴³, the prevalence of airway obstruction defined according to FEV₁/FVC < 0.70 was less when FEV₁ was measured post BD than pre BD (17.4% versus 26.2%) in the group at high risk of COPD. In the low risk group, the prevalence of airway obstruction defined according to FEV₁/FVC < 0.70 was also less when FEV₁ was measured post BD than pre BD (8.2% versus 13.8%).

When airway obstruction was defined as FEV₁/FVC < 5th percentile, the prevalence of airway obstruction in the high risk group was lower when FEV₁ was measured post BD versus pre BD (13.8% versus 14.5%); and was also lower in the low risk group (5.6% versus 6.2%).

To discriminate between high and low risk for COPD, the likelihood ratio of pre BD tests to detect FEV₁/FVC < 0.70 was 1.899. The likelihood ratio of post BD tests to detect FEV₁/FVC < 0.70 was higher at 2.122.

To discriminate between high and low risk for COPD, the likelihood ratio of pre BD tests to detect FEV₁/FVC < 5th percentile was 2.339. Again the likelihood ratio was higher for post BD tests at 2.464.

Sensitivity and specificity are not provided by the authors but the likelihood ratio combines both these parameters and provides a direct estimate of how the odds of having a disease will increase with a positive test (or decrease with a negative test).

Reproducibility of measurement: Pre versus Post BD FEV₁

Intraclass correlation coefficient

The mean post-bronchodilator FEV₁ was reproducible between visits (interclass correlation coefficient 0.93). The intraclass correlation coefficient for mean pre-BD FEV₁ was slightly less (interclass correlation coefficient 0.91) compared with post BD FEV₁.⁴⁴

Health economic evidence

No relevant economic analyses were identified that compared COPD diagnosis or severity classification using post-bronchodilator FEV₁ with pre-bronchodilator FEV₁.

Evidence to recommendations

This question looked at evidence relating to pre and post bronchodilator spirometry as stand-alone measurements in terms of confirming a diagnosis of COPD, noting that this is different issue from reversibility testing, which is still not deemed to be a necessary routine diagnostic procedure.

The GDG considered the potential clinical and health economic implications of changes in COPD severity grading if a change is made to use post-bronchodilator spirometry in COPD diagnosis. The potential benefit of using post-bronchodilator FEV₁ to improve accuracy of diagnosis is offset by a small cost implication compared to using pre-bronchodilator FEV₁ since a post-bronchodilator test necessarily takes longer.

The GDG considered that there would, however, be minimal increase in resource use as reversibility testing is currently undertaken to fulfil QOF criteria, and patients do not need detailed observation while awaiting the post-bronchodilator FEV₁ measurement.

COPD (update)

It was noted that the draft National Strategy for COPD makes no recommendation regarding restaging people unless there was a clinical indication.

In terms of quality assessment, it was noted that there are no measurements other than spirometry which have been used to confirm a diagnosis of COPD. Most studies use either pre or post bronchodilator FEV₁ as part of the definition of COPD, making it impossible to assess the independent value of the measurements in diagnosis. Furthermore no studies were found which allowed consideration of sensitivity and specificity.

Data in the PLATINO study⁴³ was from a non-UK population without robust predicted reference values. The data compared pre and post bronchodilator FEV₁ in groups at high and low risk for COPD and showed that post-bronchodilator measurements discriminated slightly better between the two groups. In the second study⁴⁴ post-bronchodilator measurements proved to be slightly more repeatable than pre-bronchodilator measurements, although the GDG noted that over time, between day variation in participant stability is often as important as the between day variation in measurement.

No evidence was found comparing pre FEV₁ and post FEV₁ over time for mortality outcome.

The GDG therefore discussed this question without the benefit of robust evidence, although the limited data available favoured post-bronchodilator values. They agreed to recommend use of post bronchodilator measurement, noting also that this would harmonise with international guidelines, the Quality Outcome Framework, and the National Strategy for COPD.

Evidence was not reviewed for what exactly constitutes a post bronchodilator test (in terms of precise recommendations for performing the test), and no recommendation was felt possible based upon evidence not examined, and with potential health-economic implications.

Finally the GDG noted that virtually all the evidence around treatment recommendations is based upon clinical trials where criteria for entry into the trial were pre bronchodilator measurements, but did not feel that this historical fact should prevent them from recommending the alternative.

6.4.2 Interpreting Spirometry

Clinical introduction

The values for the post-bronchodilator forced expiratory volume in 1 second (FEV₁) and forced vital capacity (FVC) must be compared with the predicted normal values which depend on the individual's age height and sex. Various tables of predicted normal values have been published but the ones most widely used in Europe and most relevant for patients in the UK are those published by the European Coal & Steel Community (ECCS)⁴⁵.

A controversial area of spirometry interpretation relates to whether a fixed ratio or an age dependent lower limit of normal (LLN) should be used to define air flow obstruction.

International GOLD guidelines note that specific spirometric cut-points (e.g., post-bronchodilator FEV₁/FVC ratio < 0.70 or FEV₁ < 80,50, or 30% predicted) are used for purposes of simplicity, but that these cut-points have not been clinically validated^{46,3}. The process of aging affects lung volumes, and the FEV₁/FVC ratio is dependent on age, height and sex, such that the use of a fixed ratio might result in over diagnosis of COPD in older people, and under diagnosis in younger people⁴⁷⁻⁶⁴. It has therefore been proposed that confirmation of obstructive lung disease should be based on an FEV₁/FVC ratio below the LLN, classifying the bottom 5% of the healthy population as abnormal^{45,48,65,66}. In principle, all programmable spirometers could do this calculation if reference equations for the LLN of the ratio were available. However, reference equations using post-bronchodilator FEV₁ and longitudinal studies to validate the use of the LLN are not available and urgently needed⁴⁶.

The GDG felt it appropriate to review the current guideline recommendation noting increasing availability of computerised spirometry and expertise in conducting studies, and the potential impact on accuracy of diagnosis, treatment and costs.

The GDG posed the following question:

DIAG2: In individuals where the diagnosis of COPD is considered and spirometry is conducted, what are the sensitivity and specificity of a fixed ratio FEV₁/FVC compared with the lower limit of normal FEV₁/FVC ratio to diagnose COPD?

Methodological introduction

Four cross-sectional studies^{52,56,67,68} were found that compared FEV₁/FVC ratio (fixed vs. lower limit of normal [LLN]) with a physician's diagnosis of COPD. There is no GRADE profile for diagnostic studies.

In all the studies, the definition of the fixed ratio was from GOLD or equivalent definition (FEV₁/FVC < 70%) and all measurements were post-bronchodilator (except for Celli et al)⁵². The definition of 'physician's diagnosis' in all the studies was based on a self-reported diagnosis of COPD (patients filled in a questionnaire). It is important to note that the results for the physician's diagnosis in the studies probably underestimated the true percentage of patients who had COPD.

Evidence statements

FEV₁/FVC ratio (fixed vs. LLN) vs. physician's diagnosis

The two largest studies^{52,68} showed that FEV₁/FVC (fixed ratio) was most similar to the physician's diagnosis. The two smaller studies^{56 67} showed that the FEV₁/FVC (LLN) was most similar to the physician's diagnosis. (See summary table 6.2).

Celli et al⁵² also showed that for persons aged < 50 years, the LLN produced the highest rate estimates; whereas for persons aged ≥ 55 years, the fixed ratio produced the highest rate estimates. For the older population (aged 75-80 years) GOLD IIA (defined as FEV₁/FVC < 0.70 and FEV₁ < 80% predicted) identified fewer patients than the LLN, and was nearer to the physician's diagnosis. GOLD IIA therefore gave a more conservative estimate. The GOLD Stage IIA definition for all age-groups produced lower estimates than the other definitions (LLN and fixed ratio) and was more similar to the physician diagnosis than the other definitions.

Table 6.2 Summary of studies assessing FEV₁/FVC ratio (fixed vs. LLN) vs. physician's diagnosis

Reference	Patients with diagnosis of COPD			
	N	Physician diagnosis	FEV ₁ /FVC (fixed ratio)	FEV ₁ /FVC (LLN)
Celli et al. ⁵²	9838	77.3 cases/1000 population	167.8 (fixed) 78.7 (fixed, GOLD stage IIA) cases per 1000 population	142.1 cases per 1000 population
Ko et al. ⁶⁷	1008	3.6%	25.9% Poor agreement with physician diagnosis	12.4% Poor agreement with physician diagnosis
Roche et al. ⁶⁸	4764	8.4%	8.7%	6.4% (ERS definition using ECCS equations) 7.96% (ERS definition using study population equations)
Shirtcliffe et al. ⁵⁶	749	10.6%	15.5% Poor agreement with physician diagnosis (K coefficient)	10.4% Poor agreement with physician diagnosis (K coefficient)

Health economic evidence

No relevant economic analyses were identified that compared COPD diagnosis using a fixed ratio FEV₁/FVC compared with the lower limit of normal FEV₁/FVC ratio.

Evidence to recommendations

The GDG noted that papers which compared each of these two spirometric criteria for COPD diagnosis with clinical correlates of COPD varied in use of pre and post bronchodilator spirometry values. There are currently no reference ranges for post bronchodilator values. Physician diagnosis of COPD was limited as a gold standard as current diagnostic criteria include spirometric indices by definition.

One study⁵² showed that use of pre bronchodilator values of FEV₁/FVC ratio < 70% and FEV₁ < 80% predicted derived almost identical sensitivity to use of FEV₁/FVC ratio of < 5% below the LLN. Both criteria produced the same prevalence of COPD but did not necessarily identify the same people.

Diagnosis of COPD by FEV₁/FVC ratio below LLN was considered an attractive option which may in time supersede current practice as a more precise measurement. Currently however, use of LLN was considered impractical due to lack of predictive equations and reference values for post bronchodilator FEV₁ and FVC values.

The GDG noted that the lack of normal ranges for certain ethnic populations could also create diagnostic difficulties which might merit specialist advice being sought. This was a very complicated area for which there were uneven data at the time. The GDG was aware that international research into reference values was ongoing. Whilst these data were awaited, no specific recommendation was made.

Caution was advised regarding the risk of failure to diagnose COPD in some younger people with symptomatic COPD, and the risk of inappropriate management in older people in whom symptoms do not fit the clinical pattern of COPD but in whom spirometry records FEV₁/FVC ratio < 70%. Specialist advice should be sought in such cases, (recommendation U2).

COPD (update)

Recommendations

The current recommendations can be found at www.nice.org.uk/guidance/ng115.

6.5 Differential diagnosis

None of the symptoms discussed above are specific to COPD, and several other disorders may present with similar symptoms, signs and spirometry results (Table 6.3). As well as mimicking COPD these conditions may also coexist in a patient with COPD.

Table 6.3 Conditions presenting with similar symptoms

NB Elderly patients are particularly likely to have a number of concomitant medical problems.

Other conditions that may present with similar symptoms	
Common	Less common
<ul style="list-style-type: none">• asthma• bronchiectasis• congestive cardiac failure• carcinoma of the bronchus	<ul style="list-style-type: none">• obliterative bronchiolitis• bronchopulmonary dysplasia

6.6 Further investigations

As well as spirometry a number of other investigations are helpful in the initial assessment of patients at the time of diagnosis. Further investigations are also indicated in selected patients depending on the clinical findings.

COPD (update)

Recommendations

The current recommendations can be found at www.nice.org.uk/guidance/ng115.

6.7 Reversibility testing

This section was updated in 2010

COPD is defined by the presence of airflow limitation that is “not fully reversible and does not change markedly over several months” (See Section 1.1). The GDG is aware that in the past there have been concerns about both the under and over diagnosis of COPD in the absence of an objective diagnostic test. Traditionally measurement of the degree of reversibility using bronchodilators or corticosteroids has been used to confirm the diagnosis and in particular to try to separate patients with asthma from those with COPD.

In the 2010 update, post-bronchodilator spirometry measurement is recommended in assessment of COPD for reasons discussed in the previous section. This measurement should not be confused with or equated with reversibility testing.

While post-bronchodilator FEV₁/FVC and FEV₁ measurements are recommended for the diagnosis and assessment of severity of COPD, the degree of reversibility of airflow limitation (e.g., change in FEV₁ after bronchodilator or glucocorticosteroids) is not recommended for diagnosis, or for predicting the response to long-term treatment with bronchodilators or glucocorticosteroids^{46,69,70}.

There are many difficulties with this approach. The degree of reversibility that has been regarded as significant was arbitrarily defined and varied from 10% to 20% in different settings. To overcome spurious results in patients with a low FEV₁ a minimum absolute value for the increase (e.g. 200 ml) has also been recommended. In practice, there is considerable variability in the change in FEV₁ in response to the same stimulus from day to day. This makes it virtually impossible to interpret the response to an individual reversibility test unless the response is very large (e.g. an increase in FEV₁ of more than 400 ml).

Reversibility testing was promoted in previous national and international guidelines [BTS⁷¹ & GOLD⁷²], but is not recommended in the latest guidelines produced jointly by the American Thoracic Society and the European Respiratory Society.

The BTS/SIGN⁷³ guidelines on the management of asthma recommend that objective test are used “*to try to*” confirm the diagnosis. In this section they discuss the fact that significant variability in PEF can be used to identify asthma and suggest that a 20% or greater variability in amplitude is highly suggestive. However, they highlight that many patients will show less variability than this and they conclude that the test is “reasonably specific but insensitive”. The guidelines also mention that increases of 15% or 200ml in FEV₁ after inhalation of short-acting beta₂ agonists or oral prednisolone can also be seen in asthma, but these guidelines do not deal specifically with the differentiation of asthma from COPD.

In most cases the diagnosis of COPD is suggested by the combination of the clinical history, signs and baseline spirometry. Reversibility testing does not add any additional information. It is also generally possible to identify patients who have asthma rather than COPD on the basis of the clinical picture and again reversibility testing does not add additional information.

Reversibility testing has also been advocated as a means of identifying the most appropriate therapies for individual patients. There is now evidence that the clinical response to bronchodilators or inhaled corticosteroids cannot be predicted by response to a reversibility test.

Evidence statements

There is considerable variation in the magnitude of change in FEV₁ following inhalation of a bronchodilator between individuals and within individuals tested on different days ^{44,74}. IIb

A number of different methods for assessing the response to bronchodilators have been proposed ⁷⁵⁻⁷⁸. IIb

IIb

Ib

IIb

A change in FEV₁ of at least 160 ml is required to exclude changes within the natural variability in of FEV₁ in people with obstructive ventilatory defects ⁷⁹. IIb

A study of patients with fixed airflow obstruction diagnosed as having COPD or asthma on the basis of the clinical history⁸⁰ has shown that the clinical diagnosis was correct as assessed by the basis of the pattern of inflammation seen on bronchial biopsies and the differential cell counts in induced sputum findings. Reversibility testing was unable to differentiate the two groups. III

Bronchodilator tests performed with different inspiratory manoeuvres before and after bronchodilator administration provide differing results⁸¹. IIb

The response to a short course of oral steroids does not predict the response to long-term therapy ⁸². Ib

COPD (update)

Recommendations

The current recommendations can be found at www.nice.org.uk/guidance/ng115.

6.8 Assessment of severity and prognostic factors

6.8.1 Multidimensional assessment

This section was updated and replaced in 2018. See www.nice.org.uk/guidance/ng115/evidence for the 2018 evidence reviews.

6.9 Assessment and classification of severity of airflow obstruction

This section was updated in 2010

Although the categorisation of impairment of airflow obstruction was not part of a specific question for review, the GDG felt it important that health care professionals who look after people with COPD should be aware that a number of different classifications were being used by various international guideline groups (see section 6.9, table 6.7). The GDG was aware that the forthcoming National Strategy for COPD would be referring to GOLD stages. The GDG felt the NICE 2010 categorisation of airflow obstruction should align with GOLD spirometric cut-offs in line with international consensus.

It was felt important to emphasise that the severity of COPD from a clinical patient perspective depended upon far more than the degree of impairment of spirometry (e.g. symptoms of breathlessness, exercise limitation, frequency of exacerbations) and that more attention should be paid to the multidimensional assessment of impairment in COPD (see section 6.8.1) than to purely categorising disease severity in terms of lung function impairment.

The GDG considered that the clinical diagnosis of COPD in people with mild airflow obstruction ($FEV_1 \geq 80\%$ predicted) should require the presence of respiratory symptoms as symptomatic but not asymptomatic GOLD stage 1 COPD has been associated with faster decline in FEV_1 , increased respiratory care utilisation and a lower quality of life compared with people with normal lung function¹⁰⁴. This expands the NICE 2004 definition of airflow obstruction to include the group of people with an $FEV_1 \geq 80\%$ predicted (with an FEV_1/FVC ratio < 0.7). It also expands the clinical diagnosis of COPD to include patients in this mild airflow obstruction group who are also symptomatic.

It was also noted that all of the new recommendations relating to drug treatment in this guideline update made reference to FEV_1 being above or below 50% and made no mention of GOLD stages or the terms mild, moderate or severe.

The GDG was conscious of the potential economic impact of this change but felt that in people with mild COPD the primary course of action would be to encourage smoking cessation which is known to cost-effective even in those without COPD. As other treatments are provided in response to symptoms, which will generally be less in patients with less severe disease, it was considered that the impact would be likely to be modest in relation to the potential benefits conferred by encouraging smoking cessation earlier.

6.10 Identification of early disease

In the early stages airflow limitation may be present without producing symptoms. Even if it does produce symptoms, such as breathlessness on exertion or chronic cough, these may not be recognised as being abnormal by the individual. Smoking cessation has the most to offer such patients as it slows the rate of decline in lung function.

COPD (update)

See section 2 for the methodology underpinning the evidence statements.

Evidence statements

COPD can be present in the absence of symptoms ¹¹ .	III
COPD can be detected by opportunistic case finding in primary care ^{4,106} and in patients aged 65 and over discharged from hospital.	III
Opportunistic case finding has a high uptake, reaches most of the target group and has a high yield ⁴ .	III
In a study of opportunistic case finding Van Schayck et al. found that 27% of patients who were aged over 35 years, were current or ex-smokers and had a chronic cough had reduced FEV ₁ ¹⁰⁷ .	III
Early diagnosis of abnormal lung function as part of a motivational package, significantly affects the success of smoking cessation therapy ^{108,109} .	Ib

GDG consensus statements

Opportunistic case finding should be based on the presence of risk factors (age and smoking) and symptoms. The diagnosis should be confirmed using spirometry.	IV
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Health economics

The GDG was interested in the cost effectiveness of opportunistic case finding using spirometry linked to smoking cessation therapy. They were interested in whether the extra resources involved in testing for airflow obstruction and the subsequent intervention of smoking cessation was worth the additional expected benefits. A simple cost effectiveness model was therefore built to look at this issue. This is discussed in detail in appendix B.

In summary, the model showed that opportunistic case finding in primary care is a relatively cost effective strategy. Key parameters are the prevalence of undetected COPD and the smoking cessation success rate. It should be noted that the model is quite sensitive to some of the parameters and the results must be interpreted with this in mind.

Recommendations

The current recommendations can be found at www.nice.org.uk/guidance/ng115.

6.11 Referral for specialist advice

A specialist opinion may be helpful at any stage of the disease. Referral may be to establish the diagnosis, to exclude other pathology, to reassure the patient, to reinforce the need to stop smoking, to optimise treatment, or to assess the need for the more complex and expensive therapies appropriate to severe COPD. The principal reasons are based upon original work from the BTS Statement¹¹¹ and have been augmented with consensus from the COPD Guideline Development Group. See section 2 for the methodology underpinning this section. The reasons for referral for specialist advice are summarised below:

Recommendations

The current recommendations can be found at www.nice.org.uk/guidance/ng115.

Please note that this area has been reviewed in 2018, please follow the link on the front page for the evidence review.

7 Managing stable COPD

7.1 Introduction

COPD is a heterogeneous disease that affects different patients in different ways. Some patients may be more troubled by breathlessness, others may develop ankle swelling and others may be experiencing frequent hospital admissions. The management of an individual patient's disease should be guided by the symptoms and disability that they experience. At different times in the natural history of their disease different features may predominate and their management will change to reflect this. COPD also has effects outside the lung for example on peripheral muscles and may lead to mood or cognitive changes which should also be assessed.

This section presents statements and recommendations about the efficacy and role of therapies in stable COPD. Section 8 presents statements and recommendations about the efficacy and role of therapies in managing exacerbations of COPD.

The assessment of a patient's symptoms should take into account the presence of the symptoms listed in section 6.2, the clinical signs listed in section 6.3, the results of spirometry and the frequency of exacerbations. Using the algorithm in section 5.2, the results of the assessment can be used to identify therapies that are appropriate for that individual at that time.

7.2 Smoking cessation

Getting patients with COPD to stop smoking is one of the single most important interventions. Stopping smoking slows the rate of decline in FEV₁ with consequent benefits in terms of progression of symptoms and survival.

The GDG reviewed the smoking cessation evidence for both pharmacological and non-pharmacological approaches as they related specifically to COPD. Studies were rejected either because they were non-specific to COPD or due to small sample size.

One Cochrane systematic review by van der Meer et al was identified¹¹² which was specific to chronic obstructive pulmonary disease and contained five studies¹¹³⁻¹¹⁷. The review authors highlighted that only two of the five studies were of high quality and hence these were reviewed on an individual basis^{113,117}. An additional two trials were identified^{118 119} and one NICE Technology Appraisal⁵³ met our quality appraisal criteria. Three studies^{113,118,119} were all part of the Lung Health Study.

The guideline remit was to consider smoking cessation approaches as they relate specifically to COPD. However the project Scope also highlighted that the NICE Technology Appraisal on "Smoking cessation treatments and nicotine replacement therapy", which is non-specific to COPD, should inform the COPD guideline.

Since the publication of the original guideline in February 2004, NICE has:

Published PH10 – Smoking cessation services in primary care, pharmacies, local authorities and workplaces, particularly for manual working groups, pregnant women and hard to reach communities

Published TA123 Smoking cessation – varenicline

Replaced TA39 Smoking cessation – bupropion and nicotine replacement therapy with PH10

7.2.1 Benefits of stopping smoking

Evidence statements

The Lung Health Study showed that participants in the two smoking intervention groups showed significantly smaller declines in **FEV₁** than did those in the control group. Average decreases from baseline to 5 years were 267ml for the control group, 209ml for the smoking intervention group without study bronchodilator and 184ml with study bronchodilator. (p<0.002)^{118,113} lb

Kanner, as part of the Lung Health Study evaluated the effects on **symptoms** of chronic cough, chronic phlegm production, wheezing and shortness of breath. The prevalence of each of the four symptoms in the two intervention groups was significantly less than in the usual care group (p<0.0001). Smokers with early COPD who were assigned to a smoking cessation intervention had fewer respiratory symptoms after 5 years of follow-up ¹¹⁹. lb

7.2.2 Smoking cessation therapy

Tashkin investigated the effect of sustained release **bupropion** compared to placebo in promoting abstinence from smoking in patients with mild to moderate COPD. This study specifically focused on a COPD population ¹¹⁷. lb

Continuous smoking abstinence rates from wk 4 to 7 were significantly higher in participants receiving bupropion than those receiving placebo (28% vs. 16%, p=0.003). Weeks 4 to 12 (18% vs. 10%) and weeks 4 to 26 (16% vs. 9%) smoking cessation was also higher in participants receiving bupropion than those taking placebo (p<0.05).

The National Institute of Health and Clinical Excellence guidance focuses on pharmacological approaches (nicotine replacement therapy and bupropion) to smoking cessation (although not specifically COPD)¹²⁰⁵³. NICE

Nicotine Replacement Therapy (NRT)

There is currently insufficient evidence to conclude that one form of NRT is more effective than another. In the small number of studies

COPD (update)

undertaken with specific subgroups (pulmonary disease) results were generally inconclusive on an individual study basis, but in aggregate were consistent with the overall pooled results.

Bupropion

From a meta-analysis of ten RCTs the odds ratio for smoking cessation of bupropion vs. placebo was 2.16 (1.51 to 3.10) for 6 and 12 months. In terms of percentages of smokers quitting, the average over all trials shows that about 9% had not smoked for the 12 months following placebo therapy and about 19% had not smoked following bupropion therapy. The results for specific subgroups (pulmonary disease) were generally consistent with the overall pooled results. *Bupropion should be used in conjunction with appropriate support.*

Bupropion vs. NRT

There have been only two RCTs of bupropion vs. nicotine replacement therapy. For bupropion vs. patch, the odds ratio at 12 months for continuous abstinence was 2.07 (1.22 to 3.53) in favour of bupropion, and for bupropion plus patch versus bupropion it was 1.28 (0.82 to 1.99). In the second study, which compared bupropion to NRT gum, there was no significant difference between the groups in quit rates.

Combination of NRT and bupropion

In the single study so far conducted, the result was in favour of the combination of NRT and bupropion against bupropion alone, but the difference was not statistically significant.

Health Economic Evidence

A HTA report ¹²¹ contains a review of the economic evidence of smoking cessation interventions in the UK and a decision analytic model built by the authors. Although all of this is for smoking cessation in general and not specific to COPD, most of the literature and the model suggest that smoking cessation is a reasonably cost effective intervention.

Smoking cessation interventions, including the use of nicotine replacement therapy and/or bupropion SR are relatively cost effective in terms of the of the cost per life year saved.¹²¹

Recommendations

The current recommendations can be found at www.nice.org.uk/guidance/ng115.

7.3 Inhaled therapy

Although COPD is characterised by substantially irreversible airflow obstruction, bronchodilators have been the mainstay of pharmacotherapy^{71,123}. The structural changes in the airways prevent bronchodilators returning airway calibre to normal. Clinically relevant improvements in FEV₁ may be too small to identify against the background day to day variation in an individual patient. Inhaled agents are preferred to oral because of the reduction in systemic side effects. Beta₂ agonists act directly on bronchial smooth muscle to cause bronchodilation whereas anticholinergics act by inhibiting resting broncho-motor tone. As well as improving breathlessness through their direct bronchodilator effects, both classes of drugs also appear to work by reducing hyperinflation (both static and dynamic). This probably explains why clinical benefits may be seen without clear changes in the FEV₁.

7.3.1 Short-acting beta₂ agonists (SABA)

Beta₂ agonists act directly on bronchial smooth muscle to cause bronchodilation. They are the most widely used bronchodilators for COPD. The dose response relationship for salbutamol in patients with largely or completely irreversible COPD is almost flat^{124,125}. The time to peak response is slower than in patients with asthma and the side-effect to benefits ratio is such that there is little benefit in giving more than 1 mg salbutamol. Their effects on airway calibre last for up to 4 hours and can be used on a regular, or as required, basis. Short-acting beta₂ agonists are the most commonly used short-acting bronchodilators in COPD.

One systematic review was found looking at their efficacy¹²⁶. The review comprised of 13 RCTs¹²⁷⁻¹³⁹, however 4 of these were from the same cohort of patients^{128-130,132}. All the RCTs were of a crossover design and had variable washout periods, 7 being undocumented whilst the rest ranged from washout periods of 10 hours to 2 weeks. The majority of evidence for short-acting beta₂ agonist comes from older (date range 1975 to 1991), short-term (1 to 8 weeks duration), small studies (sample size range N=5 to N=48), some of which used older compounds (interventions included isoproterenol, metaproterenol, salbutamol and terbutaline)⁵⁷.

The 2010 partial update did **not** update the section on short-acting beta₂ agonists compared with placebo.

Evidence statements

SABA versus placebo

la

Daily **breathlessness** scores were reduced with the use of short-acting beta₂ agonists (SMD 1.33, 95% CI 1.01 to 1.65, p<0.0001)¹²⁶.

One study¹²⁸ measured the effects of short-acting beta₂ agonist changes on **health related quality of life**. This study was included in the

lb

systematic review referred to above¹²⁶ however the data was not available for meta-analysis, N=32. The study showed significant improvements in the dyspnoea (p=0.003) and fatigue (p=0.0003) domains using the Chronic Respiratory Disease Questionnaire (CRQ).

Short-acting beta₂ agonists improve **FEV₁** (WMD 0.140 L, 95% CI 0.04 to 0.25, p=0.008)¹²⁶. la

Short-acting beta₂ agonists appear to be as effective when used on an **as needed basis** as when used regularly on a background of other bronchodilators¹⁴⁰. lb

7.3.2 Short-acting beta₂ agonists (SABA) and short-acting muscarinic antagonists (SAMA)

Cholinergic nerves are the main neural bronchoconstrictor pathway in the airways and the resting tone is increased in patients with COPD ¹⁴¹. Anticholinergic drugs cause bronchodilatation by blocking this bronchoconstrictor effect. Cholinergic effects on the airway are mediated by muscarinic receptors and these also mediate effects on mucus secretion.

Anticholinergic drugs are also referred to as muscarinic antagonists (e.g. short-acting muscarinic antagonist (SAMA)).

There were no systematic reviews comparing short-acting anticholinergics in comparison to placebo or other bronchodilating drugs. In view of the availability of data from longer term studies several trials were rejected due to small sample size ¹⁴²⁻¹⁴⁴ or short trial duration ¹⁴⁵. Four trials ¹⁴⁶⁻¹⁴⁹ had methodological limitations, which precluded making recommendations based upon the papers findings. Trials also used a variety of differing endpoint outcome measures.

The 2010 partial update did **not** update the section on short-acting anticholinergics compared with placebo.

Evidence statements

SAMA versus placebo

Three studies ¹⁵⁰⁻¹⁵² demonstrated significant increases in **FEV₁** with the use of short-acting anticholinergic drugs when compared to placebo, p<0.001, p<0.026 and p<0.001 respectively. Ib

One study ¹⁵² found that **dyspnoea** measured by the Transition Dyspnoea Index (TDI) was significantly improved with short-acting anticholinergics compared to placebo. Ib

Two other studies found no significant differences for **symptoms** ¹⁵¹ or **dyspnoea** ¹⁵⁰ or **walking distance** ¹⁵⁰ with the use of short-acting anticholinergics compared to placebo. Ib

One study ¹⁵² found that health related **quality of life** (measured using the Chronic Respiratory Disease Questionnaire (CRDQ)) was significantly higher for short-acting anticholinergics compared to placebo (p=0.007). Ib

Two studies ^{150,151} found no significant differences between short-acting anticholinergics and placebo groups for **quality of life**. Ib

Three studies looked at the need for **rescue medication** ¹⁵⁰⁻¹⁵². Two trials ^{150,152} found a decrease in use of rescue medication, p<0.047 ¹⁵². One study ¹⁵¹ found no significant difference in use of rescue medication use when using short-acting anticholinergic compared to placebo. Ib

Recommendation

The current recommendations can be found at www.nice.org.uk/guidance/ng115.

7.3.3 Long-acting beta₂ agonists (LABA)

This section was updated and replaced in 2018. See www.nice.org.uk/guidance/ng115/evidence for the 2018 evidence reviews.

7.3.4 Long-acting anticholinergics (long-acting muscarinic antagonists or LAMA)

This section was updated and replaced in 2018. See www.nice.org.uk/guidance/ng115/evidence for the 2018 evidence reviews

7.3.5 Inhaled corticosteroids (ICS)

This section was updated and replaced in 2018. See www.nice.org.uk/guidance/ng115/evidence for the 2018 evidence reviews

7.3.6 Inhaled combination therapy

This section was updated and replaced in 2018. See www.nice.org.uk/guidance/ng115/evidence for the 2018 evidence reviews

7.3.7 Delivery systems used to treat patients with stable COPD

The devices used to deliver drugs to the lungs are, in many respects, as important as the drugs themselves. If the device is inefficient at delivering the drugs to the lungs or is difficult for patients to learn, or remember how to use then the effectiveness of the therapy will be reduced. This is a difficult area to conduct blinded studies in because the identity of the device cannot be concealed from patients and there are no standardised validated tools that can be used to assess ease of use or patient preference.

One Health Technology Assessment was found²²⁵, one systematic review²²⁶ two additional RCTs^{227,228} and one prospective study²²⁹ that compared nebulisers, patient administered metered dose inhalers (pMDI) and or dry powered inhaler (DPI). Devices were all used to administer bronchodilators or saline placebo. The study by O'Driscoll et al.²²⁹ was excluded due to methodological limitations.

Factors for consideration within this topic included small sample sizes (range of N=7 to N=47)²²⁹, studies vary across settings (domiciliary, laboratory or clinic) raising the question of generalisability, duration of studies is extremely variable from 2 hours to 2 weeks, variable training in the use of devices (some devices require more manipulation and dexterity than others and hence may not be as user friendly in an elderly population), variable dropout rates, and differing drug doses in application to assessing clinical efficacy. Many of the studies were of a cross over design with variable washout periods (2 to 7 days) and variable age ranges (44 to 72 years)²²⁶.

The recent BTS/SIGN guidelines for asthma⁷³ have also examined the evidence concerning the comparative effectiveness of different inhaler devices. They make several important observations about methodological difficulties with the evidence in this area:

- Studies comparing different inhaler devices recruit participants who are competent using the devices involved. This is very unlike clinical practice where a patient's abilities may vary markedly between devices.
- Some studies of inhaler devices are of parallel design and some crossover. The data in these two types of studies are often not easy to combine in a meta-analysis. (This statement refers to evidence derived from the HTA²²⁵ in which parallel and crossover studies were not combined). In addition, crossover studies may not allow a suitable washout period for drugs with a longer duration of action.
- Many studies use doses of medication at the upper end of the prescribing range. This may bias towards an underestimate of difference between inhalers, if one exists.
- Clinical trials tend to recruit patients with more stable and less severe disease. Whilst this may reflect the bulk of clinical practice it does make observation of a significant difference, especially with less frequently occurring outcomes, less likely, particularly in smaller studies, so a real difference may be missed.
- Studies of novel new inhaler devices are highly likely to be prone to bias when preference is expressed. Many inhaler device studies are designed with a null hypothesis of bio-equivalence to show the new is as good as the older, established comparator. These studies may be underpowered to detect differences, if they exist.

- Although most medications are available in the pressurised Metered Dose Inhaler (pMDI) the choice of Dry Powder Inhaler (DPI) will be determined by the choice of medication, as not all devices are available to deliver all drugs.
- The recommendations are often based on a comparison of pMDI with other devices as most of the available evidence comes from trials making the comparison between newer devices and the longer established pMDI.

It is perhaps surprising that assessment of inhaler technique is so often neglected, both in individual patient terms and in terms of Phase 3 trials that include newly designed inhaler devices. Most patients whatever their age are able to acquire and maintain adequate inhaler technique given adequate instruction. The exception to this is that those with significant cognitive impairment (as a guideline, those with a Hodkinson Abbreviated Mental Test Score of 4 or less) are unable to use any form of inhaler device^{230,231}. In most patients however, a pragmatic approach guided by individual patient assessment is needed in choosing a device. It is also important to recognise that retention of inhaler technique is as important as its acquisition and many elderly patients who successfully acquire adequate technique with a particular device will demonstrate inadequate technique when assessed a month later²³². Regular reassessment and reinstruction is therefore essential, and this may explain why patients first prescribed inhalers in hospital have better technique than those first prescribed inhalers in primary care²³³.

The standard metered dose inhaler (MDI), when used in isolation (i.e. without a large-volume spacer device) is rarely appropriate for elderly patients. Elderly patients are slower to learn adequate technique, many never acquire adequate technique, and those that do frequently fail to retain their knowledge when reassessed a month later^{230,232-234}. The MDI is particularly difficult for those with impaired handgrip strength (common in those with arthritic conditions)²³⁴. The addition of a large-volume spacer improves both acquisition and retention of technique²³² and allows carers to assist with technique for those patients with cognitive impairment or physical disabilities affecting hand function. Large volume spacers have also been shown to reduce systemic absorption of inhaled corticosteroids²³⁵.

The problems elderly patients have with MDIs have been recognised by the pharmaceutical industry with a resulting plethora of newer 'patient friendly' devices (including breath-activated devices) developed over recent years. Unfortunately very few of these devices have been formally assessed in elderly patients. It is generally the case that breath actuated devices, such as the Turbohaler and Autohaler, are easier for an elderly person to use^{236,237}, but more data is needed on the retention of technique. There will however, always be a few patients who seem unable to acquire inhaler technique with any device. This may be due to praxis problems (dyspraxia) or to previously unrecognised cognitive impairment. They have

further suggested that inability to acquire adequate technique in an elderly person should prompt screening for cognitive dysfunction^{237,238}.

Nebulised therapy involves the generation of respirable aqueous particles in a nebuliser chamber. The generation of the particles usually depends on compressed gas delivered from a cylinder or more commonly a compressor. The performance of both nebuliser chambers and compressors varies considerably and this can effect drug deposition and the efficacy of the therapy. European standards for nebuliser performance have been drawn up by the European Committee for Standardization (CEN) (EN 13544-1:2001) (www.cenorm.be) and manufacturers will be required to indicate if their products comply with these.

Nebulisers should not be seen as a panacea for those few patients unable to acquire and/or retain adequate inhaler technique. Nebuliser loading and operation requires manipulative and cognitive skill, and if lack of such skill is responsible for inadequate technique with inhaler devices it is likely that this may also be the case with a nebuliser. Nebulisers, like large volume spacers, do however have the advantage that carers can be trained in their use and provide useful support²³⁹.

Recommendations on the use of nebulisers have been produced by the BTS²⁴⁰ and the ERS²⁴¹ and these have informed some of the recommendations.

Evidence statements

The systematic review²²⁶ compared pMDI with any other handheld inhaler device. The Turbohaler vs. pMDI²⁴² (N=15) and Rotohaler vs. pMDI²⁴³ (N=10) showed no significant differences in **any outcome**. However, the study²⁴⁴ contained within the systematic review referred to above, using the Respimat vs. pMDI, (N=36, open label) showed significant increases in **FEV₁** (difference in change from baseline 70ml, 95% CI; 10 to 130 ml). Respimat is unlicensed in the UK. The effect on change in **FVC** was of similar size. There were no differences observed between these two devices for any other reported outcomes.

la

COPD (update)

Using **FEV₁** as a primary outcome, there is no clinical benefit of using nebulised medication in addition to or as an alternative to a pMDI, with or without a spacer, or a DPI in stable COPD¹⁴⁹. Ia

Cuvelier et al.²²⁷ (DPI and MDI) and Eiser et al.²²⁸ (MDI with a spacer vs. larger nebulised doses) found no significant differences between the two groups. Ib

Handling of DPI was considered easier than the MDI (p=0.014) and the DPI was preferred to the MDI (p<0.001)²²⁷. Ib

Patient **ease-of-use** scores and **preference** scores were significantly better for the DPI (p=0.014 and p <0.001) respectively and 56% of patients considered the DPI easier to use than the MDI²²⁷. Ib

There were no significant differences in **quality of life** scores from the St George's questionnaires and the HAD scores²²⁸. Ib

GDG consensus statements

There is no evidence to dictate an order in which devices should be tested for those patients who cannot use pMDI. In the absence of evidence, the most important points to consider are patient preference and local cost. IV

Cognitive function and praxis are more important than age in determining the ability of an older patient to use hand held inhalers or nebulisers. IV

COPD (update)

Older patients often soon forget correct inhaler technique. IV

Patients experiencing difficulties using hand held inhalers may also have difficulty using nebulisers. IV

Not all drugs are available in a formulation that can be used in a nebuliser. IV

Regular use of nebulised therapy involves considerable time and may impair patient's ability to undertake other activities and inhibit their ability to leave their home. IV

Regular use of high doses of bronchodilators via a nebuliser may produce significant side effects (e.g. tachycardia and tremor). IV

Nebulised bronchodilator therapy may lead to significant improvements in symptoms, exercise capacity or quality of life which are not reflected in changes in FEV₁. IV

Acute changes in lung function are not the most appropriate means of assessing the benefits of nebulised therapy. IV

COPD (update)

Recommendations about Inhalers

The current recommendations can be found at www.nice.org.uk/guidance/ng115.

Recommendations about spacers

The current recommendations can be found at www.nice.org.uk/guidance/ng115

Recommendations about nebulisers

The current recommendations can be found at www.nice.org.uk/guidance/ng115.

7.4 Oral therapy

7.4.1 Oral corticosteroids

There is little evidence that inhaled steroids have any effects on the inflammatory cells present in COPD: neutrophils, unlike eosinophils are relatively insensitive to the effects of steroids. Even high doses of inhaled steroids do not reduce the number of inflammatory cells or the levels of cytokines^{179,180}. Currently up to 70% of patients with COPD are prescribed an inhaled steroid and approximately 5% are prescribed oral steroids^{33 181}. The rationale for this is unclear and at least some of this prescribing may have been based on an extrapolation from the effects of these drugs in asthma and their effects at the time of an exacerbation.

One meta-analysis that included ten trials was found that compared oral steroids to placebo²⁴⁵. The primary outcome measure was FEV₁.

COPD (update)

In addition to the trials included in the meta-analysis, two RCTs were identified both of which are of a crossover design and compare oral steroids to placebo^{246,247}. A further two RCTs^{248,249} were excluded due to methodological limitations.

Factors for consideration within this topic include:

- sample size between trials varies (ranging from N=18 to N=168).
- trial follow-up periods vary (ranging from 2 weeks to 6 weeks) and hence data is available for acute, short-term studies only.
- the trials vary as to whether or not they use washout periods.
- a variety of different steroid drugs and dosages are used.
- geographical locations vary.

It is important to note that all of the studies of suitable methodological quality are focused upon the short-term effects relating to FEV₁. No long-term studies were identified. Hence the effects of sustained oral steroid therapy on FEV₁ and the potential long-term side effects of sustained therapy have not been established.

GDG consensus statements

There are no published studies that establish which, if any, patients benefit from long term oral steroid therapy. IV

The GDG is aware that there are a small group of patients who experience frequent exacerbations and/or severe breathlessness for whom long term oral steroid therapy is the only pragmatic way of managing them. IV

The RCP guidelines²⁵⁰ on steroid-induced osteoporosis advise commencing prophylactic treatment without further monitoring or assessment in patients over the age of 65 who are starting long-term corticosteroid treatment. IV

Recommendations

The current recommendations can be found at www.nice.org.uk/guidance/ng115

7.4.2 Oral theophylline

Theophylline and its derivatives have been used for many years to treat patients with COPD. The mechanism of action of these drugs remains uncertain²⁵¹ but it is generally assumed that they relax airway smooth muscle. Theophylline may also increase diaphragmatic strength in patients with COPD²⁵² and have effects on mucociliary clearance²⁵³. It also has extra pulmonary effects, particularly improvement in cardiac output²⁵⁴ that may also be beneficial in patients with COPD. Because of potential toxicity and significant interactions with other drugs^{255 256} theophylline is no longer considered initial empirical treatment. When reference is made to theophylline it is to the long-acting/slow release formulations, unless otherwise stated.

One systematic review was found²⁵⁷, which looked at oral theophylline compared to placebo in patients with stable COPD. Twenty worldwide RCTs of a cross over design were included in the systematic review with a total sample size of N=480. Study durations ranged from 7 to 90 days. All but two of the studies were double blind and none were open label studies (see comments pertaining to Rossi et al 2002 below). Eleven studies did not describe the washout periods and as such this means that there may be possible contamination. This

may have resulted in a possible over estimation of the carry over effects of theophylline within the placebo group. Concomitant therapy varied from none to any other bronchodilator plus corticosteroid. Ages ranged from 59 to 69 years.

One additional study by Rossi et al (2002)¹⁶³ was identified, which compared formoterol, theophylline and placebo arms within the same study (N=854, of which N=122 placebo and N=209 theophylline group) over a 12-month duration. However the study was limited by the fact that the slow release theophylline arm was open label and hence both the physicians and participants were aware of the drug intervention. The authors state their rationale as *“the required dose titration of oral slow release theophylline made blinding impossible and it was therefore administered at individualised doses on the basis of plasma concentrations in an open-label fashion”*. This may have been underpinned by an ethics committee requirement however this is not stated. As this is a recently published study this may be a significant difference in the way in which study designs for this particular drug are now conducted compared to the date spans contained within the systematic review²⁵⁷ when the dates range from 1979 to 1995. Rossi et al. ¹⁶³ acknowledge this limitation and highlight that importantly *“the unblinded nature of the theophylline arm might have contributed to the very high dropout rate associated with the treatment”*. Total discontinuation rates were quoted as formoterol (12 µg) 25%, formoterol (24 µg) 19%, placebo 27% and theophylline 39% ¹⁶³.

This study illustrates the difficulty of undertaking a placebo-controlled double blind trial of the efficacy of theophylline. The need to balance achieving adequate, but not toxic therapeutic levels conflicts with the blinding of the investigators and patients. Early studies did not address this.

The trials cited above did not look at the therapeutic range for theophyllines.

Evidence statements

There was a statistically significant improvement in **FEV₁** and **FVC** in favour of the theophylline group compared to placebo. FEV₁ WMD 100ml; 95% CI; 40 to 160 ml. FVC WMD 210ml; 95% CI; 100 to 320 ml²⁵⁷.

la

Theophylline was also significantly more effective at increasing **FEV₁** than placebo at every time point and for each visit (all p < 0.005) in the study by Rossi et al.¹⁶³ and the difference was clinically relevant at 5,7,8,10,11 and 12 hours.

lb

There was a statistically significant improvement in oxygen uptake (**VO₂ max**) in favour of the treatment group. WMD 195 ml/min; 95% CI; 113 to 278 ml/min. Two studies (Fink 1994 and Newman 1994 with a sample size of N=32)^{258,259} contributed to the data²⁵⁷.

la

There was a statistically significant improvement in **PaO₂** with treatment. WMD 3.18 mmHg; 95% CI; 1.23 to 5.13 mmHg²⁵⁷.

la

There was a statistically significant decrease in **PaCO₂** with theophylline compared to placebo. WMD -2.36 mmHg; 95% CI -3.52 to -1.21 mmHg²⁵⁷.

la

Participants **preferred** theophylline to placebo. RR 2.27; 95% CI 1.26 to 4.11. Authors acknowledge an error in the text describing the data for this outcome but confirm that the results and meta view are correct as they stand. Two studies (Alexander²⁶⁰ N=40 and Mulloy²⁶¹ N=10) contribute to this data²⁵⁷.

la

Nausea was experienced more often in the theophylline

la

COPD (update)

group compared to the placebo (RR 7.67; 95%CI; 1.5 to 39.9)²⁵⁷.

There were no statistically significant differences for **distance walked**, VAS for **breathlessness**, symptoms of **wheeze** and **dyspnoea**, **exacerbations** or dropouts²⁵⁷. la

There were no statistically significant differences between the treatment groups for total **diary symptom scores** or **use of rescue medication**¹⁶³. lb

No data was available for **health status** or **mortality**²⁵⁷. la

There were fewer “moderate” and “severe” **exacerbations** over 12 months in patients treated with theophylline compared to placebo (5% v 8% (p =0.019) and 6 v 20) in an open label designed study¹⁶³. lb

Statistically significant improvements in the total **SGRQ** score over 12 months (compared to baseline) were seen for theophylline compared to placebo in an open label designed study (p=0.013)¹⁶³. lb

GDG consensus statements

The plasma levels of theophylline must be monitored to ensure that they are adequate but do not reach the toxic range²⁵⁶. IV

Although these drugs are effective, their usefulness is limited by the need to monitor plasma levels and their potential for IV

COPD (update)

interaction with other medication.

The need to monitor plasma levels and the potential for interaction with other medication restricts the therapeutic use of theophylline and its derivatives to patients who have already tried long-acting bronchodilators or who are unable to use inhaled therapy.

IV

Recommendations

The current recommendations can be found at www.nice.org.uk/guidance/ng115

7.4.3 Oral phosphodiesterase type 4 inhibitors

Only one RCT published to date was found pertaining to a phosphodiesterase-4 inhibitor (Cilomilast) compared to placebo for the treatment of COPD over a 6-week duration²⁶². Ages ranged from 40 to 80 years and with the exception of short-acting beta₂ agonists and anticholinergic agents, all other COPD medications were discontinued. The GDG felt that there was insufficient long-term data on which to base any evidence statements or recommendations.

7.4.4 Oral mucolytics

This section was updated in 2010

Many patients with COPD cough up sputum³. Mucolytics are agents which are believed to increase the expectoration of sputum by reducing its viscosity. Some of these drugs, particularly N-acetylcysteine, may also have antioxidant effects which may contribute to their clinical effects.

In some European countries mucolytics are widely prescribed in the belief that they reduce the frequency of exacerbations and / or reduce symptoms in patients with chronic bronchitis. In contrast, in the U.K. mucolytics have not been recommended in previous guidelines and until recently were black listed and could not be prescribed on the NHS.

Clinical introduction

A recent upsurge in mucolytic use has followed the publication of the above studies and NICE guidelines 2004. Nevertheless practitioners are often unsure when mucolytics should be used. The current recommendations state that “mucolytics should be considered if there is chronic cough productive of sputum, and should be continued if there is symptomatic improvement”. There is no recommendation for their use in preventing exacerbations. Two new studies and an updated systematic review have been conducted since the NICE 2004 guidance²⁶³⁻²⁶⁵.

The GDG agreed to revisit this question principally to investigate whether to add a recommendation on the use of mucolytics in the prevention of exacerbations and hospitalisations; some practitioners have advocated their use for this indication.

COPD (update)

The question posed by the GDG was:

MUCO: What is the clinical and cost effectiveness of mucolytic agents vs. placebo in people with stable COPD?

Methodological introduction

The literature was searched from 2003 onwards for systematic reviews or RCTs comparing oral mucolytic therapy (Carbosysteine, Erdosteine, or N-acetylcysteine) with placebo in people with COPD. RCTs with less than six months follow-up were excluded. Outcomes of interest included all-cause mortality, exacerbations, hospitalisations, decline in FEV₁, change in health related quality of life (measured with total SGRQ score), change in breathlessness (measured with TDI), and adverse events. The clinically important relative risk reduction (RRR) for mortality was 15%, exacerbations (20%), hospitalisation (20%), change in SGRQ (-4 points), FEV₁ (100 ml), and TDI (1 unit).

One systematic review²⁶⁶ was updated with three additional RCTs^{263 264 267} that compared mucolytic therapy with placebo in people with COPD. Studies with less than six months follow-up were removed from the meta-analysis in the Poole et al systematic review.

The double blind RCT of Schermer et al²⁶⁷ randomised people with COPD or chronic bronchitis (N=192; 3 year follow-up) to either placebo or N-acetyl cysteine (600 mg/once daily).

In the double blind PEACE RCT²⁶⁴ people with COPD (N=707; 1 year follow-up) were randomised to either placebo or carbocisteine (2x250 mg/3 times daily). In the PEACE study, there was low use of inhaled corticosteroids, beta₂ agonists, or anticholinergics in each arm.

The single blind RCT of Bachh et al randomised people with COPD (N=100; follow-up 1 year) to either placebo or N-acetyl cysteine (600 mg/once daily) for 4 months.²⁶³ The Bacch et al RCT was considered to be low quality as it had unclear allocation concealment, and no detail for loss to follow-up or whether intention to treat analysis was performed.

The evidence profile below summarises the quality of the evidence and outcome data for mucolytics compared with placebo. For further forest plots, please see appendix O.

Evidence Profile: Mucolytics versus placebo

Question: Should mucolytics vs. placebo be used in people with stable COPD?

Bibliography: Bachh AA, Shah NN, Bhargava R et al. Effect of oral N-acetylcysteine in COPD - A randomised controlled trial. JK Practitioner. 2007; 14(1):12-16; Schermer T, Chavannes N, Dekhuijzen R et al. Fluticasone and N-acetylcysteine in primary care patients with COPD or chronic bronchitis. Respiratory Medicine. 2009; 103(4):542-551; Zheng JP, Kang J, Huang SG et al. Effect of carbocisteine on acute exacerbation of chronic obstructive pulmonary disease (PEACE Study): a randomised placebo-controlled study. Lancet. 2008; 371(9629):2013-2018.; Poole P, Black PN. Mucolytic agents for chronic bronchitis or chronic obstructive pulmonary disease. Cochrane Database of Systematic Reviews. 2006 ;(Black Peter N. Mucolytic agents for chronic bronchitis or chronic obstructive pulmonary disease. Cochrane Database of Systematic Reviews: Reviews 2006 Issue 3 John Wiley & Sons)

Quality assessment							Summary of findings				Quality	Importance
							No of patients		Effect			
No of studies	Design	Limitations	Inconsistency	Indirectness	Imprecision	Other considerations	mucolytics	placebo	Relative (95% CI)	Absolute		
Frequency of exacerbation (number of exacerbations per patient per month) (follow-up 0.5 to 3 years; range of scores: -; Better indicated by less)												
15	randomised trial	very serious ¹	serious ²	no serious indirectness	no serious imprecision	none	2049	2016	-	-0.03 (-0.04 to -0.03)	⊕○○○ VERY LOW	
People with no exacerbations in study period (follow-up 0.5 to 3 years)												
11	randomised trial	very serious ³	serious ⁴	no serious indirectness	no serious imprecision	none	593/1049 (56.5%)	409/1052 (38.9%)	RR 1.46 (1.34 to 1.6)	179 more per 1000 (from 132 more to 233 more)	⊕○○○ VERY LOW	
								21%		96 more per 1,000		
								68%		312 more per 1,000		

COPD (update)

Number of people hospitalised in the study period (follow-up .66 to 3 years)												
2	randomised trial	serious ⁵	no serious inconsistency	no serious indirectness	serious ⁶	none	65/335 (19.4%)	88/343 (25.7%)	RR 0.76 (0.57 to 1.01)	62 fewer per 1000 (from 111 fewer to 3 more)	⊕⊕○○ LOW	
Change from baseline in health related quality of life (follow-up 1 to 3 years; measured with: SGRQ; range of scores: 0-100; Better indicated by less)												
2	randomised trial	serious ⁷	serious ⁸	no serious indirectness	no serious imprecision	none	571	581	-	-0.57 (-2.1 to 0.95)	⊕⊕○○ LOW	
FEV1 or % predicted FEV1 or PEFR at end of study (follow-up 0.5 to 3 years; range of scores: -; Better indicated by more)												
9	randomised trial	very serious ⁹	no serious inconsistency ¹⁰	no serious indirectness	no serious imprecision ¹¹	none	875	889	-	SMD 0.18 (0.06 to 0.3)	⊕⊕○○ LOW	
Adverse events (follow-up 0.5 to 1 years)												
9	randomised trial	very serious ¹²	no serious inconsistency	no serious indirectness	no serious imprecision	none	241/1525 (15.8%)	281/1522 (18.5%)	RR 0.86 (0.74 to 1)	26 fewer per 1000 (from 48 fewer to 0 more)	⊕⊕○○ LOW	
								4%		5 fewer per 1,000		
								51%		71 fewer per 1,000		
death (follow-up 0.5 to 3 years)												
4	randomised trial	very serious ¹³	no serious inconsistency	no serious indirectness	very serious ¹⁴	none	11/490 (2.2%)	14/503 (2.8%)	RR 0.82 (0.38 to 1.75)	5 fewer per 1000 (from 17 fewer to 21 more)	⊕○○○ VERY LOW	
								1%		1 fewer per 1,000		
								3%		5 fewer per 1,000		

¹ 2/15 studies did not conceal allocation and 10 /15 studies had unclear allocation concealment. 1/15 studies was open label. 8/15 studies had dropout rates above 20%. 9/15 studies did not perform an intention to treat analysis and 1/15 studies was unclear if intention to treat analysis was conducted.

² High heterogeneity (I2 = 87.7% p <0.00001) that could not be explained

COPD (update)

³ 2/11 RCTs did not conceal allocation and 9/11 had unclear allocation concealment. 1/11 RCTs was open label. 5/11 RCTs had dropout rate 20% or more. 8/11 did not perform an intention to treat analysis and 1/11 was unclear if an intention to treat analysis had been conducted.

⁴ High heterogeneity ($I^2 = 68.3\%$; $p = 0.0005$)

⁵ 2/2 RCTs had dropout rates > 20% and the smaller study (Moretti) had unclear allocation concealment, and did not perform an intention to treat analysis.

⁶ wide 95% CI that crosses MID

⁷ the larger RCT (Decramer) had dropout rates > 20% and unequal between arms

⁸ High heterogeneity ($I^2 = 90\%$; $p = 0.002$)

⁹ 2/9 RCTs did not conceal allocation and 6/9 RCTs have unclear allocation concealment. 1/9 studies was open label. 4/9 studies had a dropout rate of 20% or more and 1/9 studies had an unclear dropout rate. 5/9 did not perform intention to treat analyses and 2/9 were unclear as to whether or not an intention to treat analysis had been conducted.

¹⁰ high levels of heterogeneity ($I^2 = 81.5\%$; $p < 0.0001$) overall, however, this is explained by stratifying by drug type

¹¹ difficult to assess precision as the outcome is a combination of many different measures of lung function

¹² 2/9 RCTs did not conceal allocation and 6/9 studies have unclear allocation concealment. 1/9 studies is open label. 4/9 studies have a dropout rate of 20% or more. 4/9 RCTs did not perform an intention to treat analysis and one study was unclear if an intention to treat analysis had been conducted.

¹³ 1/4 RCT had unclear allocation concealment and 1/4 did not have allocation concealment; 1/4 RCT open label; 2/4 RCT had dropout rates > 20%; 2/4 RCT did not perform ITT

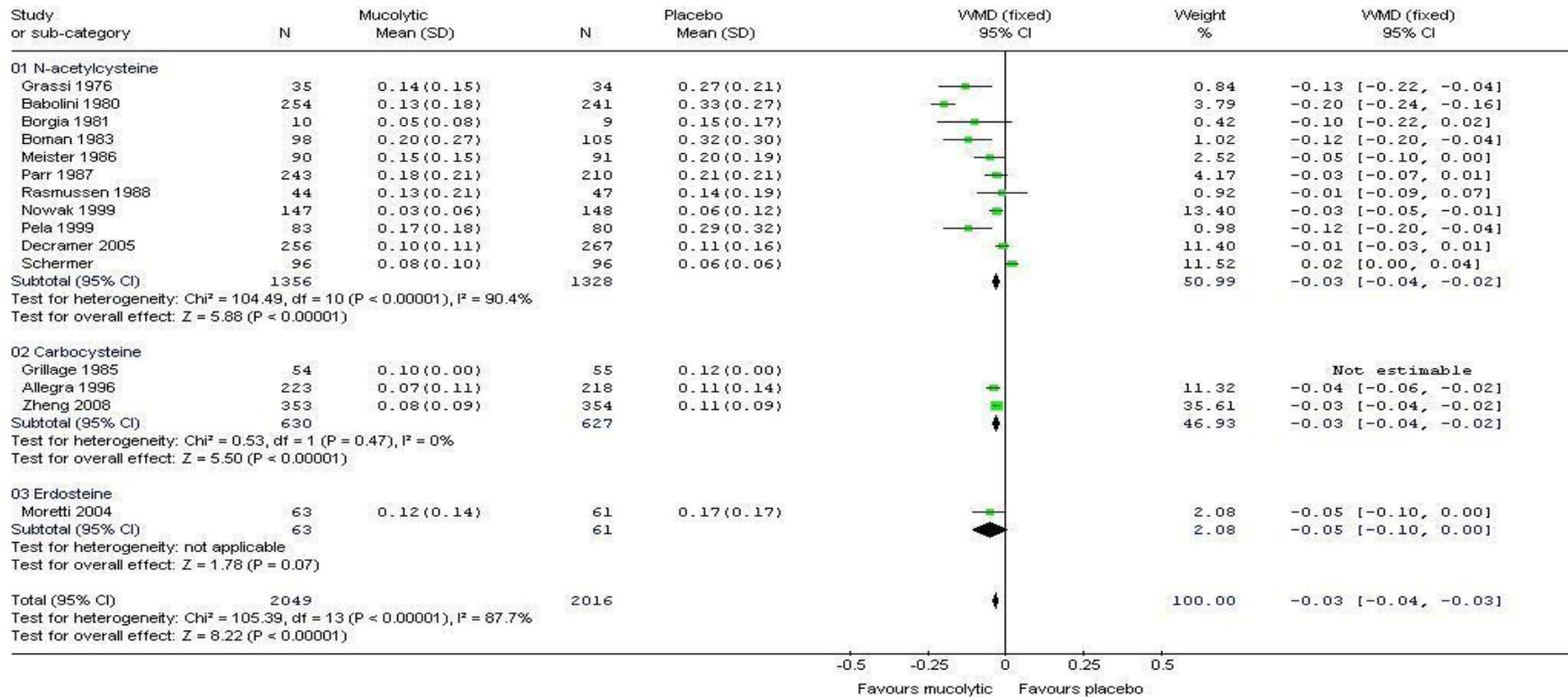
¹⁴ wide 95% CI that crosses MID twice.

Forest Plots:

Mucolytics versus Placebo

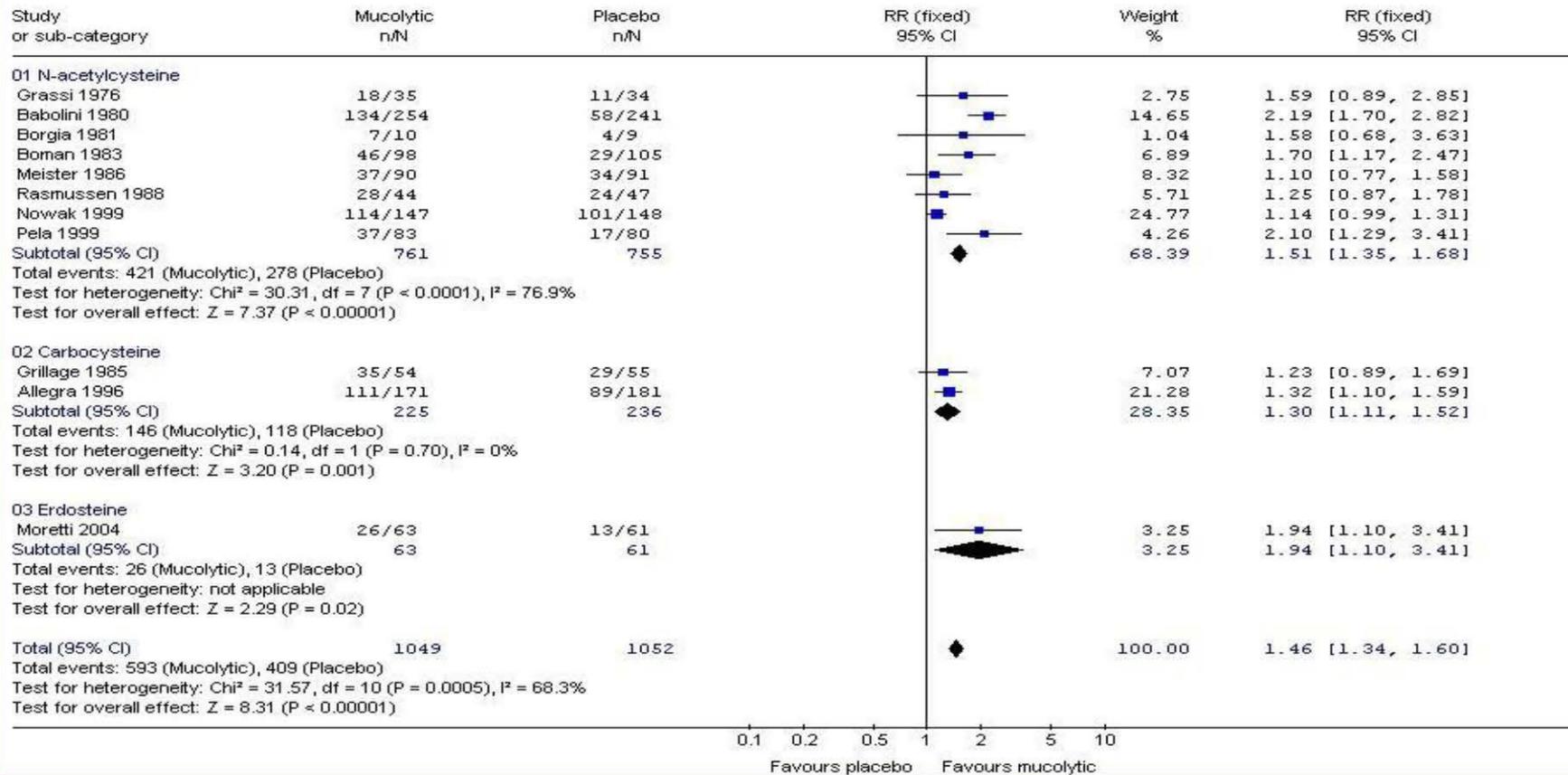
Frequency of exacerbations

Review: Mucolytics 070809 (Version 02)
 Comparison: 01 mucolytic vs. placebo
 Outcome: 01 Number of exacerbation per patient per month by type of mucolytic



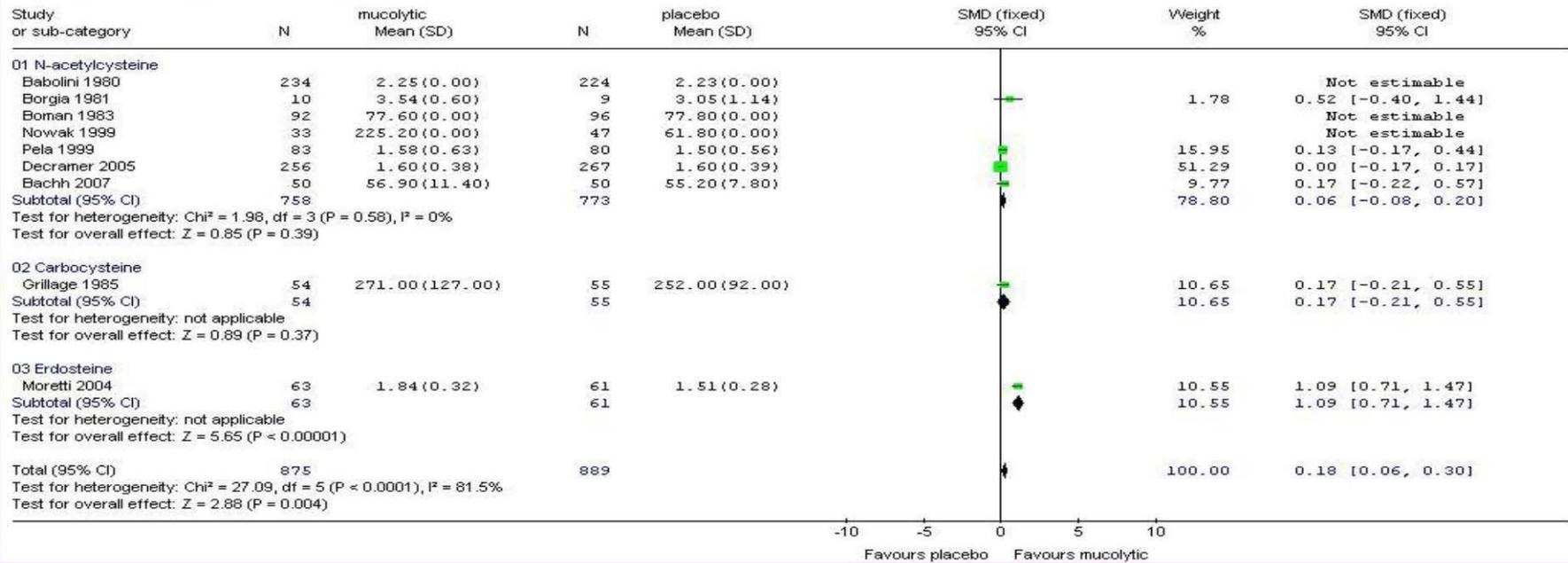
Number of people with no exacerbations

Review: Mucolytics 070809 (Version 02)
 Comparison: 01 mucolytic vs. placebo
 Outcome: 02 No exacerbation in study period



FEV₁ or % predicted FEV₁ or PEFR at study end

Review: Mucolytics 070809 (Version 02)
 Comparison: 01 mucolytic vs. placebo
 Outcome: 04 FEV₁ or % predicted FEV₁ or PEFR at end of study



Evidence statements

Compared with placebo, mucolytics significantly:

Reduce the frequency of exacerbation (expressed as number of exacerbations per patient per month) (very low quality evidence)

Increase the number of people who remain exacerbation free (very low quality evidence)

Increase FEV₁, % predicted FEV₁ or PEF (low quality evidence).

There was no significant difference between mucolytics and placebo for:

Hospitalisation (low quality evidence)

Change from baseline in health related quality of life (measured with total SGRQ score) (low quality evidence)

Adverse effects (low quality evidence)

Death (very low quality evidence)

Health economic evidence statements

One paper by Grandjean et al.²⁶⁸ was found on the cost effectiveness of oral NAC.

The results of the cost effectiveness analysis model show that mucolytic therapy is a cost effective treatment compared to placebo as it reduces the rate of exacerbations, leading to a reduction in hospitalisation and resource use. It is also associated with a reduction in days off sick, leading to a decrease in indirect costs.

The cost effectiveness of mucolytic therapy is mainly dependent on reducing the number of exacerbations in patients with mild disease. Five of the nine studies used to calculate the effectiveness were also included in the clinical review detailed above; these were Grassi 1976, Boman 1983, Meister 1986, Parr 1987 and Rasmussen 1988²⁶⁹⁻²⁷³.

2010 update: New economic evidence was sought but none was identified.

Evidence to recommendation

The purpose of updating this section of the original 2004 guideline was to establish whether or not a recommendation could be made on the use of mucolytics in preventing exacerbations. Although the evidence did show that, compared with placebo, overall there was indeed a positive effect, the GDG noted that the grading of the quality of the evidence meant that the estimate of the effect was very uncertain; there was a high degree of heterogeneity, and also short lengths of follow-up. The GDG considered possible reasons for the heterogeneity and concluded that a greater positive effect seemed to be linked to having less treatment with other COPD maintenance therapy. It was further noted that the absence of any beneficial effect on quality of life called into question the clinical validity of the exacerbation data from a patient perspective.

No new health economic evidence was available, but the GDG noted that previously documented benefit from mucolytics related to people with predominant chronic bronchitis (i.e. regular cough with sputum production) rather than the general COPD population²⁶⁸.

It was felt that, whilst it was possible to interpret some of the evidence to imply that a beneficial effect might be more likely in patients not receiving inhaled corticosteroids, the GDG did not feel there was a sufficiently strong evidence base to make a recommendation for this selected group of patients. In addition, there was concern that a positive recommendation for the use of mucolytics purely to prevent exacerbations in this group might preclude the use of other therapies which have a strong evidence base, and incorrectly imply that mucolytics should be the first-line treatment for exacerbation prevention.

Coupled with the facts that many of the studies used N-acetylcysteine (a drug currently without a UK marketing authorisation for use as a mucolytic) and that comparisons were with placebo (and not other known effective therapies), the GDG felt that the routine use of mucolytics primarily for the purpose of preventing exacerbations should not be recommended at the present time, and that future research would be appropriate.

Recommendations

The current recommendations can be found at www.nice.org.uk/guidance/ng115

7.4.5 Oral anti-oxidant therapy

There is now very good evidence for the presence of oxidative stress in people with COPD. This is critical to the inflammatory response and leads to proinflammatory gene expression²⁷⁴. Various attempts have been made to enhance the lung antioxidant activity, including administering antioxidants such as vitamin C and vitamin E. Attempts have also been made to supplement lung glutathione using glutathione itself or its precursors, particularly N-acetylcysteine (NAC)²⁷⁵. NAC also acts as a mucolytic and is considered in section 7.4.4 but at least some of its effects in reducing exacerbation rates may be due to the antioxidant properties of this drug.

COPD (update)

There was a large cross over in studies found from the literature search for mucolytics and antioxidant therapy in patients with stable COPD. Papers found upon literature searching in this area were primarily focused upon epidemiology, pathophysiology or populations non specific to COPD (acute bronchitis and bronchopneumonia). Two papers were identified that were ultimately critically appraised.

Rautalahti *et al*²⁷⁶ undertook a long term (5 to 8 years) double blind placebo controlled RCT in Finland to look at the effect of alpha-tocopherol and beta₂-carotene supplementation (ATBC) on COPD symptoms. N=10,284 for symptom follow-up.

The ATBC Cancer Prevention Study Group 1994 published a separate paper highlighting the design, methods, participant characteristics and concordance to the alpha tocopherol and beta₂ carotene lung cancer prevention study²⁷⁷. This paper provided quality appraisal information.

Epidemiological studies have looked at the relationship between dietary antioxidant intake, lung function impairment and the effects of smoking. These studies do not allow conclusions to be drawn about causality but may indicate areas for future research.

Evidence statements

During the follow up the supplementations did not affect the recurrence or incidence of **chronic cough, phlegm or dyspnoea**. The authors conclude that the results indicate **no** benefit from supplementation with alpha tocopherol or beta-carotene on the symptoms of COPD but support the beneficial effect of dietary intake of fruit and vegetables²⁷⁶. Ib

Neither of the antioxidant supplements had a statistically significant effect on the risk of being **admitted to hospital** due to a COPD diagnosis²⁷⁶. Ib

Recommendations

The current recommendations can be found at www.nice.org.uk/guidance/ng115

7.4.6 Anti-tussive therapy

Cough is the most common symptom of COPD but anti-tussive therapy is not used in the UK. This may be because of a lack of data to support their efficacy. When considering studies in this area it is important to note the difficulty in demonstrating effectiveness with objective criteria.

No systematic reviews of anti-tussive therapy were found. Four RCTs were identified²⁷⁸⁻²⁸¹ and 1 Polish observational study²⁸².

All 5 studies had methodological limitations which included a range of issues such as underpowering, small sample sizes, potential systematic biases and confounders, short duration of studies, variability in measuring compliancy and variability in reporting outcomes as either intention to treat or per protocol analysis. In some cases a heterogeneous group of respiratory disorders was reported.

Drugs included Helicidine vs. placebo²⁸¹, Moguisteine vs. codeine²⁷⁹, Moguisteine vs. Dextromethorphan²⁸⁰ and Moguisteine vs. placebo²⁷⁸.

Due to the methodological limitations apparent in these trials all results should be treated with caution and hence the GDG felt it inappropriate to present evidence statements based on these data.

Recommendation

The current recommendations can be found at www.nice.org.uk/guidance/ng115

7.4.7 Oral prophylactic antibiotic therapy

This section was updated and replaced in 2018. See www.nice.org.uk/guidance/ng115/evidence for the 2018 evidence reviews

7.5 Combined oral and inhaled therapy

7.5.1 Beta₂ agonists and theophylline

One randomised, double-blind, placebo-controlled parallel trial; Zu Wallack 2001³⁰⁶ (n = 943).

Evidence statements on combinations of beta₂ agonists and theophylline

Mean pre-dose **FEV₁** and **FVC** values significantly improved compared with baseline in both the salmeterol/theophylline group and the salmeterol group at week 4, week 8 and week 12 (p<0.001). Mean pre-dose **FVC** values significantly also improved compared with baseline in the theophylline group (p<0.021), with the exception of the pre-dose FVC assessment at week 12. The salmeterol/theophylline combination group experienced significantly greater improvement in FEV₁ & FVC than either the salmeterol alone group or the theophylline alone group (p<0.02)³⁰⁶.

1b

COPD (update)

Patients in the salmeterol/theophylline combination group experienced significantly more **symptom-free days** ($p = 0.023$) compared with the theophylline group³⁰⁶. Ib

Over 12 weeks patients in the salmeterol/theophylline combination group experienced significantly greater improvements in **PEFR** compared with either the salmeterol alone group or theophylline alone group³⁰⁶. Ib

Salmeterol/theophylline combination group required significantly fewer **supplemental albuterol** treatments during the 12 weeks of the study compared with either the salmeterol alone group or theophylline alone group³⁰⁶. Ib

Salmeterol/theophylline combination group experienced significantly greater improvements in **dyspnoea** (TDI) scores) compared with either the salmeterol alone group or theophylline alone group³⁰⁶. Ib

During the study by Zu Wallack et al.³⁰⁶, each treatment group experienced significant improvements compared with baseline in overall **CRDQ** scores. Ib

The mean overall change from baseline in the salmeterol/theophylline group (+11.2 points) was clinically meaningful (>10 points) and was significantly greater ($p < 0.019$) at week 4 compared with the salmeterol group and the theophylline alone group.

At week 12, mean improvements in overall **CRDQ** scores were +12.7 points in the salmeterol/theophylline group, +7.6 points in the salmeterol group, and +8.6 points in the theophylline group. A significantly higher percentage of patients in the salmeterol/theophylline group (52 to 54%) experienced a clinically important improvement overall compared with the salmeterol group (36 to 45%) or the theophylline group (31 to 42%) at week 4 and week 12 ($p < 0.014$).

Salmeterol/theophylline combination treatment was rated as providing

significantly greater overall **satisfaction with treatment** compared with the theophylline group at all time points ($p < 0.012$) and compared with the salmeterol group at week 8 and week 12 ($p < 0.041$). Salmeterol treatment provided significantly greater **satisfaction with treatment** with respect to side effects than either treatment involving theophylline ($p < 0.028$).

Over 12 weeks **exacerbations** were experienced by significantly fewer patients in the salmeterol/theophylline group (40 patients, 48 exacerbations) compared with the theophylline group (62 patients, 96 exacerbations; $p = 0.023$), but not the salmeterol group (56 patients, 71 exacerbations; $p = 0.076$)³⁰⁶. Ib

The proportion of patients reporting **adverse events** was not significantly different among treatment groups; however, the proportion of patients reporting adverse events that were judged to be related to study drug was significantly higher in both of the groups that received theophylline compared with the salmeterol group, most notably for gastro intestinal (GI) events ($p < 0.042$)³⁰⁶. Ib

7.5.2 Anticholinergics and theophylline

One randomised, double-blind, placebo-controlled parallel trial; Bellia 2002³⁰⁷ ($n = 236$) and 1 randomised, double-blind crossover trial; Nishimura 1995³⁰⁸ ($n = 24$).

Evidence statements on combinations of anticholinergics and theophylline

Although **FEV₁** and **FVC** values increased in patients treated with the oxitropium/theophylline combination, oxitropium alone and theophylline alone groups at weeks 4-8, no statistically significant differences between groups was observed³⁰⁷. Ib

Without inhalation of bronchodilators, **FEV₁** was significantly lower Ib

COPD (update)

during ipratropium/salbutamol combination compared with ipratropium/salbutamol/theophylline combination ($p < 0.01$)³⁰⁸.

At 15 and 60 minutes after inhalation of salbutamol, 400ug the FEV₁ was significantly lower during ipratropium/salbutamol combination compared with ipratropium/salbutamol/theophylline combination ($p < 0.01$)³⁰⁸. lb

At 15 and 60 minutes after inhalation of ipratropium 80ug, the FEV₁ was significantly lower during ipratropium/salbutamol combination compared with ipratropium/salbutamol/theophylline combination ($p < 0.01$). The **FVC** was not significantly different between the ipratropium/salbutamol combination compared with ipratropium/salbutamol/theophylline combination before and 15 and 60 minutes after the inhalation of the bronchodilating agents³⁰⁸. lb

Decreased symptom intensity for **cough frequency, cough intensity** and **dyspnoea** were observed in the majority of patients in all three groups over 8 weeks; however, no significant differences were observed between groups³⁰⁷. lb

No significant alteration of **cough, sputum, wheezing, and shortness of breath** was observed throughout the different phases of treatment³⁰⁸. lb

Morning and evening baseline pre-dosing **PEFR** showed very little change at week 8 in oxitropium/theophylline combination, oxitropium alone and theophylline groups. In contrast, the morning post-dosing PEFR markedly increased in all three groups, particularly in the combination group.; however, no statistically significant difference was observed between treatment groups for either morning or evening post-dosing PEFR change³⁰⁷. lb

Both pre-inhalation and post-inhalation values of daily **PEFR** were lb

significantly higher during the ipratropium/salbutamol/theophylline combination period than during the ipratropium/salbutamol period ($p < 0.01$)³⁰⁸.

Total **SGRQ** score decreased in all groups; oxitropium/theophylline combination, oxitropium alone and theophylline alone and the change was statistically significant compared with baseline ($p < 0.002$). The decrease in total score reached the level of “clinical significance” only in patients treated with oxitropium whether alone (4 ± 1.1 units) or in combination with theophylline (4.7 ± 1.1 units). The variance measure (standard error or standard deviation) is undefined in the primary paper. The decrease was mainly due to changes in activity and impact scores. No significant differences between treatments were observed³⁰⁷.

Ib

The proportion of patients reporting treatment-related **adverse events** ($p < 0.02$) and gastrointestinal treatment-related adverse events ($p < 0.04$) in the theophylline group was significantly greater than that found in oxitropium/theophylline combination and oxitropium group³⁰⁷.

Ib

Sixteen patients (67%) complained of gastrointestinal side effects while receiving ipratropium/salbutamol/theophylline and 10 patients (42%) reported similar effects during ipratropium/salbutamol administration³⁰⁸.

Ib

GDG consensus statements

When considering increasing therapy, adding a drug to existing therapy rather than increasing the dose of an existing therapy may reduce the risk of adverse events.

IV

When combining therapies there may be advantages in terms of convenience, concordance and cost, if equivalent doses of the same drugs are available in single inhaler devices.

IV

Recommendations

The current recommendations can be found at www.nice.org.uk/guidance/ng115

7.6 Oxygen

As the COPD progresses patients often become hypoxaemic. Many patients tolerate mild hypoxaemia well, but once the resting PaO₂ falls below 8 kPa patients begin to develop signs of cor pulmonale, principally peripheral oedema. Once this occurs the prognosis is poor and if untreated the 5 year survival is less than 50%.

Some patients with COPD also become transiently hypoxaemic on exercise and oxygen has been used to try to improve exercise capacity and reduce disability in these individuals. Oxygen is also used to provide symptomatic relief of breathlessness.

COPD (update)

Oxygen should be used with caution in patients with COPD as some patient's respiratory drive depends on their degree of hypoxia rather than the usual dependence on hypercapnia. Thus uncontrolled oxygen therapy can result in suppression of respiratory drive, carbon dioxide narcosis and ultimately respiratory arrest.

Thus, in stable COPD oxygen can be administered for long periods during the day and night (long term oxygen therapy (LTOT)), as ambulatory oxygen (either as part of LTOT or on its own to facilitate exercise) or as short burst therapy to relieve symptoms.

When considering the effects of oxygen therapy it is necessary to consider each of these uses separately. It is also necessary to consider the most effective form of supply. Oxygen can be supplied from cylinders, from tanks of liquid oxygen and can be purified from room air by electrically driven oxygen concentrators.

A rigorous literature search was not performed in this area as much of the evidence has been reviewed in the Department of Health sponsored report on oxygen therapy produced by the Royal College of Physicians³⁰⁹. The statements and recommendations contained in this report were reviewed and inform some of the guideline recommendations.

As well as looking at the report, two systematic reviews were found looking at oxygen therapy^{170;171}.

The GDG is aware that the Department of Health and Welsh Assembly Government are reviewing the processes for assessing patients for oxygen therapy and its provision. These guidelines reflect the current position but they may need revision in the light of this review.

The total cost of oxygen therapy in England and Wales in 2002-3 was £34.8 million. This is made up of £19.8 million for oxygen cylinders and £15.0 million for oxygen concentrators.

Since publishing the original COPD guideline the provision of oxygen services has been changed by the Department of Health and some statements about availability are no longer valid.

7.6.1 Long-term oxygen therapy (LTOT)

This section was updated and replaced in 2018. See www.nice.org.uk/guidance/ng115/evidence for the 2018 evidence reviews.

Recommendations

The current recommendations can be found at www.nice.org.uk/guidance/ng115.

7.6.2 Ambulatory oxygen therapy

Ambulatory oxygen is defined as oxygen delivered by equipment that can be carried by most patients. It provides portable oxygen during exercise and activities of daily living. It may be used as part of continuous oxygen therapy in which case its benefits are those of long term oxygen therapy. But it is also used in isolation in the hope of improving exercise tolerance and quality of life.

The efficacy of ambulatory oxygen therapy is currently limited by the duration of oxygen supply from portable size cylinders even at low flow rates (this is a local provider issue).

Evidence statements

Oxygen conserving devices that provide oxygen with each breath are now available with very lightweight cylinders. These can last for a similar period of time to liquid-oxygen cylinders³⁰⁹. IV

GDG consensus statements

Ambulatory oxygen therapy can be used as a way of ensuring that patients who require long term oxygen therapy and who leave the home on a regular basis receive oxygen for sufficient hours to gain the benefits of LTOT. IV

In patients who do not meet the criteria for LTOT ambulatory oxygen therapy has been proposed as a means of improving exercise capacity and or health status:

COPD (update)

- A recent cross over trial³¹⁸ (N=41) suggested benefits in health status. Ib
- In a small number of appropriately assessed patients who show desaturation on exercise, ambulatory oxygen therapy improves exercise capacity in patients with COPD. IV
- Overall, in patients who have not undergone such an assessment, evidence available to date^{171 319} does not allow any firm conclusions to be drawn concerning the effectiveness of ambulatory oxygen therapy in patients with COPD. Ia

Most of the devices for the provision of ambulatory oxygen therapy are not currently available on prescription. IV

Liquid oxygen is considerably more costly to provide for the patient. IV
Liquid-oxygen portable systems can on average supply 8 hours of oxygen at 2 l/min, though they may be used in conjunction with oxygen-conserving devices. These liquid units must be filled from a large reservoir that is delivered to the patient's home. As liquid oxygen systems evaporate with time, the large home reservoir unit requires frequent filling or replacement.

The technology for the provision of ambulatory oxygen is developing rapidly. IV

Health economic evidence

A cost utility analysis was found which compared oxygen supplied by a concentrator with cylinders for ambulation with liquid oxygen both at home and for ambulation. The total costs of using liquid oxygen were higher but liquid oxygen led to better quality of life assessed using the sickness impact profile. No significant difference was found by the EQ-5D however³²⁰.

Recommendations

The current recommendations can be found at www.nice.org.uk/guidance/ng115.

7.6.3 Short-burst oxygen therapy

This section was updated and replaced in 2018. See www.nice.org.uk/guidance/ng115/evidence for the 2018 evidence reviews.

7.7 Non-invasive ventilation

Non-invasive ventilation (NIV) is a method of providing ventilatory support that does not require the placement of an endotracheal tube. It is usually delivered via a mask that covers the nose, but occasionally a full face mask covering the nose and the mouth is required. The ventilators themselves are compact and portable and some can be run off car batteries as well as mains electricity.

NIV is most commonly used to treat acute respiratory failure during exacerbations of COPD (see section 8.13); however, interest has grown in using it as a treatment for chronic hypercapnic respiratory failure in selected patients. In these patients it may be combined with LTOT.

There are a number of mechanisms by which NIV might benefit patients with stable COPD. NIV might rest the chronically fatigued respiratory muscles and allow recovery of the inspiratory muscle function³²⁵. NIV may also improve sleep time and efficiency³²⁶ by reducing episodes of hypoventilation associated with desaturation. Thirdly, by reducing nocturnal hypoventilation NIV may allow the respiratory centre to be reset thereby leading to improvements in daytime hypercapnia³²⁷.

One systematic review was found¹⁹⁰ that compared NIV plus standard therapy with standard therapy alone. The review consisted of four RCTs. These studies all used different inclusion criteria and different ventilator settings with the result that it was felt that analysis of their pooled results was invalid.

One additional RCT was also identified³²⁸ (N=122), which compared NIV plus long-term oxygen therapy (LTOT) with LTOT alone. However, this study used lower inflation pressures than are normally used, relied on some historical control data and was not powered to detect differences in exacerbation rates. These issues make it difficult to draw firm conclusions from this study and further large scale, long-term studies are required in this important area.

Evidence statements

The addition of NIV to LTOT in stable COPD patients with chronic ventilatory failure improved **daytime PaCO₂** during oxygen breathing³²⁸. Ib

Resting dyspnoea significantly improved over time in the NIV + LTOT group and at month 24 was significantly better than in the LTOT alone group. Month 12 treatment effect 0.4, 95% CI 0.02 to 0.78 (p = 0.048). Month 24 treatment effect 0.6, 95% CI 0.15 to 1.05 (p = 0.013)³²⁸. Ib

COPD (update)

After 2 years **quality of life** (measured by the MRF-28) significantly improved in the NIV + LTOT group compared to the LTOT group, treatment effect 7.1, 95% CI; 0.13 to 4.07; ($p=0.041$). The SGRQ also showed a trend to improvement in both groups³²⁸. lb

Hospital admissions were not significantly different between groups during follow-up³²⁸. lb

The addition of non invasive ventilation (NIV) to long-term oxygen therapy (LTOT) in stable COPD patients with chronic ventilatory failure does not improve **lung function**³²⁸. lb

GDG consensus statements

There is additional inconsistent data from a small number of studies on small numbers of patients that NIV produces improvements in blood gases, dyspnoea, quality of life and exacerbation rates. IV

Patients with chronic hypercapnic respiratory failure who have been ventilated during an exacerbation or who are intolerant of LTOT may get improvements in blood gases, dyspnoea, quality of life and exacerbation rates when treated with NIV. IV

Recommendations

The current recommendations can be found at www.nice.org.uk/guidance/ng115

7.8 Management of pulmonary hypertension and cor pulmonale

Hypoxic patients with COPD develop pulmonary hypertension (i.e. pulmonary artery pressure > 20mmHg). Initially this is as a result of hypoxic vasoconstriction but structural changes also develop and these may be due to inflammatory processes. Pulmonary hypertension may be present for years without causing symptoms but in some patients it leads to the development of the clinical syndrome of cor pulmonale. For the purposes of this guideline, a clinical definition of cor pulmonale based on the pathological definition proposed by Behnke et al.³²⁹ has been adopted: *“Alteration in the structure and function of the right ventricle resulting from diseases affecting the lungs except when these pulmonary alterations are the result of diseases that primarily affect the left side of the heart.”*

In the context of this guideline, the term “cor pulmonale” has been adopted to define a clinical condition that is identified and managed on the basis of clinical features. This clinical syndrome of cor pulmonale includes patients who have right heart failure secondary to lung disease and those in whom the primary pathology is retention of salt and water, leading to the development of peripheral oedema.

Cor pulmonale is defined as a clinical syndrome characterised by fluid retention, peripheral oedema and a raised venous pressure in patients with COPD who have no other cause of ventricular dysfunction.

Although the development of cor pulmonale and the diagnosis of pulmonary hypertension are significant events in the natural history of COPD and have implications for prognosis, a full literature search and critical appraisal process was not undertaken in this area, due to the time limitations within the guideline development process. However, a MEDLINE and Cochrane Database search, and a selective review of frequently cited papers and key review articles was undertaken as part of the development of a background paper for discussion by the guideline development group (as per section 2).

7.8.1 Diagnosis of pulmonary hypertension and cor pulmonale

Evidence statements

Pulmonary arterial hypertension is associated with widening of the descending pulmonary artery on a plain chest radiograph. A high hilar cardiothoracic ratio (>35) in patients with COPD was reported to be 95% sensitive and 100% specific for the presence of pulmonary hypertension³³⁰, but could not predict the degree of hypertension and considerable inter observer variation in its measurement has been reported³³¹. III

Detection of right ventricular hypertrophy on ECG is specific but not sensitive³³². III

COPD (update)

Echocardiography can be used to assess Ppa non-invasively³³³. IV

Examinations are technically inadequate because of hyperinflation in up to 35% of patients^{334,335} and there is not always a good correlation between Ppa measured using echocardiography and the Ppa measured invasively in COPD. III

Two dimensional echocardiography can measure right ventricular dimensions and wall thickness but this is technically difficult and there is no gold standard for comparison^{334,336}. III

Doppler echocardiography measuring the tricuspid regurgitant jet is the best method of assessing Ppa non-invasively it cannot be used to accurately predict Ppa in individual patients. IV

MRI appears to be the most accurate method for measuring right ventricular dimensions non-invasively³³⁷. III

Radionuclide ventriculography is an accurate and reproducible non-invasive way of measuring **left** ventricular function but it is less good for right ventricular function because of overlap of RA and RV and presence of tricuspid regurgitation^{333,338}. III

GDG consensus statements

Pulmonary hypertension in COPD can be non-invasively assessed by echocardiography but examinations may be limited by hyperinflation and may not accurately assess the pulmonary artery pressure. IV

Pulmonary hypertension in COPD can only be quantified accurately by right heart catheterisation but this is rarely indicated. IV

COPD (update)

The diagnosis of cor pulmonale is essentially clinical but depends on excluding other causes of peripheral oedema (including left ventricular failure and chronic thromboembolic disease). IV

The diagnosis of right heart failure can be supported by ECG changes or echocardiography and, in addition, these tests can exclude other causes of oedema and heart failure. IV

MRI scanning and radionuclide ventriculography are the most accurate ways of measuring right ventricular function in patients with COPD. IV

Chest radiography cannot be relied upon to identify pulmonary hypertension in COPD. IV

Recommendations

The current recommendations can be found at www.nice.org.uk/guidance/ng115.

7.8.2 Treatment of cor pulmonale

This section was updated and replaced in 2018. See www.nice.org.uk/guidance/ng115/evidence for the 2018 evidence reviews.

7.9 Pulmonary rehabilitation

Pulmonary rehabilitation can be defined as a multidisciplinary programme of care for patients with chronic respiratory impairment that is individually tailored and designed to optimise each patient's physical and social performance and autonomy. It is widely used for patients with COPD ³⁵⁰.

Pulmonary rehabilitation is an increasingly popular and effective option for patients with moderate to severe COPD. Rehabilitation aims to prevent deconditioning and allow the patient to cope with their disease. Most programmes are hospital based and comprise individualised exercise programmes and educational talks.

Pulmonary rehabilitation has been available in North America and Europe for some years, but availability is still limited in the UK. Individual programmes differ in the precise exercises used, are of different duration, involve variable amounts of home exercise and have

different referral criteria. There is growing interest in running rehabilitation in community settings which may make it easier for patients to attend.

When reviewing the evidence for pulmonary rehabilitation many papers were rejected due to small sample size, lack of methodological detail, no comparison group or because the paper had been included in a systematic review or meta-analysis already reviewed. Pulmonary rehabilitation was compared to either usual care or education. The Cochrane Systematic Review by Lacasse²¹⁴, ACCP Evidence-Based Guidelines³⁵¹, BTS Statement³⁵⁰ and a meta-analysis³⁵² were reviewed.

Clinical introduction

This section was added in 2010

Since publication of the COPD guideline in 2004, a number of studies have examined the timing of pulmonary rehabilitation.

Some studies have examined pulmonary rehabilitation initiated during an acute exacerbation, and continued beyond the exacerbation into the stable phase. The GDG agreed that “early” pulmonary rehabilitation was that which took place within one month of hospitalisation following an exacerbation, and therefore felt it was important to look at the comparison of early rehabilitation versus control (best conventional care).

The GDG felt it appropriate to compare the relative outcomes of pulmonary rehabilitation programmes commenced early in the recovery phase after exacerbation, with those delayed until later in the stable phase. The GDG decided that only RCTs should be reviewed and that the minimum follow-up should be six months. Outcomes agreed for assessment included, hospitalisations, exacerbations, mortality, A+E attendance, SGRQ, exercise performance (incremental shuttle walk and six minute walk), but not FEV₁ or breathlessness (TDI).

7.9.1 Benefits of pulmonary rehabilitation

There is good evidence about the benefits that pulmonary rehabilitation can produce. There has been no direct comparison of the effects of a pulmonary rehabilitation course and the effects of pharmacotherapy, but most programmes require optimisation of medical therapy prior to, or as part of, enrolment.

Evidence statements

Pulmonary rehabilitation leads to statistically significant and clinically meaningful improvements in **health related quality of life** (CRQ), **functional exercise capacity** (WMD 49 meters 95% CI 26 to 72) and **maximum exercise capacity** (WMD 5.4 watts 95% CI 0.5 to 10.2)³⁵¹. Ia

Pulmonary rehabilitation reduces **dyspnoea**^{350,351}. IV & Ia

A single study (n=119) using the Centres for Epidemiologic Studies Depression Scale (CES-D) showed that there was no effect on **depression**³⁵³. Ib

The ACCP evidence-based guideline³⁵¹ highlight that there is currently little information available from RCTs that evaluate the utilisation of health care resources for patients completing a comprehensive pulmonary rehabilitation programme. It has been shown in several non randomised and observational studies that there is a trend towards a decrease in the total number of **hospitalisation days** as well as the **total number of hospitalisations** required for a patient with COPD in the years following the completion of a comprehensive pulmonary rehabilitation programme compare to the year preceding rehabilitation. Ia

The GDG was aware of one RCT³⁵⁴ (n=200) contained within the Lacasse systematic review³⁵⁵, which found no difference between the rehabilitation and control groups in the number of **hospitalisations**. Ib

There was conflicting evidence regarding the **number of days spent in hospital**.

Griffiths et al.³⁵⁴ found that the number of days rehabilitation patients compared to control patients spent in hospital differed significantly (mean 10.4 days versus 21.0 days, p=0.022) in favour of the rehabilitation patients. Ib

COPD (update)

However Ries et al. ³⁵⁶ in a smaller RCT (n=119) found that duration of hospital stay was non significant. 1b

In relation to the outcome of **primary care consultations**, Griffiths et al. ³⁵⁴ found that the rehabilitation group had more primary care consultations at the GP's premises than did the control group (p=0.033) but fewer home visits (p=0.037). 1b

A single centre RCT has shown that patients with more severe COPD undergoing a 8 week programme of pulmonary rehabilitation maintain improvements in exercise capacity and health status for up to 6 months however these were not sustained at one year³⁵⁷. 1b

Health economic evidence

Fourteen papers of potential relevance were found. Some studies were not full economic evaluations and estimated the cost of providing a pulmonary rehabilitation service. Two studies estimated the cost effectiveness in the UK. The cost per QALY was estimated at between £2,000 and £8,000 based on a minimum of four weeks rehabilitations³⁵⁸. Griffiths et al³⁵⁹ undertook an economic evaluation alongside a clinical trial and estimated that pulmonary rehabilitation was cost saving and increased quality of life. The probability of the cost per QALY generated being below £0 was 0.64 ³⁵⁹.

There is good evidence that pulmonary rehabilitation is **cost effective** in the outpatient setting compared to usual care ³⁵⁹. 1b

GDG consensus statements

The magnitude of the effects of pulmonary rehabilitation on **exercise capacity, dyspnoea and health related quality of life** are significantly greater than the effects of bronchodilator drugs.

IV

7.9.2 Course content, setting and duration

Traditionally pulmonary rehabilitation courses have been run in secondary care settings, usually on an out-patient basis but also on an in-patient basis in countries outside the UK. Recently community based programmes have also been developed. There is good evidence on the content of the programme, but less information on the optimum duration or comparative efficacy in different settings.

Evidence statements

The GDG found comprehensive evidence-based guidelines on pulmonary rehabilitation³⁵¹. These guidelines focus upon **course content** and included lower and upper extremity training, ventilatory muscle training and psychosocial, behavioural & educational components. The authors conclude that in patients with COPD, lower extremity training improves exercise tolerance whilst upper extremity training improves arm function. The evidence for ventilatory muscle training (VMT) currently does not support the routine use of VMT.

la

The evidence to date does not support the benefits of short-term psychosocial single interventions however longer-term interventions may be beneficial. Scientific evidence in this area is lacking.

N/A

Two meta analyses were found of **respiratory muscle training**^{360,361}, which demonstrate conflicting findings.

la

COPD (update)

The Smith³⁶⁰ meta-analysis of 17 RCTs demonstrated no significant findings for FEV₁ (8 trials), maximum inspiratory pressure respiratory muscle strength (11 trials), respiratory muscle endurance (9 trials), laboratory exercise capacity (9 trials), functional exercise capacity (9 trials) and functional status (QoL). The only significant effect was for respiratory muscle strength as measured by maximum voluntary ventilation. This equates to an 8.8L difference (p=0.02) (7 trials). Overall there is little evidence in support of respiratory muscle training. A disparity was noted by the GDG in the results published within the abstract and those of the body of the text for this meta-analysis. Overall the results remain the same. Ia

Lotters³⁶¹ updated the work in this area and includes five of the studies that had previously been included in the Smith³⁶⁰ meta-analysis. Ia

Lotters³⁶¹ demonstrated significant findings for inspiratory muscle strength (effect size 0.56, 95% CI 0.35 to 0.77) (15 studies), endurance (0.41, 95% CI 0.14 to 0.68) (7 studies) and dyspnoea (TDI) (2.3, 95% CI 1.44 to 3.15) (2 studies). From this recent meta-analysis, it can be concluded that inspiratory muscle training significantly improves inspiratory muscle strength and endurance whilst the sensation of dyspnoea significantly decreases. Ia

A single centre study³⁶² with small numbers of patients (N=47 between three arms) examined the effects of **strength, endurance or combined strength training**. At the end of the training period and at 12 weeks after training, all patients in the three groups showed significant increases in the duration of endurance testing as compared with pre training values. All training modalities showed significant improvements of the breathlessness score and the dyspnoea dimension of the chronic respiratory questionnaire. III

The BTS statement on pulmonary rehabilitation³⁵⁰ provides an evidence update to the ACCP guidelines³⁵¹ and concludes that pulmonary rehabilitation is effective in all **settings** including hospital inpatient, hospital outpatient, the community, and possibly the home. IV

COPD (update)

Puente-Maestu ³⁶³ undertook a small (n=41) RCT comparing the effects of **supervised versus self-monitored training programmes** in patients with COPD. Both types of training improved exercise tolerance, but the magnitude and the extent of physiological improvements were larger (p<0.05) in patients training under supervision. Ib

A single centre study³⁶⁴ compared **duration** of three compared with eighteen months of exercise training. There were small but statistically significant differences in favour of the eighteen-month programme for self reported physical disability using the Fitness Arthritis and Seniors Trial Functional Performance Inventory. There were statistically but not clinically significant improvements in six minute walk distance (6MWD). Ib

GDG consensus statements

The majority of studies have been performed in a hospital outpatient setting. There is limited data on effectiveness in community or home studies and there have been no comparative studies. IV

The GDG concluded that the evidence regarding prolonged supervised outpatient programmes showed very modest benefits and that such programmes were unrealistic. IV

The COPD GDG augmented the BTS statement with the following italicised consensus addition: IV

In relation to **duration of the initial programme**, and taking in to account current evidence (cited in³⁵⁰) the GDG believe that outpatient programmes should contain a minimum of 6 weeks *and a maximum of 12 weeks* of physical exercise, disease education, psychological and social interventions.

7.9.3 Referral criteria

No randomised trials were found looking at whether pre-determined factors influence a patient's response to pulmonary rehabilitation. Some data was found from retrospective analyses on which factors predicted concordance and response. The position statements of the BTS, ERS and ATS were considered in formulating the statements and recommendations.

Evidence statements

One cross sectional study was found³⁶⁵ (n=91) that looked at whether people who declined or failed to complete COPD rehabilitation programmes differed in terms of demographics, physiological or psychological factors from those people who completed. III

The non-adherent group compared to the adherent group were more likely to be widowed or divorced and less likely to be currently married (p<0.001), more likely to live alone (39% vs. 14%, p<0.02), and more likely to live in rented accommodation (31 vs. 6%, p<0.002). They were also more likely to be current smokers (28 vs. 8%, p<0.02). Inadequate social support for COPD related problems (51 vs. 2%, p=0.001) was more common in the non-adherent group.

The introduction of rehabilitation becomes appropriate when patients become aware of their disability³⁵⁰. IV

There is currently no justification for selection on the basis of **age, impairment, disability, smoking status or use of oxygen**. Some patients with serious co-morbidity such as cardiac or locomotor disability may not benefit as much³⁵⁰. IV

The only issues material to selection are poor motivation and the logistical factors of **geography, transport, equipment usage, and the group composition**³⁵⁰. IV

GDG consensus statements

The COPD GDG augmented the BTS statement ³⁵⁰ with the following italicised consensus addition:

IV

Rehabilitation should be considered at all stages of disease progression when symptoms *and disability* are present and not at a predetermined level of impairment. The threshold for referral would usually be breathlessness equivalent to MRC dyspnoea grade 3 (see table 6.1).

7.9.4 Repeat programmes

The benefits of pulmonary rehabilitation appear to wane with time. There is limited evidence concerning the benefits of attendance at further pulmonary rehabilitation programmes.

Evidence statements

There was evidence that repeated pulmonary rehabilitation led to further temporary improvements in breathlessness and exercise capacity and reduced exacerbations ³⁶⁶. The GDG was aware of methodological limitations of this study. The sample size was small, n=61, of which only 36 patients of the groups combined were available for evaluation.

Ib

7.9.5 Timing of rehabilitation programmes

This section was updated in 2010

The GDG posed the following question:

REHAB: Does early pulmonary rehabilitation (within one month of hospital discharge) in people who had an acute exacerbation improve outcomes compared with usual care (or no rehabilitation), in people with COPD?

Methodological introduction

The literature was searched for RCTs or systematic reviews comparing pulmonary rehabilitation after acute exacerbation of COPD with conventional community care (or control).

The clinically important relative risk reduction (RRR) for mortality was 15%, exacerbations (20%), hospitalisation (20%), change in SGRQ (-4 points), shuttle walk distance (48 meters), FEV₁ (100 ml), TDI (1 unit), and six minute walk distance (50 m).

One systematic review³⁶⁷ and one additional RCT³⁶⁸ were identified. The Eaton et al RCT³⁶⁸, which was added to the Puhan et al systematic review, randomised patients who had an exacerbation (N=97; follow-up 3 months) to an inpatient pulmonary rehabilitation program consisting of exercise; followed by an 8 week outpatient pulmonary rehabilitation programme upon hospital discharge, or to usual care.³⁶⁸ One RCT³⁶⁹ was excluded from the Puhan et al systematic review as it excluded patients who had an exacerbation within one month prior to patient enrolment.

It should be noted that the six RCTs included in the updated Puhan et al SR were all open trials (patient and investigator blinding is not possible) and consisted of mostly older people with COPD (mean age range 64-70 years; range FEV₁% predicted 32%-40%). Table 7.5 summarises the characteristics of the six included RCTs, specifically outlining the type of rehabilitation programme.

For further forest plots, please see appendix O.

Table 7.5 Summary of pulmonary rehabilitation programmes offered to people with COPD following an exacerbation

Included trials	Follow up	N	Rehabilitation details
Behnke 2000 ^{370,371}	18 months	26	Inpatient rehab consisting of endurance exercise (5 walking sessions/day for 10 days); followed by outpatient rehab of 6 months of supervised home-based endurance training 3 walking sessions/day
Kirsten 1998 ³⁷²	11 days	29	Inpatient rehab started after 6-8 days when patients were stable enough to participate. Inpatient rehab consisted of exercise training (5 walking sessions/day + 6MWD test) daily for 10 days
Nava 1998 ³⁷³	6 weeks	80	Inpatient rehab in RICU started 2-5 days after admission once patients were considered clinically stable. Inpatient rehab consisted of two daily sessions of progressive ambulation training + exercise training. Total length of RICU stay was 33.2 days control versus 38.1 days rehab NS
Eaton 2009 ³⁶⁸	3 months	97	Inpatient rehab consisting of exercise and patients encouraged to exercise 30 min/day; followed by Outpatient rehab consisting of supervised exercise training plus education twice/weekly for 8 weeks in a hospital based outpatient programme

COPD (update)

Mann 2004 ³⁷⁴	3 months	42	Outpatient rehab started within 10 days of hospital discharge. Rehab consisted of 8 week rehab program of 2 classes/week of exercise and education +home based exercise encouraging 20 min/day
Murphy 2005 ³⁷⁵	6 months	26	Outpatient rehab initiated immediately after discharge from hospital consisting of twice weekly supervised exercise sessions in their homes for 6 weeks

Evidence Profile: Early pulmonary rehabilitation post exacerbation compared with usual care/control**Author(s):** Milo Puhan, Madlaina Scharplatz, Thierry Troosters, E. Haydn Walters, Johann Steurer**Date:** 2009-08-24**Question:** Should Early Rehabilitation versus control/usual care be used for people with COPD who have had an acute exacerbation?**Settings:****Bibliography:** Puhan M, Scharplatz M, Troosters T, Walters EH, Steurer J. Pulmonary rehabilitation following exacerbations of chronic obstructive pulmonary disease [Data only. When citing this record quote "Cochrane Database of Systematic Reviews 2009, Issue 1".]. Cochrane Database of Systematic Reviews [Year], Issue [Issue].; Eaton T, Young P, Fergusson W et al. Does early pulmonary rehabilitation reduce acute health-care utilization in COPD patients admitted with an exacerbation? A randomized controlled study. *Respirology*. 2009; 14(2):230-238.

Quality assessment							Summary of findings					Importance
No of studies	Design	Limitations	Inconsistency	Indirectness	Imprecision	Other considerations	No of patients		Effect		Quality	
							Early Rehabilitation versus control/usual care	control	Relative (95% CI)	Absolute		
Hospital admission (to end of follow-up) (follow-up 3-18 months)												
4	randomised trial	very serious ¹	no serious inconsistency	no serious indirectness	no serious imprecision	none	18/94 (19.1%)	42/96 (47.8%)	RR 0.43 (0.27 to 0.7)	272 fewer per 1,000	⊕⊕○○ LOW	
Mortality (follow-up 6 weeks -18 months)												
3	randomised trial	very serious ²	no serious inconsistency	no serious indirectness	very serious ³	none	14/94 (14.9%)	7/53 (9.5%)	RR 0.88 (0.37 to 2.11)	11 fewer per 1,000	⊕○○○ VERY LOW	

COPD (update)

Exacerbations (follow-up 6-18 months)												
2	randomised trial	very serious ⁴	no serious inconsistency	no serious indirectness	very serious ³	none	3/36 (8.3%)	8/36 (25.8%)	RR 0.38 (0.11 to 1.26)	159 fewer per 1,000	⊕○○○ VERY LOW	
Health-related quality of life (follow-up 3-6 months; measured with: SGRQ; range of scores: -; Better indicated by less)												
2	randomised trial	very serious ⁵	no serious inconsistency	no serious indirectness	no serious imprecision	none	0	0	-	MD -11.14 (-17.11 to -5.17)	⊕⊕○○ LOW	
Change from baseline in 6 minute walking test (follow-up 11 days-18 months; measured with: Six minute walking distance; range of scores: -; Better indicated by more)												
3	randomised trial	very serious ⁶	serious ⁷	no serious indirectness	no serious imprecision	none	0	0	-	MD 124.81 (97.94 to 151.68)	⊕○○○ VERY LOW	
6MWD difference between groups at end of follow-up (follow-up 11 days-18 months; measured with: Six minute walking distance; range of scores: -; Better indicated by more)												
4	randomised trial	very serious ⁸	serious ⁹	no serious indirectness	no serious imprecision	none	136	95	-	MD 173.36 (157.45 to 189.28)	⊕○○○ VERY LOW	
Change from baseline in shuttle walk test (follow-up 3-6 months; range of scores: -; Better indicated by more)												
2	randomised trial	very serious ⁵	no serious inconsistency	no serious indirectness	serious ¹⁰	none	0	0	-	MD 81.23 (47.52 to 114.95)	⊕○○○ VERY LOW	

¹ 3/4 RCTs had unclear allocation concealment; 4/4 RCTs open label; high loss to follow-up in Behnke RCT (38% rehab; 39% usual care); 3/4 RCTs did not perform ITT analysis

² 3/3 RCTs had unclear allocation concealment; 3/3 open label; high loss to follow-up in Behnke RCT (38% rehab; 39% usual care); 3/3 RCTs did not perform ITT analysis

³ wide 95% CI that crosses MID twice

⁴ 1/2 RCTs had unclear allocation concealment; 2/2 RCTs were open; high loss to follow-up in Behnke RCT (38% rehab; 39% usual care); 2/2 RCTs did not perform ITT analysis

⁵ 1/2 RCTs had unclear allocation concealment; 2/2 RCTs open label; 2/2 RCTs did not perform ITT analysis

⁶ 3/3 RCTs had unclear allocation concealment; 3/3 RCTs open label; high loss to follow-up in Behnke RCT (38% rehab; 39% usual care); loss to follow-up not clearly reported in Nava and Kirsten; 3/3 RCTs did

COPD (update)

not perform ITT analysis

⁷ high heterogeneity (I² = 90%) that could not be explained by sub-grouping according to whether rehab occurred in the index hospitalisation or whether rehab occurred post discharge from hospital

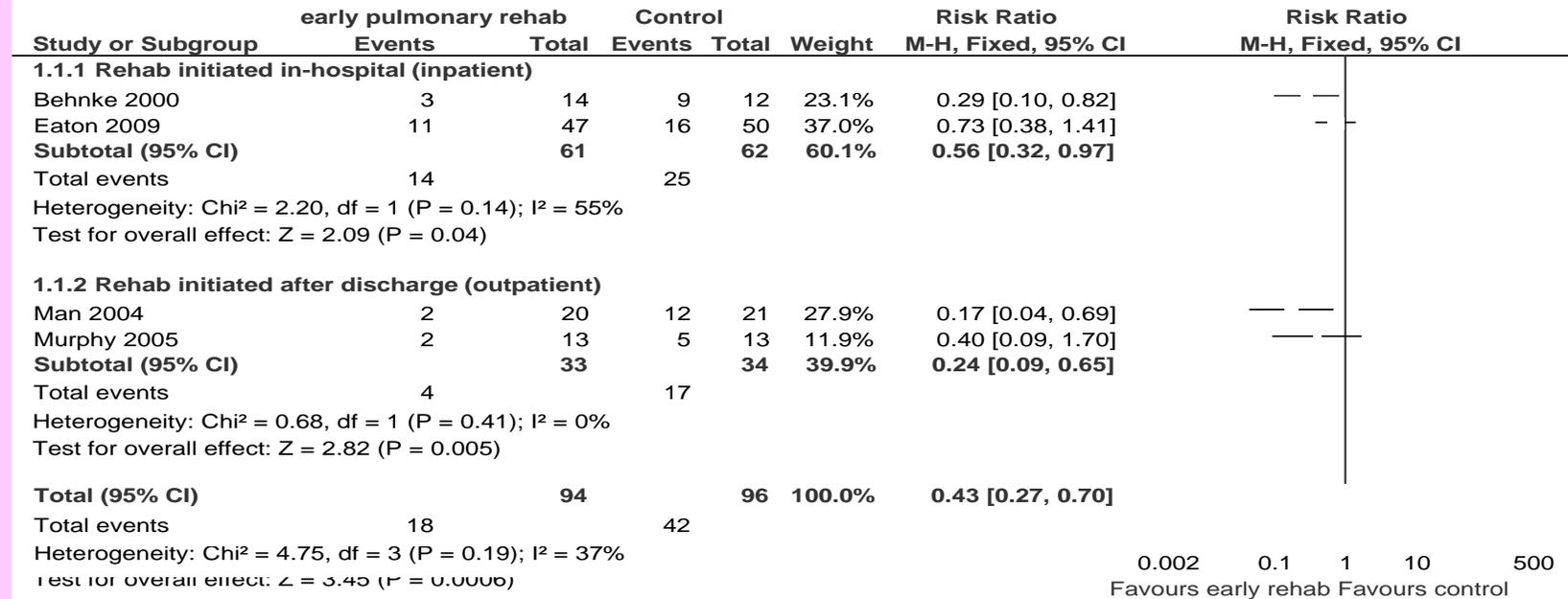
⁸ 4/4 RCTs had unclear allocation concealment; 4/4 RCTs open label; high loss to follow-up in Behnke RCT (38% rehab; 39% usual care); loss to follow-up not reported clearly in Nava and Kirsten; 3/4 RCTs did not perform ITT analysis

⁹ high heterogeneity (I² = 97%) that cannot be explained

¹⁰ wide 95% CI that crosses MID

Forest Plots

Readmission

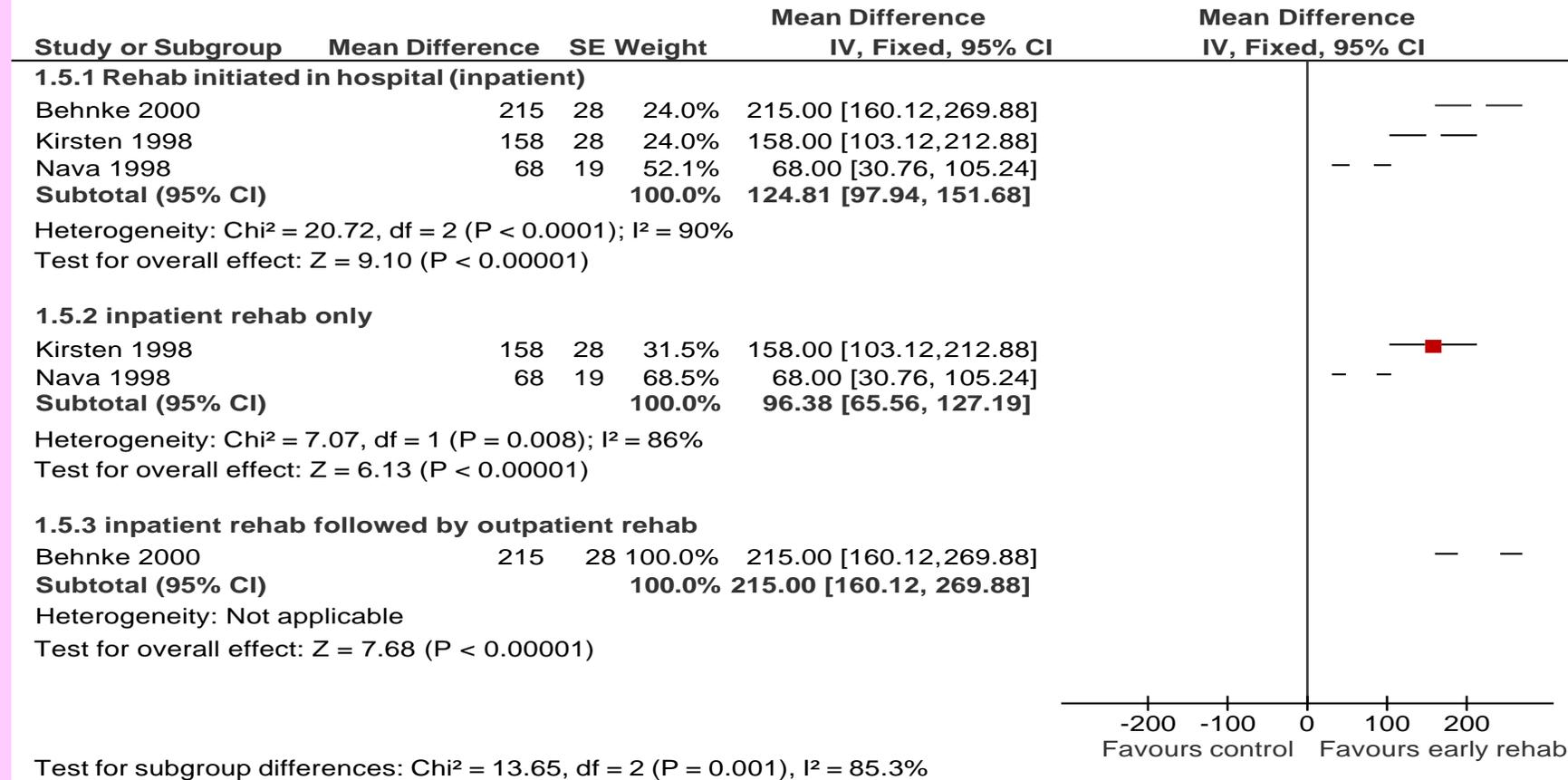


Change in SGRQ

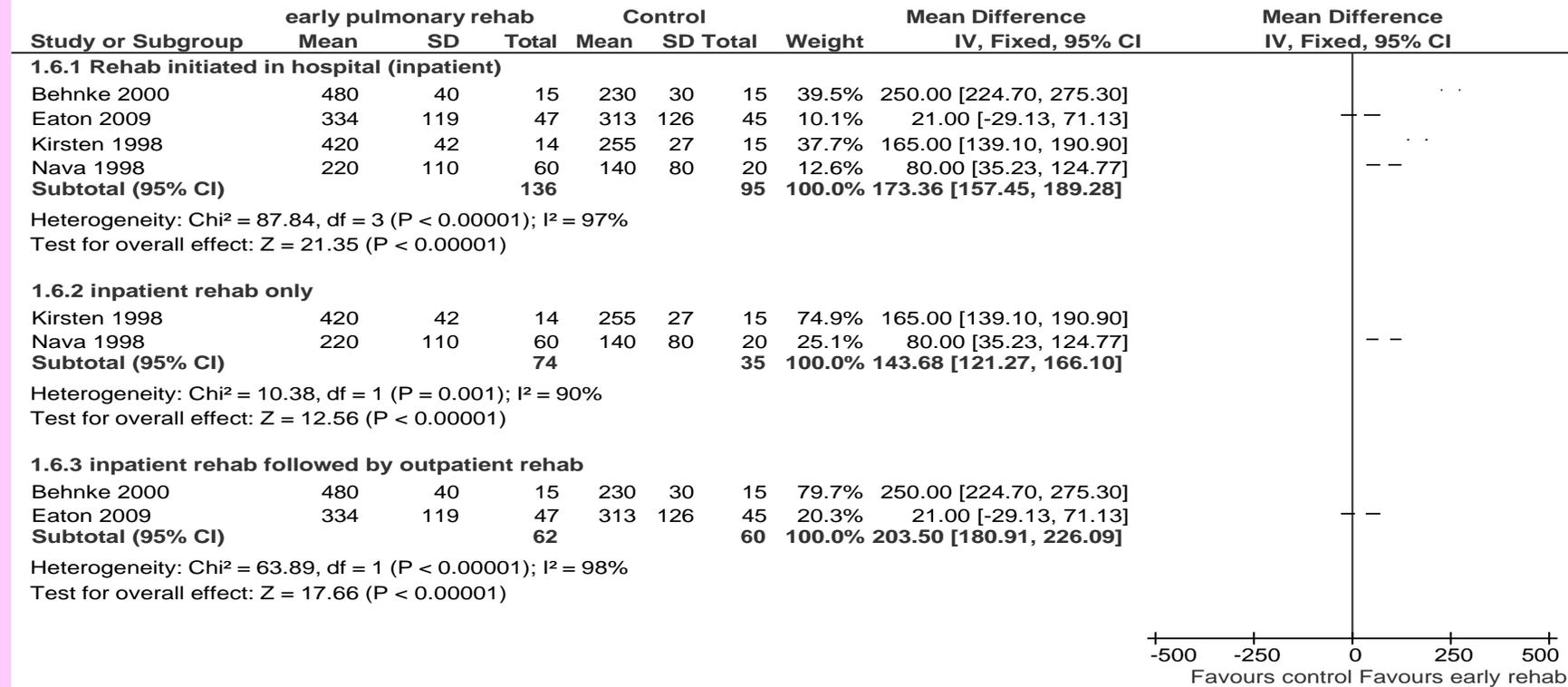
Study or Subgroup	Mean Difference	SE	Weight	Mean Difference IV, Fixed, 95% CI	Mean Difference IV, Fixed, 95% CI
1.4.1 Rehab initiated after hospital discharge (outpatient)					
Man 2004	-12.7	3.93	60.1%	-12.70 [-20.40, -5.00]	
Murphy 2005	-8.8	4.82	39.9%	-8.80 [-18.25, 0.65]	
Subtotal (95% CI)			100.0%	-11.14 [-17.11, -5.17]	
Heterogeneity: Chi ² = 0.39, df = 1 (P = 0.53); I ² = 0%					
Test for overall effect: Z = 3.66 (P = 0.0003)					

-100 -50 0 50 100
Favours early rehab Favours control

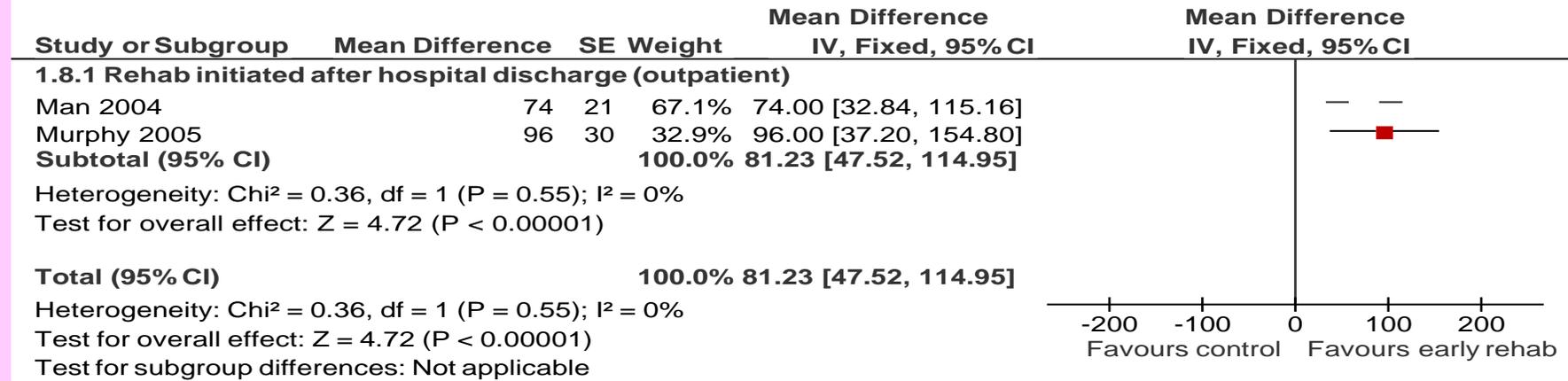
Change from baseline in 6 minute walk test



Mean difference between groups in six minute walk test at end of follow-up



Change from baseline in shuttle walk test



Evidence statement: Early rehabilitation versus usual care/control

Compared with usual care, people with an exacerbation of COPD who received early pulmonary rehabilitation had a significantly decreased:

- Risk of readmission to hospital [low quality evidence]

Compared with usual care, people with an exacerbation of COPD who received early pulmonary rehabilitation had a significantly improved:

- Six minute walk distance (expressed as change from baseline) [very low quality evidence]
- Six minute walk distance (expressed as mean difference between groups at end of follow-up) [very low quality evidence]
- Shuttle walk distance (expressed as change from baseline) [very low quality evidence]
- Health related quality of life (expressed as SGRQ total score) [low quality evidence]

There was no significant difference between people receiving early pulmonary rehabilitation compared with usual care for:

- Mortality [very low quality evidence]
- Exacerbations [very low quality evidence]

Health economic evidence

The literature was searched for economic evaluations evaluating early pulmonary rehabilitation (within one month of hospital discharge) in people who had an acute exacerbation improve outcomes compared with usual care (or no rehabilitation), in people with COPD.

No relevant studies were identified.

Evidence to recommendation

This question addressed whether it is better to provide what is normally considered to be a programme of pulmonary rehabilitation (e.g. a 6-8 week course for 2 days per week in an outpatient community setting) earlier or later in the stable phase of COPD. Early pulmonary rehabilitation was considered to be that which took place within one month of hospitalisation following an exacerbation.

The focus of the question was to examine the impact of the timing of pulmonary rehabilitation upon patient outcomes, and not to consider whether rehabilitation should be conducted in an in-patient or outpatient setting. Review of in-patient rehabilitation studies did however inform the discussion.

The question did not consider identification of new candidates for pulmonary rehabilitation, but only those eligible under current recommendations such that any recommendations would remain cost-neutral.

One systematic review³⁶⁷ compared pulmonary rehabilitation after acute exacerbation of COPD with conventional community care (or control) in people who had an acute exacerbation of COPD. Six RCTs included in this review were open trials (as patient and investigator blinding is not possible) and included mostly older people with COPD (mean age range 64-70 years; range FEV₁% predicted 32%-40%). In one RCT included in this review³⁷³ study participants were in-patients for more than 30 days, and included ICU admission, and for the majority of patients, intubation and ventilation. It was noted that ICU rehabilitation demands are very different from those on general hospital wards, and that this may skew results as in-patient physiotherapy is not necessarily considered a rehabilitation programme.

Three of the RCTs included 6-8 week pulmonary rehabilitation programmes^{374 375 368} In the Eaton et al RCT³⁶⁸, rehabilitation commenced as an inpatient and continued after discharge. Only 50% eligible patients were enrolled, and of these approximately 50% completed the programme. The other included RCTs³⁷⁰⁻³⁷² included in-patient rehabilitation and were excluded from consideration.

Two studies were identified for consideration which examined pulmonary rehabilitation in the early stable phase of COPD, and followed the 'UK model' of a 6- 8 week course for 2 days per week in an outpatient community setting.

For hospital readmission, there were overall concerns about the comparisons made in the studies considered. The systematic review ³⁶⁷ was considered problematic due to pooled data with a heterogeneous group of study designs. The GDG also noted that with care in the community, many COPD patients 'exacerbate' at home and there are no data available on community exacerbations.

It was noted that no time frame for readmission was identified in the studies. The results of the meta-analysis should be treated with caution, but the GDG felt that the outcome was probably correct.

The GDG also acknowledged that for secondary outcomes of mortality, exacerbations, quality of life (SGRQ) and exercise capacity, a number of limitations were noted in the studies considered. Most outcomes had wide confidence intervals, treatment allocation was poorly described, and few used intention to treat (ITT) analysis, such that studies were considered to have 'serious limitations' by GRADE analysis. **For mortality** as an outcome, there were serious concerns regarding pooling of the data in a meta-analysis. Mortality detection was limited in studies with a relatively short follow-period. One study in an ICU setting led to study bias. **For exacerbations and readmissions**, numbers were considered too small with few events, and few studies reported exacerbation outcome. Exacerbations were also included within the admissions data. **For quality of life (SGRQ)** the GDG noted that both studies identified reported SGRQ and both showed a benefit from pulmonary rehabilitation. **For exercise capacity**, the studies showed significant unexplained heterogeneity for 6 minute walking test (6MWD). Two studies included an incremental shuttle walk test and demonstrated benefit in favour of early pulmonary rehabilitation.

It therefore was apparent to the GDG that all of the secondary outcomes had limitations. However, overall the studies suggest that there are some advantages to early rehabilitation. The GDG also noted the strong evidence supporting the benefits of rehabilitation programmes generally, and could see no reason why patients who had recently suffered from an exacerbation should not be considered for a course of pulmonary rehabilitation. A modification to the existing recommendation was therefore made to this effect.

COPD (update)

Recommendations

The current recommendations can be found at www.nice.org.uk/guidance/ng115.

7.10 Vaccination and anti-viral therapy

Pneumococcal vaccination and annual influenza vaccination are recommended for patients with chronic respiratory disease by the Chief Medical Officer. The role of newer anti-viral agents in preventing or treating influenza has been looked at separately by NICE³⁷⁶ but clinical experience with these drugs is limited.

Since publication of the 2004 COPD guideline NICE have replaced:

TA67 Flu prevention – amantadine and oseltamivir with TA158

TA58 Flu treatment – zanamivir (review) amantadine and oseltamivir with TA168

Influenza

One systematic review was identified³⁷⁷ relating to influenza vaccine for patients with COPD. This review included studies that compared live or inactivated virus vaccines (intramuscular or intranasal routes) with placebo either alone or with another vaccine. Nine trials were included but only four (N=215) were specific to a stable COPD population. These were all carried out some years ago and used vaccines that differ from those used now.

One additional retrospective cohort study was identified relating to influenza vaccine³⁷⁸. Although this study included a heterogeneous population with chronic lung disease (N=1898) it was worthy of consideration as it included an elderly population.

Treatment of influenza

One NICE Technology Appraisal Guidance (TAG), No 58 (2003) 'Guidance on the use of zanamivir, oseltamivir and amantadine for the treatment of influenza'³⁷⁶ was identified which replaces the NICE Technology Appraisal Guidance, No 15 (2000) 'Guidance on the use of zanamivir (Relenza) in the treatment of influenza'³⁷⁹.

A systematic review and economic decision modelling for the prevention and treatment of influenza A and B³⁸⁰ underpins the NICE TAG, No 58³⁷⁶.

The TAG and systematic review referred to above relate to Zanamivir, Oseltamivir and Amantadine. Zanamivir is a neuraminidase inhibitor and is taken using an inhaler (Diskhaler). It is licensed for the treatment of influenza A and B. Oseltamivir is also a neuraminidase inhibitor. It can be taken orally and is licensed for the treatment of influenza A and B. Amantadine is not currently recommended for the treatment of influenza³⁷⁶.

Pneumococcal vaccination

Two retrospective cohort studies were found^{381,382}, which appear to use the same population. These studies were included despite having a heterogeneous chronic lung disease population. The first study looks at the health benefits associated with pneumococcal vaccination of elderly patients with chronic lung disease. The second paper by Nichols et al.³⁸² looks at the additive benefits of influenza and pneumococcal vaccination during influenza seasons among elderly people.

It is important to note that due to the relevance of the three retrospective cohort studies by Nichols the GDG felt that the studies were worthy of inclusion. However, the study design, retrospective cohort, falls lower down the hierarchy of evidence and in addition to this, extrapolation meant that the study recommendations were downgraded as per the current NICE grading system.

One Canadian RCT was found, N=189, that looked at the efficacy of Pneumococcal vaccine compared to placebo in severe COPD patients³⁸³. This was subsequently excluded by the GDG due to a heterogeneous population and the date of the study.

One RCT was identified³⁸⁴ relating to Haemophilus influenzae vaccine for prevention of exacerbation for chronic bronchitis. This was excluded as the population included bronchiectasis and chronic bronchial asthma.

Evidence statements

Influenza vaccination

Nichols et al.³⁷⁸ compared vaccinated to unvaccinated people in a cohort of N=1898 elderly persons with chronic lung disease (CLD) over three influenza seasons and demonstrated a 52% reduction in **hospitalisations** for both pneumonia and influenza (Adjusted risk ratio 0.48 p=0.008).

Ila

There was no difference in the number of hospitalisations for all respiratory conditions between the two groups³⁷⁸.

There was a 70% reduction in risk for **death** (Adjusted odds ratio, 0.30; p<0.001) in the vaccinated patients³⁷⁸.

During the influenza season, for **outpatient visits**, influenza vaccination was *not* associated with a lower risk for having at least one visit for either pneumonia or all respiratory conditions³⁷⁸.

Treatment of influenza

Italics represent direct quotes from the Technology Appraisal Guidance No. 58³⁷⁶:

NICE

Amantadine

“Amantadine is not recommended for the treatment of influenza”.

Zanamivir

“The Assessment Report identifies five RCTs (un referenced in the TAG) of zanamivir in elderly people and otherwise at-risk people (% of COPD patients not defined). A meta-analysis of these trials, N=371 people were treated with zanamivir and N=392 received placebo. On an ITT basis, the median time to alleviation of symptoms was 0.93 days sooner with zanamivir (95% CI –0.05 to 1.90 days). For people who had confirmed influenza within these groups (N=236 treated with zanamivir and N=248 placebo), the median time to symptom alleviation was 1.99 days sooner with zanamivir compared with placebo (95% CI; 0.90 to 3.08 days). The median times to return to normal activities were 0.09 days sooner for the treatment group (95% CI; -0.78 to 0.95 days) on an ITT basis and 0.20 day (95% CI; -0.79 to 1.19 days) for the influenza positive subgroup.”

“There is some evidence that treatment with zanamivir for influenza reduces complications. An analysis of a set of trials including both otherwise healthy and at risk individuals (proportion of COPD not defined) found that in a pooled subgroup of 230 high risk adults and children with laboratory confirmed influenza, antibiotics were required by 24% in the placebo group and 13% in the zanamivir group; odds ratio 0.49, 95% CI; 0.23 to 1.04.”

“In clinical trials, Zanamivir has not been extensively tested in people with chronic respiratory disease. In post licensing experience, there have been very rare reports of allergic reactions such as facial and oropharyngeal oedema, rash and urticaria”.

Oseltamivir

“The Assessment Report identifies five RCTs of oseltamivir in elderly people and otherwise at-risk adults (proportion of COPD not defined) that have been used in a meta-analysis. The analysis involved 557 people treated with oseltamivir and 577 with placebo. On an ITT basis, the median time to alleviation of symptoms was 0.35 days sooner with oseltamivir (95% CI; -0.71 to 1.40 days). For people who had confirmed influenza within these groups (341 treated with oseltamivir and 387 who received placebo), the median time to symptom alleviation was 0.45 days sooner with oseltamivir compared with placebo (95% CI; -0.97 to 1.88 days). With oseltamivir, the median times to return to normal activities were 2.45 days sooner for the treatment group (95% CI; 0.05 to 4.86) on an ITT basis and 3.00 days (95% CI; 0.13 to 5.88 days) for the influenza positive

COPD (update)

subgroup.”

“There is some evidence that treatment with oseltamivir treatment for influenza reduces complications. In an overlapping set of trials involving both otherwise health and at risk people (proportion of COPD not defined) who were diagnosed as influenza positive, 19 out of 1063 receiving placebo developed pneumonia, compared with 9 out of 1350 receiving oseltamivir (odds ratio 0.37, CI 0.15 to 0.86).”

“Oseltamivir, in clinical trials, is generally well tolerated, but has been associated with a higher rate of nausea (3 to 7% higher) and vomiting (2% higher) compared with placebo.”

Pneumococcal vaccination

Nichol et al.³⁸¹ over two influenza seasons looked at the health and economic benefits associated with pneumococcal vaccination of a cohort (N=1989) of elderly persons with chronic lung disease. Findings demonstrated that pneumococcal vaccination was associated with:

Ila

- a 43% reduction in the number of **hospitalisations** for pneumonia and influenza (Adjusted RR, 0.57; p=0.005).
- a 29% reduction in the risk for **death** from all causes (Adjusted RR, 0.71; p=0.008)³⁸¹.

Influenza and pneumococcal vaccinations

Nichols et al.³⁸² looked at the additive benefits of influenza and pneumococcal vaccinations among a cohort of N=1898 elderly persons with chronic lung disease over three influenza seasons. Results of the study indicate that for both influenza and pneumococcal vaccination there was:

IIb

- a 63% (95% CI; 29 to 80) reduction in the risk for hospitalisation for pneumonia.
- a 81% (95% CI; 68 to 88) reduction in the risk of death (versus when neither vaccination had been received).

There was no evidence of an interaction between the vaccinations.

Health economics evidence statements

Hak et al³⁸⁵ found that in the Netherlands, immunization of elderly patients with chronic lung disease against influenza is effective and cost saving.

Guidance from the NICE technology appraisal no. 58³⁷⁶ recommends routine immunisation of people of any age with chronic respiratory disease, where it is known that either influenza A or influenza B is circulating in the community.

“Vaccination offers a very cost effective initial empirical treatment of defence against influenza.”

COPD (update)

“The Committee concluded that the evidence indicated that, when influenza is circulating, it would be both clinically effective and cost effective for at-risk people with influenza-like illness to be treated with zanamivir or oseltamivir if they can begin their course of medication within 48 hours of the appearance of symptoms.”

People who have chronic respiratory disease (including COPD) are considered to be at risk.

Recommendations

The current recommendations can be found at www.nice.org.uk/guidance/ng115.

7.11 Lung surgery

This section was updated and replaced in 2018. See www.nice.org.uk/guidance/ng115/evidence for the 2018 evidence reviews.

7.12 Alpha-1 antitrypsin replacement therapy

Alpha-1 antitrypsin deficiency is an uncommon cause of COPD, accounting for around 2% of cases of COPD. There is considerable variability in the clinical manifestations it produces: some patients having minimal or no symptoms and others developing severe emphysema at an early age. Smoking is the major factor influencing the development of emphysema but some non-smokers develop airflow limitation in later life and this appears to be associated with a history of asthma or pneumonia ³⁹⁹. Recombinant alpha-1 antitrypsin is now available and replacement therapy has been proposed as a way of treating patients with alpha-1 antitrypsin deficiency.

No systematic reviews were identified on the role of alpha-1 antitrypsin replacement therapy. Dirksen ⁴⁰⁰ was the only RCT. This was powered to detect a 50% difference in decline in FEV₁ over 3 years but there is no information about completeness of follow-up and it was underpowered to detect changes in the secondary outcome measure of changes in lung density on CT. Considerations was also given to data from the alpha-1 antitrypsin deficiency register study group ⁴⁰¹(n=1129, 36 clinical centres in USA and 1 in Canada). The authors state that the results cannot be generalised as the cohort was not a representative sample. Decisions about treatment were made by the referring physician and may be subject to bias.

An uncontrolled cohort study was identified ⁴⁰² comparing a treated German population with an untreated Danish population but this was excluded due to methodological limitations.

The GDG was aware of the difficulties in attempting an RCT in this area (large sample size required, timing of intervention, long term-follow up difficult to achieve and expensive augmentation treatment required).

Evidence statements

Both Dirksen ⁴⁰⁰ and the Registry study ⁴⁰¹ found no significant effect of alpha-1 antitrypsin replacement therapy on the rate of decline in FEV₁.

Ib & III

COPD (update)

The Registry study was the only study to examine mortality. It found that patients receiving alpha-1 antitrypsin replacement therapy had a lower **mortality** (RR 0.64 95% CI 0.43 to 0.94, p=0.02) but this may have been affected by the biases referred to above ⁴⁰¹. III

Dirksen highlighted a trend towards a reduced rate of **loss of lung tissue** assessed by CT scanning in patients receiving alpha-1 antitrypsin replacement therapy⁴⁰⁰. Ib

Health economics evidence statements

Only one economic study was found ⁴⁰³. This model is 12 years old and was very uncertain around efficacy, had many assumptions, is US based and the costs of therapy and treatment may now be outdated.

The guideline developers were unable to derive any evidence statements based on this health economic evidence and felt that none of this economic evidence was useful for contributing to the formulation of the recommendations.

Recommendations

The current recommendations can be found at www.nice.org.uk/guidance/ng115.

7.13 Multidisciplinary management

Doctors, nurses, physiotherapists, occupational therapists and pharmacists are essential members of the multi-disciplinary team managing patients with COPD. In more severe COPD the multidisciplinary team will also include: dietician, social worker, mental health trained worker, behaviour nurse therapist, clinical psychologist or liaison psychiatrist. These individuals may fulfil a variety of roles including those listed below.

Many of these activities may be undertaken in the clinic or in the practice as part of routine care by the practitioner seeing the patient but in certain circumstances the patient may need to be referred to a specialist department e.g. physiotherapy. Multidisciplinary working means breaking down historic demarcation of roles because many of the activities in managing COPD can be undertaken by individuals from different professional backgrounds. Competencies are more important than professional boundaries.

The current recommendations can be found at www.nice.org.uk/guidance/ng115.

7.13.1 Respiratory nurse specialists

Research on the role of the clinical nurse specialist (CNS) in COPD is scarce. Unlike the role of the CNS in asthma, where the role is established in the BTS / SIGN guidelines for asthma⁷³, and where structured review of the patient by nurses has a clearer evidence base.

COPD specialist nurses are found both in the primary and secondary care settings.

Their role varies from place to place depending on local circumstances. But there are some common themes.

Education of patients and their carers is a key component of their work. Nurses often have more time to spend with patients and their carers than doctors and patients may feel less inhibited about asking questions or showing their lack of understanding. In their work with patients, nurses will cover many of the topics discussed in appendix C.

Support and education for other professionals caring for COPD patients, through formal and informal education sessions. Sessions on use of spirometry and early detection of COPD and on the topics covered above.

Co-ordination of care: The nurse is usually the main point of contact for the patients and their families and as such provides them with a link to the multidisciplinary team.

Through this they may pre-empt or prevent hospital admission by early intervention.

Through needs assessment they can refer patients to other professionals e.g. dietician, social services.

COPD (update)

Assessing and monitoring stable COPD over time: through use of spirometry, oxygen saturation and symptom measurements e.g. the BORG breathlessness scale.

They provide **psychological and emotional support** for the patient and their family. Through advice on anxiety management, helping them deal with issues of loss of role in the family.

Nurse prescribing, an increasing number of nurses can now prescribe, allowing them to adjust treatments according to patient's needs.

Home care provision. Nurses play a pivotal role in home care provision both in the stable COPD and during exacerbation.

Oxygen Assessment, Nurses are often involved in oxygen assessments. They monitor patients on LTOT through home assessment of oxygen saturation levels, spirometry and symptom measurement, and for evidence of heart failure.

Monitoring of patients on **home ventilation**.

Hospital-at-home: Other nurses are involved in "hospital-at-home" for COPD patients. They assess and monitor patients at home who would otherwise have required hospitalisation due to their exacerbation.

Role of the Respiratory Nurse Consultant: can be seen as evolving COPD nursing further, not just in drug management but also in other therapeutic and supportive interventions.

Due to the time limitations within the guideline development process a systematic literature search and formal critical appraisal process was not undertaken in this area, see section 2. However, a MEDLINE and Cochrane Database search, and a selective review of frequently cited papers and key review articles was undertaken. The authors of a systematic review on the role of respiratory nurse specialists which is under development⁴⁰⁴ were also contacted and they provided a database of relevant papers which included the grey literature. These studies were reviewed as part of the development of an expert opinion background paper which was then discussed by the guideline development group.

COPD (update)

There is little robust evidence relating to the role of respiratory nurses in COPD. One systematic review was identified³⁰² of home care by outreach nursing. Some of the studies related to specific aspects of COPD care (e.g. hospital-at-home schemes) which are covered elsewhere in the guideline.

GDG consensus statements

Respiratory nurse specialists form an important part of the multidisciplinary team managing patients with COPD. IV

Their role within the multi-disciplinary team will vary depending on local circumstances and individual competencies. IV

Recommendations

The current recommendations can be found at www.nice.org.uk/guidance/ng115.

7.13.2 Physiotherapy

Respiratory physiotherapy is a specialised area of care which has three main aims:

- to help reduce the work of breathing associated with respiratory disease
- to help restore patients' maximal function
- to help improve peripheral and respiratory muscle weakness

Core treatments delivered by physiotherapists include:

Techniques to reduce the work of breathing using for example relaxed breathing control in combination with positioning to maximise the function of the respiratory muscles and enhance diaphragmatic displacement. In chronic asthma, the use of diaphragmatic breathing where an element of dysfunctional breathing was identified, has shown a significant benefit on health related quality of life ⁴⁰⁵. Pursed lip breathing techniques may also be effective in helping patients manage breathlessness although data is limited.

Physiotherapeutic management of dyspnoea may include sputum clearance techniques where copious secretions cause distress. Therapists commonly use the active cycle of breathing technique (ACBT) with forced expirations to enhance expectoration. The use of the forced expiration technique (FET) appears to enhance peripheral mucus transport in patients with normal or high elastic recoil. Where secretions are basal and particularly tenacious gravity assisted drainage with manual chest percussion may aid clearance.

An extensive literature search was undertaken in this area and yielded a hit rate of 314 studies. 286 of these were excluded, as they did not focus upon the area for address, papers tended to focus on rehabilitation and / or exacerbations (addressed elsewhere in the guideline) and inspiratory muscle training.

No systematic reviews were found and overall there was generally limited research in this area. Most of the studies identified were of small sample sizes (range 7 to 44 participants). None of the identified trials were UK based. Six of the eight identified randomised controlled studies were excluded due to methodological limitations and also because short-term interventions only were considered ⁴⁰⁶⁻⁴¹¹. A cohort study by Kolaczowski et al. ⁴¹² was also excluded due to limited methodological details being available.

One randomised controlled trial was identified⁴¹³ and one quasi-experimental study⁴¹⁴ that met quality appraisal criteria.

Christensen et al. ⁴¹³1990 in a Danish RCT looked at the long term treatment of chronic bronchitis (N=44) with positive expiratory pressure mask and chest physiotherapy. Diaphragmatic breathing performed through a PEP mask followed by forced expirations and cough was compared to self-administered diaphragmatic breathing followed by forced expirations and cough.

Casciari et al. ⁴¹⁴ undertook a quasi-experimental study (controlled study without randomisation) in an American population, with a sample size of N=22. Effects of breathing retraining in patients with COPD were compared. The intervention group received exercise and breathing training and a comparison group received exercise reconditioning alone.

Evidence statements

Ila

Casciari et al. ⁴¹⁴ found that the respiratory rate in the group receiving breathing retraining at rest decreased from 17.4 breaths per minute (bpm) to 15 bpm after the exercise component (not significant) to 9.7 bpm after the breathing retraining ($p < 0.01$). During maximal exercise, the respiratory rate decreased from 32.6 bpm (baseline) to 30.3 bpm after exercise (non significant) to 23.8 bpm after breathing retraining ($p < 0.05$).

Tidal volume during exercise increased from 800ml at baseline to 910ml after exercise (not significant) to 1,320ml after breathing retraining ($p < 0.05$)⁴¹⁴.

During exercise, PaO₂ increased between exercising and breathing retraining ($p < 0.01$)⁴¹⁴.

After 9 weeks, PaO₂ and base excess differed significantly between the two groups in favour of the breathing retraining group; PaO₂ breathing retraining 77.5 compared to the control group 60.0 (mmHg)⁴¹⁴.

There were no significant differences in exercising respiratory rates or the tidal volume and arterial blood gases during rest and exercise for the group receiving exercise reconditioning only⁴¹⁴.

“The increment in work performance during the final three weeks of the program was significantly higher in the group that received breathing retraining ($p < 0.002$). Data indicate that compared with controls, exercise performance increased significantly in the group of

COPD (update)

COPD participants who received breathing retraining compared to those who received exercise only”⁴¹⁴.

Christensen et al.⁴¹³ compared diaphragmatic breathing performed through a PEP mask followed by forced expirations to self-administered diaphragmatic breathing followed by forced expirations. The PEP group reported significantly less **cough** ($p=0.025$), less **mucus production** ($p=0.013$) fewer **exacerbations** compared to the control group (6 vs. 28).

Ib

There was a significantly lower rate of **antibiotic** use in the PEP group compared to the control ($p<0.05$). The use of **mucoytics** was also significantly lower in the PEP group compared to the control group ($p<0.05$)⁴¹³.

There was a statistically significant difference in the **FEV₁** at one year in favour of the PEP group ($p=0.039$)⁴¹³.

Recommendations

The current recommendations can be found at www.nice.org.uk/guidance/ng115.

7.13.3 Identifying and managing anxiety and depression

COPD leads to disabling and distressing symptoms. Patients often become socially isolated and have to give up activities that they enjoy. These factors may lead to the development of anxiety and or depression. The symptoms and signs of these may be similar to those of COPD itself and may be overlooked. Depression is also relatively common and the two conditions may simply co-exist; however, the presence of depression or anxiety may significantly worsen patients' quality of life. A concurrent depressive disorder may bring the patient into a vicious circle: the depressed mood reduces the patient's ability to cope with the physical symptoms, which become less tolerable. The psychosocial effects of the disease may be enforced by the depressed mood.

Two systematic reviews were identified^{415,416}. One⁴¹⁵ examined the prevalence of depression in COPD, the other⁴¹⁶ examined psychologically-based interventions to reduce anxiety and panic in patients with COPD. 2 additional RCTs were critically appraised one with $n = 36$ ⁴¹⁷ and the other with $n = 56$ ⁴¹⁸ but this was rejected because of methodological limitations. One randomised self-controlled crossover trial was critically appraised⁴¹⁹ and 3 case-controlled studies⁴²⁰⁻⁴²², 2 uncontrolled cross-sectional cohort studies^{423,424} and 4 uncontrolled longitudinal cohort studies^{87,425-427} were critically appraised. One of the case controlled studies⁴²⁰ and two of the cohort studies^{426,427} were rejected because of methodological limitations.

Factors for consideration within this topic include:

- considerable pre-screening of patients
- the majority of studies are cohort studies with poor methodology
- small patient populations in some studies
- studies are in a number of different settings; outpatient, inpatient, community
- a number of different rating scales with different thresholds for depression are used in studies (see identification of depression section below)
- the majority of studies are uncontrolled
- participants baseline FEV₁ varies considerably i.e. patients have different severity of COPD.

Evidence statements

Overall prevalence of anxiety and depression

In the systematic review of 10 case-control and uncontrolled trials⁴¹⁵ the methodologically best-rated studies did not find a statistically significant difference in the **prevalence** of depression between patients with COPD and controls. III

A striking difference in prevalence of depression was seen between studies (between 6% and 42%).

Van Manen et al.⁴²¹ (case-control (n=521)) found, 21.6% of COPD patients had a score of 16 or more on the CES-D scale compared with 25% of patients with severe COPD (FEV <50%), 19.6% of those with mild to moderate COPD (FEV 50-80%), and 17.5% of the controls. IIb

Results were adjusted to account for demographic variables and co morbidity. In the multivariate analysis there appeared to be no risk for depression in the total group of COPD patients (OR 1.5, 95% CI 0.8 to 2.6) or in the subgroup of patients with mild to moderate COPD (OR 1.1, 95% CI 0.5 to 2.1).

Patients with severe COPD had a 2.5 times greater risk for depression than controls (OR 2.5, 95% CI 1.2 to 5.4).

Lacasse⁴²⁴ in a cross-sectional cohort (n = 109)) found that 62 (57%; 95% CI: 47 to 66) patients with COPD presented significant **depressive symptoms** (GDS score: 11-19). III

In addition, 20 patients (18%; 95% CI: 12 to 27) were severely depressed (GDS > 20/30).

Yohannes ⁴²³(cross-sectional cohort (n = 137)) found that 25 (18%) of patients were **clinically anxious** and 57 (42%) were **clinically depressed**. Twenty-one of the 57 depressed COPD participants (37%) had a clinical anxiety score > 3 whereas four of the 80 non-depressed COPD participants (5%) had a clinical anxiety score > 3. (p<0.001).

III

In the depressed elderly COPD population, 17 (30%) were mildly depressed (MADRS score 7-19); 39 (68%) were moderately depressed (MADRS score 20-34) and one (2%) was severely depressed (MADRS score 35-60)⁴²³.

The most powerful predictor of severity of anxiety was MADRS (the more depressed patients being more likely to suffer anxiety)⁴²³.

Relationship of depression to severity of COPD

Van Manen ⁴²¹ (case-control (n = 521)) found that 21.6 compared with 25% of patients with **severe** COPD (FEV <50%)% had a score of 16 or more on the CES-D scale, compared with 19.6% of those with **mild to moderate** COPD (FEV 50-80%), and 17.5% of the controls.

IIb

Results were adjusted to account for demographic variables and co morbidity. In the multivariate analysis there appeared to be no risk for depression in the total group of COPD patients (OR 1.5, 95% CI 0.8 to 2.6) or in the subgroup of patients with mild to moderate COPD (OR 1.1, 95% CI 0.5 to 2.1)⁴²¹.

Patients with severe COPD had a 2.5 times greater risk for depression than controls (OR 2.5, 95% CI 1.2 to 5.4)⁴²¹.

COPD (update)

The risk of depression was significantly increased in patients with a reversibility FEV_1 of < 1.1% predicted (OR 3.7, 95% CI 1.3 to 11)⁴²¹.

Lacasse⁴²⁴ (cross-sectional cohort (n = 109)) found that depression scores correlated with 7 of the 8 domains of the **SF-36**. Depression was associated with a substantial impairment in psychological and physical functioning. III

Yohannes⁴²³ cross sectional cohort (n = 137) found that the most powerful predictor of severity of depression was the MRADL score which accounted for 22% of the variance in MADRS (the more disabled patients being more likely to suffer depression). III

Depressed COPD patients (identified by GMS) had poorer **quality of life** scores compared with non-depressed patients (54 ± 1.8 vs. 36 ± 1.2, p = 0.04)⁴²³.

Depressed COPD patients (identified by GMS) had lower mean **MRADL** scores compared with non-depressed patients (9.9 ± 0.7 vs. 14.4 ± 0.5, p = 0.05)⁴²³.

Van Manen⁴²¹ (case-control (n = 521)) found that the risk of depression was significantly increased in patients with COPD with severe impaired physical functioning (OR 5.6, 95% CI 1.6 to 19.9). IIb

Yohannes⁴²³ cross sectional cohort (n = 137) found that depressed COPD patients (identified by GMS) had higher prevalence of hospital admission episodes within the previous 12 months compared with non-depressed patients (34/57 (60%) vs. 28/80 (35%), p = 0.007). III

COPD (update)

Mean inpatient days of hospitalisation for depressed was 9.8 ± 1.7 and non-depressed was 2.3 ± 0.6 days ($p < 0.0001$)⁴²³.

Yohannes⁸⁷ (uncontrolled longitudinal cohort study (n = 137)) found that depression scores and QOL scores do not predict **mortality**. IIb

Identification of depression and anxiety in COPD patients

The Brief Assessment Schedule Depression Cards (BASDEC) has been validated in patients with COPD including those over 60 years of age^{87,422,423}. IIa

Other scales that have been used are: III

- Hospital Anxiety and Depression Scale (HADS)⁴²⁸
- Geriatric Depression Scale⁴²⁴
- Geriatric Mental State Schedule⁴²³
- Montgomery Asberg Depression Rating Scale⁴²³
- Centre for Epidemiological Studies Depression Scale (CES-D)⁴²¹
- Clinical Global Improvement Scale⁴¹⁷
- Hamilton Depression Rating Scale (HAM-D)⁴¹⁷
- Patient Related Anxiety Scale⁴¹⁷

Management (pharmacological/non-pharmacological) of anxiety and depression in COPD patients

COPD (update)

There is a lack of evidence that **psychologically based interventions** reduce anxiety in COPD ⁴¹⁶. la

Borson et al. ⁴¹⁷ (RCT (n = 36)) found that **Nortriptyline** treatment was superior to placebo for treatment of depression. Ib

CGI rating showed that 10/13 (77%) patients receiving active drug experienced a sustained improvement in mood disorder compared with 2 out of 17 (12%) patients taking placebo ⁴¹⁷.

Scores on the HAM-D improved by 60% in the nortriptyline group (29.6 ± 7.6 to 12.6 ± 6.9) compared with 17% (29.5 ± 6.4 to 22.8 ± 11.3) in the placebo group (p = 0.01)⁴¹⁷.

Nortriptyline treatment was accompanied by marked improvements in anxiety. Anxiolytic effects of nortriptyline were reflected by a 45% reduction in mean score on the pRAS (54.3 ± 17 to 29.9 ± 11.4) compared with only 4% improvement (47.4 ± 21.5 to 45.3 ± 28.6) in patients receiving placebo (p<0.005)⁴¹⁷.

Oxygen therapy improved anxiety but not depression in a small subgroup of patients who were hypoxic ⁴²⁹. Ila

Yohannes ⁴³⁰ found that patient uptake of fluoxetine was poor (14 out of 57 patients aged 60-89 years). The reasons for refusing treatment varied but were largely due to misapprehension by the patient. III

GDG consensus statements

The presence of depression or anxiety may be overlooked in patients with COPD because of the overlap of many of the symptoms of these conditions and COPD. IV

A number of assessment tools have been used to identify anxiety and depression in patients with COPD. Many of these were not designed to be used in, and have not been validated for use in patients with chronic disease. IV

Depression and anxiety are more common in patients with severe COPD and particularly in those who are hypoxic or severely dyspnoeic than in normal individuals. IV

The patient's acceptance of treatment may be influenced by the way in which the diagnosis is presented to the patient and by a discussion about the reasons for their concern about starting treatment. IV

Recommendations

The current recommendations can be found at www.nice.org.uk/guidance/ng115.

7.13.4 Nutritional factors

Many patients with COPD lose weight as a consequence of decreased food intake as a result of breathlessness, altered absorption as a result of hypoxia and increased resting energy expenditure as a result of the increased work of breathing⁴³². The mechanisms of this remain unclear but probably relate to systemic effects of cytokines, particularly TNF- α ⁴³³.

There has been some interest in the consequences of this weight loss, particularly whether it is an independent predictor of outcome, and whether interventions are effective both at increasing weight and influencing outcome.

One systematic review was identified⁴³⁴ that compared oral, enteral or parenteral nutritional support (nutritional support was defined as any caloric supplementation given for more than two weeks) with placebo or usual diet or other treatment regimens such as anabolic substances.

Two additional randomised controlled trials were critically appraised^{435,436} and 14 cohort studies were critically appraised⁴³⁷⁻⁴⁵⁰, all but two of these^{449,450} had methodological limitations and hence were subsequently excluded.

Factors for consideration within this topic include:

- considerable pre-screening of patients
- the majority of studies are cohort studies with poor methodology
- small patient populations in some studies
- studies are in a number of different settings; outpatient, inpatient, community
- not yet established which outcome best predicts nutritional status (weight, BMI, fat free mass etc)
- the majority of studies are uncontrolled
- some studies rely on patient recall of diet and weight.

Evidence statements

Landbo⁴⁴⁰ (uncontrolled cohort study n = 2132) found that there was an independent effect of Body Mass Index (BMI) on **survival**, with significantly higher mortality seen in underweight participants than in those of normal weight.

IIa

The effect of BMI on **all-cause mortality** is dependent on the stage of COPD. A significant effect of BMI on all-cause mortality was present only in participants with severe COPD (FEV₁ %pred <50) in whom mortality was lowest in the obese and increased with decreasing BMI (p<0.001)⁴⁴⁰.

COPD mortality was highest in underweight participants and decreased for increasing BMI in both men and women (p<0.001). The impact of BMI on COPD mortality was stronger than that on all-cause mortality, with RRs between the lowest and highest BMI of 5.56 (range 2.47 to 12.54) and 7.17 (range 2.45 to 21) in men and women respectively⁴⁴⁰.

Schols⁴⁴⁸ (survival analysis – retrospective n = 400) found that **survival** was significantly decreased in both underweight and normal weight patients as compared with overweight and obese patients (p<0.0001).

IIb

Marquis⁴⁴¹ (uncontrolled cohort n = 142) found that a midhigh muscle cross-sectional area obtained by CT scan (MTCSAct) <70 cm² was associated with a fourfold increase (95% CI, 1.52 to 8.09) in **mortality** rate, independently of any other variables (p = 0.004).

IIb

Compared with patients with an FEV >50% predicted and a MTCSAct > 70 cm², those with an FEV < 50% predicted and a MTCSAct > 70cm² had a **mortality** odds ratio of 3.37 (95% CI 0.41 to 28), whereas patients with an FEV <50% predicted and a MTCSAct < 70cm² had a mortality odds ratio of 13.16 (95% CI, 1.74 to 99.20)⁴⁴¹.

COPD (update)

In all three stages of COPD the highest mortality was found in underweight participants. In participants with severe COPD mortality continued to decrease with increasing BMI, with an RR of 7.11 (range 2.97 to 17.05) in underweight compared with obese participants. A similar but weaker association was found in participants with mild and moderate COPD as defined in the study⁴⁴¹.

Schol⁴⁴⁸ (post hoc analysis of prospective study) found that a history of weight loss was significantly related to decreased **survival** ($p < 0.005$).

IIb

Weight gain ($> 2\text{kg}/8\text{wk}$) in depleted and non-depleted patients with COPD was significantly associated with decreased mortality risk⁴⁴⁸.

Prescott⁴⁴² (uncontrolled cohort study $n = 1612$) found that among participants with COPD, all-cause mortality was increased in participants who lost > 1 BMI unit. An excess mortality was seen in participants who lost > 3 units BMI (~ 10 kg). Mortality in participants who gained weight did not differ significantly from those with a stable weight.

IIb

Effect of weight change on mortality did not differ with severity of COPD. The effect of baseline BMI was U shaped with excess mortality associated with both under and overweight. In participants with mild (FEV_1 % predicted ≥ 70) or moderate (FEV_1 % predicted 50–69), COPD and in participants without COPD, no modification of the effect of baseline BMI was found; however, among patients with severe COPD (FEV_1 % predicted < 50), effect of weight change differed with baseline weight⁴⁴².

In all groups, weight loss was associated with increased mortality; however, normal and underweight participants ($\text{BMI} < 25$) with severe COPD differed from the remaining in experiencing increased survival after weight gain. The reverse was found in the overweight

COPD (update)

and obese (BMI > 25), among whom the best survival was seen in participants who had stable weight or who had decreased their weight⁴⁴².

The highest risks were found in participants who lost weight between examinations, whereas weight increase did not seem to increase risk of COPD-related death. Unlike all-cause mortality, the risk function for baseline BMI was linear with the lowest risk seen in patients who increased their weight⁴⁴².

Sahebji ⁴⁴³ (uncontrolled cohort study n = 126) found that:

IIb

BMI is significantly correlated with diffusing capacity for carbon monoxide (DLCO), FEV₁ and the FEV₁/FVC ratio (p<0.001).

Underweight patients (BMI < 20) are significantly more likely to have abnormally low levels of DLCO compared with normal weight (BMI = 20-27) and overweight patients (BMI>27) (p<0.001).

Underweight patients (BMI < 20) are significantly more likely to have lower FEV₁ and FEV₁/FVC compared with normal weight (BMI = 20-27) and overweight patients (BMI>27) (p<0.001).

Underweight (BMI < 21 kg/m²) patients with COPD are more dyspnoeic than normal weight (BMI 21-28 kg/m²) (p = 0.03) -
Dyspnoea scale normal weight 2.5 ± 1.2 vs. underweight 3.1 ± 0.9.

Carbon monoxide diffusing capacity (DLCO) was significantly lower in underweight compared with normal weight patients – DLCO % predicted normal weight 57 ± 17 vs. underweight 36 ± 11 (p<0.001).

Maximum inspiratory pressure (P_{imax}) was significantly lower in underweight patients compared with normal weight patients.
P_{imax} cmH₂O normal weight 66 ± 19 vs. underweight 55 ± 18 (p = 0.02). P_{imax} % predicted normal weight 62 ± 17 vs. underweight 52 ± 17 (p = 0.03).

COPD (update)

Gray-Donald ⁴⁴⁵ (uncontrolled cohort study n = 135) found that in underweight COPD participants **peak exercise performance** and **ventilatory muscle strength** are decreased. IIb

Submaximal exercise performance, dyspnoea and overall quality of life are not affected⁴⁴⁵.

Schols ⁴⁴⁶ (uncontrolled cohort study n = 255) after stepwise analysis on total group of patients (normal weight and underweight) established that the functional measures Pimax, maximal expiratory pressure (Pemax) and 12 minute walking distance were better predicted by FFMPIBW (fat-free mass as a percentage of ideal body weight) than PIBW (percent ideal body weight). IIb

Baarends ⁴³⁸ (uncontrolled cohort study n = 62) found that peak VO₂ correlated significantly with the FFM index (kg/m²; r = 0.57, p<0.001) BMI (kg/m²; r = 0.56, p<0.001) and intracellular water (kg/m²; r = 0.54, p<0.001). IIb

Depletion of FFM contributes to a blunted VT (tidal volume) and decreased peak oxygen pulse in response to peak exercise (multiple regression analysis)⁴³⁸.

Stepwise analysis demonstrated that the fat free mass index and transfer factor for carbon monoxide (T_LCO) explained 53% of the variation in peak VO₂⁴³⁸.

Marquis ⁴⁴¹ (uncontrolled cohort n = 142) also found that a midhigh muscle cross-sectional area obtained by CT scan (MTCSAct) <70 cm² was associated with a fourfold increase (95% CI, 1.52 to 8.09) in mortality rate, independently of any other variables (p = 0.004). IIb

COPD (update)

Engelen ⁴³⁹ (uncontrolled cohort n = 72) found that depleted patients are more likely to exhibit lower values for respiratory and peripheral skeletal muscle strength than nondepleted patients. IIb

Measures of muscle strength were lower in the depleted group, but only the difference in handgrip strength reached statistical significance ($p < 0.01$)⁴³⁹.

Sahebji ⁴⁴³ (uncontrolled cohort study n = 126) found that 46.8% of COPD patients (n = 126) had nutritional abnormalities (i.e. underweight BMI $< 20 \text{ kg/m}^2$ = 23% and overweight BMI $> 27 \text{ kg/m}^2$ = 23.8%). IIb

Schols ⁴⁴⁶ (uncontrolled cohort study n = 255) found that depletion of body weight, fat-free mass and muscle mass is most pronounced in patients suffering from chronic hypoxemia and in normoxic patients with severe airflow obstruction (FEV $< 35\%$) but also occurred in 25% of patients with moderate airflow obstruction. IIb

Prescott ⁴⁴² (uncontrolled cohort study n = 1612) found that in females, baseline BMI was lower in people with impaired lung function ($p = 0.009$) whereas no difference was found in males. IIb

In both females and males, weight changes differed with lung function with mean weight loss seen in participants with poorest lung function and mean weight gain seen in participants without airways obstruction ($p < 0.001$)⁴⁴².

The proportion of participants that lost > 1 unit BMI ($\sim 3.8 \text{ kg}$) increased with decreasing lung function reaching 35.3% and 27.4%, respectively in females and males with severe COPD. ($p < 0.001$)⁴⁴².

Gray-Donald ⁴⁴⁵ (uncontrolled cohort study n = 135) found that 24.4% of COPD participants had % IBW of $< 90\%$. IIb

COPD (update)

86% of those with a weight of <80% IBW and 60% of those with weight < 90% had an abnormally low triceps skin fold thickness (TSF) (< 60% standard)⁴⁴⁵.

Among underweight participants (IBW <90% predicted), 32% reported weight loss of > 5% in the last year⁴⁴⁵.

When compared with their usual weight, 81% of underweight participants had lost > 10% body weight, with self-reported weight losses of as much as 43%⁴⁴⁵.

The mean weight loss from usual weight in the underweight group was 17% (13%)⁴⁴⁵.

IIb

The systematic review / meta-analysis⁴³⁴ (n = 277 participants) found that there was no evidence from this analysis that simple nutritional support had any significant effect on anthropometric measures, lung function or exercise capacity in patients with stable COPD.

Ia

Otte ⁴³⁵ (RCT (n = 28)) found that nutritional supplementation produced weight gain (fed mean 1.5kg vs. 0.16kg control p<0.01) in malnourished patients with pulmonary emphysema, but it did not change other indices of well-being.

Ib

Schols ⁴⁴⁸ (survival analysis (n = 603)) found that nutritional intervention resulted in a significant increase in weight, fat-free mass and fat-mass whereas no significant changes in any of these parameters were seen in the placebo group.

IIb

COPD (update)

Relative to a similar body weight gain as the group receiving nutritional support only, the anabolic steroids group showed a larger increase in fat-free mass and maximal inspiratory mouth pressure without causing adverse side effects⁴⁴⁸.

On the basis of weight change > 2kg/8wk, 50% of the treated patients were characterised as responders, including 24% of placebo group⁴⁴⁸.

In 62% of the patients an improvement in Pimax was shown⁴⁴⁸.

Weight gain in depleted and non-depleted patients with COPD was significantly associated with decreased mortality risk⁴⁴⁸.

GDG consensus statements

BMI may be less reliable as an index of nutritional status in older patients because of age-related changes in height, posture and ratio of fat to muscle. In these patients changes in weight, particularly if greater than 3kg should be noted and acted upon. IV

Exercise may augment the effects of nutritional supplementation on weight gain. IV

Recommendations

The current recommendations can be found at www.nice.org.uk/guidance/ng115.

7.13.5 Palliative care

Palliative care is the active total care of patients and their families by a multiprofessional team when the patient's disease is no longer responsive to curative treatment. It is similar, but distinct from terminal care. Although traditionally linked to cancer, it is increasingly recognized that palliative care has a role for patients dying from non-cancer conditions including COPD.

The management of severe COPD has a large palliative element and focuses on symptom control and optimising quality of life.

Among its principles, palliative care promotes open communication between doctor and patient, which includes access to information about diagnosis and prognosis where appropriate. The prognosis for some patients with COPD can be very poor: a recent audit of

COPD (update)

1400 patients admitted to hospital with an exacerbation of COPD showed that 14% had died within 3 months^{449,452}. However, for most patients with COPD, the interval from diagnosis to death may be many years, so that choosing the right moment to discuss the prognosis of the disease and the patient's views on issues such as ventilatory support or advance directives can be difficult.

There was limited evidence about palliative care approaches in COPD. One Cochrane systematic review was identified³⁵¹ and four qualitative studies^{449,453-456}.

The systematic review³⁵¹ looked at opioids for the palliation of breathlessness in terminal illness. Although 14 RCTs were specifically related to a COPD population, there were limitations with these studies: including small sample sizes varying from 6 to 18 patients and variable time durations to drug interventions ranging from one off dose of drug through to 2 week periods. All of the COPD studies utilised a cross over design but were subject to variable washout periods.

The GDG acknowledge that palliative care is a difficult area in which to conduct research.

Evidence statements

A statistically significant effect of opioids was demonstrated for **breathlessness** using non-nebulised opioids, SMD -0.40 (-0.63 to -0.17), $p=0.0006$. However this was a heterogeneous population that was inclusive of both COPD and cancer patients⁴⁵⁷. 1a

There was no statistically significant effect for breathlessness in the studies using nebulised opioids.

In a subgroup analysis of nine COPD studies there was no statistically significant difference for breathlessness between the treatment and control group, SMD -0.26 (-0.44 to 0.08) $p=0.0042$ ⁴⁵⁷. 1a

COPD (update)

The four other identified studies were of a qualitative nature in their design.

Heffner ⁴⁵⁶ used a cross sectional descriptive questionnaire in the USA to assess the attitudes of N=105 patients in a pulmonary rehabilitation program with chronic lung conditions about end-of-life decision-making. 87% of the sample constituted people with COPD.

Sullivan ⁴⁵⁴ interviewed fifteen respirologists in a Canadian study to elicit what physicians told end-stage patients with COPD about intubation and mechanical ventilation.

Rhodes ⁴⁵⁵ in a UK study interviewed nine relatives of end-stage COPD deceased patients and although this represents a small sample size it does provide useful insights derived from narrative thematic experiences. The potential limitation of this study is that due to the limited sample size it may be unrealistic to generalise the experiences outside of the one UK Health Authority area from which it was derived.

Elkington ⁴⁵³ conducted a questionnaire survey of General Practitioners of one inner London Health Authority (N=389) to establish the role that discussions of prognosis play in GP's management of patients with severe COPD.

It was not possible to derive the same type of evidence statements from these qualitative studies as from RCTs but several important themes were identified.

Emergent Themes

Areas identified by Heffner ⁴⁵⁶ in a USA population included; patient interest in Advance Directives (AD), patient-doctor discussion about end-of-life issues and patient's interest in decision-making.

III

COPD (update)

Patient interest in Advanced Directives (ADs)

89% of patients stated that they would be interested in learning more about Advanced Directives whilst 69% wanted to learn more explicit details about intubation and mechanical ventilation.

Patient doctor discussions about end-of-life issues

99% of patients stated that they would find discussions with physicians about ADs, intubation and mechanical ventilation acceptable. Despite their stated interests, only 19% had already discussed AD with physicians and only 15% had had discussion about life support interventions.

There was a 50:50 split regarding whether patients thought physicians should initiate discussions or wait until patients initiated these discussion about ADs. However the data showed that waiting for the physician to initiate the discussion was an ineffective strategy; of the 20 patients who already had discussions about ADs, 19 of these had initiated these discussions themselves.

Patient interest in decision making

Most patients wished to actively participate in decision about life support. In the circumstances of being hospitalised with a serious illness 72% stated that they would want to decide themselves about life support.

Sullivan ⁴⁵⁴ highlighted emergent themes from a population of Canadian physicians which included; timing of the discussion, importance of “knowing” the patient, content of the discussion, framing the information, decision difficulty, style and delivery of discussion.

III

COPD (update)

Timing of the discussion

There was agreement that an intubation and mechanical ventilation (MV) discussion should be initiated when a patient is in a stable condition.

Importance of “knowing” the patient

Knowing the patient allowed physicians to determine the patient’s perceptions of their quality of life, satisfaction with current functioning and expectations in life. All of the 15 physicians interviewed used a combination of these factors in their decisions making.

Content of the discussion

Discussions included a tube being placed down the patient throat with emphasis on discomfort and inability to eat or speak. Regardless of whether the patient chose to be intubated the availability of analgesia was discussed. Content of discussion also included that following intubation and mechanical ventilation the best a patient may hope for was return to their pre exacerbation state of health. “Death” was not stressed by name in initial discussions.

Framing the information

Information was usually framed according to the physician’s clinical judgement. The physician would take into account how successful the mechanical ventilation outcome was likely to be including eventual quality of life. A negatively framed physician discussion included palliative care.

COPD (update)

Decision difficulty

80% of physicians highlighted the importance of family in facilitating the decision making process.

Style and delivery of discussion

Content of the narrative was similar although the style and delivery of the information varied between physicians.

Rhodes ⁴⁵⁵ identified the following themes; quality of life, services in the community, adaptations and equipment, informal care, after death support and meeting needs.

III

Relatives reported that **quality of life** in the year before death was often very low.

Regarding **services in the community**, there was little contact with the community nursing service or social workers, none had been offered or used day care.

Those transferring home from hospital were assessed for **home adaptations**, aids and equipment, similar assessments for those who had not had a hospital admission were patchy. The central role of the GP in gaining access to services was reiterated. Often services were provided too late to be of benefit.

Many of the **informal caregivers** were elderly persons themselves and had their own health problems. None of those interviewed seemed to realise that their relative's illness had been terminal.

After death support was identified as a theme. Bereaved people within the sample as a whole valued being able to talk to their GP, ask questions and talk through the illness and death. Those who received a post-death visit or letter appreciated it. A follow-up form from a district nurse was also appreciated.

In relation to **meeting needs** much of the care for this group was described as being through crisis intervention and hospital admission.

Elkington ⁴⁵⁸ highlighted descriptive percentages from 214 UK GPs relating to discussions of prognosis in severe COPD.

III

82% of respondents agreed that GPs have an important role in discussions of prognosis. 37% of GPs agreed that they found it hard to start the discussions about prognosis with patients (and 30% of GPs stated that they left it for patients or their relative to raise the subject of prognosis).

67% stated that they found it difficult to predict prognosis for individual cases (45% of GPs stated that there was insufficient information about COPD patients in the GP records to discuss prognosis with them).

GDG Consensus statement

Opioids, benzodiazepines, tricyclic anti-depressants and major tranquilizers are useful in palliating symptoms in patients in the end stages of COPD.

IV

COPD (update)

Oxygen may also be used to palliate breathlessness not relieved by other therapies (see section 7.6).

IV

Patients dying with COPD can benefit from the services of multidisciplinary palliative care teams, including admission to hospices.

IV

Recommendations

The current recommendations can be found at www.nice.org.uk/guidance/ng115.

7.13.6 Assessment for occupational therapy

The prevalence of respiratory disability in moderate and severe COPD is high. Respiratory disease has been recognised for many years as the second commonest cause of major disability in elderly people ⁴⁵⁹, and the vast majority of respiratory disability is due to COPD. Despite this the level of community support provided to patients disabled by COPD is low. It compares unfavourably with that provided to patients with similar or even lower levels of disability caused by musculoskeletal or neurological problems ^{459,460}. This may be in part the result of a lack of recognition of disability by healthcare professionals. Patients with respiratory disability do not carry an obvious 'badge' of disability such as a walking frame or a hemiparesis that marks them out (at rest) as someone in potential need of support. Until recently there has been a lack of appropriate assessment tools validated for the measurement of activities of daily living (ADL) (as opposed to quality of life) in patients with respiratory disease. Two such tools have recently been devised and validated independently ⁴⁶¹⁻⁴⁶⁴ and can be used for the global assessment of patients. An assessment tool has been developed to assess patients needs for occupational therapy ⁴⁶⁵ but this has not been validated specifically in patients with COPD.

ADL assessment, whether by questionnaire or formal occupational therapy review may take place in the outpatient setting, but commonly occurs towards the end of an inpatient stay during an exacerbation. Even when assessment has previously been performed in the stable outpatient situation it should be repeated in inpatients, particularly if patients have previously demonstrated borderline coping abilities when clinically stable. Such patients may need temporary or even permanent domiciliary support on discharge. It is well recognised that disability level is a predictor of recurrent hospital admission for COPD, though it remains unclear whether alleviation of disability or provision of appropriate support reduces admission frequency.

Occupational therapy may be relevant across the spectrum of COPD, including:

- recently diagnosed patients
- during exacerbations
- during pulmonary rehabilitation
- as part of palliative care.

GDG consensus statements

Assessment tools such as the Manchester Respiratory Activities of Daily Living (MRADL) questionnaire⁴⁶¹, the London Chest Activity of Daily Living scale (LCADL)⁴⁶⁴ or the Canadian Occupational Performance Measure (COPM)^{465,466}, can be used to formally assess patients need for occupational therapy. IV

Occupational therapy assessment of patients needs may take place as part of a programme of respiratory rehabilitation, and should certainly form part of a multidisciplinary assessment and planning package prior to discharge from hospital. IV

Recommendations

The current recommendations can be found at www.nice.org.uk/guidance/ng115.

7.13.7 Social services

Patients and their carers may be entitled to claim benefits including benefits for people who cannot work and benefits for the extra costs of disability. It may be possible to receive more than one benefit at a time. As well as benefits, patients may be entitled to disabled person's tax credit (DPTC), which is not a benefit: it is a payment from the Inland Revenue for disabled people who work. DPTC is payable in addition to benefits, for example, disability living allowance, but it depends on a person's income.

Information on benefits can be obtained from The Benefits Agency telephone help line which provides information on benefits for sick and disabled people and carers. The help line can also arrange for a person to ring a claimant adviser to help them with forms completion for disability living allowance and attendance allowance.

Benefits Enquiry Line: 0800 882200

Minicom: 0800 243355

Website: www.dwp.gov.uk

Patients and their carer can also obtain advice from the Citizens Advice Bureau and The British Lung Foundation also produces a leaflet describing the benefits that may be available for patients with COPD.

GDG consensus statements

There is a greater access to financial benefits for patients aged under 65 years. IV

The processing time for many applications for financial and social assistance reduces the potential benefits for many patients. IV

Recommendations

The current recommendations can be found at www.nice.org.uk/guidance/ng115.

7.13.8 Advice on travel

Recommendations for patients planning air travel are contained in BTS guidelines⁴⁶⁷. Information about other modes of transport and details about specific airlines policies are available from the British Lung Foundation and are summarised in their leaflet “Going on Holiday with a lung condition”. The four general points contained in this leaflet are included below and the BTS recommendations on assessment of fitness to fly have been adopted.

Modern aircraft are pressurised to cabin altitudes up to 2438 m (8000 ft) and at this altitude the partial pressure of oxygen will have dropped to the equivalent of breathing 15.1 % oxygen at sea level. Arterial oxygen tensions fall in healthy passengers and altitude exposure will exacerbate hypoxaemia in patients with COPD, particularly those who are hypoxaemic at sea level. The physiological compensations for acute hypoxaemia at rest are mild to moderate hyperventilation (lowering of arterial carbon dioxide tension (Paco₂) moderates the hyperventilation) and a moderate tachycardia but the clinical significance of temporary altitude induced hypoxaemia in patients with COPD is unclear. The BTS Working Party concluded, “The available controlled studies involve relatively small numbers of patients with stable disease and no co-existing medical problems. Simulated altitude exposure did not generally exceed 1 hour. These studies also largely excluded additional stressors such as exercise, dehydration, sleep, and active smoking. The only report to study exercise suggested that FEV₁ <50% predicted is a risk factor for desaturation.”

The BTS Working Party also noted “COPD patients with large bullae are theoretically at increased risk of pneumothorax as a result of volume expansion at reduced cabin pressures. The volume of gas in a non-communicating bulla will increase by 30% on ascent from sea

level to 2438 m (8000 ft). There is one case report of fatal air embolism in a patient with a giant intrapulmonary bronchogenic cyst⁴⁶⁸. However, there are no data to state with any confidence what the maximum volume of a bulla should be before it reaches an unacceptable level of risk of rupture leading to tension pneumothorax, pneumomediastinum, or air embolism.”

GDG consensus statements

The following points are important for patients with COPD who are considering travel: IV

- plan in advance
- be realistic
- shop around because of variability in the cost and availability of support (especially oxygen) and the regulations of different airlines, train, coach and ferry companies.
- ask questions
- travel with all necessary medication
- ensure necessary medication is accessible during journeys.

Fitness to fly can be assessed by an initial measurement of arterial oxygen saturation using a pulse oximeter, combined with history and examination (with particular reference to cardiorespiratory disease, dyspnoea, and previous flying experience) and the results of spirometry. IV

Depending on the results of the initial assessment a hypoxic challenge test may be necessary (see Table 7.6). IV

Table 7.6 Results of initial assessment

Screening result	Recommendation
Sea level SaO ₂ >95%	Oxygen not required [B]
Sea level SaO ₂ 92-95% and no risk factor*	Oxygen not required [C]
Sea level SaO ₂ 92-95% and additional risk factor*	Perform hypoxic challenge test with arterial or capillary measurements [B]
Sea level SaO ₂ <92%	In-flight oxygen [B]
Receiving supplemental oxygen at sea level	Increase the flow while at cruising altitude [B]

*Additional risk factors: hypercapnia; FEV <50% predicted; lung cancer; restrictive lung disease involving the parenchyma (fibrosis), chest wall (kyphoscoliosis) or respiratory muscles; ventilator support; cerebrovascular or cardiac disease; within 6 weeks of discharge for an exacerbation of chronic lung or cardiac disease.

Recommendations

The current recommendations can be found at www.nice.org.uk/guidance/ng115.

7.13.9 Education

This section was updated and replaced in 2018. See www.nice.org.uk/guidance/ng115/evidence for the 2018 evidence reviews.

7.13.10 Self-management

This section was updated and replaced in 2018. See www.nice.org.uk/guidance/ng115/evidence for the 2018 evidence reviews.

7.14 Fitness for general surgery

Due to the time limitations within the guideline development process and the fact that these questions address a topic at the periphery of the guideline a full literature search and critical appraisal process was not undertaken in this area. However, a MEDLINE search, a selective review of frequently cited papers and key review articles were undertaken as part of the development of a background paper for discussion by the guideline development group. See section 2 for the methodology.

Patients with COPD appear to have an increased risk of post-operative pulmonary complications (3.0 fold for unselected surgery and 4.7 fold for thoracic or abdominal surgery⁴⁸⁴). The risk may increase with increasing “severity” of COPD, but it also depends on duration of anaesthesia and nature of surgery. The GDG was aware of the conclusions of the National Confidential Enquiry into Perioperative Deaths (NCEPOD), particularly their report and recommendations relating to deaths in elderly patients⁴⁸⁵.

GDG consensus statements

Pulmonary risk factors alone do not predict the risk of post-operative pulmonary complications.	IV
FEV ₁ on its own has little clinical usefulness in predicting post-operative pulmonary complications ⁴⁸⁶⁻⁴⁸⁸ .	III
Composite assessment tools such as the widely used ASA scoring system ⁴⁸⁹ can be used to assess operative risk and plan patients' management.	IV

Recommendations

The current recommendations can be found at www.nice.org.uk/guidance/ng115.

7.15 Follow-up of patients with COPD

Throughout the course of the disease, the management of COPD is likely to be shared between health care professionals in both primary and secondary care. Most patients with mild and moderate symptoms and those who are not experiencing frequent exacerbations will be managed predominately in primary care. Follow-up of patients with more severe disease will also be predominantly in primary care but there will also be a need for access to secondary care services. Patients with severe COPD are likely to have frequent exacerbations leading to hospital admissions. They often have complex problems with co-morbidities, may be on high levels of treatment, and need monitoring for LTOT.

Clinicians in primary care have the skills to assess patients' symptoms and the adequacy of their control, monitor the progression of their disease, identify the development of complications and the need for referral to secondary care or other specialists (see section 6.11 on referral for specialist advice). There are no data to guide decisions on how frequently patients should be reviewed but clearly this will vary according to individual

circumstances and the severity of the patient's disease. Some patients with COPD deteriorate faster than others and it is important to identify these individuals as they need specialist input. Reasons for referral to hospital services are dealt with in Section 6.11.

Many of the recommendations in this section of the guideline are based on expert opinion rather than on the result of research studies, due to the paucity of evidence and difficulty of conducting studies in this area. See section 2 for the methodology underpinning this section. This does not undermine the value or importance of these recommendations, which may have a large impact on the quality of care and outcome for the person with COPD and their carers. The GDG's consensus statements are broadly based on statements contained in the BTS COPD Guidelines ⁷¹.

GDG consensus statements

Follow up of patients with mild or moderate COPD ($FEV_1 > 50\%$) will usually take place in primary care. IV

For patients with severe disease, shared care between the hospital and primary care team is the usual pattern although there are no data to show how care should be provided to achieve the best combination of clinical and cost effectiveness. IV

Patients with severe disease requiring interventions such as non-invasive ventilation should be reviewed regularly by specialists. IV

COPD (update)

Recommendations

The current recommendations can be found at www.nice.org.uk/guidance/ng115.

8 Management of exacerbations of COPD

8.1 Introduction

Exacerbations, particularly those that result in admission to hospital, are significant events in the natural history of COPD. They are distressing and disruptive for patients, and account for a significant proportion of the total costs of caring for patients with COPD.

Much of the research into the epidemiology, pathology and management of exacerbations has been hampered by the lack of an agreed uniform definition. This is in part due to the inherent difficulties in defining exacerbations⁴⁹⁰. The GDG propose the definition that follows.

8.2 Definition of an exacerbation

An exacerbation is a sustained worsening of the patient's symptoms from his or her usual stable state that is beyond normal day-to-day variations, and is acute in onset. Commonly reported symptoms are worsening breathlessness, cough, increased sputum production and change in sputum colour. The change in these symptoms often necessitates a change in medication.

8.3 Consequences of having an exacerbation

In the UK, hospitalisation or management in a hospital-at-home scheme is a major event in the natural history of COPD, heralding a significant worsening of prognosis. See section 2 for the methodology underpinning this section.

Evidence statements

In patients admitted to hospital in the UK with an exacerbation of COPD a retrospective audit of 1400 admissions has shown that 34% were **re-admitted** and 14% had **died** within 3 months⁴⁵².

III

COPD (update)

In a Spanish study of patients admitted to hospital with an exacerbation of COPD 63% were **readmitted** within 1 year⁴⁹¹. III

The factors associated with an increased risk of readmission were:

- ≥ 3 admissions in the previous year (Hazard Ratio 1.66, 95%CI 1.16 to 2.39)
- FEV₁ % predicted (Hazard Ratio 0.97, 95%CI 0.96 to 0.99)
- PaO₂ (Hazard Ratio 0.88, 95%CI 0.79 to 0.98)
- lower levels of physical activity (Hazard Ratio 1.85, 95%CI 1.16 to 2.94)
- need for an anticholinergic bronchodilator (Hazard Ratio 1.81, 95%CI 1.11 to 2.94)⁴⁹¹.

A study in the USA of patients admitted to an ITU with an exacerbation of COPD (Median FEV₁ = 0.8 l, Mean age = 70, 78% had ≥ 2 co-morbid illnesses) has shown that the 2, 6, 12 and 24 month **mortality rates** were 20%, 33%, 43% and 49% respectively⁴⁹². III

Studies of a cohort of patients observed in the community have shown that **symptoms** and **peak expiratory flow rates** recover slowly after an exacerbation. III

The median (and inter quartile range) for recovery of symptoms was 7 days (IQR 4-14 days) and for recovery of peak expiratory flow was 6 days (IQR 1-14 days).

Recovery of PEFr to baseline was not complete in 24.8% at 35 days and 7.1% at 91 days⁴⁹³.

Studies in the same cohort have shown that patients experiencing frequent exacerbations (more than 2.92 per year) have more rapid III

COPD (update)

lung function decline (40.1 ml/yr (95% CI 38 to 42 ml/yr) -v- 32.1 ml/yr (95%CI 31 to 33 ml/yr) $p < 0.05$)⁴⁹⁴.

Studies in the same cohort have also shown that **health related quality of life** measured using the SGRQ was significantly worse in patients experiencing frequent exacerbations (3 or more per year) (Total score -15.1 (95%CI -22.3 to -7.8, $p < 0.0005$; Symptoms score -21.9 (95%CI -29.7 to -14.0, $p < 0.0005$; Activities score -12.2 (95%CI -21.2 to -5.3, $p < 0.001$; Impacts score -14.1 (95%CI -22.9 to -5.6, $p < 0.002$)⁴⁹⁵.

III

Health economics Evidence statements

The costs of an exacerbation of COPD to the health care system have been estimated by Andersson et al (2002)⁴⁹⁶ and Price et al (1999)⁴⁹⁷ and have been estimated according to the severity of the exacerbation (See also Section 14) and using the severity classification current at that time.

Andersson et al (2002)⁴⁹⁶.

Costs given in SEK, converted to GB£ by using purchasing power parities for 2002 from the OECD (www.oecd.org).

Mild	£7.94
Mild/moderate	£23.43
Moderate	£139.74
Severe	£1,446.48

Price M J et al(1999)⁴⁹⁷.

COPD (update)

Mild	£14.81
Moderate	£95.20
Severe	£1,658.59

The cost of an exacerbation clearly depends on the severity of the exacerbation and there is a considerable difference in cost between a mild exacerbation and a severe exacerbation. This is mostly due to the requirement for hospitalisation for severe exacerbations.

GDG consensus statements

The **long term outcomes** of exacerbations of COPD managed in the community in the UK are not known.

IV

8.4 Causes of an exacerbation

A number of factors are known to cause exacerbations of COPD. Although bacteria can be cultured for the sputum of patients with stable COPD there is evidence that they are also responsible for exacerbations. Viruses are also important aetiological agents, particularly during winter months. Non-infectious agents are also responsible for some exacerbations. See section 2 for the methodology underpinning this section.

GDG consensus statements

The following factors are known causes of exacerbations of COPD⁴⁹⁸.

IV

Infections	Rhinoviruses (common cold)
	Influenza
	Parainfluenza
	Coronavirus
	Adenovirus
	Respiratory Syncytial Virus
	<i>C pneumoniae</i>
	<i>H influenzae</i>
	<i>S pneumoniae</i>
	<i>M catarrhalis</i>
	<i>Staph aureus</i>
	<i>P aeruginosa</i>

Common pollutants	Nitrogen dioxide
	Particulates
	Sulphur dioxide
	Ozone

The cause of the exacerbation may be unidentifiable in up to 30% of exacerbations.

IV

8.5 Symptoms of an exacerbation

Exacerbations may lead to different constellations of symptoms, of varying severity, in different patients. There is no single defining symptom of an exacerbation, but changes in breathlessness, cough and sputum production are common. See section 2 for the methodology underpinning this section.

GDG consensus statements

Exacerbations of COPD can be associated with the following symptoms: IV

- increased dyspnoea
- increased sputum purulence
- increased sputum volume
- increased cough
- upper airway symptoms (e.g. colds and sore throats)
- increased wheeze
- chest tightness
- reduced exercise tolerance
- fluid retention
- increased fatigue
- acute confusion

Chest pain and fever are uncommon features of COPD exacerbations and should prompt a search for other aetiologies. IV

8.6 Differential diagnosis of an exacerbation

Other conditions may present with similar symptoms in patients with COPD. These must be considered and excluded when making a diagnosis of an exacerbation. See section 2 for the methodology underpinning this section.

GDG consensus statements

Other causes of similar symptoms in patients with COPD are:

IV

- pneumonia
- pneumothorax
- left ventricular failure/pulmonary oedema
- pulmonary embolus
- lung cancer
- upper airway obstruction
- pleural effusion
- recurrent aspiration

8.7 Assessment of the severity of an exacerbation

Some exacerbations are mild and self-limiting. These are frequently managed by patients at home without consulting healthcare professionals. Other exacerbations are severe, carry a risk of death and require hospitalisation. A number of factors can be used to assess the severity of an exacerbation. Not all will be present, but the occurrence of any of these should alert the clinician. See section 2 for the methodology underpinning this section.

GDG consensus statements

The following signs are features of a severe exacerbation:

IV

- marked dyspnoea
- tachypnoea
- pursed lip breathing
- use of accessory muscles (sternomastoid and abdominal) at rest
- acute confusion
- new onset cyanosis
- new onset peripheral oedema
- marked reduction in activities of daily living

8.8 Assessment of need for hospital treatment

Most patients with an exacerbation of COPD can be managed at home but a few need hospital treatment. This may be because of the severity of the exacerbation, the need for therapies that are not available to that patient at home (such as oxygen or nebulised bronchodilators), or the need for specialist interventions such as non-invasive ventilation. The decision about referral to hospital involves an assessment of the severity of symptoms (particularly the degree of breathlessness, the presence of cyanosis or peripheral oedema and the level of consciousness), the presence of co-morbidities, whether or not the patient is already receiving long term oxygen therapy, the level of physical functioning, and the patient's ability to cope at home. See section 2 for the methodology underpinning this section.

Recommendations

The current recommendations can be found at www.nice.org.uk/guidance/ng115.

8.9 Investigation of an exacerbation

The diagnosis of an exacerbation is made clinically and does not depend on the results of investigations; however, in certain situations, investigations may assist in ensuring appropriate treatment is given. Different investigation strategies are required for patients in hospital (who will tend to have more severe exacerbations) and those in the community. See section 2 for the methodology underpinning this section.

Changes in lung function at the time of an exacerbation are usually small and are not helpful in routine practice.

Patients may present for the first time with an exacerbation of COPD. In this situation, patients need assessing and their diagnosis confirmed as described in Section 6.

Sending sputum samples for culture in primary care is of very limited value because empirical therapy is effective and should be prescribed promptly if the sputum is purulent.

Recommendations for primary care

The current recommendations can be found at www.nice.org.uk/guidance/ng115.

Recommendations for patients referred to hospital

The current recommendations can be found at www.nice.org.uk/guidance/ng115.

8.10 Hospital-at-home and assisted-discharge schemes

Over the last few years there has been considerable interest in hospital-based rapid assessment units and early discharge schemes for patients with exacerbations of COPD. Rapid assessment units aim to identify those patients that can safely be managed at home with additional nursing and medical input rather than being admitted⁴⁹⁹. Early discharge schemes aim to facilitate the early discharge of patients admitted with an exacerbation of COPD⁵⁰⁰. Rapid assessment units generally involve a full assessment of the patient at the hospital by a multidisciplinary team and discharge to the community with appropriate support. This may include additional equipment (e.g. a nebuliser and compressor or an oxygen concentrator), nursing supervision from visiting respiratory nurse specialists, and increased social service input. Patients remain under the care of the hospital consultant but GPs are made aware of the fact that they are receiving home care. Early discharge schemes aim to identify patients in hospital who could be discharged before they have fully recovered by providing increased support in their homes.

When reviewing the evidence in this area account was taken of the site of assessment together with the length of stay in hospital before transferring home. It was important to distinguish between those schemes that constitute hospital-at-home and those that were referred to as assisted or early discharge. Assisted or early discharge schemes by their very nature involved hospital admission and usually at least one over-night stay.

Four RCTs were found⁵⁰¹⁻⁵⁰⁴, one qualitative study⁵⁰⁵, one survey⁵⁰⁶ and one service evaluation⁴⁹⁹ which were applicable to hospital-at-home care. One RCT⁵⁰⁷ relates to early discharge. All but the qualitative research⁵⁰⁵ and the survey⁵⁰⁶ were situation specific to COPD exacerbations.

The GDG acknowledged that it was difficult to distinguish what constitutes hospital-at-home and early discharge from the papers reviewed and agreed not to make a distinction based on the minimum time spent in hospital. The GDG felt that the important distinction was whether services could be initiated at any time of day seven days per week, with the obvious implications on resources and impact on the primary care.

Evidence statements

There were no significant differences in FEV₁⁵⁰¹⁻⁵⁰⁴ or **readmission rates**⁵⁰¹⁻⁵⁰⁴ between hospital-at-home and home care for patients with COPD exacerbations. There were also no significant differences between the two groups for the **number of days in care**⁵⁰³. lb

There were no significant differences in **mortality** rates between those patients cared for as part of a hospital-at-home scheme and in-patients⁵⁰²⁻⁵⁰⁴. lb

Two studies showed no significant differences between the groups for **HRQL (SGRQ)** (subgroup analysis)⁵⁰², **chronic respiratory questionnaire (CRQ)**⁵⁰¹. One Spanish study showed significant improvement in **SGRQ**⁵⁰⁴. lb

COPD (update)

There were no significant differences between the groups for **symptom scores**⁵⁰³. Ib

In relation to **additional support services** Skwarska et al⁵⁰¹, found that GPs and carers did not differ significantly between hospital-at-home and in-patient care during an 8 wk follow up period. Ib

There were no significant differences in the **satisfaction scores** with the care package for either patient or carers between the two groups⁵⁰³. Ib

Qualitative research, using a grounded theory approach (N=29) in a population of older patients (65 to 89 years) highlighted that the likelihood of surviving illness was the most important **determinant of preference** for home or hospital care in acute illness. For some, home care was seen as a low intensity service. Factors influencing perceptions included social support, self-reliance and past experience with illness⁵⁰⁵. This study is limited by the geographical location of the research (USA) where differences in payment of healthcare systems may affect the patient's preference for site of care. This study is also not specific to COPD patients. III

Cotton et al⁵⁰⁷, N=81 found on an intention to treat basis that a policy of early discharge reduced **in-patient stay** from a mean of 6.1 days (range 1 to 13 days) with conventional management to 3.2 (range 1 to 16) days with an early discharge scheme. This study is limited by its relatively small sample size. Ib

There were no significant differences in the number of patients that were **readmitted** in each group, the number of **additional days readmitted patients spent in hospital** or the **mortality rate**⁵⁰⁷. Ib

Health economics evidence statements

Seven small studies were found. Some studies were specific to patients with severe COPD. Many of the studies had methodological limitations and were not full economic evaluations, they only gave limited details of cost. One study suggested that there was an increase in overall healthcare costs for hospital-at-home. This was mainly because of an increased use of GP services and other primary care resources, as well as the cost of the hospital-at-home care. This means that costs may be shifted to primary care when patients spend fewer days in the hospital and use the hospital-at-home scheme⁵⁰⁸.

There is limited evidence that a hospital-at-home scheme is more expensive than inpatient care, as it shifts resource use to primary care⁵⁰⁸. In a Spanish study based around tertiary referral hospitals, hospital-at-home was cheaper in the short term than conventional care⁵⁰⁴.

There is limited evidence that a supported discharge scheme may be cheaper than usual inpatient care⁵⁰¹.

COPD (update)

Recommendations

The current recommendations can be found at www.nice.org.uk/guidance/ng115.

8.11 Pharmacological management

8.11.1 Inhaled bronchodilators

Increased breathlessness is a common feature of an exacerbation of COPD. This is usually managed by taking increased doses of short-acting bronchodilators. The GDG has not reviewed the evidence for the effects of these drugs in this context but has considered their efficacy as bronchodilators in Section 7.

As well as taking increased doses of bronchodilators at the time of an exacerbation, these drugs may be given using different delivery systems. This is considered in the next section.

8.11.2 Delivery systems for inhaled therapy during exacerbations

Bronchodilators are used to treat the increased breathlessness that occurs during exacerbations. Some patients who normally inhale these drugs from hand held inhalers use nebulised therapy during exacerbations. In this section the evidence underpinning this practice is reviewed. See section 2 for the methodology underpinning this section.

Evidence statement

One meta-analysis was found⁵⁰⁹ of bronchodilator delivery in acute airflow obstruction.

1a

Subgroup analysis of 48 patients from 3 studies with COPD gave a small but non-significant treatment effect size (favouring wet nebulization) of 0.23 (95% CI -0.35 to 0.81)⁵⁰⁹.

GDG consensus statements

Hand-held inhalers (when used with spacer devices and a good inhaler technique) and nebulizers are equally effective in achieving bronchodilation in COPD exacerbations²⁴¹. IV

For low dose bronchodilator therapy - for example, 100-400 mcg salbutamol or terbutaline - treatment with a metered dose inhaler is more convenient whilst a nebuliser can deliver higher doses more easily²⁴⁰. IV

Breathless patients are less likely to be able to inspire slowly or breath hold for optimum lung deposition from a metered dose inhaler²⁴⁰. IV

Nebulizers are widely used in most hospitals because they are regarded as more convenient for healthcare staff to administer and because less patient education or cooperation is required. Based on ERS²⁴¹. IV

This usage does not imply that nebulized therapy is superior and this should be made clear to patients and their relatives²⁴¹. IV

A nebuliser has the advantage of being independent of effort or breathing pattern when a patient is distressed. This means that a patient can begin nebulised treatment using a mask or a mouthpiece while the medical attendant can continue with other tasks. The use of a metered dose inhaler in this situation would require the medical attendant (or respiratory therapist or nurse) to stand by the patient and supervise or administer multiple doses of treatment, possibly more than 20, at one minute intervals²⁴⁰. IV

Nebulised treatment might have a further beneficial effect due to its physical properties. Inhaled droplets may alter mucus viscosity in the airways and nebulised terbutaline or saline may help patients with bronchiectasis to expectorate. Whether this is also true in acute COPD is not known²⁴⁰.

IV

Theoretically a mouthpiece may be better as it avoids nasal deposition of drugs, although no advantage has been found in two small clinical studies in stable asthma and COPD.

IV

Patients may prefer a face mask, especially when acutely breathless, a situation where patients are likely to mouth breathe and thus diminish the theoretical disadvantages of the face mask. A mouthpiece may avoid the risk of ocular complication with anticholinergic agents²⁴¹.

Recommendations

The current recommendations can be found at www.nice.org.uk/guidance/ng115.

8.11.3 Systemic corticosteroids

This section focuses on the area of oral or systemic steroids (excluding inhaled steroids) in relation to exacerbations of COPD. Three systematic reviews were identified⁵¹⁰⁻⁵¹² relating to the use of oral / systemic steroids in the treatment of COPD exacerbations.

The trials within each of the systematic reviews were mostly small to moderate in sample size with short to medium term follow up of a maximum of 6 months. Drug preparations, dosages and routes of administration also varied significantly.

The GDG was aware of methodological limitations in the Bullard et al paper⁵¹³ which was included in the above systematic reviews. After transfer from emergency care blinding was broken and 12 patients (10%) crossed protocol. In addition to this there appeared to be an error in reporting the data for lung function parameters. The results reported being outside of the boundaries of the 95% confidence interval. This error was evident in the PEF_R and FEV₁ data for the non-steroid group. The FEV₁ 0-6 hour data may have been incorporated into the Wood Baker systematic review⁵¹¹ within the FEV₁ meta-analysis. Comments pertaining to this are noted on the Cochrane Internet site within the comments section (McCrory 1999). When reviewing the FEV₁ meta-analysis weighted % the Bullard⁵¹³ data only contributed 7.7%. The other two systematic reviews^{510,512} did not undertake any meta-analysis. Hence the Bullard paper has been excluded from the evidence statements made below.

In addition to the three systematic reviews, one additional randomised controlled trial was found⁵¹⁴ (N=199, 10 days follow-up), using oral prednisolone and a placebo.

The GDG also observed that the dose of steroids used in the North American studies was considerably higher than the doses used in the UK. In addition to this, although there are data on the incidence of acute adverse events, there are no data on the long term consequences of frequent courses of oral steroids.

Evidence statements

Three systematic reviews⁵¹⁰⁻⁵¹² all reviewed virtually the same RCTs. The reviews demonstrated a significant effect in favour of steroids over placebo for **FEV₁ for at least 72 hours**. In the meta-analysis by Wood Baker et al⁵¹¹ of 6 RCTs, the WMD was 120 ml (95% CI; 5ml to 190ml). la

One additional RCT was found⁵¹⁴. This trial also demonstrated significant improvements in **FEV₁ up to 36 hours** with a mean difference of 160ml (95% CI; 9ml to 240ml) in favour of the intervention compared to placebo. lb

Davies et al⁵¹⁵, Niewoehner et al⁵¹⁶ and Thompson et al⁵¹⁷ (all trials included in the systematic reviews) measured FEV₁ at multiple time points over differing time frames. These trials found statistically significant improvements occurred in the first 3 to 5 days of corticosteroid treatment compared to the control.⁵¹⁰ la

Maltais et al⁵¹⁴ and Thompson⁵¹⁷ demonstrated a statistically significant improvement in arterial **PaO₂** in the first 72 hours in favour of the steroid group compared to placebo <0.05. lb

Significantly shorter **duration of hospitalisation** was demonstrated by Niewoehner et al⁵¹⁶ (p=0.03) and Davies et al⁵¹⁵ (p=0.027) in favour of the steroids compared to placebo. lb

In one further study with no objective assessment of fitness for discharge, Maltais⁵¹⁴ found no significant differences in the mean duration of hospitalisation between steroid and placebo groups. lb

A meta-analysis of 5 RCTs found no statistically significant differences between the steroid and control groups for **mortality**⁵¹¹. la

Duration has been updated in 2019 update, not dose

The systematic review by McCrory et al⁵¹⁰ highlighted the current debate around **duration** of steroid treatment and **dose** during COPD exacerbations^{515,516,518}.

la

Niewoehner et al⁵¹⁶ included a randomised comparison between a 2 and 8-week course of systemic corticosteroids. Findings demonstrated that there were no important clinical differences in clinical outcomes between the two courses.

There is still debate about the optimal dose and duration of treatment of steroids. "Small studies suggest that even lower doses⁵¹⁵ and even shorter courses of treatment⁵¹⁸ may be effective".

Meta-analysis by Wood Baker et al⁵¹¹ of 5 RCTs showed a significantly beneficial effect of steroids compared to placebo at reducing **treatment failure**, OR 0.50 (95% CI; 0.32 to 0.79). It should be noted however that there was significant heterogeneity between the trials $p=0.0071$. This was potentially due to differences in operational definitions between the trials.

la

Three RCTs^{515,516,518} were combined in a meta-analysis by Wood Baker et al⁵¹¹ for **adverse events**. "Overall, patients receiving corticosteroid treatment were 2.7 times more likely to have an adverse drug reaction than those receiving placebo".

la

Niewoehner et al⁵¹⁶ (N=271) found that a greater proportion of patients in the steroid compared to placebo group required treatment for hyperglycaemia (15% vs. 4%, $p=0.002$). 67% of the steroid treated patients with hyperglycaemia had diabetes. Maltais et al⁵¹⁴ also found an increased incidence of hyperglycaemia. The hyperglycaemia was asymptomatic in patients in both studies and there was no increase in the onset of diabetes.

lb

Recommendations

The current recommendations can be found at www.nice.org.uk/guidance/ng115.

8.11.4 Antibiotics

This section was updated and replaced in 2018. See www.nice.org.uk/guidance/ng115/evidence for the 2018 evidence reviews.

8.11.5 Theophylline and other methylxanthines

As well as their apparent actions as bronchodilators, theophylline also appears to increase respiratory drive^{532,533} and this appears capable of overcoming some of the respiratory depression present during exacerbations⁵³⁴. For these reasons they have been used to treat patients admitted to hospital with an exacerbation.

The GDG was aware of one systematic review⁵³⁵ relating to the use of methyl-xanthines for exacerbations of COPD. All other abstracts identified by the literature search were either already included in the systematic review⁵³⁵ or were excluded due to use in stable COPD patients^{137,163,306,536,537} or small sample size⁵³⁸.

Evidence statements

The systematic review⁵³⁵ identified three RCTs and one abstract with a total sample size of N=169. Methyl-xanthines were compared to placebo in patients with exacerbations of COPD. However, the following limitations were noted: the mean age of participants was low (mean age 65 years), limited outcome measures e.g. changes in FEV₁ were used, and only three trials⁵³⁹⁻⁵⁴¹ plus one abstract⁵⁴² were available for review. These studies had relatively small sample sizes (N=50,52,39 respectively). There were no significant differences in **pulmonary function** or **symptom scores**.

la

GDG Consensus statement

The GDG concluded that there was inadequate evidence to recommend a change from the current clinical practice of using intravenous theophylline to treat exacerbations of COPD.

IV

Recommendations

The current recommendations can be found at www.nice.org.uk/guidance/ng115.

8.11.6 Respiratory stimulants

During exacerbations some patients develop hypercapnic respiratory failure. This is now usually managed using non-invasive ventilation (see section 8.13), but centrally acting drugs have also been used to stimulate respiratory drive. These drugs have a short duration of action and must be given by intravenous infusion.

One systematic review⁵⁴³ was found and one RCT⁵⁴⁴ which looked at the role of respiratory stimulants in patients with exacerbations of COPD. Both papers had methodological limitations, which included lack of detail of power calculations, small sample size, and lack of operational definitions.

The Greenstone systematic review⁴⁴¹ identified 4 RCTs (n=176 in total). One study compared doxapram with placebo⁵⁴⁵ but approximately 40% of patients had a pH > 7.35 at entry and patients had an age range of 21 to 78 years. Another unblinded RCT by Angus et al⁵⁴⁶ compared doxapram with NIV (n=17). The third study⁵⁴⁷ contained in the review⁴⁴¹ compared doxapram with other stimulants not currently used. The fourth study contains data from an

COPD (update)

unpublished study⁵⁴⁸ comparing doxapram with non-invasive ventilation. No numerical data is available for inclusion into the analyses.

An additional RCT⁵⁴⁴ was found which compared oral almitrine to placebo (n=23) but there was no power analysis. There was a general lack of methodological detail (e.g. randomisation, concealment and blinding processes). Only 74% of patients completed the study. The data was analysed on an intention to treat basis.

The results of all of these trials should be treated with caution due to the inherent methodological limitations and in light of these it was felt to be inappropriate to present evidence statements based on these data.

GDG consensus statements

Whilst the GDG acknowledges that doxapram is effective the group believe that non-invasive ventilation is more effective and is the treatment of choice for patients with respiratory failure during exacerbations of COPD. IV

There is insufficient evidence to recommend a change from current clinical practice of using doxapram to treat respiratory failure during exacerbations of COPD. IV

Recommendations

The current recommendations can be found at www.nice.org.uk/guidance/ng115.

8.12 Oxygen therapy during exacerbations of COPD

The exacerbation section of this guideline was outside the scope of the 2010 update. However the GDG was aware that some recommendations in the 'Oxygen therapy during exacerbations of COPD' section (section 8.12) of the guideline were out of date. Readers should refer to local protocols. Out of date recommendations have been deleted to appendix K.

During exacerbations of COPD patients develop worsening breathlessness. This may be associated with hypoxia and oxygen is commonly used to relieve the symptoms and raise arterial oxygen saturations. Patients are often given oxygen during their transfer to hospital in an ambulance, whilst being assessed at hospital and during the treatment of their exacerbation. The main aim is to prevent life-threatening hypoxia; however, in patients with COPD, this must be done with caution as some patient's respiratory drive depends on their degree of hypoxia rather than the usual dependence on hypercapnia. Thus uncontrolled oxygen therapy can result in suppression of respiratory drive, carbon dioxide narcosis and ultimately respiratory arrest.

Much of the literature concerning the use of oxygen therapy for exacerbations of COPD is old and many studies did not have control groups. A group of respiratory emergency medicine and intensive care physicians in the North West of England have reviewed the literature in this area⁵⁴⁹ and developed guidelines on the use of emergency oxygen therapy for breathless patients⁵⁵⁰. These guidelines are not exclusively for patients with COPD but do make specific recommendations regarding the administration of oxygen to patients with exacerbations of COPD. The GDG has considered these recommendations when formulating its consensus statements and recommendations. See section 2 for the methodology underpinning this section.

Evidence statements

During exacerbations patients with COPD may become significantly hypoxic. Three studies⁵⁵¹⁻⁵⁵³ have shown that the PaO₂ falls from 55-60mmHg to 25-50mmHg during an exacerbation. III

There are marked variations in the response of individual patients to oxygen. King et al⁵⁵⁴ gave 24% oxygen to patients with exacerbations of chronic respiratory failure. They recorded a mean PO₂ of 40.4 mm Hg in these patients on room air and a mean PO₂ of 57.3 mm Hg after 30 to 60 minutes of 24% oxygen but 15 out of 40 patients did not IIb

COPD (update)

increase their PO₂ beyond 50 mm Hg.

In a prospective randomised crossover study Agusti et al⁵⁵³ gave oxygen to 18 patients with COPD, within 48 hours of an admission with acute respiratory failure. Oxygen was given via nasal prongs at 2-4 l/min and Venturi masks at 24-28%. These concentrations raised the oxygen saturation to greater than 90% immediately in all cases. Oxygen was administered for 24 hours via each device and the oxygen saturation monitored continuously. Patients subsequently had an oxygen saturation less than 90% for a mean of 3.7 hours using the Venturi mask and 5.4 hours using nasal prongs. In extreme cases patients were poorly oxygenated for as long as 15 hours. It was found that the oxygen saturation was between 70 and 80% for a mean of 80 minutes, between 60 and 70% for a mean of 38 minutes and between 50 and 60% for a mean of 4 minutes during these periods of poor oxygenation. Inter-subject variability was considerable.

Ib

Oxygen therapy may lead to hypercapnia and acidosis.

Plant et al⁵⁵⁵, in 2000, found a significant negative correlation between pH and PaO₂ in 972 patients after oxygen therapy. The more oxygenated patients became the greater the magnitude of the subsequent respiratory acidosis. 47% of patients were hypercapnic, 20% of patients were acidotic and 4.6% of patients had a pH less than 7.25. More than 50% of hypercapnic patients were acidotic if the PaO₂ was greater than 75 mm Hg⁵⁵⁵.

III

Degaute et al⁵⁵⁶ gave 35 patients with exacerbations of COPD 28% oxygen for one hour. The average PaCO₂ rose from 59 mm Hg to 63 mm Hg during that period.

IIb

Smith et al⁵⁵⁷ gave 27 patients with an exacerbation of COPD and respiratory failure 24% to 28% oxygen for four hours. Sixteen patients had increases in PaCO₂ and, in two of these, dangerous respiratory acidosis developed with the pH decreasing to below 7.25.

IIb

COPD (update)

Eldridge et al⁵⁵⁸ gave oxygen at flow rates ranging from 2 to 12 litres per minute in random order for at least 20 minutes at each level to 19 patients with exacerbations of COPD. In 17 patients there were progressive rises in PaCO₂ with increasing PaO₂ and the PaCO₂ fell when the arterial PaO₂ changed from a higher to a lower value. Again, there was great variability in the increases in PaCO₂ for a given increase in PaO₂ between patients. IIb

Prime and Wenstlake⁵⁵⁹ gave 100% oxygen to 35 patients with stable COPD for 30 to 40 minutes. Thirty-three had increases in PaCO₂ ranging from 1.2 to 25.4 mm Hg. IIb

Aubier *et al*⁵⁶⁰ gave 100% oxygen for 15 minutes to 22 patients with an exacerbation of COPD and respiratory failure. There was an average increase in PaCO₂ of 23 +/- 5 mm Hg and there was an average drop in pH from 7.34 +/- 0.01 to 7.25 +/- 0.02. IIb

Radial stabs to obtain blood for arterial blood gas analysis are not more painful than arterialised ear lobe gases⁵⁶¹. III

Arterialised ear lobe gases may not accurately reflect PaO₂ but are acceptable for PaCO₂⁵⁶¹⁻⁵⁶⁴. III

GDG Consensus statements

Arterialised ear lobe samples are an alternative way of obtaining arterial blood gases if there is local expertise and may be less painful for patients. IV

Recommendations

The current recommendations can be found at www.nice.org.uk/guidance/ng115.

8.13 Non-invasive ventilation (NIV) and COPD exacerbations

Non-invasive ventilation (NIV) is a method of providing ventilatory support that does not require the placement of an endotracheal tube. It is usually delivered via a mask that covers the nose, but occasionally a full face mask covering the nose and the mouth is required. The ventilators themselves are compact and portable.

Non invasive ventilation is now widely used for the treatment of respiratory failure occurring during exacerbations of COPD. It has many advantages over intubation and ventilation and can be used outside ITUs.

Three systematic reviews were identified⁵⁶⁵⁻⁵⁶⁷ and two additional RCTs^{568,569} that compared NIV (nasal or mask) to usual medical care. Conti et al⁵⁶⁹ compared NIV to conventional ventilation (endotracheal ventilation).

Factors for consideration within this topic include; 1) Operational definitions regarding what constitutes an Intensive Care Unit (ICU) differ between countries; 2) Due to the type of intervention applied (NIV) double blinding is not possible; 3) The comparator of 'standard treatment' is not always defined but include oxygen, antibiotics, bronchodilators, steroids, respiratory stimulants and methylxanthines; 4) Trials are generally of small sample size and 5) Lastly, as highlighted by Ram et al⁵⁶⁷, there is potential systematic bias in the trials as patients who failed treatment before 1 hour are missing in the one hour measurements.

The RCT by Thys et al⁵⁶⁸ had methodological limitations (sample size N=20) was stopped at the interim analysis stage as the ten patients in the placebo NIV and convention medical care group all required active ventilation (3 full endotracheal intubation). Conti et al⁵⁶⁹, for the majority of the outcomes, only provides descriptive statistics in the form of percentages rather than inferential statistics.

Evidence statements

NIV compared to usual medical care decreases **mortality**. 1a

Relative risk 0.41 (95% CI; 0.26 to 0.64)⁵⁶⁷. Odds ratio (OR) 0.22; (95% CI; 0.09 to 0.54 for COPD only trials)⁵⁶⁶.

Risk difference -0.13 (95%CI; -0.21 to -0.06 for COPD sub group)⁵⁶⁵.

NIV compared to usual medical care decreased the need for **intubation**. Relative risk 0.42 (95%CI 0.31 to 0.59)⁵⁶⁷. 1a

OR 0.12 (95%CI; 0.05 to 0.29 for COPD only trials)⁵⁶⁶.

Risk difference -0.18 (95% CI; -0.33 to -0.03 for COPD sub group)⁵⁶⁵.

NIV compared to usual medical care resulted in improvement in **pH** in the first hour of treatment WMD 0.03 (95% CI; 0.02 to 0.04), **PaCO₂** WMD -0.40kPa, (95% CI; -0.78 to -0.03), and respiratory rate WMD -3.08 rpm, (95% CI; -4.26 to -1.89)⁵⁶⁷. 1a

NIV compared to usual medical care resulted in fewer **complications** (principally ventilator associated pneumonia) in the NIV group, relative risk (RR) 0.32, (95%CI 0.18 to 0.56)⁵⁶⁷. 1a

NIV compared to usual medical care resulted in a shorter **duration of hospital stay** WMD -3.24 days, (95%CI -4.42 to -2.06)⁵⁶⁷. Risk difference -5.66 (95% CI; -10.10 to -1.23 for COPD sub group)⁵⁶⁵. 1a

Although the Plant et al paper is included in two of the systematic reviews quoted above^{565,567} this is the only study to be carried out in a general medical and respiratory ward **setting** in the UK. As such the GDG felt it worthy of presenting the outcomes of this study separately. The study compared NIV to standard treatment. Overall, NIV significantly reduced the need for intubation p=0.02 and mortality was reduced p=0.05. NIV compared to standard care also led to a rapid improvement in pH in the first hour p=0.02, a greater 1b

COPD (update)

fall in respiratory rate at 4 hours $p=0.035$ and the duration of breathlessness was also reduced $p=0.025$. N.B. This study was *not* designed to identify the best setting to deliver NIV though.

The GDG noted that the hospital stay mortality in the group receiving standard care was high at 20%. This compares to a hospital stay mortality quoted by Connors et al (1996)⁴⁹² of 11%.

GDG consensus statements

Although the mean age of patients in these studies was 60 years there is no reason to suppose that the benefits are not the same in older patients.

IV

Health economics

Five papers were found. There were some methodological limitations in the papers. Keenan et al⁵⁷⁰ showed that NIV is cost effective in patients with a severe exacerbation of COPD as it is more effective and less expensive, compared to standard therapy alone.

Plant et al⁵⁷¹ found that the addition of ward based NIV to standard treatment is cost effective when compared to standard treatment alone, with an incremental cost effectiveness ratio of -£645 per death avoided. Whilst costs are increased on the respiratory wards, these are offset by savings in the cost of ICU.

Modelling of results showed that providing a NIV service will avoid 6 deaths and 3-9 admissions to ICU per annum.

COPD (update)

There is evidence that NIV is cost effective in patients with a severe exacerbation of COPD, being more effective and less expensive, compared to standard therapy alone. Keenan et al⁵⁷⁰, Plant et al 2003)⁵⁷¹.

Recommendations

The current recommendations can be found at www.nice.org.uk/guidance/ng115.

8.14 Invasive ventilation and intensive care

Although non-invasive ventilation is the initial treatment of choice for respiratory failure during exacerbations of COPD, some patients do not respond adequately to NIV and require intubation and ventilation. Other patients have multiple organ system impairment or reduced levels of consciousness and in these settings ITU care may be the appropriate first line management option. In the past there has often been a reluctance to intubate patients with COPD or admit them to ITUs because of concerns about weaning and long term outcomes. The GDG has reviewed the evidence about the outcomes of ventilation and ITU care.

The GDG identified four descriptive case series of relevance⁵⁷²⁻⁵⁷⁵. Esteban et al⁵⁷³ looked at the characteristics and outcomes in adult patients receiving endotracheal ventilation in a 28 day international study N=15,757 involving 361 ICUs and 20 countries. The study is limited due

COPD (update)

to a heterogeneous population of ventilated patients and only limited details regarding COPD patients.

Nevins et al⁵⁷⁵ looked at predictors of outcome for patients with COPD requiring invasive ventilation. This was a retrospective analysis of patients with a history of COPD to identify the patient characteristics at the time of hospital admission that predicted a poor outcome.

Seneff et al⁵⁷² in a situation specific population of patients with exacerbations of COPD looked at hospital and one year survival of patients admitted to ICU.

Rieves et al⁵⁷⁴ looked at a population of patients with severe COPD and acute respiratory failure and examined correlates for survival at the time of intubation.

Evidence statements

The mean **duration of mechanical ventilation** for COPD patients compared to acute respiratory distress syndrome (ARDS) patients was 5.1 vs. 8.8 respectively $p < 0.001$ ⁵⁷³. However Nevins et al 2001⁵⁷⁵ identified a mean duration of ventilation was 9 days (median 4 days). III

Duration of weaning was non significant between the two groups⁵⁷³. III

Length of hospital stay in ICU was 1.2 days in the COPD patients compared to 24.5 days in the ARDS patients, $p = 0.07$, whilst **length of stay in hospital** was 21.2 days in the COPD group versus 24.5 days in the ARDS group $p = 0.07$ ⁵⁷³. Nevins et al⁵⁷⁵ identified a mean duration of hospital stay of 22 days in COPD patients requiring ventilation. III

COPD (update)

The **mortality** rate in ICU for patients who received ventilation for an exacerbation of COPD was estimated at 22%. Patient receiving mechanical ventilation due to acute decompensation of COPD had a significantly lower mortality than patients receiving mechanical ventilation because of acute respiratory failure (ARF) of other aetiologies. COPD OR 0.70; (95% CI 0.59 to 0.83); $p < 0.001$ compared to coma OR 1.31; (95%CI; 1.19 to 1.45); $p < 0.001$ ⁵⁷³.

III

There was a high mortality rate for those patients who required >72 hrs mechanical ventilation compared to those with <72 (37% vs. 16%; $p < 0.01$), those without previous episodes of mechanical ventilation (33% vs. 11%; $p < 0.01$) and those with a failed extubation attempt (36% vs. 7%; $p = 0.0001$)⁵⁷⁵.

III

NIV can be successfully used to shorten duration of mechanical ventilation ($p = 0.002$)⁵⁷⁶.

Ib

GDG consensus statements

The decision on which patients with exacerbations of COPD will benefit from intubation is difficult and involves balancing health status with an estimate of expectation of survival. Factors that are likely to influence this decision are prior functional status, BMI, requirement for oxygen when stable, co-morbidities and previous ITU admissions.

IV

Recommendations

The current recommendations can be found at www.nice.org.uk/guidance/ng115.

8.15 Respiratory physiotherapy and exacerbations

Physiotherapy has traditionally been used to assist sputum clearance during exacerbations of COPD. The GDG have looked at the evidence regarding the role of respiratory physiotherapy. Physiotherapists are also involved in the reablement of patients prior to discharge but the GDG have not looked at the evidence base for this aspect of management.

An extensive literature search of the role of respiratory physiotherapy was undertaken, which identified 62 potential papers. Of these 46 were excluded from the abstract. 16 papers were retrieved and a further 10 were excluded upon full paper review. 6 papers were critically appraised. Two systematic reviews were identified⁵¹⁰, two RCTs^{577,578} and two quasi-experimental studies^{579,580}.

COPD (update)

Interventions included postural drainage, chest percussion, vibration, chest shaking, directed coughing, forced exhalation, and expiration under positive pressure (PEP mask).

There was little research in this area and there were methodological limitations inherent in the studies identified. Limitations included heterogeneous populations, Jones et al 2002⁴⁷⁵ (COPD stable and exacerbations, asthmatics, cystic fibrosis) and McCrory 2001⁵¹⁰ (stable, exacerbations and post exacerbation population), small sample sizes Bellone et al 2000⁵⁷⁷ N=10, Wollmer et al 1985⁵⁸⁰ N=10) and hence potentially significant under powering, short-term interventions, short term outcome assessments or did not report suitable outcome data⁵¹⁰. Many of the trials precluded meta-analysis due to the diversity of patient groups and outcomes⁴⁷⁵. One RCT by Bellone 2000⁵⁷⁷ on the effects of using a PEP mask included selected patients with mucus hyper secretion making it difficult to be sure that the results of this small study (sample size of N=27) can be generalised.

The results of most of these trials^{510,577,578,580} should be treated with caution due to the inherent methodological limitations and in light of this the GDG felt it inappropriate to present evidence statements based on these studies.

Evidence statements

Bellone et al⁵⁷⁹ (N=27) looked at the short term effects of using a PEP mask in patients with exacerbation of COPD and mild acidosis requiring NIV who were hypersecreting mucus. Ib

Sputum production was significantly higher in the PEP mask plus assisted coughing group (10g) compared to the control group (5g) of assisted coughing alone ($p < 0.01$)⁵⁷⁹.

Weaning time from NIV was found to be significantly lower in the intervention group (5 days v 7 days) $p < 0.01$ ⁵⁷⁹.

COPD (update)

Brown et al (N=24) looked at the effect of short term mechanical vibration on sputum production and found a significant increase at 60 minutes but not over 24 hours⁵⁸¹.

1b

Recommendations

The current recommendations can be found at www.nice.org.uk/guidance/ng115.

8.16 Monitoring recovery from an exacerbation

In patients admitted to hospital or managed in a hospital-at-home or assisted discharge scheme it is important to monitor the response to treatment. This allows appropriate reduction in additional support that patients are receiving and require and determination of the timing of discharge.

Recommendations

The current recommendations can be found at www.nice.org.uk/guidance/ng115.

8.17 Discharge planning

Advanced discharge planning can help to reduce the risk of readmission and reduce unnecessary hospital bed occupancy. Discharge planning involves an assessment of the patients fitness for discharge and assessment of their needs once back in the community.

A hospital admission gives an opportunity for spirometry to be performed on patients who may not otherwise have had this measured. Measurements taken at the time of admission or soon after may give an unrepresentative assessment of the severity of airflow obstruction and thus it is of more value to perform spirometry close to the time of discharge when the patient will be closer to their normal functional state. See section 2 for the methodology underpinning this area.

Recommendations

The current recommendations can be found at www.nice.org.uk/guidance/ng115.

9 Audit criteria

The National Clinical Guidelines for COPD makes many specific recommendations concerning the management of COPD. These deal with diagnosis and assessment, and management of stable COPD and management of exacerbations. There are far too many recommendations to monitor them all but the GDG and CRG identified seven key areas where it was felt that recommendations were likely to have the biggest impact on the management of COPD (see section 5.1). The audit criteria in the following table relate to these key areas on the management of COPD in primary and secondary care. Two additional audit criteria relating to a sentinel event audit, that links with data collected as part of the national audit of COPD exacerbations⁵⁸², and a patient-centred audit have also been included.

One of the criteria (non-invasive ventilation) relates specifically to secondary care and two relate to management in primary care (diagnosis and smoking cessation). The remainder should be applied in both primary and secondary care settings. It is anticipated that the standards will be detailed in local delivery plans in England and service and financial frameworks in Wales, but it is important that these targets reflect the development of a high quality service for people with COPD. Year-on-year improvements in the results of the audit criteria is important, an comparison with other local health care communities may be helpful in setting realistic milestones towards the target standard. There should be locally agreed plans to facilitate the achievement of the targets.

The “exception” boxes list the circumstances where applying the criterion would be inappropriate for an individual patient. It is recognised that there will be other situations where a clinical decision may be taken not to follow the guideline (for example taking into account the informed patient’s wishes), and interpretation of performance should take these factors into account. COPD disease registers are a necessary pre-requisite for performing these audits. They are needed to establish the denominator and to facilitate accurate data collection, and are also one of the quality markers in the contract for General Practitioners.

The criteria that relate to key recommendations are all process criteria. The sentinel event audit of patients readmitted within 28 days of discharge following an exacerbation of COPD is also to some extent an outcome audit, but it is important to note that it would be unrealistic to expect a routine audit to differentiate between an ‘avoidable’ and an ‘unavoidable’ admission. Nevertheless this sentinel audit reflects the fact that frequent exacerbations are associated with worse health status and more rapid decline in lung

COPD (update)

function. Exacerbations are also a major factor in determining the cost of caring for people with COPD and result in significant hospital bed occupancy.

The patient-centred audit involves asking people with COPD to record their experience of services.

The advantages of this approach are:

- it ensures a comprehensive coverage of all services
- it reflects patient experience directly
- it can be used to stimulate a general interest in services locally

The disadvantages are:

- it is anecdotal, just giving specific instances and not a statistical result
- it generates huge amounts of data
- specific standards cannot be set or checked
- it may be difficult for patients to criticise the team that cares for them

A potential problem with the criteria proposed is that general practices that have low identification rates of COPD (perhaps because of poor coding, or under investigation) may apparently perform very well against these criteria. Therefore, it is proposed that an additional data item that should be reported in general practice is age-specific prevalence of COPD. This would allow the standards achieved to be interpreted against the practice specific prevalence.

Sentinel events audit

The recommendations above concern monitoring services as routinely delivered. A second approach to audit is to use adverse events to highlight particular areas of low quality service. This requires identification of agreed 'sentinel events'. In people with COPD readmission to hospital with one month of an admission with an exacerbation of COPD may represent such an event.

COPD (update)

Criterion

Percentage of patients readmitted to hospital with an exacerbation of COPD within 28 days of discharge

Patient-centred audit

Finally it is recommended that health care commissioning organizations should consider using a patient-centred audit approach intermittently, to investigate the totality of services and identify particular areas that need further development.

• Key priority	• Criterion	• Exception
<p>1. Diagnose COPD A diagnosis of COPD should be considered in patients over the age of 35 who have a risk factor (generally smoking) and who present with exertional breathlessness, chronic cough, regular sputum production, frequent winter 'bronchitis' or wheeze. The presence of airflow obstruction should be confirmed by performing spirometry. All health professionals managing patients with COPD should have access to spirometry and they must be competent in the interpretation of the results.</p>	<p>a) percentage of smokers over the age of 35 consulting with a chronic cough and/or breathlessness who have had spirometry performed</p> <p>b) percentage of patients with a diagnosis of COPD who have had spirometry performed</p>	<p>Inability to perform spirometry, for example because of facial paralysis</p>
<p>2. Stop smoking Encouraging patients with COPD to stop smoking is one of the most important components of their management. All COPD patients still smoking, regardless of age should be encouraged to stop, and offered help to do so, at every opportunity.</p>	<p>Percentage of patients with COPD who are current smokers recorded in the general practice records as having been offered smoking cessation advice and or therapy</p>	
<p>3. Effective inhaled therapy Long-acting inhaled bronchodilators should be used in people with COPD who remain symptomatic (e.g. breathlessness or exacerbations) despite the use of short-acting drugs. A long-acting beta₂ agonist or a long-acting muscarinic antagonist should be used in people with COPD and FEV₁ > 50% predicted who continue to experience problems despite the use of short-acting</p>	<p>Appropriateness of inhaled steroid therapy</p>	<p>Patient choice</p>

<p>drugs. Either a long-acting beta₂ agonist and inhaled corticosteroid in a combination inhaler, or a long-acting muscarinic antagonist should be used in patients with an FEV₁ < 50% predicted who continue to experience problems despite the use of short-acting drugs. Additional treatment with a long-acting muscarinic antagonist should be used in people with COPD who remain symptomatic despite taking a long-acting beta-agonist and inhaled steroid in a combination inhaler, irrespective of their FEV₁.</p>		
<p>4. Pulmonary rehabilitation for all who need it Pulmonary rehabilitation should be offered to all patients who consider themselves functionally disabled by COPD. Pulmonary rehabilitation programmes must meet clinical needs in terms of access, location and availability.</p>	<p>Percentage of patients with COPD who have undergone pulmonary rehabilitation</p>	<p>Patient choice</p>
<p>5. Use non-invasive ventilation Non-invasive ventilation (NIV) is the treatment of choice for persistent hypercapnic respiratory failure during exacerbations after optimal medical therapy. It should be delivered by staff trained in its application, experienced in its use and aware of its limitations. When patients are started on NIV there should be a clear plan covering what to do in the event of deterioration and ceilings of therapy should be agreed.</p>	<p>Percentage of patients presenting with acute hypercapnic respiratory failure who have received non-invasive ventilation</p>	<p>Patient choice</p>

<p>6. Manage exacerbations</p> <p>The frequency of exacerbations should be reduced by appropriate use of inhaled corticosteroids and bronchodilators, and vaccinations. The impact of exacerbations should be minimised by:</p> <ul style="list-style-type: none">• giving self-management advice on responding promptly to the symptoms of an exacerbation• starting appropriate treatment with oral steroids and or antibiotics• use of non-invasive ventilation when indicated• use of hospital-at-home or assisted-discharge schemes	<p>Frequency and appropriateness of oral steroid and antibiotic therapy</p>	<p>Patient choice</p>
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10 Areas for Future Research

This section was updated and replaced in 2018. See www.nice.org.uk/guidance/ng115/evidence for the 2018 evidence reviews.

11 Appendix A Details of questions and literature searches

Reference made to the Cochrane Library in the table below is inclusive of the following; Cochrane Systematic Reviews database, CENTRAL and DARE. The Cochrane Systematic Reviews database contains items that are constantly updated. CENTRAL contains items resulting from searches performed in the process of creating Cochrane Systematic Reviews and goes back as far as the Cochrane searches to date. The DARE database was set up by the NHS Centre for Reviews and Dissemination in 1994. It does, however, include records that have an earlier publication date. For example, it contains a set of records from a systematic reviews database maintained by the UK Cochrane Centre prior to 1995. This set of records is no longer updated and have not been assessed by the NHS CRD.

Question	Population	Study Type	Database and Years
Q1 What is a useful, robust definition of COPD? Q2 Must the definition of COPD include the presence of airflow obstruction? Q3 Must the definition of COPD include reversibility criteria?			Expert Review

COPD (update)

Q4 Must the definition of COPD discuss causation and pathophysiology?			
Q5 What is the current and future burden of COPD in England & Wales?			Expert Review
Q6 Can COPD be detected before the onset of symptoms?			Expert Review
Q7 What factors can be used to identify patients opportunistically as being at risk of having COPD?			
Q8 What methods can be used to confirm the diagnosis in patients identified opportunistically as being at risk of having COPD?			
Q9 Question removed.			
Q10 Does early diagnosis of COPD affect the success of smoking cessation therapy?			Expert Review
Q11 What are the aims of COPD management?			Expert Review
Q12 What symptoms are suggestive of a diagnosis of COPD?			Expert Review

COPD (update)

Q13 What other conditions may present with similar symptoms/signs/results?			
Q14 In patients with suspected COPD, what are the most effective diagnostic criteria?			Expert Review
Q15 What clinical signs are useful (confirm or refute the diagnosis) in stable COPD?			Expert Review
Q16 What are the most appropriate tests in a patient with suspected COPD to confirm the diagnosis?			Expert Review
Q17 What is the role of spirometry in the diagnosis of COPD?	COPD	All study types	Cochrane Library Medline 1966-2003
Q18 Where and by whom should spirometry be performed in order to maximise reliable and valid test result outcomes?			Embase 1980-2003 CINAHL 1982-2003
Q19 What is the role of reversibility testing in the diagnosis of COPD?	COPD	All study types	Cochrane Library Medline 1966-2003
Q20 What is the role of reversibility testing in the prediction of response to COPD drugs?			Embase 1980-2003 CINAHL 1982-2003
Q21 What is the role of other lung function tests in the diagnosis of COPD? (IRC, T _L CO, KCO, Lung Volumes)			Expert Review

COPD (update)

Q22 How should the severity of stable COPD be assessed?			Expert Review
Q23 In patients with stable COPD, how should the (initial) management plan be determined?			Expert Review
Q24 Which patients with stable COPD should be referred for specialist advice?	Stable COPD Exclude asthma	Systematic Reviews RCT Cohort	Cochrane Library Medline 1966-2003 Embase 1980-2003 CINAHL 1982-2003 AMED 1985-2003
Q25 Which patients with stable COPD should be referred for an oxygen assessment?			Expert Review
Q26 What is the most appropriate smoking cessation strategy in patients with stable COPD?	COPD Exclude asthma	Systematic Reviews RCTs Cohorts	Cochrane Library Medline 1966-2003 Embase 1980-2003 CINAHL 1982-2003 PsycINFO 1887-2003 AMED 1985-2003

COPD (update)

Q27 What drug therapy is effective (reduces morbidity or mortality in) for patients with stable COPD?	This is not a question in its own right but merely a heading for questions 28-57.		
Q28 Which patients with stable COPD should be treated with short-acting inhaled bronchodilators?	This is not a question in its own right but merely a heading for questions 29 and 30.		
Q29 Which patients with stable COPD should be treated with short-acting beta ₂ -agonists? Q31 How should the effects of this treatment be assessed?	COPD Exclude asthma	Systematic Reviews RCTs	Cochrane Library Medline 1966-2003 Embase 1980-2003
Q30 Which patients with stable COPD should be treated with short-acting anticholinergics? Q31 How should the effects of this treatment be assessed?	COPD Exclude asthma	Systematic Reviews RCTs	Cochrane Library Medline 1966-2003 Embase 1980-2003
Q32 Which patients with stable COPD should be treated with long-acting inhaled bronchodilators?	This is not a question in its own right but merely a heading for questions 33 and 34.		
Q33 Which patients with stable COPD should be treated with long-acting beta ₂ -agonists?	COPD	Systematic Reviews RCTs	Cochrane Library Medline 1966-2003

COPD (update)

Q35 How should the effects of this treatment be assessed?	Exclude asthma		Embase 1980-2003
Q34 Which patients with stable COPD should be treated with long-acting anticholinergics?	COPD	Systematic Reviews	Cochrane Library
		RCTs	Medline 1966-2003
Q35 How should the effects of this treatment be assessed?	Exclude asthma		Embase 1980-2003
Q36 Which patients with stable COPD should be treated with methylxanthines / PDE4 inhibitors?	Stable COPD	Systematic Reviews	Cochrane Library
		RCTs	Medline 1966-2003
Q37 How should the effects of this treatment be assessed?	Exclude asthma		Embase 1980-2003
Q38 & Q39 Questions removed.			
Q40 Which patients with stable COPD should be treated with inhaled steroids?	COPD	Systematic Reviews	Cochrane Library
	Exclude asthma	RCTs	Medline 1966-2003
Q41 How should the effects of this treatment be assessed?			Embase 1980-2003
Q42 Which patients with stable COPD should be treated with oral steroids?	COPD	Systematic Reviews	Cochrane Library
	Exclude asthma	RCTs	Medline 1966-2003

COPD (update)

Q43 How should the effects of this treatment be assessed?			Embase 1980-2003
Q44 What is the role of combination therapy in patients with stable COPD?	Stable COPD Exclude asthma	Systematic Reviews RCTs	Cochrane Library Medline 1966-2003 Embase 1980-2003
Q45 How should the effects of this treatment be assessed?			
Q46 What are the most appropriate delivery systems for giving inhaled therapy to patients with stable COPD?	Stable COPD Exclude asthma except in elderly patients	Systematic Reviews RCTs	Cochrane Library 1980-2003 Medline 1980-2003 Embase 1980-2003 CINAHL 1982-2003
Q47 Which patients with stable COPD benefit from nebulised therapy compared to other delivery mechanisms?			
Q48 What is the role of mucolytic therapy in patients with stable COPD?	Stable COPD Exclude asthma	Systematic Reviews RCTs Cohorts	Cochrane Library Medline 1966-2003 Embase 1980-2003
Q49 In patients with stable COPD, what is the comparative efficacy of mucolytic therapy?			
Q50 In patients with stable COPD, does mucolytic therapy reduce morbidity?			

COPD (update)

<p>Q51 What is the role of antioxidant therapy in patients with stable COPD?</p> <p>Q52 In patients with stable COPD, what is the comparative efficacy of antioxidant therapy?</p> <p>Q53 In patients with stable COPD, does antioxidant therapy reduce morbidity?</p>	<p>Stable COPD</p> <p>Exclude asthma</p>	<p>Systematic Reviews</p> <p>RCTs</p>	<p>Cochrane Library</p> <p>Medline 1966-2003</p> <p>Embase 1980-2003</p> <p>AMED 1985-2003</p>
<p>Q54 What is the role of antitussive therapy in patients with stable COPD?</p> <p>Q55 In patients with stable COPD, what is the comparative efficacy of antitussive therapy?</p> <p>Q56 In patients with stable COPD, does antitussive therapy reduce morbidity?</p>	<p>Stable COPD</p> <p>Exclude asthma</p>	<p>All</p>	<p>Cochrane Library</p> <p>Medline 1966-2003</p> <p>Embase 1980-2003</p>
<p>Q57 What is the role of 1-antitrypsin replacement therapy in patients with stable COPD?</p>	<p>Stable COPD</p> <p>Exclude asthma</p>	<p>All</p>	<p>Cochrane Library Medline 1966-2003</p> <p>Embase 1980-2003</p>

COPD (update)

<p>Q58 What is the role of antibiotic therapy in patients with stable COPD?</p>	<p>Stable COPD</p> <p>Exclude asthma</p>	<p>Systematic Reviews</p> <p>RCTs</p> <p>Cohorts</p>	<p>Cochrane Library</p> <p>Medline 1966-2003</p> <p>Embase 1980-2003</p>
<p>Q59 What are the benefits of pulmonary rehabilitation programmes for patients with stable COPD?</p> <p>Q60 In stable COPD patients referred for pulmonary rehabilitation programmes, what is the optimal course content, setting & duration?</p> <p>Q61 Which patients with stable COPD should be referred for pulmonary rehabilitation and when?</p> <p>Q62 In patients with stable COPD, are there benefits in repeated pulmonary rehabilitation attendances?</p>	<p>Stable COPD</p> <p>Include asthma</p>	<p>Systematic Reviews</p> <p>RCTs</p>	<p>Cochrane Library</p> <p>Medline 1966-2003</p> <p>Embase 1980-2003</p> <p>CINAHL 1982-2003</p> <p>AMED 1985-2003</p>

COPD (update)

<p>Q63 In patients with stable COPD how can right heart failure / chronic salt and water retention be identified?</p> <p>Q64 In patients with stable COPD what therapies can be used to manage right heart failure / chronic salt and water retention?</p>			Expert Review
<p>Q65 In patients with stable COPD how can pulmonary hypertension be identified?</p> <p>Q66 In patients with stable COPD what therapies can be used to manage pulmonary hypertension?</p>			Expert Review
<p>Q67 Main Stem Question How are patients with stable COPD affected by anxiety and / or depression?</p> <p>Q68 In patients with stable COPD, how can anxiety and depression be identified?</p> <p>Q69 How can anxiety and depression in stable COPD patients be managed? (Pharmacological & non-pharmacological)</p>	<p>COPD</p> <p>Include asthma</p>	<p>Systematic Reviews</p> <p>RCTs</p> <p>Cohorts</p>	<p>Cochrane Library 1980-2003</p> <p>Medline 1966-2003</p> <p>Embase 1980-2003</p> <p>CINAHL 1982-2003</p> <p>PsycINFO</p>

COPD (update)

<p>Q70 What is the significance of nutritional problems in both stable and acute exacerbations of COPD?</p> <p>Q71 In patients with stable COPD, how can nutritional problems be identified?</p> <p>Q72 In patients with stable COPD, how can nutritional problems be managed?</p>	<p>COPD</p> <p>Exclude asthma</p>	<p>Systematic Reviews</p> <p>RCTs</p>	<p>Cochrane Library 1980-2003</p> <p>Medline 1980-2003</p> <p>Embase 1980-2003</p> <p>CINAHL 1982-2003</p> <p>PsychINFO 1980-2003</p>
<p>Q73 Do self-management plans & patient education affect concordance with treatment and improve outcomes in patients with stable COPD?</p>	<p>COPD</p> <p>Exclude asthma</p>	<p>All study types</p>	<p>Cochrane Library</p> <p>Medline 1966-2003</p> <p>Embase 1980-2003</p> <p>CINAHL 1982-2003</p> <p>PsychINFO 1887-2003</p>
<p>Q74 What is the role of oxygen therapy in patients with stable COPD?</p> <p>Q75 In patients with stable COPD, what is the best method of oxygen supply?</p>			<p>Expert Review</p>

COPD (update)

<p>Q76 In patients with stable COPD, what are the benefits of short burst oxygen?</p> <p>Q77 In patients with stable COPD, what are the benefits of portable oxygen?</p> <p>Q78 In patients with stable COPD, what are the criteria for continuous oxygen therapy?</p>			
<p>Q79 What is the role of immunisation in patients with stable COPD?</p>	<p>COPD</p> <p>Exclude asthma</p>	<p>Systematic Reviews</p> <p>RCTs</p>	<p>Cochrane Library</p> <p>Medline 1966-2003</p> <p>Embase 1980-2003</p>
<p>Q80 What is the role of non-invasive ventilation in patients with stable COPD?</p>	<p>Stable COPD</p> <p>Exclude asthma</p>	<p>Systematic Reviews</p> <p>RCTs</p>	<p>Cochrane Library 1980-2003</p> <p>Medline 1980-2003</p> <p>Embase 1980-2003</p>

COPD (update)

<p>Q81 What management strategies can be used to provide palliative care in the end stages of COPD?</p>	<p>COPD</p> <p>Exclude asthma</p>	<p>All study types</p>	<p>Cochrane Library</p> <p>Medline 1966-2003</p> <p>Embase 1980-2003</p> <p>CINAHL 1982-2003</p>
<p>Q82 How should the long term care of patients with stable COPD be organised in order to maximise patient outcomes?</p> <p>Q83 Where (Primary care versus secondary care) should the long term care of patients with stable COPD be organised in order to maximise patient outcomes?</p> <p>Q84 How often should the long term care of patients with stable COPD be reviewed in order to maximise patient outcomes?</p>			<p>Expert Review</p>
<p>Q85 In patients with stable COPD, what is the role of respiratory nurse specialists?</p>			<p>Expert Review</p>

COPD (update)

<p>Q86 What is the role of respiratory physiotherapy in the management of patients with stable COPD?</p>	<p>Stable COPD Exclude asthma</p>	<p>Systematic Reviews RCTs</p>	<p>Cochrane Library Medline 1966-2003 Embase 1980-2003 CINAHL 1982-2003</p>
<p>Q87 What is the role of lung surgery in patients with stable COPD?</p> <p>Q88 In patients with stable COPD, what is the operation of choice (bullectomy, lung volume reduction, transplantation) in reducing morbidity or mortality?</p> <p>Q89 In patients with stable COPD, what are the referral criteria for lung surgery?</p>			<p>Expert Review</p>
<p>Q90 What is a robust and useful definition of an exacerbation of COPD?</p>			<p>Expert Review</p>
<p>Q91 What symptoms are suggestive of an exacerbation of COPD?</p> <p>Q92 What other conditions present with similar symptoms?</p>			<p>Expert Review</p>

COPD (update)

Q93 What are the factors known to cause exacerbations of COPD?			Expert Review
Q94 What is known about the consequences (short & long term outcome impact) of having an exacerbation (chest episodes, infective episodes) of COPD?			Expert Review
Q95 What clinical signs are useful (confirm or refute) in making a diagnosis and assessing the severity of an exacerbation of COPD?			Expert Review
<p>Q96 What are the most appropriate tests in a patient with suspected exacerbation of COPD?</p> <p>Q97 What are the most appropriate tests to confirm the diagnosis of an exacerbation of COPD?</p> <p>Q98 What are the most appropriate tests to assist in the management of an exacerbation of COPD?</p> <p>Q99 In patients with an exacerbation of COPD, what are the most appropriate tests to assess severity?</p>			Expert Review

COPD (update)

<p>Q100 In patients with an exacerbation of COPD, what are the most appropriate tests to monitor recovery?</p>			
<p>Q101 Which patients with an exacerbation of COPD benefit from admission to hospital?</p>	<p>COPD Exacerbations Exclude asthma</p>	<p>Systematic Reviews RCTs Cohorts</p>	<p>Cochrane Library Medline 1966-2003 Embase 1980-2003</p>
<p>Q102 What is the role (reduction of morbidity or mortality and comparative efficacy) of pharmacotherapy in patients with an exacerbation of COPD?</p>	<p>This is not a question in its own right but merely a heading for questions 103-110 & 112-113</p>		
<p>Q103 Are bronchodilators useful / effective in the treatment of patients with an exacerbation of COPD?</p> <p>Q104 Which patients with an exacerbation of COPD should be treated with bronchodilators?</p>	<p>COPD Exacerbations Exclude asthma</p>	<p>Systematic Reviews RCTs</p>	<p>Cochrane Library Medline 1966-2003 Embase 1980-2003</p>
<p>Q105 Are oral steroids useful / effective in the treatment of patients with an exacerbation of COPD?</p>	<p>COPD Exacerbations</p>	<p>Systematic Reviews RCTs</p>	<p>Cochrane Library Medline 1966-2003 Embase 1980-2003</p>

COPD (update)

<p>Q106 Which patients with an exacerbation of COPD should be treated with oral steroids?</p>	<p>Exclude asthma</p>		
<p>Q107 Question removed.</p>			
<p>Q108 Which delivery systems should be used for giving inhaled therapy to patients with an exacerbation of COPD?</p>			<p>Expert Review</p>
<p>Q109 Are antibiotics useful / effective in the treatment of patients with an exacerbation of COPD?</p> <p>Q110 Which patients with an exacerbation of COPD should be treated with antibiotics?</p>	<p>COPD</p> <p>Exclude asthma</p>	<p>Systematic Reviews</p> <p>RCTs</p>	<p>Cochrane Library</p> <p>Medline 1966-2003</p> <p>Embase 1980-2003</p>
<p>Q111 Which patients with an exacerbation of COPD should be treated with oxygen (how much and how monitored, including use during transfer to hospital)?</p>			<p>Expert Review</p>

COPD (update)

<p>Q112 What is the role of theophylline in patients with exacerbations of COPD?</p>	<p>COPD Exacerbations Exclude asthma</p>	<p>Systematic Reviews RCTs</p>	<p>Cochrane Library Medline 1966-2003 Embase 1980-2003</p>
<p>Q113 What is the role of respiratory stimulants in patients with exacerbations of COPD?</p>	<p>COPD Exacerbations Exclude asthma</p>	<p>Systematic Reviews RCTs</p>	<p>Cochrane Library Medline 1966-2003 Embase 1980-2003</p>
<p>Q114 What is the role of therapies for managing right heart failure / chronic salt and water retention in patients with exacerbations of COPD?</p>			<p>Expert Review</p>
<p>Q115 Question removed.</p>			
<p>Q116 Which patients with exacerbations of COPD require non-invasive ventilation? Q117 In patients with exacerbations of COPD who require non-invasive ventilation, where should this be performed (Ward/HDU/ITU) so that morbidity or mortality measures are minimised?</p>	<p>COPD Exacerbations Exclude asthma</p>	<p>Systematic Reviews RCTs</p>	<p>Cochrane Library 1980-2003 Medline 1980-2003 Embase 1980-2003</p>

<p>Q118 Which patients with exacerbations of COPD require IPPV / ITU care?</p>			
<p>Q119 In patients with exacerbations of COPD, what is the role of hospital-at-home / assisted discharge schemes compared to inpatient management taking into account morbidity or mortality outcomes.</p> <p>Q120 What multi professional team membership is effective in providing hospital-at-home / assisted discharge schemes for patients with exacerbations of COPD?</p> <p>Q121 In patients with an exacerbation of COPD, what criteria are useful in assessing the suitability of and planning for home treatment / early discharge?</p> <p>Q122 In patients with an exacerbation of COPD, what is the optimal duration of home care?</p>	<p>COPD</p> <p>Exacerbations</p> <p>Exclude asthma</p>	<p>Systematic Reviews</p> <p>RCTs</p>	<p>Cochrane Library</p> <p>Medline 1966-2003</p> <p>Embase 1980-2003</p> <p>CINAHL 1982-2003</p>

COPD (update)

<p>Q123 What is the role of respiratory physiotherapy in the management of exacerbations of COPD?</p>	<p>COPD Exacerbations Exclude asthma</p>	<p>Systematic Reviews RCTs Cohorts</p>	<p>Cochrane Library Medline 1966-2003 Embase 1980-2003 CINAHL 1982-2003</p>
<p>Q124 Which patients with COPD benefit from referral to palliative care services?</p> <p>Q125 Which patients with COPD benefit from referral to occupational therapists?</p> <p>Q126 Which patients with COPD benefit from referral to social services?</p>			<p>Expert Review</p>
<p>Q127 What information / education / support is needed for stable COPD patients and their families to understand and cope with the diagnosis, treatment and outcome in COPD?</p> <p>Q128 In patients with stable COPD and their relatives / carer, what effect does education have on morbidity, quality of life, advanced directives or mortality measures?</p>	<p>Stable COPD Exclude asthma</p>	<p>All studies</p>	<p>Cochrane Library Medline 1966-2003 Embase 1980-2003 CINAHL 1982-2003 PsycINFO 1887-2003</p>

COPD (update)

<p>Q129 Do cultural factors modify the uptake of COPD care?</p> <p>Question and section relating to cultural factors deleted by NICE as defined as “outside of Scope”</p>	<p>COPD</p> <p>Exclude asthma</p>	<p>All</p>	<p>Cochrane Library</p> <p>Medline 1966-2003</p> <p>Embase 1980-2003</p> <p>CINAHL 1982-2003</p> <p>AMED 1985-2003</p>
<p>Q130 What advice should be given to patients with COPD who wish to travel?</p>			<p>Expert Review</p>
<p>Q131 How should the fitness for surgery of patients with COPD be assessed?</p>			<p>Expert Review</p>

12 Appendix B Cost effectiveness of opportunistic case finding in primary care

Background

The GDG was interested in the issue of opportunistic case finding of COPD in primary care.

Since the BTS guidelines were published in 1997⁷¹, the use of spirometry has become more widespread in primary care. Spirometry can be used to detect the presence of airflow obstruction in a patient. At present, the mean age of detection of COPD in the UK is 55, as by this time the patient usually presents with symptoms. Use of spirometry can detect the presence of airflow obstruction earlier, even if no symptoms are present.

It is well known that the biggest factor that can have an impact on disease progression is smoking cessation^{113,583}. Smoking cessation can alter length of life and quality of life and the earlier smoking cessation is achieved, the greater the effect¹²¹. Patients detected at age 55 are encouraged to quit smoking as it can alter their disease progression. If COPD were detected earlier, patients could be referred to smoking cessation programmes with an added incentive of extra benefit.

Smoking cessation has a greater effect if it is achieved earlier in life, therefore the advantages of detecting people with airflow obstruction earlier are three fold:

- Additional life years saved.
- Quality of life gain.
- A greater incentive to quit (as they have been diagnosed at an earlier stage of their disease, they can be told that they can make a difference if they quit smoking).

A recent study by van Schayk et al¹⁰⁷ found that in a population with the following characteristics; age over 35, smoker/ex smoker and a chronic cough, 27% of people had airflow obstruction when tested using spirometry.

If a policy of opportunistic case finding by spirometry in primary care was followed, the results of the van Schayk study suggest that there would be a reasonably high yield. These patients could then be targeted with an intensive smoking cessation programme.

This is associated with a substantial resource input from primary care, both in terms of the time and equipment used in spirometry and the subsequent cost of smoking intervention programmes.

The GDG was interested in the cost effectiveness of this strategy, based on the results of the van Schayk study. They were interested in whether the extra resources involved in testing for airflow obstruction and the subsequent intervention of smoking cessation was worth the additional expected benefits. A simple cost effectiveness model was therefore built to look at this issue.

Aim

The aim was to compare the costs and benefits of opportunistically testing patients who present at the GP with the following characteristics; age over 35, smoker/ex smoker, chronic cough, with the costs and benefits of current practice. The cost per life year gained and the cost per quality adjusted life year (QALY) gained were calculated.

Methods

A cost effectiveness model was built from the perspective of the NHS. A simple decision tree was constructed which outlined the pathways of the alternative options (see figure 1). A decision node is indicated by a square and a circle indicates a chance node. Each of the 8 pathways is labelled with a letter, from A to H, at the end of each pathway.

The primary outcome measure used was life years gained and the primary outcome of the model is the cost per life year gained. The use of life years gained as the primary outcome measure may not capture all the benefit, as there is likely to be a quality of life improvement if the disease progression is slowed down. A secondary outcome measure for the model is therefore quality adjusted life years (QALY) gained and the cost per QALY is calculated.

COPD (update)

For each of the 8 pathways (A-H) of the model, the total costs, life years and quality adjusted life years were calculated. The data sources and assumptions used in calculating these are described in more detail below. The expected cost, life years and quality adjusted life years were then calculated for each arm of the decision node (opportunistically case find or don't opportunistically case find). Costs were discounted at 6% and benefits at 1.5% in line with current NICE recommendations. The incremental cost per life year saved and the incremental cost per QALY were then calculated as follows.

$$\text{Incremental cost per life year gained} = (C_1 - C_2) / (Y_1 - Y_2)$$

$$\text{Incremental cost per QALY} = (C_1 - C_2) / (Q_1 - Q_2)$$

Where C_1 = Expected cost of opportunistic case finding

C_2 = Expected cost of not opportunistic case finding

Y_1 = Expected life years if opportunistically case find

Y_2 = Expected life years if don't opportunistically case find

Q_1 = Expected quality adjusted life years if opportunistically case find

Q_2 = Expected quality adjusted life years if don't opportunistically case find

Data sources and assumptions

The table below lists the baseline values used in the model along with the data sources or assumption where appropriate. More details are provided on the methods of calculating each of these values below.

Life expectancy	Baseline value	Source
A	74.5	Fletcher C (1977) ⁵⁸³ and HTA (2002) ¹²¹
B	71	Fletcher C (1977) ⁵⁸³ and HTA (2002) ¹²¹
C	71	Fletcher C (1977) ⁵⁸³ and HTA (2002) ¹²¹
D	79.73	Life tables (http://www.gad.gov.uk/Life_Tables/Interim_life_tables.htm)
E	73.1	Fletcher C (1977) ⁵⁸³ and HTA (2002) ¹²¹
F	71	Fletcher C (1977) ⁵⁸³ and HTA (2002)
G	71	Fletcher C (1977) and HTA (2002) ¹²¹
H	79.73	Life tables

COPD (update)

Probabilities	Baseline value	Source
COPD	0.27	van Schayck (2002) ¹⁰⁷
no COPD	0.73	van Schayck (2002) ¹⁰⁷
success of smoking if early	0.1305	HTA (2002) ¹²¹
Failure of smoking if early	0.8695	HTA (2002) ¹²¹
success of smoking if late	0.1305	HTA (2002) ¹²¹
Failure of smoking if late	0.8695	HTA (2002) ¹²¹
Compliance if early	0.9	Assumption
Non concordance if early	0.1	Assumption
Compliance if late	0.5	Assumption
Non concordance if late	0.5	Assumption

Cost	Baseline value	Source
Incremental cost p.a. for mild COPD	£159.63	Britton et al 2003 ³³
Incremental cost p.a. for moderate COPD	£328.21	Britton et al 2003 ³³
Incremental cost p.a. for severe COPD	£1,394	Britton et al 2003 ³³

COPD (update)

Cost	Baseline value	Source
Cost of spirometry test in GP practice	£9.91	From estimates provided by GDG
Cost of intensive smoking cessation programme	£171.49	HTA (2002) ¹²¹
Other diagnosis costs	£50	Assumption

Utility	Baseline value	Source
Mild	0.6102	Data from Harper et al (1997) ⁵⁸⁴
Moderate	0.5659	Data from Harper et al (1997) ⁵⁸⁴
Severe	0.5428	Data from Harper et al (1997) ⁵⁸⁴
Non COPD	1	Assumption

Explanation of assumptions and data used

Probability of airflow obstruction

The probability of having COPD was taken to be 27% (the same as the van Schayk study¹⁰⁷). The mean age of this sub group of smokers who have a chronic cough was 46 (van Schayk, personal communication). This was used as the basis for calculating life expectancy as this is the average age of the population being tested.

The mean age of detection of COPD was provided by the GDG group as 55 years old.

Life expectancy and time spent in each stage of the disease

As well as estimating the life expectancy of each pathway, the years spent in each state of the disease (mild, moderate, severe) was estimated. This was to allow more accurate calculations of the cost of care and quality of life.

Data on the natural history of COPD is very limited. A paper by Fletcher and Peto⁵⁸³ looked at the natural history of chronic airflow obstruction in a prospective study on London working men. They looked at the decline of % of predicted FEV₁ over a lifetime for a smoker, a non smoker/not susceptible to smoke, a smoker who stops at age 45 and a smoker who stops at age 65. These were the only data available and it should be noted that this was a highly selective population.

The definitions for severity of COPD recommended in this guideline are:

Mild: <80 % predicted FEV₁

Moderate 50-80 % predicted FEV₁

Severe <30% predicted FEV₁

COPD (update)

Fetcher and Peto plot a graph of FEV₁ as a percentage of predicted value at age 25 against age in Figure 1 of their paper⁵⁸³. Using this and the above classification for disease state, the time spent in each disease state in years and total life expectancy was read off from the graph for a smoker who does not quit.

The graph also shows the FEV₁ curve for a smoker who stops at age 65. The cost effectiveness model requires data on a person who quits at age 55. An assumption was made that the FEV₁ curve for this would be midway between the 45 year old and the 65 year old at the same rate of decline.

The age of death for a smoker who does not quit was read to be 71 from the graph.

Data from an HTA report (2002 pp51) ¹²¹ gives the gain in life years for someone who quits smoking at age 45-54 as 3.5 years (undiscounted) and for age 55-64 as 2.1 years (undiscounted).

The life years gained for a 45 and 55 year old were assumed to be 3.5 and 2.1 respectively. This is potentially underestimating the benefit. The years spent in each state were then read off the Fletcher and Peto graph for each of these alternatives.

The life expectancy of a smoker who does not have COPD (or is not susceptible) was estimated using life tables for a 46 year old today.

(http://www.gad.gov.uk/Life_Tables/Interim_life_tables.htm)

Men and women's life expectancy was combined and divided by 2. (This may be an overestimate as even though they are not diagnosed with COPD, they are still at a greater risk for other diseases).

The life expectancy was estimated as 79.73. From the Fletcher and Peto graph, a person who has never smoked or is not susceptible to smoke has mild airflow obstruction at age 62. They therefore spend 79.73 – 62 years = 17.73 years in the mild state. Although this is a very crude method, this was the best data available at the time.

COPD (update)

Compliance

This was estimated to be 90% if detected at age 46 and 50% if detected at age 55. This was an assumption and different rates will be tested out in the sensitivity analysis.

Success of the intervention (smoking cessation)

This was taken as 0.1305 and was taken from the HTA report¹²¹. The quit rate was assumed to be the same for both a 46 year old and a 55 year old. A study by Risser and Belcher¹⁰⁹ looked at whether giving patients information about their pulmonary status provided enhanced motivation to quit. Although not statistically significant from the control group, 20% of patients had CO validated cessation at 12 months when assuming loss to follow up to be smokers. Although not a long term quit rate, this figure will be used in the sensitivity analysis.

Costs

All costs are for the year 2000/01

Cost of spirometry

The cost of spirometry was estimated using data provided by David Bellamy, a member of the GDG.

Equipment cost for a spirometer was given as £300-£1500 with a useful lifetime of 5 years. Maintenance and consumables cost £200 p.a. It takes a practice nurses 10 minutes to carry out the test and spirometry is carried out approximately 1-10 times per week. Assuming a practice nurse salary is £27 per hour⁵⁸⁵ and a 6% discount rate and not paid in arrears for calculating the annual equivalent cost for the spirometer, the cost per test was estimated as £9.91. The minimum cost was estimated as £5.01 and the maximum cost as £14.81.

COPD (update)

Diagnosis costs

When a patient is diagnosed, they are other procedures recommended in the guideline to be carried out. They are:

- Chest radiograph
- Assessment of breathlessness
- Full blood count
- BMI calculated.

The cost of these is assumed to be £50, as time constraints did not permit detailed costing of these. This figure was tested out in the sensitivity analysis.

Intervention

The cost of the intervention (smoking cessation programme) was taken from the HTA report ¹²¹. It is the lifetime quit rate for a package of counselling, NRT and bupropion SR. The same intervention is given to patients whether they are 45 or 55 at the time of diagnosis.

Cost of care

As the model is taking a lifetime perspective, the costs of care for each year alive are included for each pathway.

For COPD, the cost of care each year is taken by using data by Britton ³³ on the costs for mild, moderate and severe COPD and multiplying it by the time spent in each state. It is assumed that patients not diagnosed until the age of 55 still occur the costs of their underlying disease, however this will be tested in the sensitivity analysis.

COPD (update)

For non COPD costs of care, no cost is applied apart from the years in mild disease, as the COPD cost from the Britton data³³ is taken to be the incremental cost of having COPD (i.e. the cost over and above the cost of a non COPD person to the NHS). For the years in mild, the cost of mild COPD is assumed. The paper by Britton asks patients about their resource use to do with their COPD, giving more weight to this assumption. Patients with severe COPD are approximately 8 times more expensive p.a. than patients with mild COPD. By slowing the progression of the disease, patients will be in the milder state for longer, therefore reducing the costs.

QALYs

There is extremely limited data available for generating QALYs for COPD health states. Data was obtained from a study comparing outcome measures in COPD⁵⁸⁴. One of the outcome measures used was the SF-6D which is a preference based measure of quality of life and can be used to estimate QALYs as each health state generated is associated with a utility value. In the study, SF-6D values were collected as well as % predicted of FEV₁. Using the classification of disease severity recommended in this guideline, a mean SF-6D score was calculated for mild, moderate and severe COPD. This data must be treated with caution, as it has not been adjusted for anything. The mean SF-6D utility was multiplied by the number of years spent in each state to give the total number of QALYs. Area under the curve was not used to calculate the QALY gain. Instead, the patient was assumed to stay at the utility level of the mild state for all the years they were in the mild state until they reached the moderate state. The utility value for a non COPD person was assumed to be 1.

Discounting

Benefits (life expectancy and QALYs) are discounted at 1.5% in line with current NICE recommendations and costs are discounted at 6%. Sensitivity analysis will examine the effects of using rates of 0% for both, 3% for both 6% for both and 10% for both.

General assumptions of the model

Those who present and have spirometry, with a result of no airflow obstruction, would usually be offered brief smoking cessation advice from the GP. As the lifetime cessation success rate is small (0.018)¹²¹ and there is unlikely to be an incentive due to them receiving a 'clear' diagnosis, and the cost of this intervention (estimated at £3.53¹²¹ is small, this has been excluded from the model, in order to keep the model simple.

The mean age of the van Schayk cohort was 46. The Fletcher and Peto graph shows the decline in lung function of a person who quits at age 45. This decline is assumed to be the same as for a 46 year old for the model, as there is only 1 year of difference.

Results

The results of the model using baseline values are shown below.

Opportunistically case finding	
Life expectancy	25.25
QALYS	19.36
Cost	£1,731.83
<hr/>	
Not opportunistically case finding	
Life expectancy	25.20
QALYS	19.32
Cost	£1,696.33
<hr/>	
Incremental life expectancy	0.050
Incremental QALYs	0.044
Incremental cost	£35.49
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Incremental cost effectiveness ratio (ICER)	
Cost per life year gained	£713.16
Cost per QALY	£814.56
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Under the base case analysis, the cost per life year gained is £713.16 and the cost per quality adjusted life year gained is £814.56. Under current decision making conditions, this is a very favourable cost effectiveness ratio.

Sensitivity Analysis

As the model is subject to much uncertainty due to the many different data sources and the uncertainty associated with these, one way sensitivity analysis was carried out on key parameters. One way sensitivity analysis varies one parameter at a time whilst keeping the other parameters at their baseline values.

The main parameters of the model were varied one at a time to examine the effect on the model results. Parameters varied were the discount rate, the prevalence of COPD, smoking cessation success rate, concordance with smoking cessation programme if diagnosed early, cost of diagnosis and the cost of the intervention.

The parameters were varied between the following ranges as these were thought to be plausible or were guided by the literature.

Parameter	Range			
Discount rate of costs and benefits	Both 0%	Both 3%	Both 6%	Both 10%
Prevalence of COPD	5%	10%	20%	35%
Smoking cessation success rate	3%	5%	10%	20%
Compliance for early diagnosis	50%	60%	70%	
Cost of diagnosis	Base+low spirometry	£150+high spirometry	£300+high spirometry	
Cost of the intervention	£300	£500	£1,000	

Appendix B.1 shows the results of the 1 way sensitivity analysis. The costs per life year gained/QALY are plotted against the different values of the parameter being varied.

COPD (update)

The results are fairly sensitive to the discount rate, as increasing benefits to be in line with costs at 6% gives a cost per LYG of £2,261.59 and a cost per QALY of £2,219.26. Increasing both discount rates to 10% gives a cost per LYG of £10,770.89 and a cost per QALY of £8,935.03.

Decreasing the prevalence (or proportion who are found to have airflow obstruction when tested) reduces the cost effectiveness, however even at 5%, the cost per life year gained is £6,009.59 and the cost per QALY is £6,864.04 which would still be considered to be reasonably cost effective.

The results are fairly sensitive to the smoking cessation rate. Altering the early smoking cessation rate to 20%¹⁰⁹ and leaving the later quit rate at the baseline value of 0.1305 gives a cost per LYG of -£23.30 and a cost per QALY of -£27.76. These are both dominant cases, in that the intervention increases the benefit and decreases the cost (graph not shown).

Altering both smoking cessation rates to just 5% gives a cost per LYG of £3,246.21 and a cost per QALY of £3,707.76.

Reducing the concordance rate to 50% for patients diagnosed early gives a cost per LYG of £2,945.18 and a cost per QALY of £2,833.34.

The results are sensitive to the cost of the intervention (smoking cessation programme). When the cost of the intervention is increased to £1,100, the cost per LYG increases to £3,755.82 and the cost per QALY increases to £4,289.83.

Finally, the cost of diagnosis was varied. The cost of the other tests was increased to £300 and the highest value for the spirometry test was used. This gave a cost per LYG of £5,016.15 and a cost per QALY of £5,729.34.

In order to test out the assumptions of the model further, the prevalence rate was lowered to 10% and the percentage who quit smoking was varied from 3-10%.

The results of this are shown in appendix B.2.

COPD (update)

At a smoking cessation rate of 3%, the cost per LYG is £14,885.41 and the cost per QALY is £17,001.82.

The life years gained by quitting smoking at age 46 and 55 was taken from the HTA report¹²¹. The life years gained for a person who quits at age 35-44 is 5.5, age 45-54 is 3.5 and age 55-64 is 2.1.

The benefit used for a 46 year old was taken to be 3.5 and for a 55 year old, 2.1. Altering this assumption and giving a benefit of 5.5 years to the 46 year old quitter and 3.5 years to the 55 year old quitter does not make a big difference to the model results. The results are shown in appendix B.3. The cost per life year gained decreases to £510.94 and the cost per QALY decreases to £661.31

The assumption that a patient undiagnosed until 55 incurs costs of care the same as those with a patient with mild COPD is perhaps unrealistic as they will not be receiving treatment. They may still incur some costs, for example more frequent visits to the GP, or be given treatment for mild symptoms. To test this assumptions, the model was recalculated assuming 0 costs of care until diagnosis. This gave a cost per LYG of £6,567.43 and a cost per QALY of £7,501.19 (graph not shown).

Discussion

Even when conservative assumptions are applied, opportunistic case finding is a relatively cost effective strategy compared to current practice, in the current climate of current decision making.

This model is a simplistic version of real life and is built using many data sources and assumptions. The results are fairly sensitive to changes in parameters. Key parameters are the prevalence and the smoking cessation rate.

This model also assumes that spirometry has 100% sensitivity and specificity and is carried out by staff who are trained and competent in its use and interpretation. This is not the

COPD (update)

status quo at present and not every practice has a spirometer. Things are changing however, especially since the publication of the BTS guidelines in 1997.

In order to improve the model, better data on the natural history of the disease, especially in relation to smoking cessation and quality of life would be desirable.

The Fletcher and Peto diagram gives the % predicted values for a 25 year old. This would be different for a 46 year old. This means that the benefit has been underestimated in this model, which would decrease the cost effectiveness ratios.

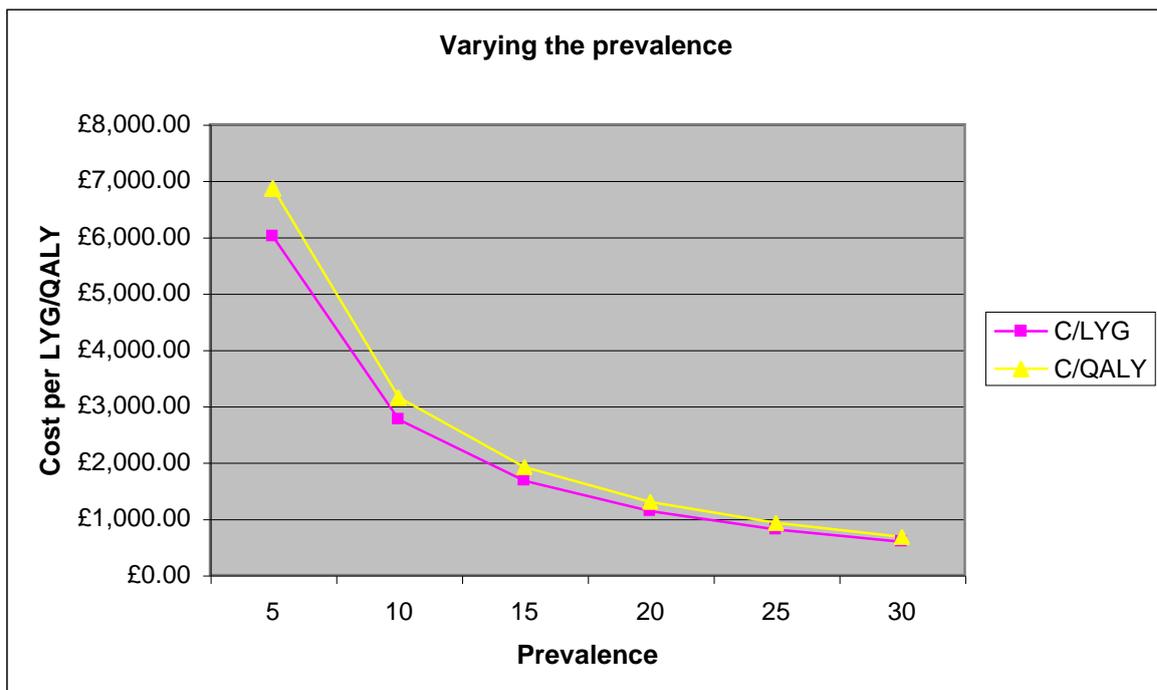
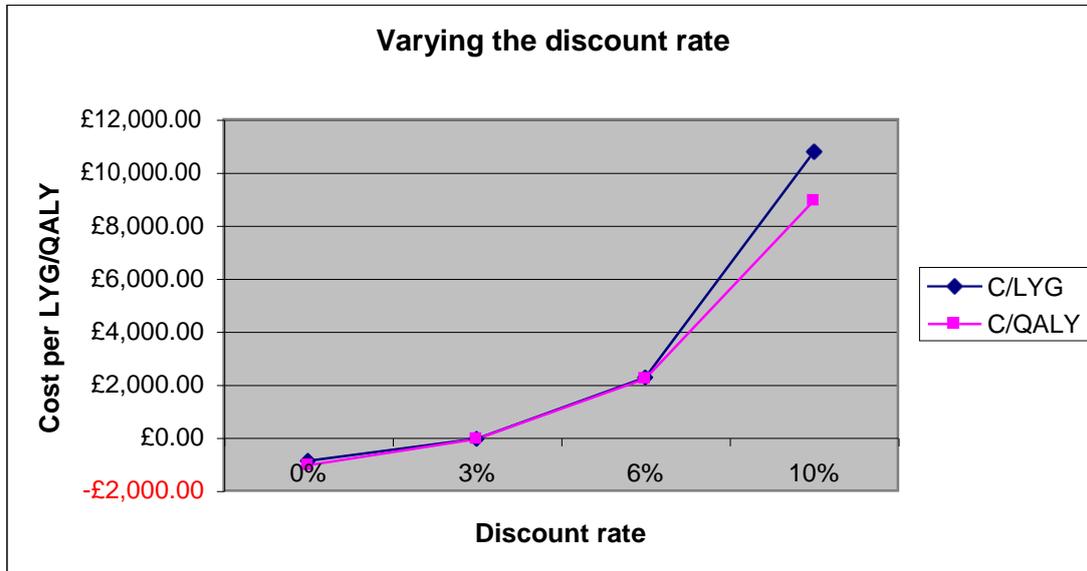
The utility weights used were also from a small sample of patients in a different study. There is a lack of utility data for COPD as most studies tend to use disease specific based measures rather than preference based measures. This is a simple deterministic model and better data would help to build a more sophisticated model.

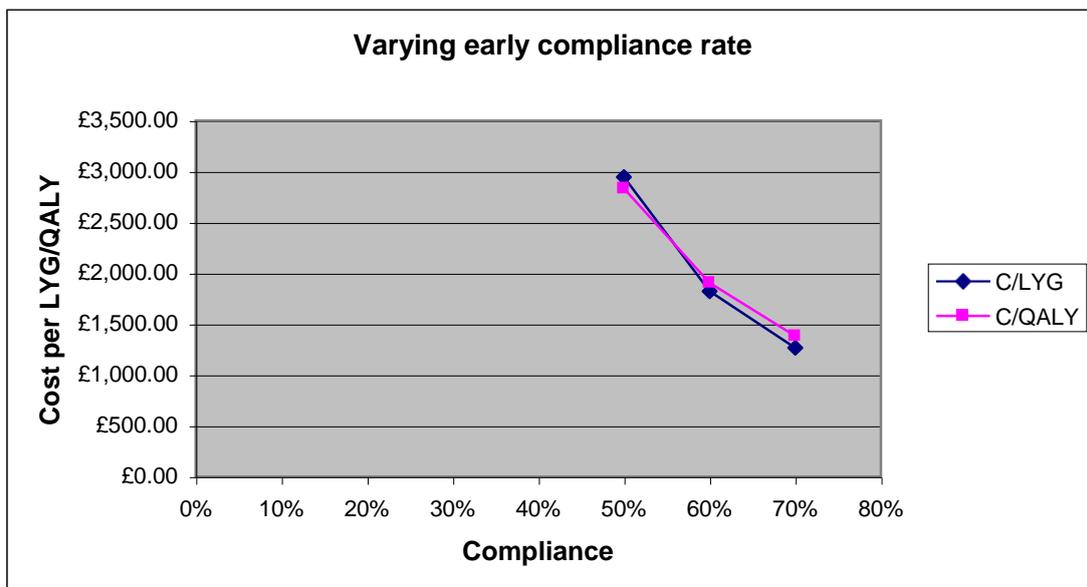
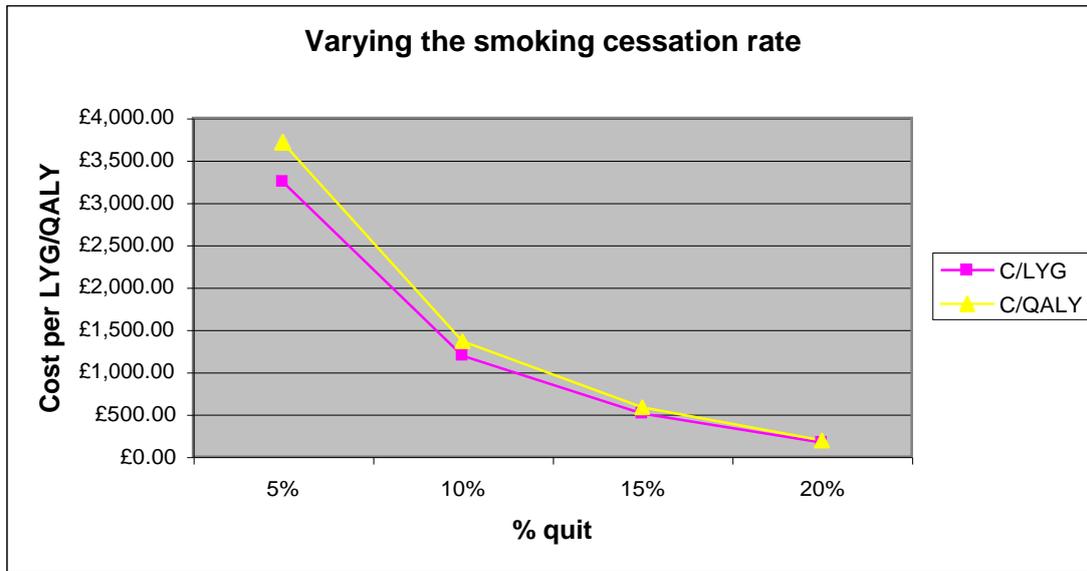
Conclusion

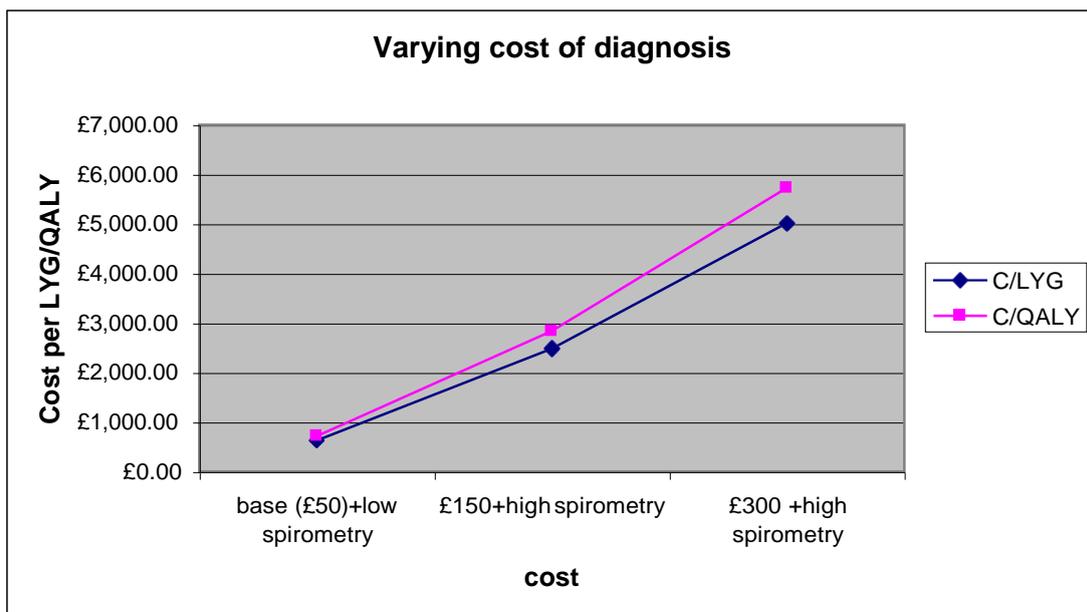
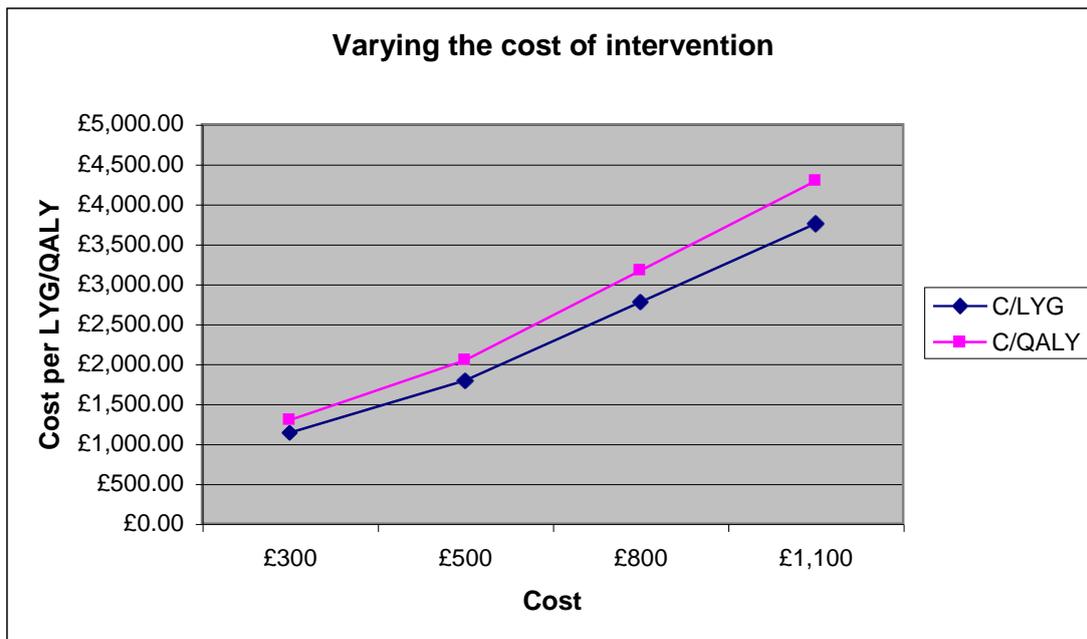
In summary, opportunistic case finding in primary care is a relatively cost effective strategy, subject to the assumptions outlined above. Key parameters are the prevalence of COPD that is undetected and the smoking cessation success rate. It should be noted that the model is quite sensitive to some of the parameters and there are many assumptions. Therefore, the results must be interpreted with this in mind.

Appendix B.1

One-way sensitivity analysis

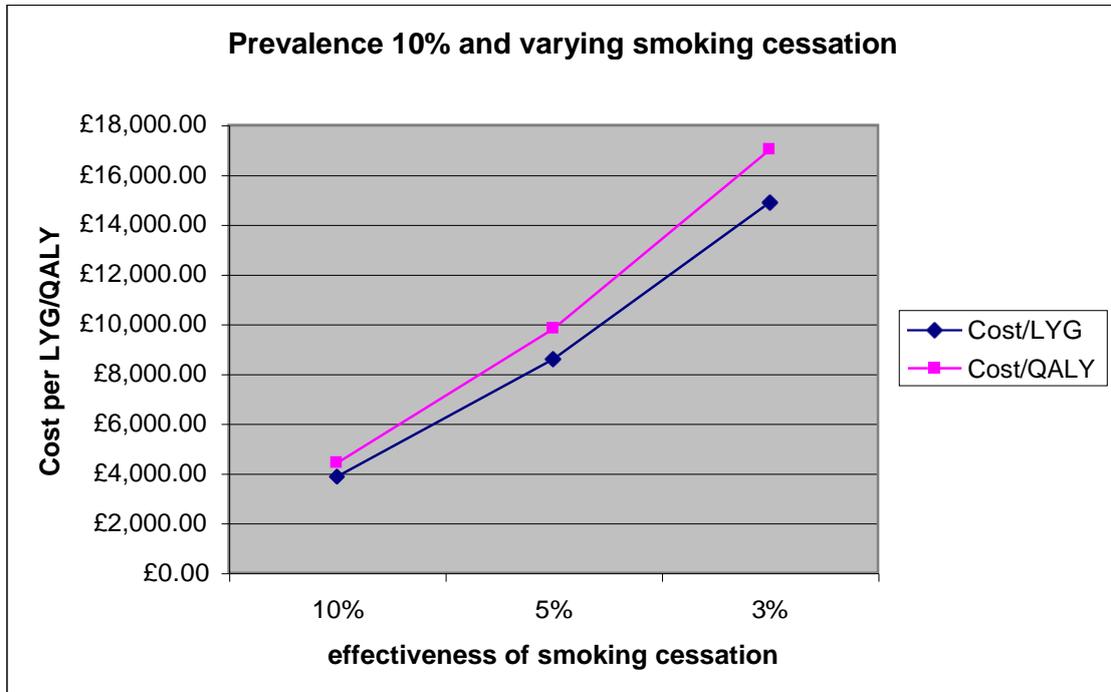






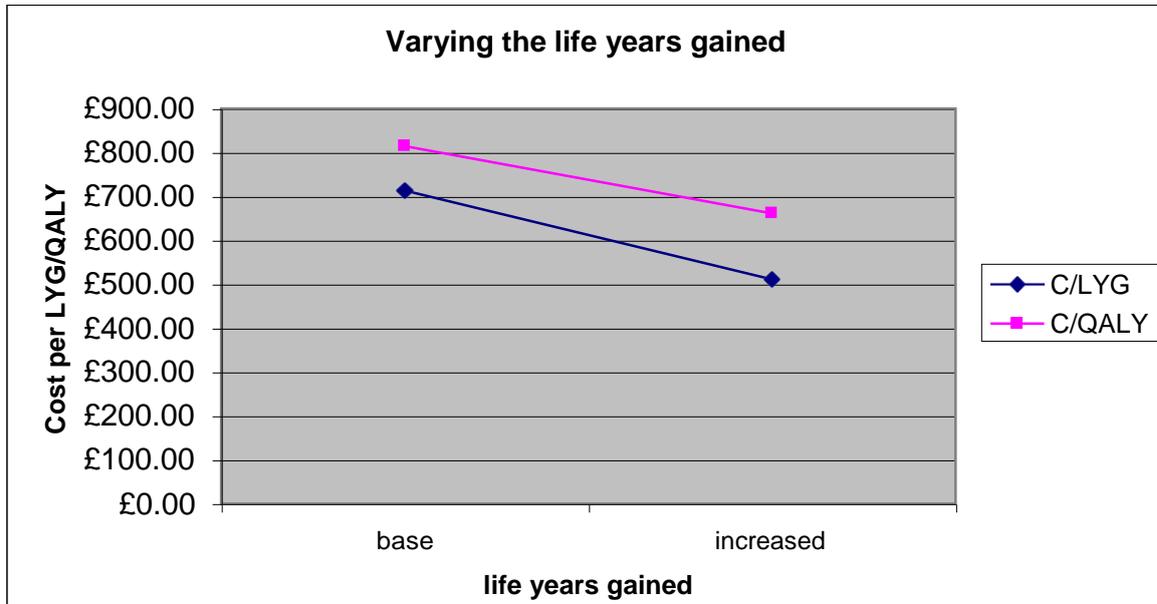
Appendix B.2

Varying the smoking cessation rate when the prevalence is 10%



Appendix B.3

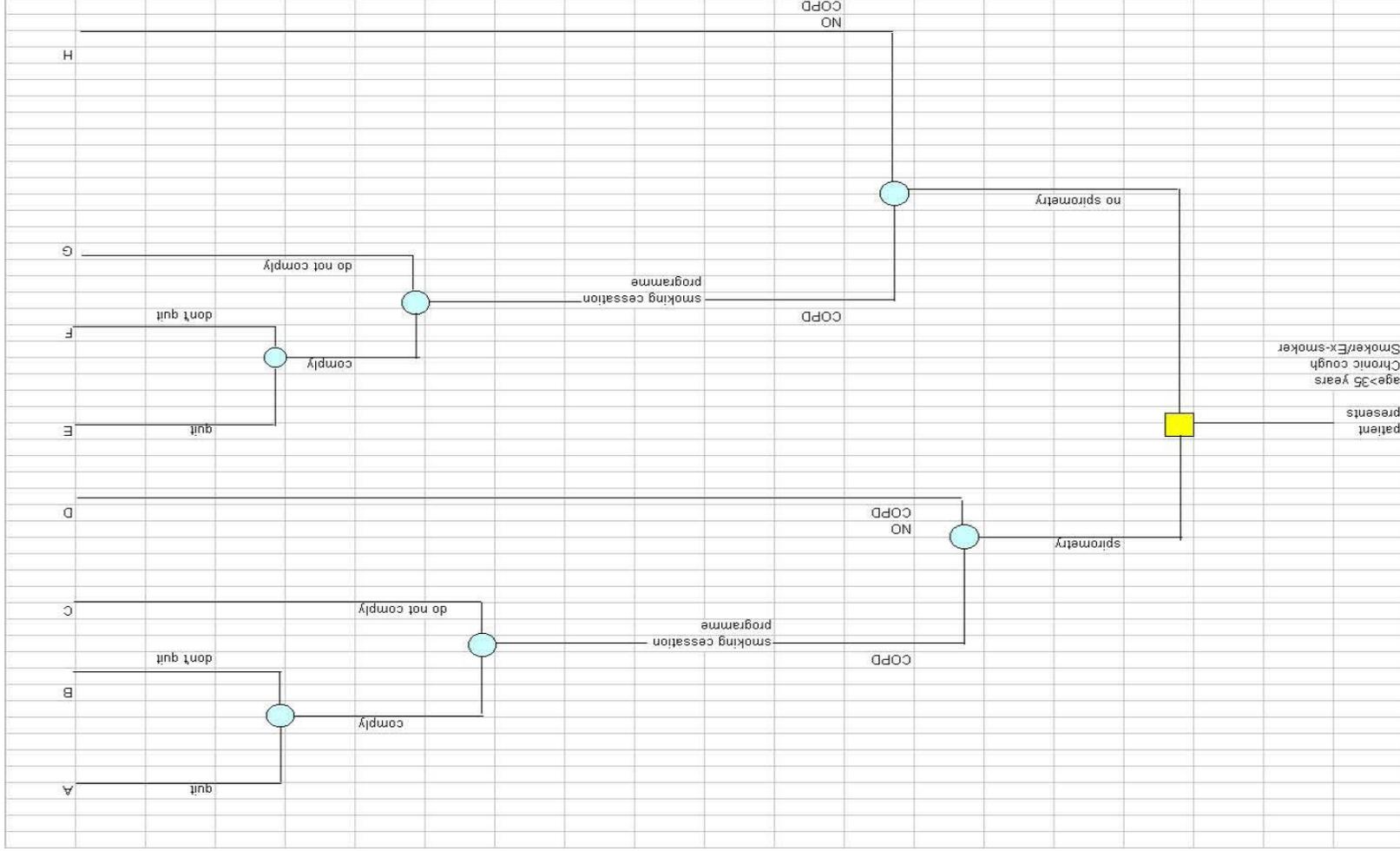
Varying the life years gained



Where 'base' is baseline parameter values of 3.5 years gained if quit smoking at age 46 and 2.1 years gained if quit smoking at age 55.

'Increased' is altering the life years gained to 5.5 years gained if quit smoking at age 46 and 3.5 years gained if quit smoking at age 55.

Figure 1 Tree structure



13 Appendix C Educational packages

Specific educational packages should be developed for patients with COPD. The packages should take account of the different needs of patients at different stages of their disease. Suggested topics for inclusion are:

- Disease education (Anatomy, physiology, pathology and pharmacology, including oxygen therapy & vaccination)
- Dyspnoea/symptom management, including chest clearance techniques
- Smoking cessation
- Energy conservation/ pacing
- Nutritional advice
- Managing travel
- Benefits system and disable parking badges
- Advance directives (living wills)
- Making a change plan
- Anxiety management
- Goal setting and rewards
- Relaxation
- Identifying and changing beliefs about exercise and health related behaviours
- Loving relationships/sexuality
- Exacerbation management (including when to seek help, self-management and decision making, coping with setbacks and relapses)
- Home care support
- Managing surgery (non thoracic)
- The benefits of physical exercise
- Support groups – such as the British Lung Foundation Breathe Easy groups, which operate throughout the UK

14 Appendix D Economic costs of COPD to the NHS

Titles were reviewed for references relating to the financial cost/economic burden of COPD in England and Wales. Studies relating to the cost in other countries were excluded.

Four relevant sources of information were identified. Two papers^{586,587}, an abstract⁵⁸⁸ and a discussion document⁵⁸⁹ were identified. In addition, one paper³³ was identified at a later date by referral from a GDG member as it had just been published. The paper by Sullivan et al was based on the NHS discussion document, another identified source. Only the Sullivan paper has been included.

References from these sources were checked for further references. No further references were identified. The details of each source are reported in the table below.

Author Category	Calverley⁵⁸⁸	Guest 1999⁵⁸⁶	Sullivan 2000⁵⁸⁷	Britton 2003³³
Year for cost data	1995/6	1996/7	1996	2000/01
Sources	Used data from the 4 th GP National Morbidity Study, Hospital Episode Statistics, Scottish NHS, Welsh Office, Mortality Statistics and DSS.	Based on a sub group analysis of a previously published prevalence-based burden of illness analysis	NHS Burdens of disease: a discussion document 1996	Telephone interviews. Part of the confronting COPD in North America and Europe survey. Collected data on resource use on a sample of the UK population with COPD. Used UK unit costs for resources to estimate an average per patient cost. Also estimated by severity of COPD

COPD (update)

Method	Top down	Top down	Top down	Micro costing
GP costs £	21,000,000	236,500,000	88,000,000 (primary care and community based services)	105.54 per patient
Medications £	85,000,000		402,000,000	130.54 per patient
GP		116,900,000		
Hospital		8,900,000		
Oxygen	156,000,000		207,000,000 (ambulatory)	Home oxygen 22.30 per patient
Hospital £	224,000,000		151,000,000	
Inpatient		243,400,000		444.60 per patient
Outpatient		35,000,000		
Day Case				
Emergency Admission	174,000,000			116.47 per patient
Other £		164,300,000		
Total £	486,000,000	817,500,000	848,000,000	491,652,000 direct 982,000,000 direct and indirect combined
Per patient	781		1,154	819.42
Direct costs £				
Per patient				819.66
Indirect costs £				

COPD (update)

The papers all differ in terms of their methodology and their data sources, as well as the costs that they include. The cost per patient for those using a top down approach also depends on the total number of patients they divide the total cost by. This may also explain some of the wide variation seen in the costs.

The paper by Britton et al also estimates the cost by disease severity.

Estimated cost by disease severity p.a. (2000/01) ³³

- | | | |
|------------|-------|-----------|
| • Mild | €232 | £149.68 |
| • Moderate | €477 | £307.74 |
| • Severe | €2026 | £1,307.10 |

These cost estimates could be viewed as the incremental cost of a COPD patient compared to the general population, as the study asked patients about resource use related to their COPD.

Cost of an exacerbation

Four papers of potential relevance were found.

Andersson et al (2002)⁴⁹⁶

COPD (update)

Costs given in SEK, converted to GB£ by using purchasing power parities for 2002 from the OECD <http://www.oecd.org/>

Mild	£7.94
Mild/moderate	£23.43
Moderate	£139.74
Severe	£1,446.48

Price et al (1999)⁴⁹⁷

Mild	£14.81
Moderate	£95.20
Severe	£1,658.59

Gibson et al (1998)⁵⁹⁰ This identifies resource by COPD patients with an exacerbation but does not cost it.

McGuire et al (2001)⁵⁹¹

This gives a total excess cost of exacerbations, but does not give a per patient cost.

1994/5 excess costs: £35.7 million.

Note that the cost-effectiveness analysis undertaken for the update of the guideline includes additional information about the cost of COPD exacerbations – see appendix M.

15 Appendix E Searching for health economics evidence

A separate search was carried out for health economics evidence as the clinical searches were not designed to capture this type of evidence. The searching was carried out by an information scientist at the School of Health and Related Research (SchARR) with guidance on the search terms from the health economist.

Selection of papers and reviewing was carried out by the health economist.

Search Strategy

The search strategy used was as follows

Methodological search filters used

Economic evaluations

- economics/
- exp “costs and cost analysis”/
- economic value of life/
- exp economics, hospital/
- exp economics, medical/
- economics, nursing/
- economics, pharmaceutical/
- exp models, economic/
- exp “fees and charges”/
- exp budgets/
- ec.fs

COPD (update)

- (cost or costs or costed or costly or costing\$.tw
- (economic\$ or pharmacoeconomic\$ or price\$ or pricing).tw
- or/1-13

Searches were restricted to 1995 to the present (August 2002) and to the English language. The following databases were searched with the number of hits shown in brackets:

- Medline (430)
- Embase(207)
- NHS EED (41)
- OHE HEED (161)

Databases were searched on 01/08/02

In addition, reference lists from appraised papers were checked for further useful references. A list of health economic terms was given to the systematic reviewer and information scientist at the NCC to help them identify any papers of potential relevance. Any found were then passed on to the health economist. The GDG also highlighted references they thought might be useful.

Inclusion criteria

The titles, and where available the abstracts, were screened to assess whether the study met the following inclusion criteria:

Patients: at least some of the patients had COPD.

COPD (update)

Economic evidence: the study was an economic evaluation or included information on resources, costs or specific quality of life measures.

Study design: no criteria for study design were imposed a priori.

Summary Results

After reviewing titles, abstracts and CRD/OHE HEED commentaries (where available), 115 potentially useful papers were included.

Full papers were obtained and led to a further exclusion of 47 papers. 68 papers were appraised and presented to the GDG. Very few of these were good quality formal economic evaluations. The table below shows the number of papers that were reviewed in each area.

Area	Number of papers reviewed
Financial cost of COPD to the NHS	5
Cost of an exacerbation	4
Bronchodilators	10
Pulmonary rehabilitation	15
Smoking cessation	4
Education	3
Oxygen-stable COPD: Long term oxygen therapy	1
Oxygen – stable COPD: Ambulatory oxygen therapy	1
Antibiotics	3
Hospital-at-home	7
Antitrypsin	1
Non invasive ventilation	5

COPD (update)

Mucolytics	1
Immunisation	3
Lung volume reduction surgery	1
Corticosteroids for stable COPD	4

Areas not listed above did not have any useful economic evidence.

16 Appendix F Evidence tables

Evidence tables from the COPD update guideline (GC101) are available at <http://guidance.nice.org.uk/CG101/EvidenceTables/pdf/English>

The evidence tables for the original COPD guideline (CG12) are available at http://thorax.bmj.com/content/59/suppl_1

The evidence tables provide full details for the studies identified and critically appraised as part of the formal systematic review. They are organised according to the guideline sections.

17 Appendices for NEW 2010 update

Update COPD Scope

Update questions

Update literature searches

Update research protocols

Deleted sections

Criteria for selecting future research recommendations

Cost effectiveness model

Forest plots

Declarations of Interest Register

18 Appendix G NEW 2010 update Scope

NATIONAL INSTITUTE FOR HEALTH AND CLINICAL EXCELLENCE

SCOPE

Guideline title

Chronic obstructive pulmonary disease: the management of adults with chronic obstructive pulmonary disease in primary and secondary care (partial update)

Short title

COPD (partial update)

Background

- a) The National Institute for Health and Clinical Excellence ('NICE' or 'the Institute') has commissioned the National Collaborating Centre for Chronic Conditions to review recent evidence on chronic obstructive pulmonary disease and to update some sections of the existing guideline 'Chronic obstructive pulmonary disease: management of chronic obstructive pulmonary disease in adults in primary and secondary care' (NICE clinical guideline 12, 2004) for use in the NHS in England and Wales. The guideline will provide recommendations for good practice that are based on the best available evidence of clinical and cost effectiveness.
- b) NICE clinical guidelines support the implementation of National Service Frameworks (NSFs) in those aspects of care where a Framework has been published. The statements in each NSF reflect the evidence that was used at the time the Framework was prepared. The clinical guidelines and technology appraisals published by NICE after an NSF has been issued have the effect of updating the Framework.
- c) NICE clinical guidelines support the role of healthcare professionals in providing care in partnership with patients, taking account of their individual needs and preferences, and ensuring that patients (and their carers and families, if appropriate) can make informed decisions about their care and treatment.

Clinical need for the guideline

- a) Since the publication of NICE clinical guideline 12 (2004), there has been progress in the management of chronic obstructive pulmonary disease (COPD) and the importance of systemic aspects of the disease also has been recognised. New initiatives such as the introduction of the Quality and Outcomes Framework for General Practice have helped the delivery of evidence-based care. But COPD is still a common cause of morbidity and mortality in England and Wales.
- b) People with COPD experience progressive breathlessness and reduction in exercise capacity. Exacerbations frequently result in hospital admission. COPD remains the fifth most common cause of death in England and Wales, accounting for more than 28,000

COPD (update)

deaths in 2005. It is also one of the ten most common causes of hospital admission. Many patients, including those with severe airflow obstruction, remain undiagnosed even though diagnostic testing using spirometry is increasingly available.

- c) The development of a NSF for COPD was announced in 2006 and it is expected that this will be published in late 2008 or early 2009. This partial update will provide evidence-based recommendations that will support the implementation of the Clinical Strategy for COPD (formerly known as the NSF).
- d) The guideline development process is described in detail in two publications that are available from the NICE website (see 'Further information'). 'The guideline development process: an overview for stakeholders, the public and the NHS' describes how organisations can become involved in the development of a guideline. 'The guidelines manual' provides advice on the technical aspects of guideline development.
- e) This scope defines what this guideline will (and will not) examine, and what the guideline developers will consider. This scope should be read along with the original scope for 'Chronic obstructive pulmonary disease: management of chronic obstructive pulmonary disease in adults in primary and secondary care' (NICE clinical guideline 12, 2004), which is reproduced in the appendix.
- f) The areas that will be addressed by the guideline are described in the following sections.

Population

Groups that will be covered

- a) Adults with stable COPD (including chronic bronchitis, emphysema and chronic airflow limitation/obstruction).

Groups that will not be covered

- a) People with asthma, bronchopulmonary dysplasia or bronchiectasis.
- b) Children younger than 16 years.
- c) People with an acute exacerbation of COPD.

Healthcare setting

- a) Care given by primary and secondary healthcare professionals who have responsibility for patients with COPD and who make decisions concerning their care.
- b) The guideline will also be relevant to the work, but will not cover the practice, of social services or patient support groups.

Clinical management

3.3.1 Topics that will be covered

a) Diagnosis and severity classification:

spirometry and post bronchodilator values

multidimensional severity assessment indices, for example the BODE Index which comprises body mass index, airflow obstruction, dyspnoea and exercise tolerance

b) Management of stable COPD and prevention of disease progression (updates section 7 of NICE clinical guideline 12):

long-acting bronchodilators: beta₂-agonists and anticholinergics (tiotropium, formoterol fumarate, salmeterol) as monotherapy and in combination, both with and without inhaled corticosteroids

mucoytic therapy (carbocisteine and mecysteine hydrochloride)

c) Note that guideline recommendations will normally fall within licensed indications; exceptionally, and only if clearly supported by evidence, use outside a licensed indication may be recommended. The guideline will assume that prescribers will use a drug's summary of product characteristics to inform their decisions for individual patients.

d) The Guideline Development Group will take reasonable steps to identify ineffective interventions and approaches to care. If robust and credible recommendations for re-positioning the intervention for optimal use, or changing the approach to care to make more efficient use of resources can be made, they will be clearly stated. If the resources released are substantial, consideration will be given to listing such recommendations in the 'Key priorities for implementation' section of the guideline.

e) Where there is evidence, the guideline will consider any sub-groups (for example, ethnicity) in whom the recognition and diagnosis of COPD may differ from the general population.

3.3.2 Topics that will not be updated:

a) Short-acting bronchodilator therapy (except as a comparator with long-acting bronchodilator therapy)

b) Theophylline

c) Phosphodiesterase type 4 inhibitors

d) Delivery systems

e) Oxygen therapy

f) Management of pulmonary hypertension and cor pulmonale

COPD (update)

- g) Pulmonary rehabilitation interventions
- h) Vaccination and anti-viral therapy
- i) Lung surgery
- j) Alpha-1 antitrypsin replacement therapy
- k) Anti-oxidant therapy
- l) Anti-tussive therapy
- m) Prophylactic antibiotic therapy
- n) Multi-disciplinary management (respiratory nurse specialist, physiotherapy, identifying and managing anxiety and depression, nutritional factors, palliative care, assessment for occupational therapy, social services, education, self-management, advice on travel),
- o) Fitness for general surgery
- p) Follow-up of patients with COPD
- q) Management of exacerbations
- r) Audit criteria

Status

Scope

This is the final version of the scope.

The guideline will partially update the following NICE guidance.

Chronic obstructive pulmonary disease: management of chronic obstructive pulmonary disease in adults in primary and secondary care. NICE clinical guideline 12 (2004).

The guideline will incorporate the following NICE guidance.

Varenicline for smoking cessation. NICE technology appraisal guidance 123 (2007).

Guideline

The development of the guideline recommendations will begin in September 2008.

Further information

The guideline development process is described in:

‘The guideline development process: an overview for stakeholders, the public and the NHS’

‘The guidelines manual’.

These are available from the NICE website (www.nice.org.uk/guidelinesmanual). Information on the progress of the guideline will also be available from the website.

COPD (update)

Appendix: Scope for NICE clinical guideline 12

NATIONAL INSTITUTE FOR CLINICAL EXCELLENCE

SCOPE

Guideline title

Chronic obstructive pulmonary disease: the management of adults with chronic obstructive pulmonary disease in primary and secondary care

Short title

COPD

Background

- a) The National Institute for Clinical Excellence ('NICE' or 'the Institute') has commissioned the National Collaborating Centre for Chronic Conditions to develop a clinical guideline on the management of chronic obstructive pulmonary disease for use in the NHS in England and Wales. This follows referral of the topic by the Department of Health and National Assembly for Wales (see appendix). The guideline will provide recommendations for good practice that are based on the best available evidence of clinical and cost effectiveness.
- b) The Institute's clinical guidelines will support the implementation of National Service Frameworks (NSFs) in those aspects of care where a Framework has been published. The statements in each NSF reflect the evidence that was used at the time the Framework was prepared. The clinical guidelines and technology appraisals published by the Institute after an NSF has been issued will have the effect of updating the Framework.

Clinical need for the guideline

- a) COPD is the fifth commonest cause of death in England and Wales, accounting for nearly 28,000 deaths each year and Britain has one of the highest death rates from COPD in the European Union. It is estimated that there are about 600,000 patients in the UK with diagnosed COPD and there may be as many again who remain undiagnosed. COPD patients are frequent users of primary and secondary care services with an estimate of one in eight hospital admissions being due to COPD. Consultation rates in general practice rise with age from 417 in those aged 45–64 per 10,000 population per year to 1032 in those aged 75–84 per year per 10,000 population (BTS, 1997). COPD results in an estimated 27 million lost working days per year.
- b) Recent national guidelines in the area include the guideline developed by the British Thoracic Society (Thorax 1997; 52 [suppl 5]; S1), the GOLD International guidelines (2001), Use of Nebulisers (Thorax 1997; 52 [suppl 2]) and the NIV guidelines (in press: Thorax).

COPD (update)

- c) Technology appraisals on the Institute's programme that will inform this guideline include guidance on zanamivir (Relenza) for influenza, smoking cessation treatments and nicotine replacement therapy (expected March 2002) and comparison of the effectiveness of inhaler devices in asthma and chronic obstructive airways disease: a systematic review of the literature (Health Technology Assessment 2001; Vol. 5: No. 26).

The guideline

- a) The guideline development process is described in detail in three booklets that are available from the NICE website (see 'Further information'). The Guideline Development Process – Information for Stakeholders describes how organisations can become involved in the development of a guideline.
- b) This document is the scope. It defines exactly what this guideline will (and will not) examine, and what the guideline developers will consider. The scope is based on the referral from the Department of Health and National Assembly for Wales (see Box).
- c) The areas that will be addressed by the guideline are described in the following sections.

Population

Groups that will be covered

- a) The guideline will offer best practice advice on the care of adults who have a clinical working diagnosis of COPD including chronic bronchitis, emphysema, and chronic airflow limitation/obstruction.

Groups that will not be covered

- a) The guideline will not cover the management of people with asthma, bronchopulmonary dysplasia or bronchiectasis.
- b) The guideline will not cover children (aged < 16 years).

Healthcare setting

- a) The guideline will cover the care received from primary and secondary healthcare professionals who have direct contact with and make decisions concerning the care of patients with COPD.
- b) The guideline will also be relevant to the work, but will not cover the practice, of social services, patient support groups or palliative care services.

Clinical management

The guideline will include recommendations in the following areas.

- a) Diagnostic criteria, including the role of spirometry in primary and secondary care.

COPD (update)

- b) Identification of early disease to facilitate preventative approaches. The guideline will not cover general population screening, but will include opportunistic case find.
- c) Management of stable patients, management of acute exacerbations and prevention of progression of the disease, to include:
 - smoking cessation, including pharmacological and non-pharmacological approaches as they relate specifically to COPD
 - bronchodilator management including methods of delivery and methods of assessing efficacy
 - inhaled and oral corticosteroid therapy
 - non-pharmacological interventions, including pulmonary rehabilitation and respiratory physiotherapy, lifestyle advice including nutritional/metabolic assessment and management and self-management techniques
 - the management of right heart failure as it pertains to COPD
 - oxygen therapy including when it should be used and what type is appropriate in different circumstances
 - non-invasive ventilation
 - indications for surgery
- d) Criteria for admission and/or management at home of exacerbations.
- e) Management of depression and/or anxiety as it pertains directly to patients with COPD and is outside the scope of the 'Management of Depression' guideline which is under development.
- f) Advice on treatment options will be based on the best evidence available to the development group. When referring to pharmacological treatments, the guideline will normally recommend use within licensed indications. Exceptionally, and only where the evidence clearly supports it, recommendations for the guideline may recommend use outside the licence indications. The guideline assumes that prescribers will use the Summary of Product Characteristics to inform their prescribing decisions for individual patients.

Audit support within guideline

The guideline will include review criteria for audit.

Status

Scope

This is the final version of the scope.

COPD (update)

Guideline

The development of the guideline recommendations will begin in the second quarter of 2002.

Further information

Information on the guideline development process is provided in:

The Guideline Development Process – Information for the Public and the NHS

The Guideline Development Process – Information for Stakeholders

The Guideline Development Process – Information for National Collaborating Centres and Guideline Development Groups.

These booklets are available as PDF files from the NICE website (www.nice.org.uk). Information of the progress of the guideline will also be available from the website.

References

BTS guidelines for the management of chronic obstructive pulmonary disease. The COPD Guidelines Group of the Standards of Care Committee of the BTS. *Thorax* 1997; 52 Suppl 5:S1-28.

Current best practice for nebuliser treatment. British Thoracic Society Nebulizer Project Group [published erratum appears in *Thorax* 1997 Sep; 52(9): 838] *Thorax* 1997; 52 (Suppl 2): S1-S3.

Pocket Guide to COPD Diagnosis, Management, and Prevention. Global Initiative for Chronic Obstructive Lung Disease; U.S. Department of Health and Human Services; Public Health Service; National Institutes of Health; National Heart, Lung, and Blood Institute; NIH Publication No. 2701B

Referral from the Department of Health and National Assembly for Wales

“To prepare clinical guidelines for the NHS in England and Wales for the prevention, diagnosis, management and treatment of COPD.”

19 Appendix H NEW 2010 update PICO questions

DRUG 1: LABA vs. LAMA

What is the clinical and cost effectiveness of long-acting beta₂ agonists compared with long-acting muscarinic antagonists in the management of people with stable COPD?

DRUG 3a) LABA + ICS vs. LABA alone

What is the clinical and cost effectiveness of long-acting beta₂ agonists plus inhaled corticosteroids compared to long-acting beta₂ agonists in the management of people with stable COPD?

DRUG 3b) LABA + ICS vs. LAMA alone

What is the clinical and cost effectiveness of long-acting beta₂ agonists plus inhaled corticosteroids compared to long-acting muscarinic antagonists in the management of people with stable COPD?

DRUG 4a) LAMA + ICS vs. LABA alone

What is the clinical and cost effectiveness of long-acting muscarinic antagonists plus inhaled corticosteroids compared to long-acting beta₂ agonists in the management of people with stable COPD?

DRUG 4b) LAMA + ICS vs. LAMA alone

What is the clinical and cost effectiveness of long-acting muscarinic antagonists plus inhaled corticosteroids compared to long-acting muscarinic antagonists in the management of people with stable COPD?

DRUG 5a) LAMA + LABA vs. LABA alone

What is the clinical and cost effectiveness of long-acting muscarinic antagonists plus long-acting beta₂ agonists compared to long-acting beta₂ agonists in the management of people with stable COPD?

DRUG 5b) LAMA + LABA vs. LAMA alone

What is the clinical and cost effectiveness of long-acting muscarinic antagonists plus long-acting beta₂ agonists compared to long-acting muscarinic antagonists in the management of people with stable COPD?

COPD (update)

DRUG 5 c) LAMA + LABA vs. LABA +ICS

What is the clinical and cost effectiveness of long-acting muscarinic antagonists plus long-acting beta₂ agonists compared to long-acting beta₂ agonists plus inhaled corticosteroids in the management of people with stable COPD?

DRUG 6a) LAMA + LABA + ICS vs. LABA + ICS

What is the clinical and cost effectiveness of long-acting muscarinic antagonists plus long-acting beta₂ agonists plus inhaled corticosteroids compared to long-acting beta₂ agonists plus inhaled corticosteroids in the management of people with stable COPD

DRUG 6b) LAMA + LABA + ICS vs. LAMA alone

What is the clinical and cost effectiveness of long-acting muscarinic antagonists plus long-acting beta₂ agonists plus inhaled corticosteroids compared to long-acting muscarinic antagonists alone in the management of people with stable COPD?

DRUG 6c) LAMA + LABA + ICS vs. LABA + LAMA

What is the clinical and cost effectiveness of long-acting muscarinic antagonists plus long-acting beta₂ agonists plus inhaled corticosteroids compared to long-acting beta₂ agonists plus long-acting muscarinic antagonists in the management of people with stable COPD ?

DRUG 8: LAMA vs. SAMA

What is the clinical and cost effectiveness of long-acting muscarinic antagonists compared to short-acting muscarinic antagonists in the management of people with stable COPD?

DIAG 1: How does post bronchodilator FEV₁ (forced expiratory volume in one second) compare with pre bronchodilator FEV₁ in terms of: a) sensitivity / specificity of FEV₁ for diagnosis; b) classification of severity of disease?

DIAG2: In individuals where the diagnosis of COPD is considered and spirometry is conducted, what is the sensitivity and specificity of a fixed ratio FEV₁ / FVC compared with lower limit of normal FEV₁ / FVC ratio to diagnose COPD?

MUCO: What is the clinical and cost effectiveness of mucolytic agents vs. placebo in people with stable COPD?

COPD (update)

REHAB: Does early pulmonary rehabilitation (within one month of hospital discharge) in people who had an acute exacerbation improve outcomes compared with usual care (or no rehabilitation), in people with COPD?

MULTI: Is routine assessment using multidimensional severity assessment indices (e.g. BODE) more predictive of outcomes compared to FEV₁ alone?

20 Appendix I NEW 2010 update research protocols

	Research protocol
	DIAG 1
Question	How does post bronchodilator FEV ₁ (forced expiratory volume in one second) compare with pre bronchodilator FEV ₁ in terms of: a) sensitivity / specificity of FEV ₁ for diagnosis; b) classification of severity of disease?
Objective	To determine if spirometry should be performed pre or post bronchodilator in order to accurately diagnose COPD
Criteria	Observational studies that compare pre and post bronchodilator (BD) FEV ₁ values to a clinical diagnosis of COPD (based on symptoms). Exclude studies if pre and post BD FEV ₁ values were compared to identify COPD defined according to GOLD criteria (post bronchodilator FEV ₁ /FVC < 0.70). By definition, post bronchodilator FEV ₁ would correlate better with a definition of COPD that is based on post bronchodilator FEV ₁ . Outcomes: sensitivity, specificity; % people identified with COPD; correlation coefficient
Search Strategy	Literature Search Strategy: Stable COPD AND FEV ₁ AND Bronchodilators. Sources: MED,EMB,CIN,COCH.
Review Strategy	No RCTs; no GRADE performed; summary of study quality provided

COPD (update)

	Research protocol
	DIAG 2
Question	In individuals where the diagnosis of COPD is considered and spirometry is conducted, what is the sensitivity and specificity of a fixed ratio FEV ₁ / FVC compared with the lower limit of normal FEV ₁ / FVC ratio to diagnose COPD?
Objective	To determine if fixed FEV ₁ / FVC ratio or lower limit of normal [LLN] FEV ₁ / FVC is a more accurate way to diagnose COPD (especially in younger and older people).
Criteria	Observational/diagnostic studies comparing fixed FEV ₁ / FVC ratio or lower limit of normal [LLN] FEV ₁ / FVC ratio with a physician's diagnosis of COPD. Comparison is with a physician's diagnosis. Outcomes: sensitivity; specificity; % identified with COPD
Search Strategy	Literature Search Strategy: Fixed Ratio FEV ₁ AND Lower Limit FEV ₁ . Sources: MED,EMB,CIN,COCH. Limits: Study Types: RCTs, SRs
Review Strategy	No RCTs; no GRADE performed; summary of study quality provided

Research protocol

Mucolytics

Question	What is the clinical and cost effectiveness of mucolytic agents vs. placebo in people with stable COPD?
Objective	to determine if mucolytic agents improve outcomes (specifically decrease exacerbations) in people with COPD
Criteria	SRs or RCTs with at least 6 months follow-up comparing oral mucolytic therapy (Carbosysteine, Erdosteine, or N-acetylcysteine) with placebo (or each other) in people with stable COPD. Outcomes of interest included all-cause mortality, exacerbations, hospitalisations, decline in FEV ₁ , change in health related quality of life (measured with total SGRQ score), change in breathlessness (measured with TDI), and adverse events. The clinically important relative risk reduction (RRR) for mortality was 15%, exacerbations (20%), hospitalisation (20%), change in SGRQ (-4 points), FEV ₁ (100 ml), and TDI (1 unit).
Search Strategy	Literature Search Strategy: Stable COPD AND Mucolytics. Sources: MED,EMB,CIN,COCH. Limits: Study Types: RCTs, SRs, Years: 2003-20/8/09
Review Strategy	Meta-analysis where appropriate; important subgroups are type of mucolytic agent and study duration

Research protocol

DRUG 1: LABA vs. LAMA

Question	DRUG 1: LABA vs. LAMA: What is the clinical and cost effectiveness of long-acting beta2 agonists compared with long-acting antimuscarinic agents in the management of people with stable COPD?
Objective	To compare the 2 classes of long-acting bronchodilators
Criteria	SRs and RCTs with minimum 6 month follow-up comparing LABA with LAMA in adults with stable COPD (without asthma) characterised by no recent infections, exacerbations or hospitalisations in the previous month. Minimum of 10 smoking pack years. Outcomes: All cause mortality (at ≥ 1 year), <ul style="list-style-type: none">• Mean rate of exacerbation (at ≥ 1 year),• Hospitalisation (at ≥ 1 year),• Rate of decline of FEV₁ (at ≥ 1 year)• SRGQ QoL (6-12 months),• TDI score (≥ 6 month follow up)• Adverse events (specifically MI, arrhythmia, CHF) The clinically important relative risk reduction (RRR) for mortality was 15%, exacerbations (20%), hospitalisation (20%), change in SGRQ (-4 points), FEV₁ (100 ml), and TDI (1 unit). adverse events (15%)
Search Strategy	Literature Search Strategy: DRUG1,3,4,5,6 were run as one search: Stable COPD AND (LABA OR LAMA OR ICS). Sources: MED, EMB, CIN, COCH. Limits: Study Types: RCTs, SRs, Years: 2003-20/8/09
Review Strategy	Original MA may be required or updating published MA

Research protocol	
DRUG 3a: LABA + ICS vs. LABA / DRUG 3b) LABA + ICS vs. LAMA alone	
Question	<p>DRUG 3a: LABA + ICS vs. LABA What is the clinical and cost effectiveness of long-acting beta2 agonists plus inhaled corticosteroids compared to long-acting beta2 agonists in the management of people with stable COPD?</p> <p>DRUG 3b) LABA + ICS vs. LAMA alone What is the clinical and cost effectiveness of long-acting beta2 agonists plus inhaled corticosteroids compared to long-acting muscarinic antagonists in the management of people with stable COPD?</p>
Objective	To determine if addition of ICS to long-acting bronchodilators is clinically and economically beneficial compared with monotherapy with long-acting bronchodilators
Criteria	<p>SRs and RCTs with minimum 6 month follow-up comparing LABA + ICS with either LABA alone or LAMA alone in adults with stable COPD (without asthma) characterised by no recent infections, exacerbations or hospitalisations in the previous month. Minimum of 10 smoking pack years.</p> <p>Outcomes:</p> <ul style="list-style-type: none"> • All cause mortality (at ≥ 1year), • Mean rate of exacerbation (at ≥ 1year), • Hospitalisation (at ≥ 1year), • Rate of decline of FEV₁ (at ≥ 1year) • SRGQ QoL (6-12 months), • TDI score (≥ 6 month follow up) • Adverse events (specifically MI, arrhythmia, CHF, pneumonia, bone fracture, BMD)

The clinically important relative risk reduction (RRR) for mortality was 15%, exacerbations (20%), hospitalisation (20%), change in SGRQ (-4 points), FEV₁ (100 ml), and TDI (1 unit); adverse events (15%)

**Search
Strategy**

Literature Search Strategy: **DRUG1,3,4,5,6 were run as one search**: Stable COPD **AND** (LABA OR LAMA OR ICS). Sources: MED,EMB,CIN,COCH. Limits: Study Types: RCTs, SRs, Years: 2003-20/8/09

**Review
Strategy**

Original MA may be required or updating published MA
Important subgroup analyses: study duration; type of run-in (either not stated; drug withdrawal; or drug optimisation)
- lung function level: separate by FEV₁ < 50, <60, < 70
- exacerbations at baseline: separate those studies where people had exacerbations in previous year versus those who did not have exacerbations (or this detail is not stated in inclusion criteria)

Research protocol	
DRUG 4a: LAMA + ICS vs LABA and DRUG 4b) LAMA + ICS vs. LAMA alone	
Question	<p>DRUG 4a: LAMA + ICS vs. LABA What is the clinical and cost effectiveness of long-acting antimuscarinic agents plus inhaled corticosteroids compared to long-acting beta2 agonists in the management of people with stable COPD?</p> <p>DRUG 4b) LAMA + ICS vs. LAMA alone What is the clinical and cost effectiveness of long-acting antimuscarinic agents plus inhaled corticosteroids compared to long-acting muscarinic antagonists in the management of people with stable COPD?</p>
Objective	To determine if addition of ICS to long-acting antimuscarinic agents is clinically and economically beneficial compared with monotherapy with long-acting bronchodilators
Criteria	<p>SRs and RCTs with minimum 6 month follow-up comparing LAMA + ICS with either LABA alone or LAMA alone in adults with stable COPD (without asthma) characterised by no recent infections, exacerbations or hospitalisations in the previous month. Minimum of 10 smoking pack years. Outcomes:</p> <ul style="list-style-type: none"> • All cause mortality (at ≥1year), • Mean rate of exacerbation (at ≥1year), • Hospitalisation (at ≥1year), • Rate of decline of FEV₁ (at ≥1year) • SRGQ QoL (6-12 months), • TDI score (≥ 6 month follow up) • Adverse events (specifically MI, arrhythmia, CHF, pneumonia, bone fracture, BMD) • The clinically important relative risk reduction (RRR) for mortality was 15%, exacerbations (20%), hospitalisation (20%), change in SGRQ (-4 points), FEV₁ (100 ml), and TDI (1 unit); adverse events (15%)

COPD (update)

Search Strategy	Literature Search Strategy: DRUG1,3,4,5,6 were run as one search : Stable COPD AND (LABA OR LAMA OR ICS). Sources: MED,EMB,CIN,COCH. Limits: Study Types: RCTs, SRs, Years: 2003-20/8/09
Review Strategy	Original MA may be required or updating published MA Important subgroup analyses: study duration; type of run-in (either not stated; drug withdrawal; or drug optimisation) - lung function level: separate by FEV ₁ < 50, <60, < 70 - exacerbations at baseline: separate those studies where people had exacerbations in previous year versus those who did not have exacerbations (or this detail is not stated in inclusion criteria)

Research protocol	
DRUG 5a: LAMA + LABA vs LABA / DRUG 5b) LAMA + LABA vs. LAMA /	
DRUG 5c) LAMA + LABA vs LABA + ICS	
Question	<p>DRUG 5a: LAMA + LABA vs. LABA What is the clinical and cost effectiveness of long-acting antimuscarinic agents plus long-acting beta2 agonists compared to long-acting beta2 agonists in the management of people with stable COPD?</p> <p>DRUG 5b) LAMA + LABA vs. LAMA What is the clinical and cost effectiveness of long-acting antimuscarinic agents plus long-acting beta2 agonists compared to long-acting muscarinic antagonists in the management of people with stable COPD?</p> <p>DRUG 5c) LAMA + LABA vs. LABA + ICS What is the clinical and cost effectiveness of long-acting antimuscarinic agents plus long-acting beta2 agonists compared to long-acting beta2 agonists plus inhaled corticosteroids in the management of people with stable COPD?</p>
Objective	To determine if dual therapy with long-acting bronchodilators is clinically and economically beneficial compared with monotherapy with long-acting bronchodilators or dual therapy with LABA + ICS
Criteria	<p>SRs and RCTs with minimum 6 month follow-up comparing LAMA + LABA with either LABA alone or LAMA alone or LABA + ICS in adults with stable COPD (without asthma) characterised by no recent infections, exacerbations or hospitalisations in the previous month. Minimum of 10 smoking pack years. Outcomes:</p> <ul style="list-style-type: none">• All cause mortality (at ≥1year),• Mean rate of exacerbation (at ≥1year),• Hospitalisation (at ≥1year),

COPD (update)

	<p>Rate of decline of FEV₁ (at ≥1year) SRGQ QoL (6-12 months), TDI score (≥ 6 month follow up) Adverse events (specifically MI, arrhythmia, CHF) (pneumonia, bone fracture, BMD for any comparison involving ICS) The clinically important relative risk reduction (RRR) for mortality was 15%, exacerbations (20%), hospitalisation (20%), change in SGRQ (-4 points), FEV₁ (100 ml), and TDI (1 unit); adverse events (15%)</p>
Search Strategy	<p>Literature Search Strategy: DRUG1,3,4,5,6 were run as one search: Stable COPD AND (LABA OR LAMA OR ICS). Sources: MED,EMB,CIN,COCH. Limits: Study Types: RCTs, SRs, Years: 2003-20/8/09</p>
Review Strategy	<p>Original MA may be required or updating published MA Important subgroup analyses: study duration; type of run-in (either not stated; drug withdrawal; or drug optimisation) - lung function level: separate by FEV₁ < 50, <60, < 70 - exacerbations at baseline: separate those studies where people had exacerbations in previous year versus those who did not have exacerbations (or this detail is not stated in inclusion criteria)</p>

Research protocol	
	DRUG 6a: LAMA + LABA + ICS vs LABA + ICS / DRUG 6b) LAMA + LABA + ICS vs. LAMA alone / DRUG 6c) LAMA + LABA + ICS vs LABA + LAMA
Question	<p>DRUG 6a: LAMA + LABA + ICS vs. LABA + ICS What is the clinical and cost effectiveness of long-acting antimuscarinic agents plus long-acting beta2 agonists plus inhaled corticosteroids compared to long-acting beta2 agonists plus inhaled corticosteroids in the management of people with stable COPD?</p> <p>DRUG 6b) LAMA + LABA + ICS vs. LAMA alone What is the clinical and cost effectiveness of long-acting antimuscarinic agents plus long-acting beta2 agonists plus inhaled corticosteroids compared to long-acting muscarinic antagonists alone in the management of people with stable COPD?</p> <p>DRUG 6c) LAMA + LABA + ICS vs. LABA + LAMA What is the clinical and cost effectiveness of long-acting antimuscarinic agents plus long-acting beta2 agonists plus inhaled corticosteroids compared to long-acting beta2 agonists plus long-acting antimuscarinic agents in the management of people with stable COPD?</p>
Objective	To determine if triple therapy is clinically and economically beneficial compared with long-acting bronchodilators or dual therapy with LABA + ICS

COPD (update)

SRs and RCTs with minimum 6 month follow-up comparing triple therapy with either LABA + ICS or LABA + LAMA or LAMA alone in adults with stable COPD (without asthma) characterised by no recent infections, exacerbations or hospitalisations in the previous month. Minimum of 10 smoking pack years.

Outcomes:

- All cause mortality (at ≥ 1 year),
- Mean rate of exacerbation (at ≥ 1 year),
- Hospitalisation (at ≥ 1 year),
- Rate of decline of FEV₁ (at ≥ 1 year)
- SRGQ QoL (6-12 months),
- TDI score (≥ 6 month follow up)
- Adverse events (specifically MI, arrhythmia, CHF) (pneumonia, bone fracture, BMD for any comparison involving ICS)

Criteria

The clinically important relative risk reduction (RRR) for mortality was 15%, exacerbations (20%), hospitalisation (20%), change in SGRQ (-4 points), FEV₁ (100 ml), and TDI (1 unit); adverse events (15%)

Search Strategy

Literature Search Strategy: **DRUG1,3,4,5,6 were run as one search: Stable COPD AND (LABA OR LAMA OR ICS)**. Sources: MED, EMB, CIN, COCH. Limits: Study Types: RCTs, SRs, Years: 2003-20/8/09

Review Strategy

Original MA may be required or updating published MA
Important subgroup analyses: study duration; type of run-in (either not stated; drug withdrawal; or drug optimisation)
- lung function level: separate by FEV₁ < 50, < 60, < 70
- exacerbations at baseline: separate those studies where people had exacerbations in previous year versus those who did not have exacerbations (or this detail is not stated in inclusion criteria)

Research protocol Drug 8 LAMA vs SAMA	
Question	What is the clinical and cost effectiveness of long-acting muscarinic antagonists compared to short-acting muscarinic antagonists in the management of people with stable COPD?
Objective	To determine if once a day LAMA is clinically and economically beneficial compared with four times a day SAMA in people with COPD
Criteria	SRs and RCTs with minimum 6 month follow-up comparing LAMA with SAMA in adults with stable COPD (without asthma) characterised by no recent infections, exacerbations or hospitalisations in the previous month. Outcomes of interest were mortality, exacerbations, hospitalisations, decline in FEV ₁ , change in health related quality of life (measured with total SGRQ), adverse events (MI or acute arrhythmia), and change in breathlessness score (measured with TDI). The clinically important relative risk reduction (RRR) for mortality was 15%, exacerbations (20%), hospitalisation (20%), change in SGRQ (-4 points), FEV ₁ (100 ml), and TDI (1 unit); adverse events (15%)
Search Strategy	Literature Search Strategy: Stable COPD AND LAMA AND SAMA. Sources: MED,EMB,CIN,COCH. Limits: Study Types: RCTs, SRs, Years: 2003-20/8/09
Review Strategy	Original MA may be required or updating published MA Important subgroup analyses: study duration; type of run-in (either not stated; drug withdrawal; or drug optimisation) - lung function level: separate by FEV ₁ < 50, <60, < 70 - exacerbations at baseline

	Research protocol REHAB
Question	Does early pulmonary rehabilitation (within one month of hospital discharge) in people who had an acute exacerbation improve outcomes compared with usual care (or no rehabilitation), in people with COPD?
Objective	To determine if early rehab (within 1 month of hospital discharge) in people who have suffered an exacerbation is clinically and economically beneficial compared with no rehab or usual care
Criteria	SRs and RCTs comparing early rehab (within 1 month of hospital discharge) in people who have suffered an exacerbation with no rehab or usual care. Outcomes: <ul style="list-style-type: none"> • All cause mortality (at ≥ 1 year), • Mean rate of exacerbation (at ≥ 1 year), • Hospitalisation (at ≥ 1 year), • Rate of decline of FEV₁ (at ≥ 1 year) • SRGQ QoL (6-12 months), shuttle walk distance; six minute walk distance • TDI score (≥ 6 month follow-up); • The clinically important relative risk reduction (RRR) for mortality was 15%, exacerbations (20%), hospitalisation (20%), change in SGRQ (-4 points), shuttle walk distance (48 meters), FEV₁ (100 ml), TDI (1 unit), and six minute walk distance (50 m).
Search Strategy	Literature Search Strategy: Stable COPD AND Pulmonary Rehabilitation. Sources: MED, EMB, CIN, COCH. Limits: Study Types: RCTs, SRs, Years: 2003-20/8/09
Review Strategy	Original MA may be required or updating published MA Important subgroup analyses: - rehab initiated in hospital - rehab initiated after hospital discharge

	Research protocol
	MULTI
Question	Is routine assessment using multidimensional severity assessment indices (e.g. BODE) more predictive of outcomes compared to FEV ₁ alone?
Objective	To determine the prognostic ability of FEV ₁ vs. multidimensional indices to predict outcomes in stable COPD patients
Criteria	Observational studies comparing FEV ₁ with multidimensional indices in people with COPD. Exclusion criteria: retrospective studies, univariate analyses, multivariate analysis if it did not adjust for age and smoking, any index that was not multidimensional (i.e. it must include measures of different outcome combinations such as QoL + symptoms, not just multiple dimensions of one type of outcome measure such as QoL). Outcomes :mortality, hospitalisations and exacerbations
Search Strategy	Literature Search Strategy: Stable COPD AND Assessment Indices AND FEV ₁ . Sources: MED,EMB,CIN,COCH. Limits: Study Types: RCTs, SRs, Years: 2003-20/8/09
Review Strategy	Summary of study quality (no GRADE profiles)

Research protocol (Call for evidence)	
Question	<p>The Guideline Development Group is seeking detailed unpublished data on patients entering published drug studies of long-acting bronchodilators and studies of combinations of long-acting bronchodilators with inhaled steroids.</p> <p>The data should be able to provide evidence for the following comparisons:</p> <ol style="list-style-type: none"> 1) LABA + ICS v LABA 2) LAMA + ICS v LAMA 3) LAMA + ICS v LABA + LAMA 4) LABA + LAMA v LABA 5) LABA + LAMA v LAMA 6) LABA + LAMA + ICS v LABA + ICS 7) LABA + LAMA + ICS v LAMA 8) LABA + LAMA + ICS v LABA + LAMA
Objective	<p>to identify subgroups of trials that have background combination therapy (i.e. LABA + LAMA+ ICS)</p> <p>With minimum 6 month follow-up comparing in adults with stable COPD (without asthma) characterised by no recent infections, exacerbations or hospitalisations in the previous month. Minimum of 10 smoking pack years.</p> <p>Outcomes: All cause mortality (at ≥ 1year),</p> <ul style="list-style-type: none"> • Mean rate of exacerbation (at ≥ 1year), • Hospitalisation (at ≥ 1year), • Rate of decline of FEV₁ (at ≥ 1year) • SRGQ QoL (6-12 months), • TDI score (≥ 6 month follow up)
Criteria	<ul style="list-style-type: none"> • Adverse events (specifically MI, arrhythmia, CHF, pneumonia, osteoporosis)

COPD (update)

Search

Strategy Letter to stakeholders - no search required

Review Strategy RCTs with subgroup analysis by LABA/LAMA/ICS background which may inform clinical questions; baseline characteristics should be similar enough between groups; key trials with important background medication are: INSPIRE, TORCH, UPLIFT

Overall protocol		
	Inclusion	Exclusion
Types of Studies	Meta analyses / RCTs (parallel and crossover)	
Types of participants	Adults with stable COPD (without asthma) characterised by no recent infections, exacerbations or hospitalisations in the previous month. Minimum of 10 smoking pack years	Specific populations that are not relevant e.g. Japanese and African American
Types of intervention	LAMA vs SAMA LAMA vs LABA LABA + LAMA vs LAMA LABA+LAMA vs. LABA LAMA + ICS vs LAMA LAMA + ICS vs LABA LABA+ICS vs LABA LABA + ICS vs LAMA LABA+LAMA+ICS vs. LABA + LAMA LABA+LAMA+ICS vs. LABA + ICS LABA + LAMA + ICS vs LAMA	Nebulised route of delivery Short-acting LAMA or LABA

COPD (update)

<p>Types of Outcome measures</p>	<ul style="list-style-type: none"> • All cause mortality (at ≥ 1 year), • Mean rate of exacerbation (at ≥ 1 year), • Hospitalisation (at ≥ 1 year), • Rate of decline of FEV₁ (at ≥ 1 year) • SRGQ QoL (6-12 months), • TDI score (≥ 6 month follow up) • Adverse events (cardiac, osteoporosis and pneumonia) 	<p>End exercise isotime Transdiaphragmatic pressure Dynamic hyperinflation Trough FEV₁/FVC Inspired capacity FEV₁ AUC 0-12</p>
<p>Follow up</p>	<p>≥ 6 months</p>	

Research protocol

Health economic literature review protocol

Question	All clinical questions for guideline as specified in clinical review protocol
Objective	<p>To identify economic evaluations that address the clinical questions as specified above</p> <p><u>Population and Interventions</u></p> <p>Include: Generally as for clinical review - patients with COPD</p> <p><u>Setting</u></p> <p>Included: UK NHS</p> <p>Potentially includable (depending on availability and quality of other evidence; in hierarchical order): OECD countries with predominantly public health insurance systems (e.g. France, Germany, Sweden); OECD countries with predominantly private health insurance systems (e.g. USA, Switzerland)</p> <p>Excluded: Non-OECD settings</p> <p><u>Outcome</u></p> <p>Included: Full economic evaluations; Cost-utility (QALYs)</p> <p>Potentially includable (depending on availability and quality of other evidence; in hierarchical order): Cost-effectiveness; Cost-benefit;</p>
Criteria	<p>Cost-consequences; Comparative costs (including cost minimisation analysis); QALYs (without cost); Willingness to pay (without cost)</p>

Excluded: Studies that report only cost per hospital (not cost per patient); Studies that report only average cost-effectiveness ratios and do not disaggregate the costs and effects to allow an incremental analysis to be conducted; Utility – i.e. quality of life on a zero-one score – (without cost); Resource use (e.g. hospitalisation; without cost)

Study design criteria

Included: Economic evaluations conducted alongside randomised controlled trials included in clinical review; Economic evaluation models where treatment effect is based on one or more randomised controlled trial where all are included in clinical review

Potentially includable (depending on availability and quality of other evidence): Economic evaluation models where treatment effect is based on one or more randomised controlled trial where not all are included in clinical review; Economic evaluations based on non-randomised controlled trials or observational evidence (especially where include in clinical review or there are concerns over generalisability of RCT-based studies); Study quality rating = very serious limitations

Excluded: Non-comparative studies (e.g. cost of illness studies); Comparative studies where only one intervention is within the scope of the question; Reviews of economic evaluations (recent reviews ordered and checked for references); Study applicability rating = not applicable

Publication status

Included: Published papers; Unpublished reports/papers submitted in response to a call for evidence

Excluded: Unpublished reports/papers NOT submitted in response to a call for evidence; Abstract-only studies; Letters, editorials; Foreign language

Search Strategy

Literature Search Strategy: Stable COPD. Sources: MED,EMB, CRD (EED & HTA). Limits: Study Types: Economic, Years: MED & EMB 2007-24/7/09, CRD (EED & HTA) 2003-24/7/09

Review Strategy

- Economic GRADE profile if evidence identified.
- Studies that are excluded that were potentially includable (as per above criteria) to be noted in methodological introduction.

21 Appendix J NEW 2010 update literature searches

Search Strategies

Search strategies used for COPD guideline update are outlined below.

The cut off date was: 20/8/09

Searches were run in Medline, Embase (OVID), the Cochrane Library and Cinahl (EBSCO) as per the NICE Guidelines Manual 2007

<http://www.nice.org.uk/media/FA1/59/GuidelinesManualChapters2007.pdf> and 2009

http://www.nice.org.uk/media/5F2/44/The_guidelines_manual_2009_-_All_chapters.pdf.

Searches were constructed using the PICO format.

Population AND Intervention AND Comparison (if there was one) AND Search Filters (if used)

Outcomes were not used in the search strategy.

COPD Population search strategies

Medline search terms

1. exp Pulmonary Disease, Chronic Obstructive/
2. copd.ti,ab.
3. coad.ti,ab.
4. Bronchitis/
5. Chronic bronchitis/
6. (chronic adj5 (obstruct\$ or limit#\$)).ti.
7. (obstruct\$ adj3 (airflow\$ or airway\$ or respirat\$ or lung or pulmonary) adj2 (disease\$ or disorder\$)).ti,ab.
8. Pulmonary emphysema/
9. emphysema.ti,ab.

COPD (update)

10. "chronic bronchitis".ti,ab.

11. or/1-10

12. bronchial neoplasms/ or exp bronchiectasis/ or exp bronchiolitis/ or cystic fibrosis/ or lung diseases, interstitial/ or lung neoplasms/

13. exp Sleep Apnea Syndromes/

14. Bronchopulmonary Dysplasia/

15. (cancer or neoplas\$).ti.

16. "acute bronchitis".ti.

17. sleep apnea.ti.

18. (bronchiolitis or bronchiectasis).ti.

19. interstitial.ti.

20. (interstitial adj2 (lung or pulmonary or airway\$ or airflow\$)).ti.

21. exp Asthma/

22. asthma.ti.

23. or/12-22

24. 11 not 23

25. letter/

26. editorial/

27. exp historical article/

28. Anecdotes as Topic/

29. comment/

30. case report/

31. animal/ not (animal/ and human/)

32. Animals, Laboratory/

33. exp animal experiment/

34. exp animal model/

35. exp Rodentia/

36. or/25-35

37. 24 not 36

COPD (update)

38. limit 37 to english language
39. (exp child/ or exp infant/) not exp adult/
40. 38 not 39

Embase search terms

1. exp Chronic Obstructive Lung Disease/
2. copd.ti,ab.
3. coad.ti,ab.
4. Bronchitis/
5. Chronic bronchitis/
6. (chronic adj5 (obstruct\$ or limit#\$)).ti.
7. (obstruct\$ adj3 (airflow\$ or airway\$ or respirat\$ or lung or pulmonary) adj2 (disease\$ or disorder\$)).ti,ab.
8. Lung emphysema/
9. emphysema.ti,ab.
10. "chronic bronchitis".ti,ab.
11. or/1-10
12. bronchial neoplasms/ or exp bronchiectasis/ or exp bronchiolitis/ or cystic fibrosis/ or lung diseases, interstitial/ or lung neoplasms/
13. exp Sleep Apnea Syndrome/
14. Lung Dysplasia/
15. (cancer or neoplas\$).ti.
16. "acute bronchitis".ti.
17. sleep apnea.ti.
18. (bronchiolitis or bronchiectasis).ti.
19. interstitial.ti.
20. (interstitial adj2 (lung or pulmonary or airway\$ or airflow\$)).ti.
21. exp Asthma/
22. asthma.ti.

COPD (update)

23. or/12-22
24. 11 not 23
25. letter.pt.
26. letter/
27. editorial.pt.
28. note.pt.
29. case report/
30. case study/
31. animal/ not (animal/ and human/)
32. nonhuman/
33. exp Animal Studies/
34. Animals, Laboratory/
35. exp experimental animal/
36. exp animal experiment/
37. exp animal model/
38. exp Rodent/
39. or/25-38
40. 24 not 39
41. limit 40 to english language
42. (exp child/ or exp newborn/) not exp adult/
43. 41 not 42

Cinahl search terms

S1 Pulmonary Disease, Chronic Obstructive or TX COPD or TX COAD or SU chronic bronchitis or TX chronic bronchitis or (TX obstruct* near airflow or TX obstruct* near airway* or TX obstruct* near respirat*) or TX obstruct* near lung or TX obstruct* near pulmonary

COPD (update)

Cochrane search terms

- #1 MeSH descriptor Pulmonary Disease, Chronic Obstructive explode all trees
- #2 (COPD):ti or (COAD):ti
- #3 MeSH descriptor Bronchitis, Chronic explode all trees
- #4 MeSH descriptor Pulmonary Emphysema explode all trees
- #5 (chronic near (obstruct* or limit*)):ab
- #6 [\(chronic next bronchitis\):ti](#)
- #7 (emphysema):ti
- #8 (#1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7)
- #9 MeSH descriptor Sleep Apnea Syndromes explode all trees
- #10 MeSH descriptor Bronchopulmonary Dysplasia explode all trees
- #11 MeSH descriptor Bronchial Neoplasms explode all trees
- #12 [MeSH descriptor](#) Bronchiectasis [explode all trees](#)
- #13 [MeSH descriptor](#) Bronchiolitis [explode all trees](#)
- #14 MeSH descriptor Cystic Fibrosis explode all trees
- #15 MeSH descriptor Lung Diseases, Interstitial explode all trees
- #16 [MeSH descriptor](#) Lung Neoplasms [explode all trees](#)
- #17 [\(cancer or neoplas*\):ti](#)
- #18 [\(acute next bronchitis\):ti](#)
- #19 [sleep apnea:ti](#)
- #20 [\(bronchiolitis\):ti or \(bronchiectasis\):ti or \(interstitial\):ti or \(asthma\):ti](#)
- #21 MeSH descriptor Asthma explode all trees
- #22 [\(#9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16 OR #17 OR #18 OR #19 OR #20 OR #21\)](#)
- #23 [\(#8 AND NOT #22\)](#)

COPD (update)

Randomised control trials and systematic reviews filters search strategies

Medline systematic reviews search terms

1. "review"/ or review.pt. or review.ti.
2. (systematic or evidence\$ or methodol\$ or quantitativ\$ or analys\$ or assessment\$).ti,sh,ab.
3. 1 and 2
4. meta-analysis.pt.
5. Meta-Analysis/
6. exp Meta-Analysis as Topic/
7. (meta-analy\$ or metanaly\$ or metaanaly\$ or meta analy\$).mp.
8. ((systematic\$ or evidence\$ or methodol\$ or quantitativ\$) adj5 (review\$ or survey\$ or overview\$)).ti,ab,sh.
9. ((pool\$ or combined or combining) adj (data or trials or studies or results)).ti,ab.
10. or/3-9

Medline randomised control trials search terms

1. randomized controlled trial.pt.
2. controlled clinical trial.pt.
3. double-blind method/ or random allocation/ or single-blind method/
4. exp Clinical Trial/
5. exp Clinical Trials as Topic/
6. clinical trial.pt.
7. random\$.ti,ab.
8. ((clin\$ or control\$) adj5 trial\$).ti,ab.
9. ((singl\$ or doubl\$ or trebl\$ or tripl\$) adj25 (blind\$ or mask\$)).ti,ab.
10. Placebos/ or placebo\$.ti,ab.
11. (volunteer\$ or "control group" or controls or prospectiv\$).ti,ab.
12. Cross-Over Studies/
13. ((crossover or cross-over or cross over) adj2 (design\$ or stud\$ or procedure\$ or trial\$)).ti,ab.
14. or/1-13

COPD (update)

Medline randomised control trials including observational studies search terms

1. randomized controlled trial.pt.
2. controlled clinical trial.pt.
3. double-blind method/ or random allocation/ or single-blind method/
4. exp Clinical Trial/
5. exp Clinical Trials as Topic/
6. clinical trial.pt.
7. random.ti,ab.
8. (clin\$ adj25 trial\$).ti,ab.
9. ((singl\$ or doubl\$ or trebl\$ or tripl\$) adj25 (blind\$ or mask\$)).ti,ab.
10. Placebos/ or placebo\$.ti,ab.
11. Research Design/ or Comparative Study/
12. exp Evaluation Studies/ or follow-up studies/ or prospective studies/
13. (volunteer\$ or "control group" or controls or prospectiv\$).ti,ab.
14. exp epidemiological studies/
15. cohort stud\$.ti,ab.
16. case control stud\$.ti,ab.
17. ((crossover or cross-over or cross over) adj2 (design\$ or stud\$ or procedure\$ or trial\$)).ti,ab.
18. or/1-17

Embase systematic reviews search terms

1. "review"/ or review.pt. or review.ti.
2. (systematic or evidence\$ or methodol\$ or quantitativ\$ or analys\$ or assessment\$).ti,sh,ab.
3. 1 and 2
4. Meta-Analysis/
5. "systematic review"/
6. (meta-analy\$ or metanaly\$ or metaanaly\$ or meta analy\$).mp.
7. ((systematic\$ or evidence\$ or methodol\$ or quantitativ\$) adj5 (review\$ or survey\$ or overview\$)).ti,ab,sh.

COPD (update)

8. ((pool\$ or combined or combining) adj (data or trials or studies or results)).ti,ab.

9. or/3-8

Embase randomised control trials search terms

1. controlled study/ or randomized controlled trial/

2. Clinical Trial/

3. clinical study/ or major clinical study/ or clinical trial/ or phase 1 clinical trial/ or phase 2 clinical trial/ or phase 3 clinical trial/ or phase 4 clinical trial/

4. Placebo/

5. "Double Blind Procedure"/

6. ((clinical\$ or control\$ or compar\$) adj3 (trial\$ or study or studies)).mp.

7. "Clinical Article"/

8. Randomization/

9. placebo.tw.

10. randomi\$.tw.

11. ((singl* or double\$ or triple\$ or treble\$) adj5 (blind\$ or mask\$)).tw.

12. crossover procedure/

13. ((crossover or cross-over or cross over) adj2 (design\$ or stud\$ or procedure\$ or trial\$)).ti,ab.

14. or/1-13

15. compar\$.tw.

16. control\$.tw.

17. 15 and 16

18. 14 or 17

Embase randomised control trials including observational studies search terms

1. controlled study/ or randomized controlled trial/

2. Clinical Trial/

3. clinical study/ or major clinical study/ or clinical trial/ or phase 1 clinical trial/ or phase 2 clinical trial/ or phase 3 clinical trial/ or phase 4 clinical trial/

COPD (update)

4. Placebo/
5. "Double Blind Procedure"/
6. Randomization/
7. ((clinical\$ or control\$ or compar\$) adj3 (trial\$ or study or studies)).mp.
8. compar\$.tw.
9. control\$.tw.
10. 8 and 9
11. placebo.tw.
12. randomi\$.tw.
13. (blind\$ or mask\$).tw.
14. crossover procedure/
15. (cross adj2 over adj2 (study or design)).ti,ab.
16. exp Cohort Analysis/
17. exp Longitudinal Study/
18. exp Prospective Study/
19. exp follow up/
20. cohort studies.ti,ab.
21. or/1-7,10-20
22. exp Case Control Study/
23. case control stud\$.ti,ab.
24. or/22-23
25. 21 not 24

Cinhal and Cochrane search filters

None used

Clinical Questions search strategies

DRUG 1: LABA vs. LAMA

What is the clinical and cost effectiveness of long-acting beta₂ agonists compared long-acting muscarinic antagonists in the management of people with stable COPD?

DRUG 3a) LABA + ICS vs. LABA alone

What is the clinical and cost effectiveness of long-acting beta₂ agonists plus inhaled corticosteroids compared to long-acting beta₂ agonists in the management of people with stable COPD?

DRUG 3b) LABA + ICS vs. LAMA alone

What is the clinical and cost effectiveness of long-acting beta₂ agonists plus inhaled corticosteroids compared to long-acting muscarinic antagonists in the management of people with stable COPD?

DRUG 4a) LAMA + ICS vs. LABA alone

What is the clinical and cost effectiveness of long-acting muscarinic antagonists plus inhaled corticosteroids compared to long acting beta₂ agonists in the management of people with stable COPD?

DRUG 4b) LAMA + ICS vs. LAMA alone

What is the clinical and cost effectiveness of long-acting muscarinic antagonists plus inhaled corticosteroids compared to long-acting muscarinic antagonists in the management of people with stable COPD?

DRUG 5a) LAMA + LABA vs. LABA alone

What is the clinical and cost effectiveness of long-acting muscarinic antagonists plus long-acting beta₂ agonists compared to long-acting beta₂ agonists in the management of people with stable COPD?

DRUG 5b) LAMA + LABA vs. LAMA alone

What is the clinical and cost effectiveness of long-acting muscarinic antagonists plus long-acting beta₂ agonists compared to long-acting muscarinic antagonists in the management of people with stable COPD?

DRUG 5 c) LAMA + LABA vs. LABA +ICS

What is the clinical and cost effectiveness of long-acting muscarinic antagonists plus long-acting beta₂ agonists compared to long-acting beta₂ agonists plus inhaled corticosteroids in the management of people with stable COPD?

COPD (update)

DRUG 6a) LAMA + LABA + ICS vs. LABA + ICS

What is the clinical and cost effectiveness of long-acting muscarinic antagonists plus long-acting beta₂ agonists plus inhaled corticosteroids compared to long-acting beta₂ agonists plus inhaled corticosteroids in the management of people with stable COPD

DRUG 6b) LAMA + LABA + ICS vs. LAMA alone

What is the clinical and cost effectiveness of long-acting muscarinic antagonists plus long-acting beta₂ agonists plus inhaled corticosteroids compared to long-acting muscarinic antagonists alone in the management of people with stable COPD?

DRUG 6c) LAMA + LABA + ICS vs. LABA + LAMA

What is the clinical and cost effectiveness of long-acting muscarinic antagonists plus long-acting beta₂ agonists plus inhaled corticosteroids compared to long-acting beta₂ agonists plus long-acting muscarinic antagonists in the management of people with stable COPD ?

Questions Drug 1,3,4,5,6 were run as one search

Population	Intervention	Comparison	Filters used	Date parameters
Stable COPD	LABA or LAMA or ICS		SRs,RCTs, (Medline and Embase only)	2003-20/8/09

Literature search strategy

Medline search terms

1. Adrenergic beta-Agonists/
2. ((agonist\$ or adrenergic) adj3 beta).ti,ab.
3. betamimetics.ti,ab.
4. ((agonist\$ or adrenergic) adj3 beta).ti.
5. Ethanolamines/
6. (ethanolamines or aminoethanols).ti,ab.
7. ((Formoterol or Eformoterol) adj fumarate).ti,ab.

COPD (update)

8. (Atimos Modulite or Foradil or Oxis).ti,ab.
9. Albuterol/
10. albuterol.ti,ab.
11. (Salmeterol or Serevent or Accuhaler or Evohaler or Diskhaler).ti,ab.
12. Bronchodilator Agents/
13. or/1-12
14. Cholinergic Antagonists/
15. Muscarinic Antagonists/
16. (anti?muscarinic\$ adj2 (agent\$ or antagonist\$)).ti,ab.
17. (anti?cholinergic\$ adj2 (agent\$ or antagonist\$)).ti,ab.
18. (Tiotropium or Spiriva).ti,ab.
19. anticholinergic bronchodilator.ti,ab.
20. or/14-19
21. Adrenal Cortex Hormones/
22. Glucocorticoids/
23. (Glucocorticoid\$ or Steroid\$ or Corticosteroid\$).ti,ab.
24. Budesonide/
25. (Novolizer or Pulmicort or Turbohaler or Respules or Symbicort).ti,ab.
26. fluticasone.ti,ab.
27. (Flixotide or Accuhaler or Diskhaler or Nebules or Seretide).ti,ab.
28. Beclomethasone/
29. (Budesonide or Beclomethasone or AeroBec or Asmabec Clickhaler or Beclazone Easi?breathe or Becodisks or Clenil Modulite or Qvar or Cyclohaler or Fostair).ti,ab.
30. or/21-29
31. 13 or 20 or 30

Embase search terms

1. Beta Adrenergic Receptor Stimulating Agent/
2. ((agonist\$ or adrenergic) adj3 beta).ti,ab.

COPD (update)

3. betamimetics.ti,ab.
4. ((agonist\$ or adrenergic) adj3 beta).ti.
5. Ethanolamine/
6. Ethanolamine Derivative/
7. (ethanolamines or aminoethanols).ti,ab.
8. Formoterol/
9. Formoterol Fumarate/
10. ((Formoterol or Eformoterol) adj fumarate).ti,ab.
11. (Atimos Modulite or Foradil or Oxis).ti,ab.
12. Albuterol/
13. albuterol.ti,ab.
14. Salmeterol/
15. (Salmeterol or Serevent or Accuhaler or Evohaler or Diskhaler).ti,ab.
16. Bronchodilator Agent/
17. or/1-16
18. Cholinergic Receptor Blocking Agent/
19. Muscarinic Receptor Blocking Agent/
21. (anti?muscarinic\$ adj2 (agent\$ or antagonist\$)).ti,ab.
22. (anti?cholinergic\$ adj2 (agent\$ or antagonist\$)).ti,ab.
23. Tiotropium Bromide/
24. (Tiotropium or Spiriva).ti,ab.
25. anticholinergic bronchodilator.ti,ab.
26. or/18-25
27. Corticosteroid/
28. Glucocorticoid/
29. (Glucocorticoid\$ or Steroid\$ or Corticosteroid\$).ti,ab.
30. Budesonide/
31. (Novolizer or Pulmicort or Turbohaler or Respules or Symbicort).ti,ab.

COPD (update)

32. fluticasone.ti,ab.
33. (Flixotide or Accuhaler or Diskhaler or Nebules or Seretide).ti,ab.
34. Beclomethasone/
35. (Budesonide or Beclomethasone or AeroBec or Asmabec Clickhaler or Beclazone Easi?breathe or Becodisks or Clenil Modulite or Qvar or Cyclohaler or Fostair).ti,ab.
36. Budesonide Plus Formoterol/
37. or/27-45
38. 17 or 26 or 37

Cinahl search terms

- S6 S2 or S3 or S4 or S5
- S5 TX Becodisks or TX Clenil Modulite or TX Qvar or TX Cyclohaler or TX Fostair
- S4 TX Respules or TX Symbicort or TX fluticasone or TX Flixotide or TX Accuhaler or TX Nebules or TX Seretide or TX Beclomethasone or TX AeroBec or TX Asmabec Clickhaler or TX Beclazone Easi breathe or TX Diskhaler
- S3 SU Bronchodilator Agents or SU Cholinergic Antagonists or TX Muscarinic Antagonist or TX Tiotropium or TX Spiriva or SU Adrenal Cortex Hormones or SU Glucocorticoids or TX Budesonide or TX Novolizer or TX Pulmicort or TX Pulmicort
- S2 SU Adrenergic beta-Agonists or SU ethanolamines or TX Formoterol fumarate or TX Eformoterol fumarate or TX Atimos Modulite or TX Foradil or TX Oxis or TX Albuterol or TX Salmeterol or TX Serevent or TX Accuhaler or TX Evohaler

Cochrane search terms

- #1 MeSH descriptor Adrenergic beta-Agonists, this term only
- #2 MeSH descriptor Ethanolamines explode all trees
- #3 Formoterol fumarate:ti,ab.
- #4 Eformoterol fumarate:ti,ab.
- #5 Atimos Modulite or Foradil or Oxis:ti,ab.
- #6 MeSH descriptor Albuterol explode all trees
- #7 Salmeterol or Serevent or Accuhaler or Evohaler or Diskhaler:ti,ab.
- #8 MeSH descriptor Bronchodilator Agents, this term only

COPD (update)

- #9 MeSH descriptor Adrenal Cortex Hormones, this term only
- #10 MeSH descriptor Glucocorticoids, this term only
- #11 MeSH descriptor Budesonide explode all trees
- #12 Novolizer or Pulmicort or Turbohaler or Respules or Symbicort:ti,ab.
- #13 fluticasone:ti,ab
- #14 Flixotide or Accuhaler or Diskhaler or Nebules or Seretide:ti,ab.
- #15 MeSH descriptor Beclomethasone explode all trees
- #16 Budesonide or Beclomethasone or AeroBec or Asmabec Clickhaler or Beclazone Easi breathe or Becodisks or Clenil Modulite or Qvar or Cyclohaler or Fostair:ti,ab.
- #17 MeSH descriptor Cholinergic Antagonists, this term only
- #18 MeSH descriptor Muscarinic Antagonists, this term only
- #19 tiotropium or apiriva:ti,ab
- #20 (#1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16 OR #17 OR 18 OR #19)

DRUG 8: LAMA vs. SAMA

What is the clinical and cost effectiveness of long-acting muscarinic antagonists compared to short-acting muscarinic antagonists in the management of people with stable COPD?

Population	Intervention	Comparison	Filters used	Date parameters
Stable COPD	LAMA	SAMA	SRs RCTs (Medline and Embase only)	2003-20/8/09

Literature search strategy

Medline search terms

1. Cholinergic Antagonists/
2. Muscarinic Antagonists/
3. (anti?muscarinic\$ adj2 (agent\$ or antagonist\$)).ti,ab.
4. (anti?cholinergic\$ adj2 (agent\$ or antagonist\$)).ti,ab.
5. anticholinergic bronchodilator\$.ti,ab.
6. Bronchodilator agents/
7. (Bronchodilat\$ adj2 (drug\$ or agent\$)).ti,ab.
8. (Broncholytic adj2 (drug\$ or agent\$)).ti,ab.
9. or/1-8
10. (Tiotropium or Spiriva or respimat).ti,ab.
11. Ipratropium Bromide/
12. (Ipratropium or Atrovent or Aerocaps).ti,ab.
13. 11 or 12
14. 10 and 13
15. 9 or 14

Embase search terms

1. Cholinergic Receptor Blocking Agent/
2. Muscarinic Receptor Blocking Agent/
3. (anti?muscarinic\$ adj2 (agent\$ or antagonist\$)).ti,ab.
4. (anti?cholinergic\$ adj2 (agent\$ or antagonist\$)).ti,ab.
5. anticholinergic bronchodilator\$.ti,ab.
6. *Bronchodilator agent/
7. (Bronchodilat\$ adj2 (drug\$ or agent\$)).ti,ab.
8. (Broncholytic adj2 (drug\$ or agent\$)).ti,ab.

COPD (update)

9. or/1-8

10. (Tiotropium or Spiriva or respimat).ti,ab.

11. Tiotropium/

12. 10 or 11

13. Ipratropium Bromide/

14. (Ipratropium or Atrovent or Aerocaps).ti,ab.

15. 13 or 15

16. 12 and 15

17. 9 or 16

Cinahl search terms

S6 S2 or S5

S5 S3 and S4

S4 SU Ipratropium or TX Ipratropium or TX Atrovent or TX Aerocaps

S3 SU Tiotropium or TX Tiotropium or TX Spiriva or TX respima

S2 SU Cholinergic antagonists or SU Muscarinic Antagonists or SU Bronchodilator agents or TX Bronchodilat* near agent* or TX Bronchodilat* near drug* or TX Broncholytic near agent* or TX Broncholytic near drug* or TX anti muscarinic* near agent* or TX anti muscarinic* near antagonist* or TX anti cholinergic* near agent* or TX anti cholinergic* near antagonist*

Cochrane search terms

#1 MeSH descriptor Bronchodilator Agents, this term only

#2 MeSH descriptor Cholinergic Antagonists, this term only

#3 MeSH descriptor Muscarinic Antagonists, this term only

#4 (#3 OR #4 OR #5)

#5 tiotropium or spiriva or respimat:ti,ab

#6 MeSH descriptor Ipratropium explode all trees

#7 Ipratropium or Atrovent or Aerocaps:ti,ab

#8 (#6 OR #7)

#9 (#5 AND #8)

COPD (update)

#10 (#4 OR #9)

DIAG 1: How does post bronchodilator FEV₁ (forced expiratory volume in one second) compare with pre bronchodilator FEV₁ in terms of: a) sensitivity / specificity of FEV₁ for diagnosis; b) classification of severity of disease?

Population	Intervention	Comparison	Filters used	Date parameters
	FEV1	bronchodilators	None	None

Literature search strategy

Medline search terms

1. *Respiratory Function Tests/
2. *Lung function Test/
3. exp Spirometry/
4. Bronchspirometry/
5. ((respiratory or lung) adj2 function test\$).ti,ab.
6. spirometry.ti,ab.
7. exp Forced Expiratory Volume/
8. FEV1.ti,ab.
9. (Forced adj2 expirat\$ adj3 (maximum or test or index)).ti,ab.
10. Lung Forced Expiratory Volume.ti,ab.
11. "FEV(1)".ti,ab.
12. or/1-11
13. Bronchodilator Agents/
14. Bronchodilator\$.ti,ab.
15. (broncholytic adj2 (agent\$ or drugs\$)).ti,ab.

COPD (update)

16. or/13-15

17. 12 and 16

Embase search terms

1. *Respiratory Function Tests/

2. *Lung function Test/

3. exp Spirometry/

4. Bronchspirometry/

5. ((respiratory or lung) adj2 function test\$).ti,ab.

6. spirometry.ti,ab.

7. exp Forced Expiratory Volume/

8. FEV1.ti,ab.

9. (Forced adj2 expirat\$ adj3 (maximum or test or index)).ti,ab.

10. Lung Forced Expiratory Volume.ti,ab.

11. "FEV(1)".ti,ab.

12. or/1-11

13. Bronchodilator Agents/

14. Bronchodilator\$.ti,ab.

15. (broncholytic adj2 (agent\$ or drugs\$)).ti,ab.

16. or/13-15

60. 12 and 16

Cinahl search terms

S4 S2 and S3

S3 TX Bronchodilator* or TX broncholytic near agent* or TX broncholytic near drug*

S2 Sh Respiratory Function Tests or sh Lung function Test or sh Spirometry or sh Bronchspirometry or TX respiratory near test or TX lung near test or TX spirometry or sh Forced Expiratory Volume or TX FEV1 or TX Lung Forced Expiratory Volume

COPD (update)

Cochrane search terms

- #1 MeSH descriptor Respiratory Function Tests, this term only
- #2 MeSH descriptor Spirometry explode all trees
- #3 MeSH descriptor Forced Expiratory Volume explode all trees
- #4 (#1 OR #2 OR #3)
- #5 MeSH descriptor Bronchodilator Agents explode all trees
- #6 (#4 AND #5)

DIAG2: In individuals where the diagnosis of COPD is considered and spirometry is conducted, what is the sensitivity and specificity of a fixed ratio FEV₁ / FVC compared with lower limit of normal FEV₁ / FVC ratio to diagnose COPD?

Population	Intervention	Comparison	Filters used	Date parameters
	Fixed ratio FEV1	Lower limit FEV1	None	None

Literature search strategy

Medline search terms

1. *Respiratory Function Tests/
2. *Lung function Test/
3. exp Spirometry/
4. Bronchspirometry/
5. ((respiratory or lung) adj2 function test\$).ti,ab.
6. spirometry.ti,ab.
7. exp Forced Expiratory Volume/
8. FEV1.ti,ab.

COPD (update)

9. FVC.ti,ab.
10. (Forced adj2 expirat\$ adj3 (volume or maximum or test or index)).ti,ab.
11. Lung Forced Expiratory Volume.ti,ab.
12. "FEV(1)".ti,ab.
13. or/1-12
14. (fixed adj2 ratio\$).ti,ab.
15. (lower adj2 limit\$).ti,ab.
16. "GOLD".ti,ab.
17. ("ATS" or "ERS").ti,ab.
18. or/14-17
19. 13 and 18
20. letter/
21. editorial/
22. exp historical article/
23. Anecdotes as Topic/
24. comment/
25. case report/
26. animal/ not (animal/ and human/)
27. Animals, Laboratory/
28. exp animal experiment/
29. exp animal model/
30. exp Rodentia/
31. or/20-30
32. 19 not 31
33. limit 32 to english language

COPD (update)

Embase search terms

1. *Respiratory Function Tests/
2. *Lung function Test/
3. exp Spirometry/
4. Bronchspirometry/
5. ((respiratory or lung) adj2 function test\$).ti,ab.
6. spirometry.ti,ab.
7. exp Forced Expiratory Volume/
8. FEV1.ti,ab.
9. FVC.ti,ab.
10. (Forced adj2 expirat\$ adj3 (volume or maximum or test or index)).ti,ab.
11. Lung Forced Expiratory Volume.ti,ab.
12. "FEV(1)".ti,ab.
13. or/1-12
14. (fixed adj2 ratio\$).ti,ab.
15. (lower adj2 limit\$).ti,ab.
16. "GOLD".ti,ab.
17. ("ATS" or "ERS").ti,ab.
18. or/14-17
19. 13 and 18
20. letter.pt.
21. letter/
22. editorial.pt.
23. note.pt.
24. case report/
25. case study/
26. animal/ not (animal/ and human/)
27. nonhuman/

COPD (update)

28. exp Animal Studies/
29. Animals, Laboratory/
30. exp experimental animal/
31. exp animal experiment/
32. exp animal model/
33. exp Rodent/
34. or/20-33
35. 19 not 34
36. limit 35 to english language

Cinahl search strategy

- S3 S1 and S2
- S2 fixed n2 ratio* or lower n2 limit* or "GOLD" or "ATS" or "ERS"
- S1 mh Respiratory Function Tests or mh Spirometry+ or respiratory n2 function test* or lung n2 function test* or spirometry or mh Forced Expiratory Volume or FEV or FVC or Forced n2 expirat*

Cochrane search terms

- #1 MeSH descriptor Respiratory Function Tests, this term only
- #2 MeSH descriptor Spirometry explode all trees
- #3 (respiratory or lung) near2 function test*:ti,ab,kw
- #4 (spirometry):ti,ab,kw
- #5 MeSH descriptor Forced Expiratory Volume explode all trees
- #6 (FEV1):ti,ab,kw or (FVC):ti,ab,kw
- #7 (Forced near2 expirat* near3 (volume or maximum or test or index))
- #8 (#1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7)
- #9 MeSH descriptor Bronchodilator Agents explode all trees
- #10 Bronchodilator*:ti,ab.
- #11 (broncholytic near (agent* or drugs*)):ti,ab,kw

COPD (update)

#12 (#9 OR #10 OR #11)

#13 (#8 and #12)

MUCO: What is the clinical and cost effectiveness of mucolytic agents vs. placebo in people with stable COPD?

Population	Intervention	Comparison	Filters used	Date parameters
Stable COPD	Mucolytics		SRs RCTs	2003-20/8/09

Literature search strategy

Medline search terms

1. Expectorants/
2. Mucolytic\$.ti,ab.
3. (Mucolytic\$ adj2 (agent\$ or drug\$)).ti,ab.
4. Mucinolytic\$.ti,ab.
5. Mucociliary clearance.ti,ab.
6. Secretolytic Agent\$.ti,ab.
7. Carbocisteine.ti,ab.
8. (Carbocisteine or Carbocistine or Carbocysteine or Carboxymethylcysteine).ti,ab.
9. (Mecysteine or Cysteine Methylester or Cysteine Methyl Ester or Visclair or Methyl Cysteine or Methylcysteine).ti,ab.
10. (Erdosteine or Dithiosteine or Erdotin).ti,ab.
11. (Acetylcysteine or Acetyl Cystein or Acetylcystein or Acetyl Cysteine or Acetylcysteine or Acetyl Cysteine).ti,ab.
12. Acetylcysteine/
13. or/1-12

COPD (update)

Embase search terms

1. Expectorant agent/
2. Mucolytic agent/
3. Mucolytic\$.ti,ab.
4. (Mucolytic\$ adj2 (agent\$ or drug\$)).ti,ab.
5. Mucinolytic\$.ti,ab.
6. Mucociliary clearance.ti,ab.
7. Secretolytic Agent\$.ti,ab.
8. Carbocisteine/
9. Carbocisteine.ti,ab.
10. (Carbocisteine or Carbocistine or Carbocysteine or Carboxymethylcysteine).ti,ab.
11. Mecysteine/
12. (Mecysteine or Cysteine Methylester or Cysteine Methyl Ester or Visclair or Methyl Cysteine or Methylcysteine).ti,ab.
13. Erdosteine/
14. (Erdosteine or Dithiosteine or Erdotin).ti,ab.
15. Acetylcysteine/
16. (Acetylcysteine or Acetyl Cystein or Acetylcystein or Acetyl Cysteine or Acetylcysteine or Acetyl Cysteine).ti,ab.
17. Acetylcysteine/
18. or/1-17

Cinahl search terms

- S5 S4 or S3 or S2
- S4 TX Acetylcysteine or TX Acetyl Cystein or TX Acetylcystein or TX Acetyl Cysteine or TX Acetylcysteine or TX Acetyl I Cysteine
- S3 TX Mecysteine or TX Cysteine Methylester or TX Cysteine Methyl Ester or TX Methyl Cysteine or TX Methylcysteine or TX Erdosteine or TX Dithiosteine or TX Erdotin
- S2 SU Expectorants or TX Mucolytic* or TX Mucinolytic* or TX Mucociliary clearance or TX Secretolytic Agent* or TX Carbocisteine or TX Carbocistine or TX Carbocysteine or TX Carboxymethylcysteine

COPD (update)

Cochrane search terms

- #1 MeSH descriptor Expectorants explode all trees
- #2 (Mucolytic*):ti,ab,kw
- #3 (Mucolytic* near (agent* or drug*)):ti,ab,kw
- #4 (Secretolytic Agent*):ti,ab,kw
- #5 (Mucociliary clearance):ti,ab,kw
- #6 (Carbocisteine or Carbocistine or Carbocysteine or Carboxymethylcysteine):ti,ab,kw
- #7 (Mecysteine or Cysteine Methylene or Cysteine Methyl Ester or Visclair or Methyl Cysteine or Methylcysteine):ti,ab,kw
- #8 (Erdosteine or Dithiosteine or Erdotin):ti,ab,kw
- #9 (Acetylcysteine or Acetyl Cystein or Acetylcystein or Acetyl Cysteine or Acetylcysteine or Acetyl I Cysteine):ti,ab,kw
- #10 MeSH descriptor Acetylcysteine explode all trees
- #12 (#1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 or #10)

REHAB: Does early pulmonary rehabilitation (within one month of hospital discharge) in people who had an acute exacerbation improve outcomes compared with usual care (or no rehabilitation), in people with COPD?

Population	Intervention	Comparison	Filters used	Date parameters
Stable COPD	Pulmonary rehabilitation		SRs RCTs	2003-20/8/09

Literature search strategy

Medline search terms

1. *Rehabilitation/
2. (Pulmonary adj2 rehabilitat\$).ti,ab.

COPD (update)

3. *Exercise Therapy/
4. exp Exercise Movement Techniques/
5. *Exercise Test/
6. exp Exercise Tolerance/
7. (exercise adj (testing or tolerance or capacity)).ti,ab.
8. *Physical Endurance/
9. ((stress or treadmill or step) adj testing).ti,ab.
10. (shuttle adj2 walk\$).ti,ab.
11. *Community Health Services/
12. *"Delivery of Health Care"/
13. or/1-12

Embase search terms

1. exp Pulmonary Rehabilitation/
2. *Rehabilitation/
3. Pulmonary Rehabilitation Program/
4. (Pulmonary adj2 rehabilitat\$).ti,ab.
5. *Exercise/
6. *Exercise Test/
7. exp Exercise Tolerance/
8. Muscle training/
9. (exercise adj (testing or tolerance or capacity)).ti,ab.
10. ((stress or treadmill or step) adj testing).ti,ab.
11. (shuttle adj2 walk\$).ti,ab.
12. *Community care/
13. *Health Program/
14. or/1-13

COPD (update)

Cinahl search terms

S2 mh Rehabilitation or pulmonary n2 rehabilitat* or mh Exercise Therapy or mh Exercise Movement Techniques or mh Exercise Test or mh Exercise Tolerance or mh Physical Endurance or mh Community Health Services or mh Delivery of Health Care or shuttle n2 walk

Cochrane search terms

- #1 MeSH descriptor Rehabilitation, this term only
- #2 Pulmonary near rehabilitat*:ti,ab
- #3 MeSH descriptor Exercise Therapy, this term only
- #4 MeSH descriptor Exercise Movement Techniques explode all trees
- #5 MeSH descriptor Exercise Test, this term only
- #6 MeSH descriptor Exercise Tolerance explode all trees
- #7 MeSH descriptor Physical Endurance, this term only
- #8 MeSH descriptor Community Health Services, this term only
- #9 MeSH descriptor Delivery of Health Care, this term only
- #10 (#1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9)

MULTI: Is routine assessment using multidimensional severity assessment indices (eg BODE) more predictive of outcomes compared to FEV₁ alone?

Population	Intervention	Comparison	Filters used	Date parameters
Stable COPD	Assessment indices	FEV1	SRs RCTs, Observational studies	2003-20/8/09

COPD (update)

Literature search strategy

Medline search terms

1. Body-Mass Index/
2. ("Body mass index" or BMI).ti,ab.
3. 1 or 2
4. Dyspnea/
5. (dyspnea or dyspnoea).ti,ab.
6. 4 or 5
7. Airway obstruction/
8. ((airflow or airway) adj2 obstruction).ti,ab.
9. 7 or 8
10. Exercise tolerance/
11. exercise capacity.ti,ab.
2. "6 adj2 walk\$.ti,ab.
13. 10 or 11 or 12
14. 3 and 6 and 9 and 13
15. BODE.ti,ab.
16. mBODE.ti,ab.
17. assessment indice\$.ti,ab.
18. Disease severity grad\$.ti,ab.
19. CAT.ti,ab.
20. assessment tool\$.ti,ab.
21. CCQ.ti,ab.
22. (COPD adj3 Questionnaire\$.ti,ab.
23. St Georges respiratory questionnaire.ti,ab.
24. SGRQ.ti,ab.
25. *Questionnaires/

COPD (update)

26. Predictive value of tests/
27. Severity of illness Index/
28. or/14-27
29. *Respiratory Function Tests/
30. *Lung function Test/
31. exp Spirometry/
32. Bronchspirometry/
33. ((respiratory or lung) adj2 function test\$).ti,ab.
34. spirometry.ti,ab.
35. exp Forced Expiratory Volume/
36. FEV1.ti,ab.
37. (Forced adj2 expirat\$ adj3 (maximum or volume or test or index)).ti,ab.
38. "FEV(1)".ti,ab.
39. or/29-88
40. 28 and 39

Embase search terms

1. Body Mass/
2. ("Body mass index" or BMI).ti,ab.
3. 1 or 2
4. Dyspnea/
5. (dyspnea or dyspnoea).ti,ab.
6. 4 or 5
7. Airway obstruction/
8. ((airflow or airway) adj2 obstruction).ti,ab.
9. 7 or 8
10. Exercise tolerance/
11. exercise capacity.ti,ab.

COPD (update)

12. 10 or 11

13. 3 and 6 and 9 and 12

14. BODE index/

15. BODE.ti,ab.

16. mBODE.ti,ab.

17. assessment indice\$.ti,ab.

18. Disease severity grad\$.ti,ab.

19. Clinical assessment tool/

20. CAT.ti,ab.

21. assessment tool\$.ti,ab.

22. CCQ.ti,ab.

23. (COPD adj3 Questionnaire\$.ti,ab.

24. St Georges respiratory questionnaire.ti,ab.

25. SGRQ.ti,ab.

26. *Questionnaire/

27. "prediction and forecasting"/

28. Hospitalization/

29. or/13-28

30. *Respiratory Function Tests/

31. *Lung function Test/

32. exp Spirometry/

33. Bronchspirometry/

34. ((respiratory or lung) adj2 function test\$.ti,ab.

35. spirometry.ti,ab.

36. exp Forced Expiratory Volume/

37. FEV1.ti,ab.

38. (Forced adj2 expirat\$ adj3 (volume or maximum or test or index)).ti,ab.

39. "FEV(1)".ti,ab.

COPD (update)

40. or/30-39

45. 29 and 40

Cinahl search terms

S10 S2 and S9

S9 S3 or S8

S8 S4 and S5 and S6 and S7

S7 MW Exercise capacity or exercise capacity or exercise capacity

S6 MW Airflow obstruction or Airflow obstruction or Airway obstruction

S5 MW Dyspnea or Dyspnea or Dyspnea

S4 MW body mass index or body mass index

S3 BODE index or BODE score or mBODE or assessment tool* or assessment indice* or CAT or CCQ or SGRQ or St Georges respiratory questionnaire or COPD n3 questionnaire* or disease severity grad*

S2 mh Respiratory Function Tests or mh Spirometry+ or respiratory n2 function test* or lung n2 function test* or spirometry or mh Forced Expiratory Volume or FEV or Forced n2expirat*

Cochrane search terms

#1 MeSH descriptor Body Mass Index explode all trees

#2 MeSH descriptor Dyspnea explode all trees

#3 MeSH descriptor Airway Obstruction explode all trees

#4 MeSH descriptor Exercise Tolerance explode all trees

#5 (#1 AND #2 AND #3 AND #4)

#6 MeSH descriptor Questionnaires, this term only

#7 MeSH descriptor Predictive Value of Tests, this term only

#8 MeSH descriptor Severity of Illness Index, this term only

#9 (BODE):ti,ab,kw or (assessment indice*):ti,ab,kw or (assessment tool*):ti,ab,kw or (CAT or CCQ or SGRQ):ti,ab,kw or (mBODE):kw

#10 (disease severity grad*):ti,ab,kw or (St Georges respiratory questionnaire):ti,ab,kw

#11 (#5 OR #6 OR #7 OR #8 OR #9 OR #10)

COPD (update)

- #12 MeSH descriptor Respiratory Function Tests explode all trees
- #13 MeSH descriptor Spirometry explode all trees
- #14 MeSH descriptor Forced Expiratory Volume explode all trees
- #15 (#12 OR #13 OR #14)
- #16 (#11 AND #15)

Economics Search

Economic searches were conducted in Medline, Embase and CRD for EED and HTA

Population	Intervention	Comparison	Filters used	Date parameters
Stable COPD			Economic (Medline and Embase only)	Medline and Embase 2007- 24/7/09 CRD EED and HTA 2003- 24/7/09

Medline economic filter search terms

1. costs.tw.
2. cost effective.tw.
3. economic.tw.
4. 1 or 2 or 3
5. (metabolic adj cost).tw.
6. ((energy or oxygen) adj cost).tw.

COPD (update)

7. 5 or 6
8. 4 not 7

Embase economic filter search terms

1. costs.tw.
2. cost effective.tw.
3. economic.tw.
4. 1 or 2 or 3
5. (metabolic adj cost).tw.
6. ((energy or oxygen) adj cost).tw.
7. 5 or 6
8. 4 not 7

COPD CRD search terms

chronic obstructive pulmonary disease or COPD

22 Appendix K NEW 2010 deleted sections from original guideline

Definition of chronic obstructive pulmonary disease

Airflow obstruction is defined as a reduced post-bronchodilator FEV1 (forced expiratory volume in 1 second) and a reduced post-bronchodilator FEV1/FVC ratio (where FVC is forced vital capacity), such that FEV1 is less than 80% predicted and FEV1/FVC is less than 0.7.

2 Methodology

2.1 Background

This chapter describes the people and techniques used to derive the clinical recommendations that follow in later chapters.

2.2 The developers

2.2.1 The National Collaborating Centre for Chronic Conditions (NCC-CC)

The NCC-CC is housed by the Royal College of Physicians (RCP) but governed by a multi-professional partners board inclusive of patient groups and NHS management. The Collaborating Centre was set up in 2001, to undertake commissions from the National Institute for Clinical Excellence (NICE), to develop clinical guidelines for the National Health Service.

2.2.2 The technical team

The technical team consisted of an information scientist, a systematic reviewer, a lead clinical advisor, and a health economist, supported by project management and administrative personnel. The clinical advisor also acted as the appointed Chair of the Guidelines Development Group (GDG, see below). The technical team met monthly in addition to partaking in the meetings of the GDG.

2.2.3 The Guideline Development Group (GDG)

The GDG met twelve times at monthly intervals to review the evidence identified by the technical team, to comment on its completeness, and to develop and refine clinical recommendations based on that evidence and other considerations.

Editorial responsibility for the guideline rested solely with the GDG, which also developed the audit criteria.

2.2.4 The Consensus Reference Group (CRG)

An extension of the GDG, the larger CRG, met three times throughout the process, once early in the development to ensure the aims and clinical questions were appropriate, once after three meetings of the GDG to confirm an operational definition of COPD and agree recommendations on diagnosis. Finally, at the end of the process to review the validity of the recommendations drafted by the GDG. The group employed formal consensus techniques for these latter meetings.

Nominations for all group members were invited from key stakeholder organisations, which were selected to ensure an appropriate mix of clinical professions and patient groups. Each nominee was expected to serve as an individual expert in their own right and not as a mandated representative, although they were encouraged to keep their parent organisation informed of the process. Group membership details can be found on the inside of the front cover of this document.

All group members made a formal "Declaration of Interests" at the start of the guideline development and provided updates throughout the process. The NCC-CC and the Group Chair monitored these.

2.2.5 Involvement of people with COPD

As part of the development process, the NCC CC was keen to ensure that the guideline development process was informed by the views of people with COPD and their carers. This was achieved in two ways:

- by securing patient organisation representation on the guideline development group
- by having a patient with COPD on the guideline development group

The patient and a representative of the British Lung Foundation's Breathe Easy patient support groups was present at every meeting of the GDG and CRG. They were therefore involved at every stage of the guideline development process and were able to consult with their wider constituencies throughout the process.

2.3 Searching for the evidence

There are four stages to evidence identification and retrieval:

- i. The technical team set out a series of specific clinical questions (appendix A) that covered the issues identified in the project scope. The CRG met to discuss, refine and approve these questions as suitable for identifying appropriate evidence within the published literature.
- ii. A total of 120 questions were identified. The technical team and project executive agreed that a full literature search and critical appraisal process could not be undertaken for all of these areas due to the time limitations within the guideline

development process. The technical team identified questions where it was felt that a full literature search and critical appraisal was essential.

- iii. The Information Scientist developed a search strategy for each evidence-based question to identify the available evidence. Identified titles and abstracts were reviewed for relevance to the agreed clinical questions and full papers obtained as appropriate.
- iv. The full papers were critically appraised and the pertinent data entered into evidence tables that were then reviewed and analysed by the GDG as the basis upon which to formulate recommendations. The evidence tables are available on request.

Limited details of the searches with regard to databases and constraints applied can be found in appendix A. In general no formal contact was made with authors of identified studies, but occasionally it was necessary to contact authors for clarification of specific points. Additional contemporary articles were identified by the GDG on an *ad hoc* basis. Stakeholder evidence identified via a process established by NICE⁵⁹² was incorporated where appropriate. Both were assessed for inclusion by the same criteria as evidence provided by the electronic searches.

Searches were re-run at the end of the guideline development process, thus including evidence published up to the end of May 2003. Studies recommended by stakeholders or GDG members that were published after this date were not considered for inclusion. This time-point should be the starting point for searching for new evidence for future updates to this guideline.

2.4 Synthesising the evidence

Abstracts of articles identified from the searches were screened for relevance. Hard copies were ordered of papers that appeared to provide useful evidence relevant to each clinical question. Each paper was assessed for its methodological quality against pre-defined criteria using a validated quality appraisal tool⁵⁹³. Papers that met the inclusion criteria were then assigned a level according to the evidence hierarchy as detailed on page 20. Owing to practical limitations, the selection, critical appraisal, and data extraction were undertaken by one reviewer only. Evidence was considered carefully by the GDG group for accuracy and completeness.

Each clinical question dictated the appropriate study design that was prioritised in the search strategy. In addition certain topics within any one clinical question at times required different evidence types to be considered. Randomised control trials (RCTs) were the most appropriate study design for a number of clinical questions as they lend themselves particularly well to research into medicines. They were not, however, the most appropriate study design for all clinical questions. For example, the evaluation of diagnostic tests is more

suited to alternative research designs. Furthermore, RCTs are more difficult to perform in areas such as rehabilitation and lifestyle, where interventions may be tailored to the needs of the individual. As such, pharmaceutical interventions tend to be placed higher in the evidence hierarchy than other equally important interventions. This should not be interpreted as a preference for a particular type of intervention or as a reflection of the quality of the evidence, particularly for those clinical areas where non-RCT evidence is valid and most appropriate.

Where available, evidence from well-conducted systematic reviews was appraised and presented. Trials included within these reviews are listed in the evidence table but were not critically appraised. Studies identified in addition to those included in the systematic review were included in the appraisal process.

The study populations considered varied between clinical questions. At times evidence was not available from studies that were specific to a COPD population; therefore, it was necessary to consider studies in either a heterogeneous respiratory disease population or other chronic conditions.

Study quality, although formally assessed, was not used as a basis for informing the evidence level assigned to evidence statements. Descriptive limitations of studies are included in the evidence statements as appropriate.

2.4.1 Expert papers

On occasion the GDG identified a clinical question that could not be appropriately answered through undertaking a systematic review (where the evidence was scarce, or where the question could not usefully be answered with the largely dichotomous output of a review). These questions were addressed via an expert-drafted discussion paper, subject to consideration by the GDG. In these instances Medline and Cochrane databases were searched together with a review of frequently cited papers and key review articles but there was no formal assessment of the studies cited. These review papers were developed and used as a basis for discussion by the GDG as a whole.

Finally, national and international evidence based guidelines were referred to during the development process. These were not formally appraised owing to the inherent difficulties of such a process, in that the consistency of process and of evidence base can be difficult to ascertain across such documents.

2.5 Health economic evidence

While evidence on cost effectiveness was extracted from the main searches wherever it existed, this was rare. It was necessary to undertake a separate search for information on the potential costs and benefits of the interventions and management strategies considered in this guideline. These searches were carried out by the health economist. The GDG realised that few formal cost effectiveness analyses would be identified, therefore the search for economic evidence was very broad and designed to identify information about the resources used in providing a service or intervention and/or the benefits that can be attributed to it. No study design criteria were imposed a priori i.e. the searches were not limited to RCTs or formal economic evaluations. Further details of the searches for economic evidence are given in section 15.

Identified titles and abstracts from the economics searches were reviewed by the health economist and full papers obtained as appropriate. The full papers were critically appraised by the health economist and the relevant data was conveyed to the GDG alongside the clinical evidence for each question. Given that the economics searches were broad and that no standard measure of assessing the quality of economic evidence is available, careful consideration was given to each study design and the applicability of the results to the guideline context. An important issue in this respect is that much of the evidence on costs and benefits comes from the health care systems around the world and is therefore of limited applicability to a guideline for England and Wales.

As well as presenting existing evidence on the costs and benefits of a broad range of interventions to the GDG, the issue of opportunistic case finding linked to targeted smoking cessation programmes was identified as an important area for further economic analysis. This choice was made on the grounds that this approach may be associated with:

- potentially large health benefits;
- a potentially large effect on NHS resources;
- uncertainty surrounding the benefits and resources;
- a potentially large service impact.

Health economic analysis can provide a framework for collating information from a variety of sources in order to estimate, and systematically compare, costs and benefits. This is a complex and labour intensive process and it does require a level of clinical evidence that is not always readily available. The results of this analysis are discussed briefly in section 15.

2.6 Drafting recommendations

Evidence for each topic was extracted into tables and summarised in evidence statements. The GDG reviewed the evidence tables and statements at each meeting and reached a group opinion. Recommendations were explicitly linked to the evidence supporting them and

graded according to the level of the evidence upon which they were based, using the grading system detailed in Section 0.

It should be noted that the level of evidence determines the grade assigned to each recommendation and as such does not necessarily reflect the clinical importance attached to the recommendation.

2.7 Agreeing recommendations

Once the evidence review had been completed and an early draft of the guideline produced, a one-day meeting of the CRG was held to finalise the recommendations. This included a pre-meeting vote on the recommendations and a further vote at the CRG meeting, where the group were asked to consider the draft guideline in 2 stages:

- 1) Are the evidence-based statements acceptable and is the evidence cited sufficient to justify the grading attached?
- 2) Are the recommendations derived from the evidence justified and are they sufficiently practical so that those at the clinical front line can implement them prospectively? There were 3 types of recommendation to be considered:
 - (a) a recommendation from the GDG based on strong evidence - usually non controversial unless there was important evidence that had been missed or misinterpreted
 - (b) a recommendation that was based on good evidence but where it was necessary to extrapolate the findings to make it useful in the NHS - the extrapolation approved by consensus
 - (c) recommendations for which no evidence exists but which address important aspects of COPD care or management - and for which a consensus on best practice could be reached.

This formal consensus method has been established within the NCC CC, drawing on the knowledge set out in the Health Technology Appraisal⁵⁹⁴, and practical experience. It approximates to a modification of the RAND Nominal Group process (as cited in the Health Technology Appraisal⁵⁹⁴ and will be fully described in future publications.

2.8 Writing the guideline

The first formal version of the guideline was drawn up by the technical team in accord with the decisions of the Guideline Development Groups. The draft guideline was circulated to stakeholders according to the formal NICE stakeholder consultation and validation phase¹⁸ prior to publication.

6.4 Spirometry

GDG consensus statements

A diagnosis of airflow obstruction can be made if the $FEV_1/FVC < 0.7$ (i.e. 70%) and $FEV_1 < 80\%$ predicted. IV

6.8 Assessment of severity

GDG consensus statements

Currently there are no validated severity assessment tools that incorporate the variables quoted above. IV

R18

Mild airflow obstruction can be associated with significant disability in patients with COPD. A true assessment of severity should include assessment of the degree of airflow obstruction and disability, the frequency of exacerbations and the following known prognostic factors:

- FEV_1
- T_1CO
- breathlessness (MRC scale)
- health status
- exercise capacity
- body mass index (BMI)
- partial pressure of oxygen in arterial blood (PaO_2)
- cor pulmonale.

Grade D

R19 The severity of airflow obstruction should be assessed according to the reduction in FEV₁ as shown in table 7

Table 7 Assessment of severity of airflow obstruction according to FEV₁ as a percentage of the predicted value

Severity	FEV ₁
Mild airflow obstruction	50-79% predicted
Moderate airflow obstruction	30-49% predicted
Severe airflow obstruction	<30% predicted

7.2.2 Smoking cessation therapy

Recommendations

R26 Unless contraindicated, bupropion or nicotine replacement therapy combined with an appropriate support programme should be used to optimise smoking quit rates for people with COPD.

Grade B

R27 NICE Technology Appraisal Guidance No 39 recommends: *'If a smoker's attempt to quit is unsuccessful with treatment using either NRT or bupropion, the NHS should normally fund no further attempts within 6 months. However, if external factors interfere with a person's initial attempt to stop smoking, it may be reasonable to try again sooner'*.

NICE

7.3 Inhaled bronchodilator therapy

Although COPD is characterised by substantially irreversible airflow obstruction, bronchodilators have been the mainstay of pharmacotherapy^{71,123}. Beta₂-agonists, anticholinergics and theophylline have all been used to treat COPD.

The structural changes in the airways prevent bronchodilators returning airway calibre to normal. Clinically relevant improvements in FEV₁ may be too small to identify against the background day to day variation in an individual patient. Inhaled agents are preferred to oral because of the reduction in systemic side effects. Beta₂ agonists act directly on bronchial smooth muscle to cause bronchodilation whereas anticholinergics act by inhibiting resting broncho-motor tone. As well as improving breathlessness through their direct bronchodilator effects, both classes of drugs also appear to work by reducing hyperinflation (both static and dynamic). This probably explains why clinical benefits may be seen without clear changes in the FEV₁.

R30 Patients who remain symptomatic should have their inhaled treatment intensified to include long-acting bronchodilators or combined therapy with a short-acting beta₂ agonist and a short-acting anticholinergic.

Grade A

R31 Long-acting bronchodilators should be used in patients who remain symptomatic despite treatment with short-acting bronchodilators because these drugs appear to have additional benefits over combinations of short-acting drugs.

Grade A

R32 Long-acting bronchodilators should also be used in patients who have 2 or more exacerbations per year.

Grade D

7.3.6.1 Beta₂-agonists and anticholinergics

Two randomised, double-blind, placebo-controlled parallel trials; Van Noord 2000¹⁶⁰ (n = 144), Chapman 2002⁵⁹⁵ (n = 409) and 3 randomised, double-blind, non placebo-controlled parallel trials; Auerbach 1997⁵⁹⁶ (n = 652), Bone 1994⁵⁹⁷ (n = 534), Gross 1998⁵⁹⁸ (n = 863) and 1 randomised, double-blind, crossover; D'Urzo 2001⁵⁹⁹ (n = 172). One study report⁶⁰⁰ provided additional information about 2 critically appraised trials^{596,597}.

Evidence statements on combinations of beta₂-agonists and anticholinergics

During 12 weeks of treatment, **FEV₁** responses to ipratropium and salmeterol combination were significantly increased compared with salmeterol alone and placebo (n = 144) (p<0.01)¹⁶⁰. Ib

Among salmeterol/anticholinergic treated patients, morning pre-treatment **FEV₁** levels improved significantly above baseline levels. This effect persisted during the six month treatment period. These improvements in lung function were significantly greater in the salmeterol /anticholinergic group than in the placebo/anticholinergic group for all but the last clinic visit. Analysis of adjusted treatment differences showed the mean improvement over the 24-week period was significantly higher in the salmeterol/anticholinergic group than in the placebo/anticholinergic group (p<0.01)⁵⁹⁵. Ib

Mean peak **FEV₁** responses to ipratropium + albuterol were significantly greater than those to each of the components on all test days (day 1, 29, 57 and 85)⁵⁹⁶. Ib

Mean peak **FEV₁** responses to ipratropium + albuterol were significantly greater than those to each of the components on all test days (day 1, 29, 57 and 85). Clinically significant mean **FEV₁ response** (>15% above baseline) was observed in all three treatment groups on all test days⁵⁹⁷. Ib

Mean change from pre-dose to peak **FEV₁** was significantly greater with ipratropium/albuterol combination compared with either albuterol alone or ipratropium alone in 863 participants over 12 weeks (p<0.001)⁵⁹⁸. Ib

COPD (update)

Compared with baseline values, premedication **FEV₁** increased following 3 weeks treatment with formoterol/ipratropium and decreased following treatment with salbutamol/ipratropium (n = 172 participants treated over 6 weeks). Estimated treatment difference was 0.116 L (p<0.0001). Peak post medication FEV₁ was significantly higher with formoterol/ipratropium than with salbutamol/ipratropium (p<0.0001). AUC of FEV₁ for formoterol/ipratropium was much higher than for salbutamol/ipratropium (p<0.0001)⁵⁹⁹.

lb

During 12 weeks of treatment, **FVC** responses to ipratropium and salmeterol combination were significantly increased compared with salmeterol alone and placebo (p<0.01)¹⁶⁰.

lb

Overall **FVC** response to ipratropium/albuterol combination was significantly greater than the response to either ipratropium or albuterol alone (p<0.01 to p=0.04)⁵⁹⁷.

During 12 weeks of treatment a significant decrease was seen in **daytime symptoms score** between both salmeterol alone (p<0.005) and salmeterol + ipratropium (p<0.001) compared with placebo. No significant difference was seen between salmeterol and combination groups. There were also no differences in **night symptoms** between ipratropium and salmeterol combination compared with salmeterol alone and placebo¹⁶⁰.

lb

COPD **symptom scores** did not change and did not differ between ipratropium + albuterol combination and individual component groups^{596 597}.

lb

Mean **total symptom score** was 0.6 points lower during 6 weeks treatment with formoterol/ipratropium than with salbutamol/ipratropium (p = 0.0042)⁵⁹⁹.

lb

Baseline PEFR and **PEFR** did not differ significantly between ipratropium/albuterol combination compared with either ipratropium or albuterol alone and did not change during 12 weeks of treatment⁵⁹⁷. lb

Over 12 weeks improvements in **morning PEFR** were significantly better in both ipratropium/salmeterol combination group and salmeterol alone group than in the placebo group ($p < 0.001$). No difference was observed between the salmeterol and combination treatment groups. Improvements in **evening PEFR** were significantly better in both ipratropium/salmeterol combination group compared with salmeterol alone ($p < 0.01$). No difference was observed between the salmeterol and placebo treatment groups¹⁶⁰. lb

Morning PEFR did not differ significantly between ipratropium + albuterol combination and individual component groups and did not change during the study. **Evening PEFR** values in the ipratropium/albuterol group were significantly greater than those for the albuterol group⁵⁹⁶. lb

Over 6 weeks, the mean morning premedication **PEFR** increased during both treatment periods; however the change in favour of formoterol/ipratropium was statistically significant compared with ipratropium/salbutamol ($p < 0.001$)⁵⁹⁹. lb

During 12 weeks of treatment, compared with placebo treatment with both salmeterol and ipratropium/salmeterol combination therapy were associated with a higher percentage of days and nights without use of **additional salbutamol** ($p < 0.01$). No significant difference was observed between the two active treatments¹⁶⁰. lb

COPD (update)

No significant difference between ipratropium and albuterol group and individual component groups in **use of concomitant respiratory medication** ⁵⁹⁶. lb

After 12 weeks treatment there were no significant differences between ipratropium/albuterol combination and either component alone in **distance walked** in 6 minutes ⁵⁹⁸. lb

Scores for the **SGRQ** were reduced from baseline for all components of the questionnaire (symptoms, activity, impact on daily life) among patients treated with salmeterol for 6 months, with a significant improvement in the symptom component ($p < 0.005$), the impact on daily life component ($p = 0.05$) and the total score ($p < 0.05$). There was no significant difference between the salmeterol/anticholinergic group and placebo anticholinergic group ⁵⁹⁵. lb

During 12 weeks of treatment, 35 patients experienced a COPD **exacerbation**, 18 (36%) in the placebo group, 11 (23%) in the salmeterol group and six (13%) in the salmeterol and ipratropium group ($p < 0.01$ combination treatment v placebo) ¹⁶⁰. lb

During the 6 month treatment period, 26% of salmeterol-treated patients and 33% of placebo-treated patients experienced at least one **exacerbation** of COPD ($p = 0.117$). Fewer salmeterol-treated patients experienced more than 2 exacerbations (non significant) ⁵⁹⁵. lb

The number of patients with no COPD **exacerbations** during the 6 week treatment period was slightly higher with formoterol/ipratropium than with salbutamol/ipratropium: 55 patients (43.6%) and 49 patients (30.8%)⁵⁹⁹. lb

COPD (update)

During 12 weeks of treatment, no significant difference in **adverse events** was seen in salmeterol alone, placebo and ipratropium/salmeterol combination groups¹⁶⁰. lb

Incidence of **adverse events** recorded during a 6 month study were similar for both treatment groups, with at least one adverse event being reported by 72% of patients in the salmeterol group and 71% patients in the placebo group⁵⁹⁵. lb

Most common **adverse events** were related to the respiratory system in both treatment groups, with exacerbations of COPD being the most common event reported by 44 patients (22%) receiving placebo and 41 patients (20%) receiving salmeterol. Events considered to be related to drug treatment were recorded in 11% of patients in the salmeterol group and 10% of the patients in the placebo group⁵⁹⁵. lb

No significant differences were found in **adverse events** over 12 weeks in 863 patients treated with ipratropium/albuterol combination and either component alone⁵⁹⁸. lb

Beta₂-agonists and inhaled steroids

Three randomised, double-blind, placebo-controlled parallel trials; Calverley 2003¹⁶⁷ (n = 1465), Szanfranski 2003¹⁶⁶ (n = 812), Mahler 2002¹⁶⁵ (n = 691).

Factors for consideration within this topic include:

- considerable pre-screening of patients
- small patient populations in some studies
- only some studies are placebo controlled
- only some studies select both responders and non-responders to B-agonists
- concomitant medication is permitted in some studies, whereas in others it is restricted
- age limits differ e.g. >18yr and > 40yrs

COPD (update)

- drug washout periods vary
- severity of COPD varies between studies.

Evidence statements on combinations of beta₂-agonists and inhaled steroids

In the study by Calverley et al.¹⁶⁷ the three active treatments increased pre-treatment **FEV₁** significantly compared with placebo (salmeterol/fluticasone p<0.0001; salmeterol p<0.0001; fluticasone p = 0.0063). This improvement was evident by week 2 and was sustained throughout treatment. The increase in **FEV₁** associated with combination therapy was significantly greater than with either of its components separately. lb

In the study by Szanfranski et al.¹⁶⁶ all active treatments (formoterol/budesonide combination, budesonide alone and formoterol alone) increased **FEV₁** compared with placebo. Budesonide/formoterol also increased **FEV₁** compared with budesonide. There was no significant difference for budesonide/formoterol versus formoterol for **FEV₁**. Improvements in **FEV₁** were sustained with budesonide/formoterol throughout the study period compared with budesonide and placebo. All active treatments improved **FVC** compared with placebo: budesonide/formoterol by 9% (p<0.001), budesonide by 4% (p<0.05) and formoterol by 11% (p<0.001). lb

In the study by Mahler et al.¹⁶⁵ a significantly greater increase in **pre-dose FEV₁** at the endpoint was observed after treatment with salmeterol/fluticasone combination therapy (156ml) compared with salmeterol (107 ml) p = 0.012 and placebo (-4ml) (p<0.001). A significantly greater increase in pre-dose **FEV₁** was also observed for treatment with fluticasone v placebo at the endpoint (109 v -4ml respectively p<0.001). There was no significant difference between the combination and fluticasone. lb

A significantly greater increase in 2 hour **post-dose FEV₁** at the endpoint was observed after treatment with salmeterol/fluticasone combination therapy (261 ml) compared with fluticasone (138ml, p<0.001) and placebo (28ml, p<0.001)¹⁶⁵. Significantly greater increases in 2 hour post-dose **FEV₁** were observed at Day 1 and throughout the study during treatment with salmeterol/fluticasone combination therapy compared with fluticasone. Significantly greater increases in 2-hour post-dose **FEV₁** were observed for the salmeterol group versus placebo (233 v 28ml, respectively p<0.024) at the lb

endpoint and at all assessment points throughout the study ¹⁶⁵.

Budesonide/formoterol significantly reduced all **symptom scores** within the first week of treatment compared with budesonide, formoterol and placebo. This significant effect was sustained for 12 months for budesonide/formoterol compared with placebo and budesonide regarding the total score and awakenings. For budesonide/formoterol compared with formoterol at 12 months the total symptom score was non significant. ¹⁶⁶

lb

Budesonide/formoterol increased **days free from shortness of breath** by 12% compared with placebo ($p < 0.001$). Budesonide/formoterol compared to budesonide also demonstrated a statistically significant effect for shortness of breath sustained for 12 months, this was non significant for budesonide/formoterol versus formoterol ¹⁶⁶.

lb

Budesonide/formoterol increased **awakening-free nights** by 14% compared with placebo ($p < 0.001$). Awakening scores at 12 months were statistically significant for budesonide/formoterol versus placebo, budesonide alone and formoterol alone ¹⁶⁶.

lb

Budesonide/formoterol improved and maintained morning and evening **PEFR** compared with placebo, budesonide and formoterol alone ($p < 0.001$) ¹⁶⁶.

lb

Increases in morning **PEFR** on Day 2, approximately 24 hours after the initiation of treatment, were greater for salmeterol/fluticasone combination treatment compared with fluticasone, salmeterol and placebo ($p < 0.005$) ¹⁶⁵.

lb

Greater increases in morning PEF were observed throughout the 24 week treatment period with salmeterol/fluticasone combination treatment compared with fluticasone, salmeterol and placebo ¹⁶⁵.

lb

The overall change from baseline in morning **PEF** with combination treatment (31.9L/min) was greater than the sum of the mean changes from baseline observed with the individual components, 12.9 and 16.8L/min for fluticasone

lb

($p < 0.001$) and salmeterol ($p < 0.001$), respectively. Mean overall changes from baseline were also significantly greater for both fluticasone and salmeterol versus placebo ($p < 0.001$)¹⁶⁵.

Budesonide/formoterol reduced use of **rescue medication** by 1.3 and 0.7 inhalations per 24h compared with placebo and budesonide respectively (both $p < 0.001$)¹⁶⁶. lb

Significant reductions in **overall albuterol use** (number of inhalations per day and percentage of days without albuterol use) were observed during treatment with salmeterol/fluticasone combination compared with fluticasone and placebo. A significant reduction in overall albuterol use was also observed after treatment with salmeterol compared with placebo and with fluticasone compared with placebo¹⁶⁵. There was no difference between the combination and salmeterol groups. lb

A significant increase in the overall percentage of **nights with no awakenings** requiring albuterol was observed for treatment with salmeterol/fluticasone combination, fluticasone and salmeterol compared with placebo ($p < 0.001$)¹⁶⁵. lb

At the endpoint, **breathlessness** (as assessed by the mean TDI score) in patients treated with the salmeterol/fluticasone combination (2.1) was greater than that after treatment with fluticasone (1.3, $p = 0.033$) and was significantly greater than that after treatment with salmeterol (0.9, $p < 0.001$) and placebo (0.4, $p < 0.001$). At the endpoint, TDI scores were significantly greater for fluticasone (1.3, $p = 0.002$), but not salmeterol, compared with placebo¹⁶⁵. lb

Calverley et al¹⁶⁷ showed a clinically significant improvement in **health status questionnaire** score by week 52. The raw mean changes in health status total score were -4.5 (12.9) at week 52. The change in SGRQ score in the combination group (salmeterol and fluticasone) over 52 weeks at the end of the study was significantly greater than that in both the placebo and fluticasone groups. lb

COPD (update)

In the study by Szanfranski et al.¹⁶⁶ compared with placebo, budesonide/formoterol showed clinically and statistically significant improvements in **SGRQ** symptoms score (mean difference 5.9, $p < 0.001$) and impact score (mean difference 4.7, $p = 0.006$) domains. Ib

In the study by Mahler et al.¹⁶⁵ after 6 months, treatment with salmeterol/fluticasone combination therapy resulted in a clinically important increase from baseline in mean overall **CRDQ** score (10) that was significantly greater compared with the placebo (5.0, $p = 0.007$) and fluticasone (4.8, $p = 0.017$) groups, but not with salmeterol (8.0). Ib

Clinically important increases in dyspnoea score (4.2), fatigue score (2.0) and physical summary score (6.1) were observed after treatment with salmeterol/fluticasone combination. These increases were also statistically significant versus the fluticasone and placebo treatment groups ($p < 0.016$)¹⁶⁵. Ib

In the study by Calverley et al.¹⁶⁷ compared with placebo, all active treatments (salmeterol/fluticasone combination, salmeterol alone and fluticasone alone) significantly reduced the number of **exacerbations** per patient per year and the number of exacerbations that needed treatment with oral corticosteroids. Ib

The rate of exacerbations fell by 25% in the combination group ($p < 0.0001$) and by 20% ($p = 0.0027$) and 19% ($p = 0.0033$) in the salmeterol and fluticasone groups respectively compared with placebo¹⁶⁷. Ib

The treatment effect in relation to the number of exacerbations was more pronounced in patients with a baseline FEV₁ of <50% predicted who showed a 30% reduction with the combination compared with placebo, as against a 10% reduction in patients who had a baseline FEV₁ that was greater than 50% of that predicted¹⁶⁷. Ib

Acute episodes of symptom exacerbation that required oral corticosteroids were reduced by 39% in the combination group ($p < 0.0001$), 29% in the salmeterol group ($p = 0.0003$) and 34% in the fluticasone group ($p = 0.0001$) compared with placebo¹⁶⁷. Ib

Szafranski et al¹⁶⁶ showed that compared with placebo, budesonide/formoterol combination significantly reduced the number of **severe exacerbations**.

lb

The mean number of severe exacerbations fell by 24% in the combination group (p=0.035) and by 15% (p=0.224) and 2% (p=0.895) in the budesonide and formoterol groups respectively versus placebo.

Budesonide/formoterol combination group also significantly reduced mean severe exacerbation rate versus formoterol (23% reduction; p=0.043).

Compared with placebo, the combination budesonide/formoterol and the budesonide group significantly reduced the number of oral steroid courses used in association with exacerbations (31%, p=0.027 and 29%, p=0.045 respectively).

In the study by Szafranski et al.¹⁶⁶ the **adverse event** profile was similar in each group (formoterol/budesonide combination, budesonide alone and formoterol alone). The frequency of discontinuations due to other adverse events was similar in all groups.

lb

In the study by Calverley et al¹⁶⁷ there were no differences between groups in the number of patients reporting an **adverse event** apart from an increased frequency of oropharyngeal candidiasis (placebo 2%, salmeterol 2%, fluticasone 7%, and combination 8%).

lb

In the study by Mahler et al.¹⁶⁵ a greater percentage of patients in the fluticasone and the combination groups experienced candidiasis (mouth/throat) based on visual inspection compared with the placebo and salmeterol groups.

lb

R43

If patients remain symptomatic on monotherapy, their treatment should be intensified by combining therapies from different drug classes. Effective combinations include:

- beta₂-agonist and anticholinergic*
- long-acting beta₂ agonist and inhaled corticosteroid.*

Grade A

R44

The clinical effectiveness of combined treatments can be assessed by improvements in symptoms, activities of daily living, exercise capacity and lung function. Combination treatment should be discontinued if there is no benefit after 4 weeks.

Grade D

7.3.7 Delivery systems used to treat patients with stable COPD

R49

To ensure optimum efficacy for each patient with COPD, the dose of medication should be titrated according to individual clinical response.

Grade D

7.5.4 Oral mucolytics

Many patients with COPD cough up sputum³. Mucolytics are agents which are believed to increase the expectoration of sputum by reducing its viscosity. Some of these drugs, particularly N-acetylcysteine, may also have antioxidant effects which may contribute to their clinical effects.

In some European countries mucolytics are widely prescribed in the belief that they reduce the frequency of exacerbations and / or reduce symptoms in patients with chronic bronchitis. In contrast, in the U.K. mucolytics have not been recommended in previous guidelines and until recently were black listed and could not be prescribed on the NHS.

Three systematic reviews were found^{265,601,602}. The studies included in these systematic reviews tended to be the same trials although the systematic review by Poole²⁶⁵ did include additional papers. In addition to the trials included in the systematic reviews there were two other papers, an RCT⁶⁰³ that compared mucolytic agents to placebo and a retrospective cohort study⁶⁰⁴ that looked at the risk of re-hospitalisation among COPD patients using N-acetylcysteine compared to non-users.

Stey et al.⁶⁰² looked at the effect of oral N-acetylcysteine compared to placebo in chronic bronchitis (11 RCTs, N=2011) with treatment durations of 12 to 24 weeks.

Grandjean et al.⁶⁰¹ determined the efficacy of oral N-acetylcysteine compared to placebo in chronic bronchopulmonary disease (8 RCTs, N=1408) with a treatment duration ranging from three to six months.

Poole et al.²⁶⁵ undertook a meta-analysis of mucolytics compared to placebo in the treatment of chronic bronchitis (22 RCTs, N=6,415) with a treatment duration of 2 to 24 months. The mucolytics included within this systematic review and meta-analysis include N-acetylcysteine (NAC), ambroxol, sobrerol, carbocysteine lysine, carbocysteine sobrerol, letosteine, cithiolone, iodinated glycerol, N-isobutyrylcysteine (NIC) and myrtol.

Most of the study participants in the three systematic reviews^{601,602,605} had mild COPD, only McGavin 1995 and Petty 1990 included patients with an FEV₁ of <50% predicted. Most of the studies were carried out at least 10 years ago. There are differences between the studies in the definition of exacerbation that has been used but almost all used generally accepted definitions. This, together with the short duration of the studies makes it difficult to draw firm conclusions about effects on exacerbation rates.

The efficacy of mucolytic treatment needs to be considered in relation to the severity of COPD and duration of treatment.

Confounders not consistently accounted for in the studies include concomitant use of antibiotic therapy, drug concordance and drug type and dosage, except for the systematic review by Poole et al²⁶⁵ which excluded combination mucolytics and antibiotics.

Other considerations include the degree of benefit that may be conferred for those who are repeatedly admitted to hospital with exacerbations of their COPD or those patients who have frequent or prolonged exacerbations. Poole et al.²⁶⁵ highlighted that none of the studies reported the effect of treatment with mucolytics on hospitalisation due to COPD.

Oral mucolytic therapy was removed from schedules 10 and 11 (the so called "black" and "selected" lists) from 1st February 2003 and can now be prescribed. Carbocisteine is available in the UK.

Evidence statements

All three systematic reviews^{265,601,602} demonstrate that compared to placebo, mucolytic therapy was associated with a significant reduction in the **number of exacerbations**. 1a

The systematic review by Poole et al²⁶⁵ also demonstrated that the odds ratio for having **no exacerbations** in the study period on a mucolytic compared to placebo was 2.22 ($p < 0.0001$).

In addition there was a significant reduction in the **number of days of COPD illness**, a benefit of 0.56 day per month 95% CI -0.77 to -0.35 , ($p < 0.0001$) and a reduction in the **number of days on prescribed antibiotics** of 0.53 days per month ($p < 0.0001$); however both of these analyses relied on a smaller number of primary studies where these outcomes were reported.

N-acetylcysteine (NAC) was significantly associated with a lower risk of **re hospitalisation**, RR=0.67 (95%CI; 0.53 to 0.85)⁶⁰⁴. 11b

There were no significant differences for **lung function** parameters (FEV₁ or % predicted or PEFr) between the treatment and placebo groups (meta-analysis of 10 RCTs²⁶⁵). 1a

Improvement of their **symptoms** was reported by 61% of patients receiving NAC compared to 35% receiving placebo (relative benefit 1.78 (95% CI; 1.54 to 2.05), NNT 3.7)⁶⁰². 1a

Cattaneo⁶⁰³ in an Italian RCT (N=60) found that there was a statistically significant improvement in dyspnoea ($p < 0.02$), cough ($p < 0.02$), and difficulty in expectorating ($p < 0.02$) in patients treated with neltexine (smokers and non smokers) compared with placebo. There was also a statistically significant improvement in sputum characteristics ($p < 0.02$) and volume ($p < 0.01$) in neltexine treated patients when compared with placebo treated patients. 1b

Petty et al.⁶⁰⁶ in an eight-week study compared iodinated glycerol to placebo in patients (N=361) with severe COPD. Primary outcomes were based upon **symptom efficacy** parameters (cough frequency, severity, chest discomfort, ease in expectorating) and these were statistically significant ($p < 0.05$) in favour of iodinated glycerol. There were no statistically significant differences between treatment groups for frequency of aerosol **bronchodilator use** or frequency of **concomitant medications**. Ib

There were no significant serious **adverse events** reported^{265,601,602}. Ia

7.6.1 Inhaled corticosteroids

Recommendations

R39 Inhaled corticosteroids should be prescribed for patients $FEV_1 \leq 50\%$ predicted, who are having 2 or more exacerbations requiring treatment with antibiotics or oral corticosteroid month period. The aim of treatment is to reduce exacerbation rates and slow the decline in health status and not to improve lung function per se.

R40 Clinicians should be aware of the potential risk of developing osteoporosis and other side effects in patients treated with high-dose inhaled corticosteroids (especially in the presence of risk factors) and should discuss the risk with patients.

LAMA vs. LABA

Evidence statements

Over 6 months, there was no statistically significant difference in **exacerbation rates** ¹⁶⁴.

7.6.2 Ambulatory oxygen therapy

Table 7.3 Duration of oxygen supply from a size DD portable oxygen cylinder at different flow rates

Used at a flow rate of	A portable cylinder without an oxygen conserving device will last
1 l/min	7 hours 40 minutes
2 l/min	3 hours 50 minutes
4 l/min	1 hour 55 minutes
6 l/min	57 minutes

(N.B. The usual regulator only delivers at 2 l/min and 4 l/min)

Table 7.4 Appropriate equipment for ambulatory oxygen therapy

Usage	Equipment
For a duration of use of less than 90 minutes	Small cylinder
For a duration of use of less than 4 hours but more than 90 min	Small cylinder with oxygen conserving device
For duration of use of more than 4 hours	Liquid oxygen
For flow rates greater than 2 l/min and duration of use of	Liquid oxygen

more than 30 min	
------------------	--

7.7 Combination therapy

There are similar theoretical advantages in combining a bronchodilator with its effects on symptoms, with an inhaled steroid with its effects on exacerbations to produce additive or synergistic clinical benefits.

The following four types of combination therapy were considered and evidence is presented for each combination separately:

- beta₂-agonist and anticholinergic
- beta₂-agonist and theophylline
- anticholinergic and theophylline
- long-acting beta₂ agonist and inhaled steroid.
- A full literature search was also undertaken for anticholinergic and inhaled steroid but no evidence was found for this combination.
- For each of these combinations, no systematic reviews were found, however a good body of RCT data was identified:

7.12 Pulmonary rehabilitation

R83

Pulmonary rehabilitation should be made available to all appropriate patients with COPD.

Grade A

7.13 Vaccination and anti-viral therapy

National policy for 2003/2004 is that influenza immunisation should be offered to all patients with chronic obstructive pulmonary disease and pneumococcal vaccine should be offered to those with chronic lung disease²⁴⁰.

Detailed information regarding both the influenza and pneumococcal vaccine is available in the HMSO publication on Immunisation against Infectious Disease (1996) otherwise known as the “Green Book”⁶⁰⁷. This publication includes a new (draft) pneumococcal replacement chapter (November 2003)⁶⁰⁸.

R89

NICE Technology Appraisal Guidance No. 58³⁷⁶ makes the following recommendation:

Within licensed indications, zanamivir and oseltamivir are recommended for the treatment of at-risk adults who present with influenza like illness and who can start therapy within 48 hours of the onset of symptoms.

The technology appraisal also notes that zanamivir should be used with caution in people with COPD because of risk of bronchospasm. If people with COPD are prescribed zanamivir they should be made aware of the risks and have a fast-acting bronchodilator available.

NICE

7.13.3 Identifying and managing anxiety and depression

R104

The presence of anxiety and depression in patients with COPD can be identified using validated assessment tools.

Grade D

R105

Patients found to be depressed or anxious should be treated with conventional pharmacotherapy.

Grade A

R106

For antidepressant treatment to be successful, it needs to be supplemented by spending time with the patient explaining why depression needs to be treated alongside the physical disorder.

Grade C

7.15 Follow-up of patients with COPD

R131

Patients with mild or moderate COPD should be reviewed at least once per year, or more frequently if indicated, and the review should cover the issues listed in table 7.7.

Grade D

8.12 Oxygen therapy during exacerbations of COPD

R165

If necessary, oxygen should be given to keep the SaO₂ greater than 90%.

Grade C

R167

In the interim period while the recommendation on the availability of oximeters is implemented, oxygen should be given to all patients with an exacerbation of COPD who are breathless, if the oxygen saturations are not known.

Grade D

R168

During the transfer to hospital the following points should be considered:

Grade D

- It is not desirable to exceed an oxygen saturation of 93%. Oxygen therapy should be commenced at approximately 40% and titrated upwards if saturation falls below 90% and downwards if the patient becomes drowsy or if the saturation exceeds 93-94%.
- Patients with known type II respiratory failure need special care, especially if they require a long ambulance journey or if they are given oxygen at home for a

prolonged period before the ambulance arrives.

R170

The aim of supplemental oxygen therapy in exacerbations of COPD is to maintain adequate levels of oxygenation ($\text{SaO}_2 > 90\%$), without precipitating respiratory acidosis or worsening hypercapnia. Patients with $\text{pH} < 7.35$ should be considered for ventilatory support.

Grade D

23 Appendix L NEW 2010 update criteria for selecting high-priority research recommendations

Criteria for selecting high-priority research recommendations				
Criterion	FRR1 – Timing of pulmonary rehabilitation	FRR2 – Multi dimensional assessment	FRR3 – Triple therapy	FRR4 – Mucolytics
Importance to the patients of the population	Impacts upon patient quality of life	Impacts upon assessment of disease severity	Impacts upon severity of disease and quality of life	Impacts upon quality of life
Relevance to NICE guidance	Medium, the research is relevant to the recommendations in the guideline	Medium, the research is relevant to the recommendations in the guideline	High, the research is essential to inform future updates of key recommendations in the guideline	Low, the research is of interest and will fill exiting evidence gaps
Relevance to NHS	Facilities already exist therefore benefits are to people with COPD	Would impact upon both primary and secondary care	Clinical and cost effectiveness issues of relevance to NHS	Clinical and cost effectiveness issues of relevance to NHS
National priorities	National Strategy for COPD yet to be published	National Strategy for COPD yet to be published	National Strategy for COPD yet to be published	National Strategy for COPD yet to be published
Current evidence base	Nil found on timing	BODE index felt by the GDG to be time-consuming and impractical for use in a primary care setting	Limited evidence base. Needs adequate powering and study duration	Limited evidence base. Requires trial design stratification re concomitant therapies
Equality	No special considerations – applies to all with	No special considerations – applies to all with	No special considerations – applies to all with	No special considerations

COPD (update)

	COPD	COPD	COPD	
Feasibility	No identified ethical or technical issues	No identified ethical or technical issues	No identified ethical (equipoise demonstrable) or technical issues	No identified ethical or technical issues
Other comments	Would benefit from cluster randomised design	Important to both primary and secondary care settings	Focus on differential dropout rates would be prudent	Baseline severity needs well defining out the outset

24 Appendix M NEW 2010 update cost effectiveness modelling

A cost-effectiveness model comparing LAMA, LABA+ICS, and LAMA+LABA+ICS (triple therapy) in people with severe/very severe COPD requiring initial maintenance therapy

> Model overview

The GDG were interested in the following question: Is LAMA, LABA+ICS or triple therapy more cost-effective as initial therapy in COPD patients with an FEV₁ <50% predicted (severe to very severe COPD)?

A cost-utility analysis was undertaken where costs and quality-adjusted life-years (QALYs) were considered from a UK NHS perspective. Both costs and QALYs were discounted at a rate of 3.5% per annum in line with NICE methodological guidance³⁷.

Topic selection for modelling

Areas were prioritised for new analysis by the GDG. The GDG was interested in assessing the cost-effectiveness of alternative regular maintenance therapies (or combinations of such therapies) for people with stable COPD. Due to complexities in the clinical data it was judged unfeasible to adequately conduct an analysis looking at all possible inhaled interventions in all treatment scenarios within the scope of the guideline update. This included the following issues:

There were inconsistencies in the clinical evidence network i.e. seemingly contradictory relative risks

The maintenance therapy decision is not a one off decision – there is the initial decision and then subsequent decisions about adding in additional therapy. Clinical trials generally do not match a particular scenario, i.e. initial maintenance treatment or patients on a specific treatment who are experiencing symptoms, but instead recruit COPD patients meeting variable criteria and randomise to therapy – this makes explicit consideration of the initial decision and subsequent decisions muddled (for example we have information about using triple therapy but not separately for using it straight away and using it after using other therapies but still experiencing symptoms).

The aim was to therefore undertake a focussed analysis that would be useful to the guideline and inform decision making. Following review of the clinical evidence and published economic literature it was considered that examining the following question was the highest priority: is LAMA, LABA+ICS or triple therapy more cost-effective as initial therapy in COPD patients with an FEV₁ <50% predicted (severe to very severe COPD)?

These treatment options were selected as those that represent the most appropriate possible clinical options for people with COPD and an $FEV_1 < 50\%$ predicted. However, it was felt that if triple therapy could be justified on cost-effectiveness terms that it might be considered as an initial therapy. Therefore these options were incorporated into the model. It was felt unnecessary to include LABA as there was good existing evidence that use of LABA+ICS over LABA alone was more effective and cost-effective in this patient group. No data was available for LAMA+ICS as a treatment option and so it was considered inappropriate to include in the model. Clinical effectiveness data for LAMA+LABA was considered insufficient for it to be considered a primary treatment option and it was felt that it would only be appropriate to consider in patients in whom ICS was declined or not tolerated. On this basis, it was felt that inclusion of LAMA+LABA was also not a priority for inclusion in the model.

It was felt that in less severe patients ($FEV_1 \geq 50\%$ predicted) the key issue was whether to use LAMA or LABA in initial therapy but that issues with the available clinical data would mean that new health economic modelling would be unlikely to reduce uncertainty around this decision and so was considered less of a priority for modelling.

The analysis aimed to consider initial maintenance treatment. It did not incorporate changes to therapy over time. This was judged to be a pragmatic approach given the available data.

Approach to modelling

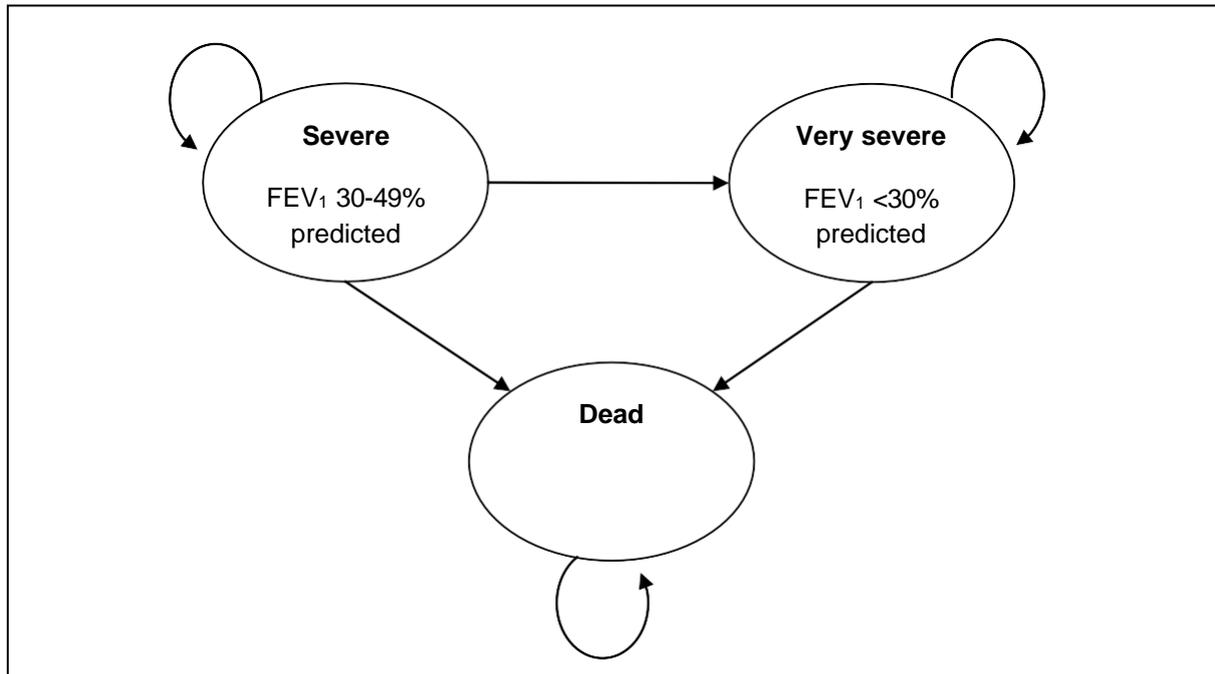
A Markov model was constructed describing how a population with COPD changes over time. Specifically, this represents an increase in mortality and exacerbations over time, and a reduction in quality of life, as patients' lung function declines. The Markov model consisted of three mutually exclusive health states: severe COPD ($FEV_1 30$ to $< 50\%$ predicted), very severe COPD ($FEV_1 < 30\%$ predicted) and dead. Patients can progress from severe to very severe COPD; they cannot regress in COPD severity. A cycle length of one year was used. Different exacerbation and hospitalisation rates, mortality rates, utilities and maintenance costs are assigned to each COPD severity stage.

For the baseline, we populated the model with data relating to the LABA+ICS treatment group. Running the model estimates outcomes over a specified time period. By applying cost and utility weights we estimated mean costs and QALYs over the whole time period.

To compare the impact of treating the same population with a different treatment option we applied relative treatment effects from RCTs for each treatment option to the baseline estimates in the model, reran the model and then recalculated mean costs and mean QALYs.

Comparing these mean results for the three different treatment options allowed us to identify which was the most cost-effective.

Table 1: Markov model depiction



> Analyses undertaken

Outcomes incorporated into the model were based on the systematic review of the clinical effectiveness data and GDG discussion. The aim was to incorporate key outcomes that are differentially impacted by treatment across the treatment options being considered by the model and that result in differences in costs and/or QALYs.

The basecase analysis incorporates a differential treatment effect in terms of exacerbations. Exacerbations in the model are attributed a cost and a utility loss (quality of life impact) and so impact costs and QALYs. This was considered the most robust assessment that could be made based on the available data. Some EQ-5D utility data was available from the literature to inform the estimate of the impact of exacerbations.

- **Basecase analysis (exacerbation effect only):**
 - Outcomes impacted by treatment:
 - exacerbations (non-hospitalised)
 - exacerbations (hospitalised)
 - Costs will vary between treatment options due to differences in drug costs and exacerbations between treatment options.
 - QALYs will vary between treatment options due to differences in exacerbations between treatment options – each exacerbation is associated with a QALY loss; so if the number of exacerbations

An alternative analysis was undertaken that incorporated a differential treatment effect in terms of stable utility (quality of life) as well as exacerbations. This was not included in the basecase due to concerns regarding estimating this effect. Model inputs are discussed in detail in subsequent sections.

Alternative analysis 1 (exacerbation and stable utility effect):

- Outcomes impacted by treatment:
 - exacerbations (non-hospitalised)
 - exacerbations (hospitalised)
 - quality of life during stable COPD (due to improved symptoms with treatment)
- Costs will vary between treatments as in the basecase analysis.
- QALYs will vary as in the basecase analysis but also due to the difference in utility between treatment arms whilst patients are stable.

Careful consideration was given to whether or not it was appropriate to incorporate a differential treatment effect in terms of mortality. It was generally considered that there was not currently strong evidence to support a differential mortality effect between the treatments being considered in the model but that it was plausible given the effect of treatments on exacerbations. Many studies were also not powered to detect a mortality effect. It was concluded that it would be most appropriate to run the analysis both excluding and including mortality. As such, a second sensitivity analysis was undertaken where mortality was differentially impacted between the treatments in the model, in addition to exacerbations.

Alternative analysis 2 (exacerbations and mortality effect):

- Outcomes impacted by treatment:
 - exacerbations (non-hospitalised)
 - exacerbations (hospitalised)
 - mortality
- Costs will vary due as in primary analysis but COPD maintenance costs will also vary between treatment options as there will be different numbers of people alive with each treatment option due to differences in mortality.
- QALYs will vary as in primary analysis but there will also be a difference in life years between treatment options due to the different mortality with the treatment options.

Note that progression was assumed not to be impacted differentially between the treatments being compared.

Time horizon

In all the above analyses, a treatment duration of four years was examined. This matches the longest follow-up of the clinical trials that inform the comparisons in this model.

As sensitivity analyses, we also examined the effect of using a shorter time horizon of 1 year (matching the shortest follow-up of the clinical trials that inform the comparisons in this model) and a longer time horizon of a lifetime (35 cycles).

In the basecase and first alternative analysis, where a differential treatment effect on mortality was not incorporated, it was expected that the time horizon would not have a large impact on results. In the analysis that included mortality however it was considered that it may have a greater impact. When mortality is impacted differentially between treatments there are a different numbers of people alive at the end of the four year treatment period. Due to this, even assuming no further differential treatment impact, costs and QALYs therefore vary between treatment options beyond 4-years.

Uncertainty

The model was built probabilistically in order to take account of the uncertainty around input parameter point estimates. A probability distribution is defined for each model input parameter. When the model is run a value for each input is randomly selected from its respective probability distribution simultaneously and costs and QALYs are calculated using these values. The model is run repeatedly – in this case 5000 times – and results are summarised. Probability distributions in the analysis were based on error estimates from data sources, for example confidence intervals around relative risk estimates.

In addition to the sensitivity analyses already described above around the outcomes incorporated in the model and the time horizon, various additional sensitivity analyses, where one or more inputs were varied, were undertaken to test the robustness of model assumptions and data sources.

> Model inputs

Inputs summary table

Model inputs were selected following a review of the literature and validated with the GDG. Note that healthcare utilisation defined exacerbations were used in the model. Point estimates and the 95% confidence interval for inputs are shown in the table; the latter to illustrate the range of values taken in the probabilistic analysis. Confidence intervals are as reported from the data where available (for COPD utility and relative treatment effects for exacerbations, hospitalisations and mortality), where not reported or where the input value in the table below is the result of a calculation the confidence interval shown is generated from 10,000 simulations of the probabilistic analysis. Where no confidence interval is presented the input was not varied in the probabilistic analysis. More details about sources and any calculations can be found in the sections following this summary table. Details of the probability distributions used for the probabilistic analysis are also included in subsequent sections.

Table 2: Summary of model inputs – point estimates and 95% confidence intervals*

Input	Data	Sources
Comparators	LAMA • LABA+ICS • Triple therapy (LAMA+LABA+ICS)	
Population	COPD, FEV ₁ <50% predicted, requiring initial maintenance therapy	
Initial cohort	Age (a) 66 years Female (b) 46%	(a) Mean across RCTs used to inform treatment effects ^{200,201,219} (b) Analysis of UK GP records ¹⁵
<i>Severity:</i>	Severe (c) 67% Very severe (c) 33%	(c) DH analysis ⁶⁰⁹
Progression		
Annual probability	Severe to very severe 0.064 (0.053-0.076)	Derived from mean decline in FEV ₁ of 39ml/year ⁶¹⁰
Baseline event rates (LABA+ICS)		
Exacerbation/year	Severe 0.91 (0.87-0.96) Very severe 1.54 (1.44-1.64)	LABA+ICS arm in TORCH analysis by GOLD stage ²⁰⁷
Hospitalisation/year	Severe 0.17 (0.16-0.18) Very severe 0.29 (0.27-0.31)	Based on 19% of exac requiring hospitalisation with LABA+ICS ¹⁹⁷
Mortality RR vs. gen pop	Severe 3.1 (2.6-4.1) Very severe 5.0 (3.5-11.8)	Mortality risk by GOLD stage vs. non-COPD population ⁶¹¹ (applied to age dependent mortality rates for the UK general population ⁶¹²)
Utilities		
COPD utility	Severe 0.750 (0.731-0.768) Very severe 0.647 (0.598-0.695)	EQ-5D utilities reported by Rutten van Molken ⁶¹³
QALY loss per exacerbation	Non-hospitalised 0.011 (0.006-0.018) Hospitalised 0.020 (0.015-0.027)	Derived from O'Reilly ⁶¹⁴ , Paterson ⁶¹⁵ , Spencer ⁶¹⁶ , Starkie ⁶¹⁷

COPD (update)

Costs

Drug costs	LAMA	£395.18	Based on recommended dosing ^{221,618-621} , UK prices ⁶²² , and the Prescription Cost Analysis 2007 ⁶²³
	LABA+ICS	£488.76	
	Triple therapy	£883.94	
Cost per exacerbation	Non-hospitalised	£34 (22-48)	O'Reilly et al.† ⁶²⁴
	Hospitalised	£2403 (2063-2771)	Derived from NHS reference costs ⁶²⁵ , UK COPD audit ⁶²⁶ , PSSRU costs ⁶²⁷ , ICU estimates ^{174,628}
Maintenance costs/year (excl. exacerbations)	Severe	£273 (208-347)	Derived from Britton et al. 2003† ³³
	Very severe	£896 (735-1079)	

Relative treatment effects

	LABA+ICS vs. LAMA	Triple vs. LABA+ICS	Triple vs. LAMA	
Exacerbations	0.97 (0.84-1.12)	0.85 (0.79-0.92)	0.85 (0.65-1.11)	LABA+ICS vs LAMA: INSPIRE ²¹⁹ Triple vs LAMA: OPTIMAL ²⁰⁰ Triple vs LABA+ICS: UPLIFT RCT subgroup ²⁰¹
Hospitalisations	1.08 (0.73-1.59)	0.89 (0.75-1.07)	0.53 (0.33-0.86)	
Mortality	0.56 (0.33-0.94)	0.91 (0.76-1.15)	1.61 (0.46-5.60)	
Stable utility	+0.023 (0.001-0.046)	+0.021 (0.006-0.036)	+0.040 (0.007-0.075)	Observed SGRQ from above RCTs mapped to EQ-5D ⁶¹⁷

*Confidence intervals are as reported from the data where available (for COPD utility and relative treatment effects for exacerbations, hospitalisations and mortality), where not reported or where the input value shown is the results of a calculation the confidence interval shown is generated from 10,000 simulations of the probabilistic analysis; where no confidence interval is presented the input was not varied in the probabilistic analysis.

†Inflated to 2007/8 costs using healthcare inflation index⁶²⁷

Initial cohort setting

The cohort is assumed to have a starting age of 66 years and be 46% female. The former is based on the average age in the three trials utilised in the model for treatment effects^{197,200,219}. The latter is based on a published analysis of UK GP records¹⁵.

The analysis considers a population of people with COPD and an FEV₁ less than 50% predicted (that is people with more severe disease). On entering the model the cohort is distributed as 67% severe (FEV₁ 30 to <50% predicted) and 33% very severe (FEV₁ <30% predicted). This was based on the estimated distribution of severity stages in people diagnosed with COPD in England from an analysis undertaken by the Department of Health⁶⁰⁹.

Progression

The annual transition probability for progression from severe (FEV₁ 30% to <50% predicted) to very severe (FEV₁ <30%) in the model was derived based on a mean decline in FEV₁ of 39ml/year (SE 0.003) as reported in the TORCH study in the LABA+ICS arm⁶¹⁰. The mean annual decline was incorporated into the probabilistic analysis using a gamma distribution. Details of calculations and data selection are provided below.

Note that no differential effect between the three treatment options in the model was applied to disease progression as the GDG felt that current evidence did not support this. This means that the time spent in the severe and very severe severity states only varied between treatment options in the secondary analysis where mortality was impacted.

A non-systematic review of the literature identified a variety of potential sources of data for the annual decline in lung function, including cohort studies and randomised controlled trials. Data from a selection of key studies are summarised in Table 3. There is some evidence of a significant difference in decline in FEV₁ with pharmacological treatment compared to no treatment (notably in the TORCH study)⁶¹⁰. On this basis it was considered that an 'on-treatment' rate of decline was most appropriate to use in the model as all comparators were active treatments. Given that TORCH was a large study with 3-years of follow-up this was considered an appropriate source of data.

Table 3: Selected studies of COPD lung function decline

COPD populations	Annual FEV₁ decline
Lung Health Study 5-year FU (Scanlon 2000) ¹¹⁸	52ml/year (SD 55)
East London Cohort (Donaldson 2003) ⁶²⁹	34.5ml/year
Anthonisen (Anthonisen 1986) ⁴¹	44ml/year (SD 129)
Fletcher and Peto (1977) ⁵⁸³	48 (SE 2)
Treatment specific	Annual FEV₁ decline (post-bronchodilator)
TORCH RCT (3-year follow-up; n = 5343) ⁶¹⁰	LABA+ICS 39.0ml/year (SE 3.0) LABA 42.3ml/year (SE 3.1) ICS 42.3ml/year (SE 3.1) Placebo 55.3ml/year (SE 3.2)
UPLIFT RCT (4-year follow-up n = 4993) ²²⁴	Current treatment +placebo 42ml/year (SE 1) Current treatment +LAMA 40ml/year (SE 1)

The probability of transitioning from severe (FEV₁ 30 to <50% predicted) to very severe (FEV₁ <30% predicted) was calculated as follows.

A typical patient in the severe (FEV₁ 30 to <50% predicted) was attributed the following characteristics:

male – based on UK GP records¹⁵

aged 66 years – the average in the trials used in this analysis for treatment effects^{197,200,219}

1.75m tall – the average male height in the UK⁶³⁰

an FEV₁ 40% of predicted – the midpoint of the range in this group and the mean in this group in the TORCH study²⁰⁷.

COPD (update)

A male, aged 66 years, of height 1.75m and with an FEV₁ of 40% his predicted FEV₁ must have an FEV₁ of 1.27 according to the European Respiratory Society 1993 reference equations⁴⁵. Assuming a decline of 39ml/year in FEV₁ we calculated his FEV₁ for subsequent years. His predicted FEV₁ in corresponding years was also calculated using the same reference equations as above. His resulting FEV₁ % predicted was then calculated for each year by dividing his FEV₁ by his predicted FEV₁. The resulting figures are displayed in Table 4. On this basis, he would reach the very severe stage (FEV₁<30%) in 10.4 years.

It was then assumed he represents the median patient and that on average 50% of the population would have progressed by 10.4 years. Therefore in the population there would be a 50% probability of progressing in 10.4 years. Assuming a constant hazard the instantaneous rate was calculated as:

$$\text{Annual rate} = \frac{\ln(1 - p)}{t} = \frac{\ln(1 - 0.5)}{10.4} = 0.0664$$

Where: p = the proportion of patients that progress over time period t .

This was then converted from an annual rate to an annual transition probability using the standard formula:

$$\begin{aligned} \text{Probability of progressing (moderate to severe)} &= 1 - e^{-rt} \\ &= 1 - e^{-0.0664 \times 1} \\ &= 0.0642 \end{aligned}$$

Where: r = rate; t = time period

Table 4: Modelled FEV₁ decline for male aged 66, height 1.76m, FEV₁ 40% predicted and a decline of 39ml/year

Age	FEV ₁	Predicted FEV ₁	FEV ₁ % predicted
66	1.27	3.16	40.0%
67	1.23	3.14	39.1%
68	1.19	3.11	38.2%
69	1.15	3.08	37.3%
70	1.11	3.05	36.4%
71	1.07	3.02	35.5%
72	1.03	2.99	34.5%
73	0.99	2.96	33.5%
74	0.95	2.93	32.5%
75	0.91	2.90	31.5%
76	0.88	2.87	30.5%
77	0.84	2.85	29.4%
78	0.80	2.82	28.3%
79	0.76	2.79	27.2%
80	0.72	2.76	26.1%
81	0.68	2.73	24.9%
82	0.64	2.70	23.8%
83	0.60	2.67	22.6%
84	0.56	2.64	21.3%
85	0.52	2.61	20.1%
86	0.49	2.58	18.8%

Baseline event rates with LABA+ICS

The model must be populated with appropriate event rates for one of the comparators in the model (baseline events). Event rates for the other comparators are then calculated in the model by applying relative effect figures from randomised controlled trials. The model was populated with baseline event rates for LABA+ICS.

Exacerbations

Overall average annual exacerbation rates of 0.91 (SE 0.023) per person per year for severe (FEV₁ 30 to <50% predicted) and 1.54 (SE 0.051) per person per year for very severe (FEV₁ <30% predicted) were applied in the model for people treated with LABA+ICS. This was based on rates observed in the TORCH study LABA+ICS arm in these FEV₁ groups and imputed error estimates (see below)²⁰⁷. Hospitalisation rates for exacerbations were not reported by GOLD stage and it was assumed that 19% of all exacerbations required hospitalisation as observed in the TORCH LABA+ICS arm¹⁹⁷. This equated to an average of 0.17 per patient per year and 0.29 per patient per year for severe and very severe respectively. Note that healthcare utilisation defined exacerbations were used in the model. Exacerbation rates were incorporated into the probabilistic analysis using log normal distributions.

Error estimates were not reported for the exacerbations rates by FEV₁ severity stage. In order to incorporate uncertainty around the exacerbation rate into the model a standard error was imputed based on the reported mean rate for each severity stage and the estimated total patient years. Total patient years were estimated using the number of patients for each severity stage (GOLD 3 = 728; GOLD 4 = 243) multiplied by the average patient follow-up for the TORCH study as a whole (2.4 years). The following formula for the standard error of a rate was then used:

$$SE_{rate} = \frac{rate}{total\ patient\ years}$$

Baseline exacerbation rate data stratified by FEV₁ was sought through a non-systematic review of the literature. The TORCH study data was selected as it provided stratified rates from a large cohort for people treated with LABA+ICS²⁰⁷. Rates were also similar to those observed in the clinical trials being used in the model for relative treatment effect. It included 728 LABA+ICS patients FEV₁ 30-49% predicted and 243 FEV₁ <30% predicted. Donaldson et al. also reported stratified rates from a UK cohort however the population was smaller and rates were not specific to any one treatment⁶³¹. A Spanish and a Swedish cohort study were also identified^{496,632}.

Mortality

Age-dependant mortality was incorporated into the model using life tables for England and Wales and severity specific COPD mortality data^{611,612}. A relative risk for mortality with COPD was applied of 3.1 and 5.0 for severe (FEV₁ 30 to <50% predicted) and very severe (FEV₁ <30%) stage respectively⁶¹¹.

COPD severity specific mortality data was reported by Ekberg et al. based on a Swedish population study with 22,044 people⁶¹¹. Relative risks were presented for smokers, former smokers and never smokers stratified by GOLD COPD severity stage and gender compared to the general population without symptoms of chronic bronchitis and with normal pulmonary function (see Table 5). A weighted average of the reported GOLD stage 3 (FEV₁ 30 to <50% predicted) and GOLD stage 4 (FEV₁ <30% predicted) figures were used in the model. These inputs were incorporated into the probabilistic analysis using log normal distributions.

Table 5: COPD mortality risks in GOLD stages 3 and 4 compared with the general population

	GOLD 3 (FEV ₁ 30 to <50%)				GOLD 4 (FEV ₁ <30%)			
	RR	LCI	UCI	N	RR	LCI	UCI	N
Men – smoker	2.42	1.84	3.18	101	3.57	2.23	5.71	27
Men - former smoker	2.42	1.44	4.08	33	2.59	0.83	8.07	8
Men - never smoker	3.93	1.86	8.3	15	1.04	0.15	7.39	7
Female - smoker	5.11	3.09	8.45	36	10.26	4.53	23.25	9
Female - former smoker	-	-	-	-	-	-	-	-
Female never smoker	3.91	0.96	15.8	7	18.1	2.53	129.6	3
Weighted average	3.1			192	5.0			54

Source: Ekberg et al. 2005⁶¹¹

COPD mortality rates stratified by FEV₁ were sought through a non-systematic review of the literature. The Ekberg et al. data was selected as it provided relative estimates of COPD mortality by FEV₁ group compared with a general population⁶¹¹. Soriano et al. also reported stratified COPD mortality rates compared to a matched control group from a UK cohort¹⁵. COPD severity was however classified as mild, severe and very severe by prescribed drugs and the Ekberg FEV₁ stratified data was considered more appropriate for the model. Both studies found higher COPD mortality in the more severe groups. Other COPD mortality data was identified but was either not stratified, not compared with a control non-COPD group or the source of estimates was unclear.

Utilities (health-related quality of life)

QALY loss per exacerbation

Exacerbations drive the differences in QALYs between treatment options in the basecase analysis. Each hospitalised exacerbation was attributed a QALY loss of 0.020 and each non-hospitalised exacerbation was attributed a QALY loss of 0.011. The basis for this is described below.

In order to estimate the impact of COPD exacerbations on QALYs, information was required on the magnitude of effect on utility during an exacerbation and the duration of effect.

COPD utility data was sought by searching Medline using COPD and EQ-5D specific terms and reviewing previous cost-utility analyses. As limited data was identified further ad hoc searches looked more broadly for information about the impact of COPD exacerbations on quality of life. A review of health-related quality of life data (including utility and non-utility measures) in COPD was identified and checked for useful papers⁶³³.

Two studies were identified that looked at utility change during exacerbations of COPD:

Paterson and colleagues evaluated utility using EQ-5D in patients with an established diagnosis of chronic bronchitis and who presented at a general practice clinic with an acute exacerbation^{kkk615}. The study enrolled 81 patients at a single centre in Glasgow, UK. The UK tariff for the EQ-5D was used. They reported a mean increase in EQ-5D of 0.17 (SD 0.24) from initial presentation for an acute exacerbation and at a second visit within one week of treatment completion. Average treatment duration is not reported but typically treatment with antibiotics/oral corticosteroids would be for 7-14 days.

O'Reilly and colleagues evaluated utility using EQ-5D in patients hospitalised for an acute exacerbation of COPD⁶¹⁴. The study enrolled 222 patients at a single hospital in Blackpool, UK. Patients had a diagnosis of COPD and were admitted for an acute exacerbationⁱⁱⁱ. The UK tariff for the EQ-5D was used. Patients were assessed at admission, then every other day

^{kkk} An increase in at least two of the following: increased frequency and/or severity of cough; increase in sputum volume, dyspnoea or increased dyspnoea; increase in chest congestion as indicated by adventitious sounds, and chills and/or fever. Patients also had to be able to produce mucopurulent or purulent sputum and had to be able to provide a suitable sample for laboratory analysis and microbiological confirmation.

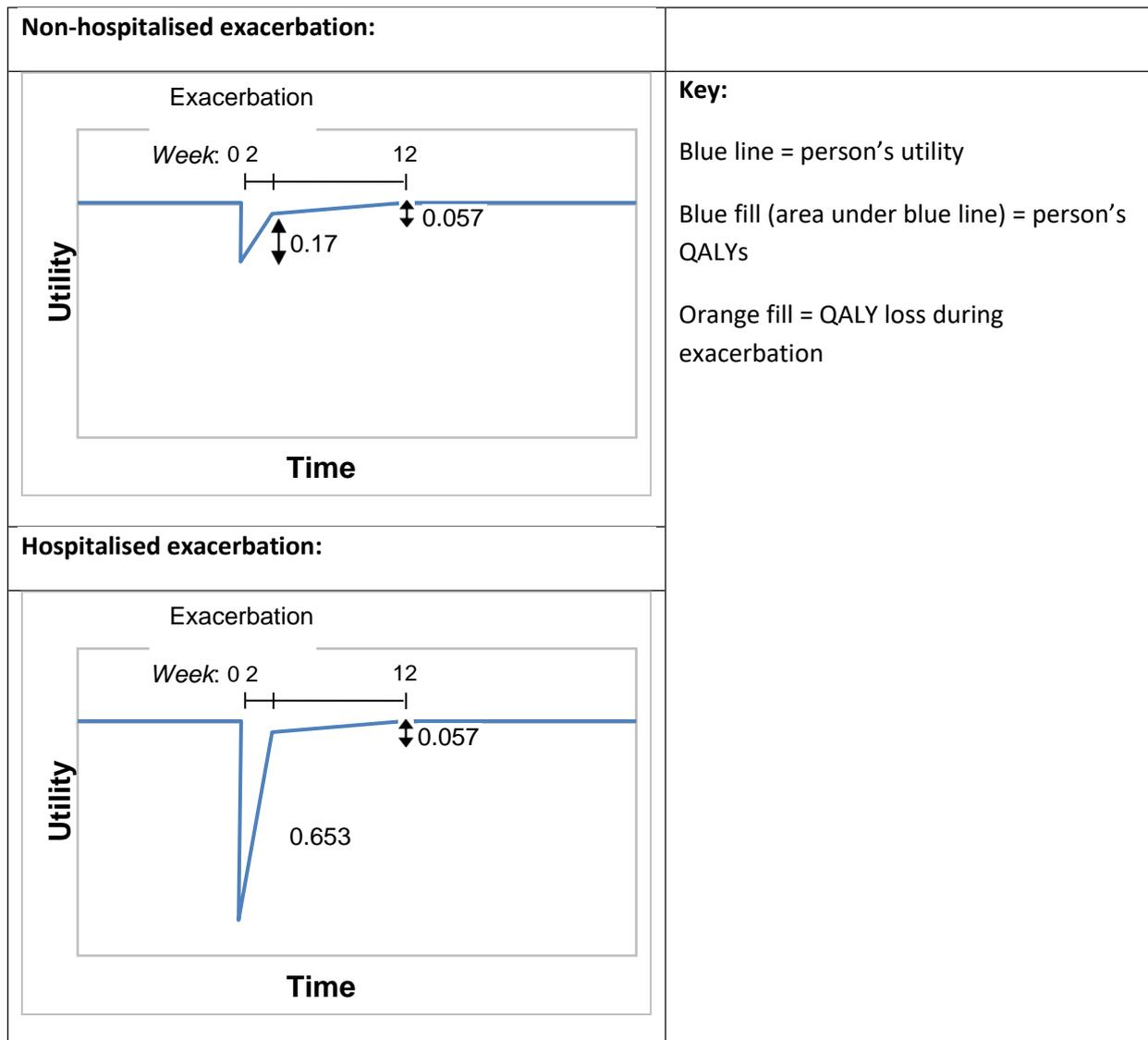
ⁱⁱⁱ No specific definition of an exacerbation was used; it was based on the physician and respiratory nurse's determination.

during their hospital stay. A group that entered the study following a protocol amendment were also assessed at 3 months after discharge (n = 40). They reported a mean increase in EQ-5D of 0.653 (SD 0.434) between admission and discharge, and a decrease of 0.240 (SD 0.373) between discharge and 3-month follow-up. Average length of stay in hospital was eleven days.

Limited information was identified regarding the duration of impact on utility. As described above, O'Reilly and colleagues reported a reduction in utility between discharge and 3-month follow-up, however this result is difficult to interpret and may reflect new exacerbations that occur during the 3-month follow-up. Spencer and Jones used the SGRQ (a disease specific measure of health-related quality of life) to examine the time course of recovery of health status following an acute exacerbation⁶¹⁶. They reported the biggest improvement between presentation and 4 weeks. But SGRQ score continued to improve beyond this. In patients that did not experience another exacerbation SGRQ continued to improve (although at a slower rate) 4 to 12 weeks and even up to 26 weeks. In patients that did experience another exacerbation, SGRQ showed a minor improvement beyond 4 weeks. This suggests that the impact of COPD exacerbation on patients extends beyond the treatment phase.

QALY loss due to an exacerbation was modelled in two parts – the first 2 weeks following an exacerbation and then following this up to 12 weeks (3 months). For non-hospitalised exacerbations, the change in utility from the start of an exacerbation to 2 weeks is based on that reported by Paterson and colleagues (0.17) as this was from exacerbations presenting in general practice⁶¹⁵. For hospitalised exacerbations the figure reported by O'Reilly and colleagues is used (0.653) for the corresponding period⁶¹⁴. These decrements were incorporated into the probabilistic analysis using a gamma distribution. The utility change over the period 2-12 weeks was estimated based on the rate of change in SGRQ between week 4 and 12 for people not experiencing a new exacerbation reported by Spencer and Jones. SGRQ values at week 4 and 12 (42.5 and 37.8 – mean difference 4.7) were mapped to EQ-5D using a published algorithm⁶¹⁷. The average change in EQ-5D per week was then calculated. This rate of utility change was then applied for the 2-12 week period resulting in a change in utility of 0.057 over the latter 10 week period of the 12 week period modelled. This parameter was incorporated into the probabilistic analysis using a gamma distribution for the mean SGRQ difference. QALY loss was then calculated for a non-hospitalised and hospitalised exacerbation using the EQ5D decrements and the durations stated. Figure 2 illustrates this graphically. Using this approach the QALY loss is the same irrespective of starting utility and so does not vary with COPD severity. Note that more detail regarding the mapping of SGRQ to EQ5D is given later in this report.

Figure 2: QALY loss during an exacerbation



Previous approaches to modelling the impact of exacerbations on utility

Previous cost-utility analyses in COPD were also reviewed for methods employed for estimating the impact of exacerbations in terms of utility as part of the model development. These are summarised in Table 6.

Table 6: Approaches to exacerbations in cost-utility analyses in the literature

Approach to exacerbations		Sources		
	<i>Utility during exacerbation</i>	<i>Duration</i>	<i>Utility during exacerbation</i>	<i>Duration</i>
Spencer et al. 2005 ⁶³⁴	ATS 1/2/3: Minor = 0.72/0.658/0.475 Major = 0.519/0.447/0.408 ^{mmm}	3 months	Based on area under curve assuming initial utility low and logarithmic recovery curve over 3 months to within 0.03 of stable utility. Utility low points based on expert panel (n=27) who completed EQ-5D from patient perspective. Non-linear recovery and prolonged improvement period based on Spencer and Jones, 2003 ⁶¹⁶ .	
Borg et al. 2004 ⁶³⁵	Mild = -5% Moderate = -15% Severe = -70% ⁿⁿⁿ	GOLD 1: mild 12.64 days, moderate 12.55, severe 4.67 GOLD 2a: mild 12.64, moderate 12.55, severe 4.67 GOLD 2b: mild 12.64, moderate 14.06, severe 8.49 GOLD 3: mild 10.20, moderate 12.58, severe 9.33 ^{ooo}	Mild and moderate – expert panel estimation (n=3) Severe – assumed to be equal to severe asthma exacerbation; UK asthma patient data (n=100) ⁶³⁶	Symptom duration by GOLD severity and exacerbation type (n=138) ⁶³¹
Oostenbrink et al. 2005 ¹⁷³ Rutten-van Molken et al. 2007 ¹⁷⁴	Non-severe = -15% Severe = -50% ^{ppp}	1 month	Non-severe – derivation unclear, referenced to Paterson et al. 2000 ⁶¹⁵ Severe – derivation unclear, referenced to Spencer & Jones 2003 ⁶¹⁶	Assumption

^{mmm} minor = requiring oral corticosteroids and/or antibacterials; major = hospitalisationⁿⁿⁿ mild = patient manages in normal environment including telephone call to doctor and possibly antibiotics or oral steroids; moderate = patient must make an unscheduled visit to DR;

severe = requires hospitalisation or ER visit

^{ooo} GOLD 1 = FEV1 >80% predicted; GOLD 2a = FEV1 50-80% predicted; GOLD 2b = FEV1 30 to <50% predicted; GOLD 3 = FEV1 <30% predicted^{ppp} Non-severe = awareness of sign or symptom AND discomfort that interferes with usual activities; severe = inability to do work or usual activities

COPD (update)

Maniadakis et al. 2006 ⁶³⁷				
Sin et al. 2004 ⁶³⁸	-0.32	Mild = 1 week Moderate = 2 weeks Severe = 4 weeks ^{qqq}	Utility weight for 'cough, wheeze or trouble breathing' from US stated preference experiment ⁶³⁹	Assumption
Brady et al. 2007 ²¹⁰	Mild = -0.17 Moderate = -0.47 Severe = -0.47 ^{qqq}	3 months	Mild – estimate reported by Paterson et al. 2000 ⁶¹⁵ Moderate and severe – derivation unclear, reference to Spencer et al. 2001 ⁶⁴⁰	Assumption

^{qqq} Mild = worsening of symptoms requiring outpatient physician services and institution of systemic corticosteroids or antimicrobial agents; moderate = requiring emergency department utilisation or urgent physician office visits; severe = requiring inpatient care

COPD (update)

Utility by COPD severity

In the model, utilities of 0.750 (CI: 0.731-0.768) and 0.647 (CI: 0.598-0.695) are used for severe (FEV₁ 30 to <50% predicted) and very severe (FEV₁ <30%) stages respectively based on data collected pre-randomisation in the UPLIFT study⁶¹³. These inputs are incorporated into the probabilistic analysis with a beta distribution.

COPD EQ-5D utility data was sought by searching Medline using COPD and EQ-5D specific terms and reviewing previous cost-utility analyses. A review of the use of EQ-5D in COPD was identified and checked for additional papers⁶⁴¹. A number of studies were identified that reported EQ-5D estimates of COPD utility – nine reported overall COPD utility and four reported utility by severity stratification. These are summarised in Table 7. Two studies reported COPD utilities stratified into FEV₁ 30 to <50% predicted and FEV₁ <50% predicted. Rutten-van Molken et al. reports EQ-5D data using the UK tariff collected in the multinational UPLIFT trial⁶¹³. Questionnaires were administered at randomisation and patients therefore weren't on LAMA but could be on other drugs. At baseline 65% were on LABA and 62% were on ICS. Stahl et al. reports EQ-5D data using the UK tariff from a Swedish population⁶⁴². Data from the Rutten-van Molken study was selected for use in the model as the population was larger.

COPD (update)

Table 7: COPD EQ-5D data

	Studies	Population	EQ-5D tariff	Stratification [†]	N	EQ-5D index
Overall COPD	Rutten-van Molken ⁶¹³	Multinational	UK	n/a	1235	0.76 (SD 0.21)
	Punekar ⁶⁴³	Multinational	UK	n/a	2703	0.62-0.71 (range across countries)
	Sullivan ⁶⁴⁴	USA	US	n/a	1609	0.797 (IQR 0.76-0.83)
	Harper ^{584*}	UK	NR	n/a	125	0.524 (SD 0.157)
	Hazell ⁶⁴⁵	UK	UK	n/a	1054	0.63
	Stavem ⁶⁴⁶	Norway	UK	n/a	59	0.73 (IQR 0.62-0.81)
	Polley ⁶⁴⁷	UK	NR	n/a	18	0.45 (SD 0.31)
	Szende ⁶⁴⁸	Sweden	European	n/a	176	0.76 (SD 0.22)
	Johansson ⁶⁴⁹	Sweden	NR	n/a	21	0.52 (SD 0.30)
By severity	Rutten-van Molken ⁶¹³	Multinational	UK	GOLD 2 GOLD 3 GOLD 4	622 513 91	0.787 (CI: 0.771-0.802) 0.750 (CI: 0.731-0.768) 0.647 (CI: 0.598-0.695)
	Stahl ^{642**}	Sweden	UK	GOLD 1 GOLD 2 GOLD 3 GOLD 4 BTS 0 BTS 1 BTS 2 BTS 3	26 91 33 9 26 63 47 23	0.84 (SD 0.15) 0.73 (SD 0.23) 0.74 (SD 0.25) 0.52 (SD 0.26) 0.84 (SD 0.15) 0.74 (SD 0.21) 0.72 (SD 0.28) 0.63 (SD 0.25)
	Punekar ⁶⁴³	Multinational	UK	GOLD 1 GOLD 2 GOLD 3/4	92/218 77/314 79/340	PCP [‡] 0.77 (CI: 0.73-0.81) / RS [‡] 0.68 (CI: 0.64-0.72) 0.68 (CI:0.62-0.74) / 0.72 (CI:0.69-0.75) 0.62 (CI:0.56-0.68) / 0.64 (CI:0.61-0.67)
	Spencer ⁶³⁴	UK	UK	ATS 1 ATS 2 ATS 3	283	0.81 (SE 0.02) 0.72 (SE 0.03) 0.67 (SE 0.05)

*Brazier et al.⁶⁵⁰ also reports on the same dataset⁶⁴¹ and is not included above. **Szende⁶⁴⁸ also reports on the same dataset and is not included above.

[†] FEV₁ % predicted: GOLD 1/2/3/4 = ≥80/79-50/49-30/<30; ATS 1/2/4 = 80-50/50-35/<35; BTS 0/1/2/3 = ≥80/79-60/59-40/<40. [‡] PCP = patients treated by a primary care physician; RS patients treated by a respiratory specialist.

Costs

Drug costs

The annual costs applied for the treatment options in the model were £395.18 for LAMA alone, £488.76 for LABA+ICS and £883.94 for triple therapy.

Treatment costs were estimated based on recommended licensed dosing from summaries of product characteristics, costs from the NHS Drug Tariff and relative usage of different drugs and preparations within each class of therapy (that is: LAMA, LABA+ICS) based on the Prescription Cost Analysis for England 2007^{221,222,618-623}. Table 8 presents a summary of included drug preparations, costs and usage used to calculate costs.

Note the following for costing purposes:

- LABA+ICS are assumed to be administered only as a combination inhaler product (rather than separate inhalers for each mono-component) as all clinical evidence reviewed used the combination products and the GDG felt it was therefore only appropriate to recommend use of combination products.
- LAMA and LABA+ICS products are available in a number of different inhalers. As the different inhalers have slightly different prices, an average cost was used in the model based on the relative usage of the different available inhalers from the Prescription Cost Analysis⁶²³.
- Two LABA+ICS combination products are available that are licensed for use in COPD – salmeterol/fluticasone and formoterol/budesonide. The cost of LABA+ICS used in the model was therefore based on a weighted average of the two drug costs.
- Salmeterol/fluticasone and formoterol/budesonide are also licensed in asthma. A range of different preparations (that is different inhalers/doses) are available, some have a COPD and asthma indication and some only asthma. Inhalers without a COPD indication will generally not be suitable to fulfil the recommended COPD dose. Information was not available in the Prescription Cost Analysis regarding what a prescription was used for and so asthma and COPD usage could not be separated. The average cost of salmeterol/fluticasone and formoterol/budesonide for a patient with COPD was based on the usage of preparations with a COPD indication only.
- Taking the usage only from preparations of salmeterol/fluticasone and formoterol/budesonide with a COPD indication gave a relative usage between the two products of 74% and 26% respectively. However, GDG members considered this likely to be unrepresentative of true usage, probably due to misprescribing. On this basis a relative usage between the agents was calculated based on overall usage of the drugs which results in 26% salmeterol/fluticasone and 74% formoterol/budesonide. This relative split between the agents was used for costing purposes.

Table 8: Drug unit costs for LAMA and LABA+ICS

Drug	Within class use*	Formulation	Preparation	Units/ pack	Cost/ pack†	Cost/ unit	Units/ dose‡	Doses / day‡	Cost/ day	Cost/ year	Preparation use %**	Av. cost
LAMA												
Tiotropium	100%	Spiriva® (Boehringer Ingelheim)	HandiHaler® (inhalation powder), device + capsules, 18 micrograms	30	£34.87	£1.16	1	1	£1.16	£424.25	20%	£395.18
			HandiHaler® (inhalation powder), capsules, 18 micrograms	30	£31.89	£1.06	1	1	£1.06	£388.00	80%	
LABA+ICS												
Budesonide/ formoterol	26%	Symbicort® (AstraZeneca)	200/6 Turbohaler® (dry powder inhaler), metered dose, 200/6 micrograms	120	£38.00	£0.32	2	2	£1.27	£462.33	72%	
			400/12 Turbohaler® (dry powder inhaler), metered dose, 400/12 micrograms	60	£38.00	£0.63	1	2	£1.27	£462.33	28%	
Fluticasone/ salmeterol	74%	Seretide® (A&H)	500 Accuhaler® (dry powder for inhalation), device + blisters, 500/50 micrograms	60	£40.92	£0.68	1	2	£1.36	£497.86	100%	£488.76

*Based on usage of all preparations of drugs within each class (e.g. LABA+ICS) reported in Prescription Cost Analysis 2007 – each class sums to 100% **Based on use of the specific drug preparations shown that have an indication for COPD reported in Prescription Cost Analysis 2007 – each drug (e.g. budesonide/formoterol) sums to 100%. Sources: †NHS Drug Tariff February 2010⁶²², ‡product licences^{221,618,620,621}, */** Prescription Cost Analysis 2007⁶²³

Acute COPD exacerbation costs

Costs of £2403 per hospitalised COPD exacerbation and £34 per non-hospitalised COPD exacerbation were applied in the model. The cost per hospitalised exacerbation was based primarily based on 2007/8 NHS reference costs⁶²⁵. The cost per non-hospitalised exacerbation was based on the results of a UK costing study inflated using UK healthcare inflation indices to 2007/8 prices (latest indices available at time of analysis)^{624,627}. Further details are provided below. Cost parameters were incorporated into the probabilistic analysis using gamma distributions.

Hospitalised exacerbation cost

A cost of £2403 per hospitalised exacerbation of COPD was estimated as follows.

The NHS reference costs provide average UK costs per hospitalisation by HRG code. A weighted average of the costs for all categories of COPD hospitalisation (HRG DZ21A-K) from the 2007/2008 NHS reference costs (latest available at time of analysis) were used to estimate the cost of a hospitalisation for a COPD exacerbation⁶²⁵.

Costs for accident and emergency (A&E) services, paramedic services and critical care are reported unbundled from hospital costs by HRG code in the NHS reference costs and so needed to be added to the above basic hospitalisation cost⁶²⁵. Resource use for these services for a COPD admission was not available from the NHS reference costs and so was sought elsewhere.

It was estimated that 67% of patients would come to hospital by ambulance. This was based on data from the 2008 National COPD audit that reported data regarding admission route for a group of patients hospitalised for COPD an exacerbation⁶²⁶. This reported that 34% of patients saw their GP and were sent to hospital, 12% went to A&E via their own steam and 41% didn't see their GP but called an ambulance (16% had an 'other' route and 1% did not state a route). Information was not given about what proportion of patients who saw a GP and were sent to hospital used an ambulance. Based on discussion with a GP representative from the GDG it was judged reasonable to assume that ambulance use would be the same as among those who did not see a GP (that is of the 53% of people who did not see a GP 12% went to A&E via own stream and 41% called an ambulance). The estimate of 67% ambulance use for the model was therefore based on the 41% of patients who didn't see a GP but called an ambulance plus 26% who saw their GP and were sent to hospital by ambulance. The cost of coming to hospital by ambulance was based on a weighted average of the costs for all categories of 'Paramedic services' for breathing difficulties (HRG PS06A-C) from the NHS reference costs⁶²⁵.

It was assumed that all patients attended A&E. The cost of A&E was based on the weighted average of the costs for all categories of 'A&E services leading to admitted' from the NHS reference costs⁶²⁵.

UK data regarding the use of critical care services per hospitalisation for a COPD exacerbation was not identified. Two studies (one from Italy and one from Spain) were identified from the literature that provided estimates of time spent in ICU per COPD hospitalisation and so an average of these estimates was used; 0.6 days^{174,628}. The cost per day in ICU was based on a weighted average of the costs per day for all categories of 'Critical care services – Adult: intensive therapy unit' (HRG XC01Z-XC07Z) from the NHS reference costs⁶²⁵.

The 2008 National COPD Audit indicated that 34% of patients would see their GP prior to coming to hospital and so this cost was also incorporated⁶²⁶. The cost of a GP visit was based on the 2008 average UK cost (latest available at time of analysis)⁶²⁷.

Non-hospitalised exacerbation cost

A cost of £34 per non-hospitalised exacerbation was based on the results of a UK costing study inflated using UK healthcare inflation indices to 2007/8 prices (latest indices available at time of analysis)(before inflated £30.69, SD 111.4)^{624,627}. Details of the selection of the data source are provided below.

The literature was reviewed for estimates of resource use and/or the costs of non-hospitalised COPD exacerbations. Studies that were identified are summarised in Table 9. Original reports of resource or costing studies are included in this table, including those reported within cost-effectiveness study reports. Cost-effectiveness studies that utilise data reported elsewhere are not included in the table (as this would be duplication) nor are those that use estimates based on assumptions or expert opinion. Note that studies that only reported in-hospital costs for patients with COPD exacerbations are also not included in the table.

Estimates of cost for a non-hospitalised exacerbation from the studies varied considerably. A number of considerations were relevant in selecting a source for the model. The definition of exacerbations varied between studies and did not necessarily match up with the categorisation being used in this analysis; we were looking for an estimate where hospitalised exacerbations were not included. Most studies were not in a UK setting and management may vary between countries. For example, in the UK access to healthcare is generally via a GP but in other countries this may not be the case.

Only one study was identified that was conducted in a UK setting and the exacerbation definition in this study also matched that being used in the model⁶²⁴. On this basis this source was utilised. It was noted that this cost estimate was quite low compared with the overseas estimates. However, it was difficult to judge if it was inaccurate or if it represented a genuine difference in management between countries. This issue was discussed with the GDG and consideration was given to the cost of drugs used to treat an exacerbation and the average cost of typical healthcare contacts. It was concluded that while it did appear possibly too low it was not unfeasible and, in the absence of other data, should be used in the model. Sensitivity analysis was planned to explore the impact of this cost on results.

Table 9: COPD exacerbation costing studies

Study reference	Setting and study design	Exacerbation definitions	Cost/exacerbation (2007/8 £) ^{rrr}	Resource use reported?
Lucioni et al 2005 ⁶²⁸	Italy (resource use and unit costs) People diagnosed with COPD hospitalised for an exacerbation; followed-up prospectively for 6 months post-discharge Data collection via patient questionnaires N = 570 (282 with ≥ 1 exacerbation) Exacerbations = 282	Not reported (includes exacerbations requiring hospitalisation and not)	<ul style="list-style-type: none"> £1085^{sss} Resource use included: medical visits, hospital admission, tests, drugs, oxygen therapy, ventilation, rehabilitation.	No
Andersson et al 2002 ⁴⁹⁶	Sweden (resource use and unit costs) People diagnosed with COPD who had experienced had experienced an exacerbation the previous winter Data collection via patient questionnaires; visits and hospitalisations verified via medical records N = 61 Exacerbations = 75	Mild = self-managed by increasing dose of current medication (including adding OTC medication) Mild-moderate = telephone contact and/or antibiotics/systemic corticosteroids Moderate = requiring GP/outpatient visit Severe = requiring A&E visit or hospitalisation	Mild = £11 Mild/moderate = £34 Moderate = £202 Severe = £2092 Resource use included: drugs, healthcare contacts, A&E visits, hospitalisation, transportation.	No
Miravittles et al. 2002 ⁶⁵¹	Spain (resource use and unit costs) People diagnosed with COPD who presented to GP with exacerbation; followed-up at 1 month Data collection by GP at planned follow-up visits N = 2414	Exacerbation = presence of increased dyspnoea, and/or increased production and/or purulence that led to a change or increase in treatment	<ul style="list-style-type: none"> £144 Resource use included: drugs, clinic visits, A&E visits, hospitalisation, oxygen (cost of exacerbation includes treatment failure defined as new GP/A&E visit or hospitalisation in month following exacerbation)	No

^{rrr} All costs are converted to UK £ using PPP for the appropriate year, and then inflated to 2007/8 costs using the PSSRU healthcare inflation indices^{177,627}. Reported to nearest whole £.

^{sss} Direct cost only presented here; calculated by dividing exacerbation costs/year by exacerbations/year

Rutten-van Molken 2007 ¹⁷⁴	Spain (resource use and unit costs) Reanalysis of data from Miravittles et al 2002 above.	Exacerbation = as per Miravittles et al. 2002 above Severe = unspecified but appears to be requiring A&E visit or hospitalisation	Non-severe = £75 ^{ttt} Severe = £1940 ^{ttt,uuu} Resource use included: healthcare contacts, A&E visits, hospitalisation, drugs, oxygen	Yes
O'Reilly et al. 2006 ⁶²⁴	UK (resource use and unit costs) People diagnosed with COPD registered in a PCT; followed-up prospectively for 1 year Data collection by daily diary cards N = 848 Exacerbations: symptom-defined = 296; healthcare defined = 351	Symptom-defined = increased symptoms for ≥2days Healthcare-defined = requiring antibiotics and/or oral corticosteroids for chest problems	Symptom-defined = £18 Healthcare-defined = £34 Resource use included: drugs, healthcare contacts, A&E visits, hospitalisation Note: no patients were hospitalised during study	Partly
Price et al (1999) ⁶⁵²	Resource use from RCT – country unspecified (UK unit costs) Symptomatic COPD patients enrolled in fluticasone propionate RCT; resource use collected prospectively Exacerbations: mild = 64; moderate = 112; severe = 18	<ul style="list-style-type: none"> Mild = self-managed by patient Moderate = physician-treated Severe = hospitalised 	Mild = £21 Moderate = £136 Severe = £2362	No
Oostenbrink et al. 2004 ¹⁷⁶	Netherlands/Belgium (86%/14%) (Netherlands unit costs) People with stable COPD enrolled in 2 tiotropium vs. ipratropium RCTs; prospective follow-up for 1 year N = 519 (207 with ≥1 exacerbation) <ul style="list-style-type: none"> Exacerbations = 364 	<ul style="list-style-type: none"> Mild = awareness of a sign or symptom which is easily tolerated^{vvv} Moderate = causing discomfort enough to cause interference with usual activity^{vvv} Severe = incapacitating or causing inability to do work or usual activity^{vvv} 	Mild = £74 Moderate = £498 ^{www} Severe = £3448 ^{www} Resource use included: hospitalisation, A&E visits, healthcare contacts, ambulance transportation, tests, drugs	Partly

^{ttt} Direct medical costs only included here; NHS sick leave benefit and other excluded.

^{uuu} 52% of severe exacerbations required hospital admission.

^{vvv} Classification of exacerbations based on ratings by the physician-investigator.

^{www} Hospitalisation was 16% and 78% in moderate and severe exacerbations respectively.

Oostenbrink et al. 2005 ¹⁷³	Canada ^{xxx} (resource use and unit costs) Original resource use data reported as part of CEA. People with COPD; prospective follow-up for 1 year N = 598 Exacerbations = NR	Canada Exacerbation = NR Severe = hospitalisation or A&E visit	Canada Non severe = £58 Severe = £4036 Resource use included: hospitalisation, A&E visits, healthcare visits, drugs, oxygen	Yes
Maniadakis et al. 2006 ⁶³⁷	Greece (resource use and unit costs) Original resource use data reported as part of CEA. Analysis of medical records at the University General Hospital of Heraklion in Greece. N = NR Exacerbations = NR	NR	Non-severe = £477 Severe = £882 Resource use included: hospitalisation, A&E visits, healthcare visits, drugs, oxygen	Yes

^{xxx} This CEA also reports Netherlands estimates using different data but as this is based on Oostenbrink 2004 detailed above this is not included here.

COPD maintenance costs

Annual maintenance costs for COPD of £273 (SE 35.0) and £896 (SE 79.5) for severe (FEV₁ 30 to <50% predicted) and very severe (FEV₁ <30% predicted) stages respectively were applied in the model. Mean estimates were derived from a UK COPD costing study³³; error estimates were imputed (see below for details). Details of derivation and data selection are provided below.

Note that in the model, maintenance costs only vary between treatment arms in the secondary analyses where a mortality impact of treatment is incorporated.

The literature was reviewed for estimates of per patient annual maintenance costs for stable COPD stratified by severity. Studies that were identified are summarised in Table 10. Original reports of resource or costing studies were included. This included estimates reported within a cost-effectiveness analysis. Cost-effectiveness studies that utilise data reported elsewhere are not included in the table (as this would be duplication) nor are those that use estimates based on assumptions or expert opinion. Only estimates stratified by severity are included. If this did not include stratification of the <50% group they are also not included in the table.

Estimates of annual costs excluding those associated with exacerbations were required for the model as exacerbations are costed separately. This would therefore cover healthcare contact such as regular follow-up visits and additional medications and therapies, such as oxygen. Ideally resource use would have been collected in a UK setting.

Only one study reported costs from a UK setting³³. Severity classification was by self-designation or dyspnoea scale (into mild, moderate and severe) rather than FEV₁ cut-offs as used in the model. Exacerbations costs were included in the estimates however the study also reported that 60% of costs in the overall population are due to unscheduled care. Some data were available that reported by FEV₁ based severity groups and excluded exacerbation costs but from non-UK settings^{173,174}. The UK data was prioritised. The figures for moderate and severe COPD defined by dyspnoea score with 60% of costs subtracted to remove unscheduled care (i.e. treatment of exacerbations) were used for severe and very severe COPD in the model respectively.

These parameters were incorporated into the probabilistic analysis using the cost for severe COPD (£723) and the difference in cost between severe and very severe COPD (£623). Gamma distributions were assigned. No error estimates were reported for the cost estimates and so a standard error was imputed that would generate a confidence interval half that of the mean cost estimate.

Table 10: COPD maintenance costing studies

Study design		Maintenance cost/year (2007/8 £) ^{yyy}	Resource use reported?
Lucioni et al 2005 ⁶²⁸	Italy (resource use and unit costs) People diagnosed with COPD hospitalised for an exacerbation; followed-up prospectively for 6 months post-discharge Data collection via patient questionnaires N = 570	<ul style="list-style-type: none"> GOLD 2 = £2544^{zzz} GOLD 3 = £3489 GOLD 4 = £6740 <p>Resource use included: medical visits, hospital admission, tests, drugs, oxygen therapy, ventilation, rehabilitation. Includes exacerbation costs; in whole population costs not related to exacerbations = 48%.</p>	No
Miravittles et al. 2003 ⁶⁵³	Spain (resource use and unit costs) People diagnosed with COPD who presented to GP with exacerbation; followed-up at 1 year Data collection by GP at planned follow-up visits N = 766	<ul style="list-style-type: none"> ATS 1 = £1236 ATS 2 = £1704 ATS 3 = £2424 <p>Resource use included: drugs, clinic visits, A&E visits, hospitalisation, oxygen. Includes exacerbation costs</p>	No
Rutten-van Molken 2005 ¹⁷⁴	Spain (resource use and unit costs) Reanalysis of data from Miravittles et al 2003 above.	<ul style="list-style-type: none"> GOLD 2 = £393 GOLD 3 = £537 GOLD 4 = £748 <p>Resource use included: healthcare contacts, tests, drugs, oxygen. Excludes exacerbation costs.</p>	Yes
Oostenbrink et al. 2005 ¹⁷³	<ul style="list-style-type: none"> Netherlands/Belgium (86%/14%) (Netherlands unit costs) People with stable COPD enrolled in 2 tiotropium vs. ipratropium RCT; prospective follow-up for 1 year (reanalysis of data from RCT) N = 519 	<p>Netherlands</p> <ul style="list-style-type: none"> GOLD 2 = £352 GOLD 3 = £617 GOLD 4 = £1363 	Yes

^{yyy} All costs are converted to UK £ using PPP for the appropriate year, and then inflated to 2007/8 costs using the PSSRU healthcare inflation indices⁶²⁷. Reported to nearest whole £. FEV₁ % predicted: GOLD 1/2/3/4 = ≥80/79-50/49-30/<30; ATS 1/2/4 = 80-50/50-35/<35.

^{zzz} Direct cost only presented here; calculated by dividing exacerbation costs/year by exacerbations/year.

	<p>Canada (resource use and unit costs) Original resource use data reported as part of CEA. People with COPD; prospective follow-up for 1 year N = 598</p>	<p>Canada</p> <ul style="list-style-type: none"> • GOLD 2 = £330 • GOLD 3 = £797 • GOLD 4 = £1594 <p>Resource use included: healthcare contacts, tests, drugs, oxygen. Excludes exacerbation costs.</p>	
Maniadakis et al. 2006 ⁶³⁷	<p>Greece (resource use and unit costs) Original resource use data reported as part of CEA. Analysis of medical records at the University General Hospital of Heraklion in Greece.</p> <ul style="list-style-type: none"> • N = NR 	<ul style="list-style-type: none"> • GOLD 2 = £355 • GOLD 3 = £431 • GOLD 4 = £562 <p>Resource use included: healthcare contacts, spirometry, drugs. Excludes exacerbation costs.</p>	Yes
Tynan 2005 ⁶⁵⁴	<p>Ireland People with COPD diagnosis attending an outpatients clinic Data collected by patient interview for previous 6 months and annualised N = 150 (GOLD 0/1/2/3/4 = 20/14/46/38/24)</p>	<ul style="list-style-type: none"> • GOLD 0 = £1637 • GOLD 1 = £2000 • GOLD 2 = £2753 • GOLD 3 = £4004 • GOLD 4 = £6703 <p>Resource use included: healthcare contacts, hospitalisation, drugs, tests. Includes exacerbation costs</p>	
Britton 2003 ^{33aaaa}	<p>UK N = 400 Data from telephone interviews Recorded info about the past year People with COPD</p>	<ul style="list-style-type: none"> • Mild = £171 / £291^{bbbb} • Moderate = £352 / £683 • Severe = £1494 / £2239 <p>Mild, moderate, severe = Self reported severity / MRC dyspnoea 0-2, 3-4, 5. Resource use included: healthcare contacts, tests, drugs, oxygen. Includes exacerbation costs; in whole population costs not related to unscheduled care = 40%.</p>	

^{aaaa} Other country reports of same study available but not reported as same format as for UK.

^{bbbb} Direct costs only presented here

<p>Jansson 2002⁶⁵⁵</p>	<p>Sweden (resource use and costs) People with COPD; followed-up over 1 year Data collected via telephone interviews every 3 months N = 212</p>	<p>FEV₁ ≥80% predicted = £173 FEV₁ 60-79% predicted = £384 FEV₁ 40-59% predicted = £1297 FEV₁ <40% predicted = £4258</p> <p>Resource use included: drugs, healthcare contacts, hospitalisation, oxygen. Includes exacerbation costs.</p>	<p>Partly</p>
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Relative treatment effects

As described above, baseline event rates for the LABA+ICS arm of the model were obtained from the literature. The impact of alternative treatment combinations were then modelled by applying relevant relative treatment effects from randomised controlled trials to these baseline event rates.

In the base case analysis only exacerbations are impacted differentially by treatment in the model. Two alternative analyses also incorporate: a) a difference in utility when stable; b) mortality.

Relative treatment effect data were sought from the randomised controlled trials identified in the systematic evidence reviews undertaken for the guideline. Three studies were identified that each compared two of the three treatment options that are incorporated into the model:

- INSPIRE study²¹⁹: LAMA vs LABA+ICS
- UPLIFT subgroup analysis²⁰¹: triple therapy vs LABA+ICS
- OPTIMAL study²⁰⁰: triple therapy vs. LAMA

All three studies provide direct comparisons of two treatment options in the model. However, the studies form an evidence loop and cannot all be used at the same time to inform the model. For example, if we know the relative number of exacerbations with LAMA compared to LABA+ICS from one study, and the relative number of exacerbations with triple therapy compared to LABA+ICS from another study, the relative number of exacerbations with triple therapy compared in LAMA is therefore implicit without the use of the study that compares triple and LAMA.

There are three possible pairs of trials that can therefore be used in provide the estimates of relative treatment effect for the model (see also Figure 3 below):

1. INSPIRE and UPLIFT subgroup
2. INSPIRE and OPTIMAL
3. UPLIFT subgroup and OPTIMAL

Figure 3: Trials data combinations for estimates of relative effect

1. INSPIRE, UPLIFT		2. INSPIRE, OPTIMAL		3. UPLIFT, OPTIMAL	
LABA+ICS		LABA+ICS		LABA+ICS	
LAMA	Triple	LAMA	Triple	LAMA	Triple

Solid black line = comparison in trial; Dashed grey line = implicit comparison

Table 11 below summarises the resulting treatment effect estimates using each of the three pairs of trials. Rate ratios are used for exacerbations, and exacerbations requiring hospitalisation. Risk ratios are used for mortality. Mean difference is used for EQ-5D – this is obtained by mapping mean SGRQ data to EQ5D and calculating the difference. Note that more detail regarding the mapping of SGRQ to EQ5D is given later in this report.

Table 11: Relative effect estimates used in model for each three pairs of trials

	LABA+ICS vs. LAMA	Triple vs. LABA+ICS	Triple vs. LAMA
Exacerbations: rate ratio (95% confidence interval); grey/italic = implicit value			
1. INSPIRE, UPLIFT	0.97 (0.84-1.12)	0.85 (0.78-0.92)	<i>0.82</i>
2. INSPIRE, OPTIMAL	0.97 (0.84-1.12)	<i>0.88</i>	0.85 (0.65-1.11)
3. UPLIFT, OPTIMAL	<i>1.00</i>	0.85 (0.78-0.92)	0.85 (0.65-1.11)
Hospitalisations: rate ratio (95% confidence interval); grey/italic = implicit value			
1. INSPIRE, UPLIFT	1.08 (0.73-1.59)	0.89 (0.75-1.07)	<i>0.96</i>
2. INSPIRE, OPTIMAL	1.08 (0.73-1.59)	<i>0.49</i>	0.53 (0.33-0.86)
3. UPLIFT, OPTIMAL	<i>0.60</i>	0.89 (0.75-1.07)	0.53 (0.33-0.86)
Stable utility (EQ-5D): mean difference mapped from SGRQ*; grey/italic = implicit value			
1. INSPIRE, UPLIFT	0.023 (0.001-0.046)	0.021 (0.006-0.036)	<i>0.044</i>
2. INSPIRE, OPTIMAL	0.023 (0.001-0.046)	<i>0.017</i>	0.040 (0.007-0.075)
3. UPLIFT, OPTIMAL	<i>0.019</i>	0.021 (0.006-0.036)	0.040 (0.007-0.075)
Mortality: risk ratio (95% confidence interval); grey box = implicit value			
1. INSPIRE, UPLIFT	0.56 (0.33-0.94)	0.91 (0.76-1.11)	<i>0.51</i>
2. INSPIRE, OPTIMAL	0.56 (0.33-0.94)	<i>2.88</i>	1.61 (0.46-0.56)
3. UPLIFT, OPTIMAL	<i>1.72</i>	0.91 (0.76-1.11)	1.61 (0.46-0.56)

*Confidence intervals reflect uncertainty in mean difference in SGRQ translated to uncertainty in EQ-5D.

Confidence interval generated from 10,000 simulations of probabilistic analysis

Sources: INSPIRE²¹⁹, UPLIFT subgroup²⁰¹, OPTIMAL²⁰⁰

The model was run using each of the three pairs of trials so that the impact on results and conclusions could be examined. As LABA+ICS data had been used to populate the model, relative treatment effects were calculated and applied in the model for LAMA and triple therapy compared to LABA+ICS using the above data. In the probabilistic analysis log normal distributions were used for rate ratios and risk ratios. Normal distributions were used for the mean SGRQ differences that were used calculate the mean EQ5D differences.

Mapping SGRQ to EQ-5D

Due to a lack of utility data, SGRQ data were mapped to EQ-5D where required. This was done as part of the estimation of QALY loss with an exacerbation (direct utility data was available for the initial impact but not over the longer term) and also to estimate the impact of treatment on stable utility as described in the relevant sections above.

The SGRQ (St Georges Respiratory Questionnaire) is a widely used measure of health impairment in COPD and asthma. SGRQ is not a utility measure and so cannot be used directly to calculate QALYs. There have however been some reports of mapping of SGRQ to EQ-5D. Two algorithms were identified that mapped total SGRQ score to EQ-5D utility^{175,617}. These were compared and the Starkie method was selected in preference to the Oba method as the latter resulted in impossible values at the extreme ends^{175,617}. However, it is noted that both approaches yielded similar values in the middle. The Starkie formula is displayed below.

$$\text{Predicted utility score} = 1 - 0.0335 - 0.0017T - 0.0001T^2 + 0.0279G$$

Where: T = total SGRQ score; G = gender (0=female, 1=male)

The GDG highlighted that they were aware of some issues with mapping SGRQ to EQ-5D when examined at a patient level and it was judged inferior to direct utility data. However, in the absence of alternatives this was considered a reasonable approach to fill in gaps in the data.

In addition, the SGRQ reflects exacerbations as well as stable symptoms. This is likely to more of an issue when used as an approximation of the difference in stable utility between treatment options than when estimating the rate of recovery following an exacerbation. In particular because the data used for the rate of recovery is in patients who do not have a new exacerbation and is also non-comparative.

> Computations

The model was constructed in Microsoft Excel and was evaluated by cohort simulation.

Patients start in cycle 0 distributed amongst the model health states (severe, very severe, dead) as described above. Patients were redistributed amongst the model health states over time as follows. Each cycle, the age-dependant COPD-severity specific death rates were applied to alive patients and the probability of progressing from severe to very severe was then applied to the remaining alive patients in the severe severity group in order to recalculate the number of people in each state. Life years in severe and very severe COPD states for the cohort are computed each cycle. A half-cycle correction is applied.

Each cycle, the number of exacerbations the cohort experienced was calculated by applying the severity-specific exacerbation rates to the number of life years in each severity state.

The number of hospitalised exacerbations experienced was calculated by applying the

severity-specific hospitalisation rates to the number of life years in each severity state. The number of non-hospitalised exacerbations was calculated by subtracting the number of hospitalised exacerbations from the total exacerbations.

Total QALYs were calculated from the above information as follows. Each cycle, the time spent (i.e. 1 year) in each state of the model was weighted by the utility for that state. This gives the QALYs for each state for the cycle. The number of non-hospitalised and hospitalised exacerbations that occurred was multiplied by the relevant QALY loss due to an exacerbation. These were combined to give the QALYs per cycle, $Q(t)$, and discounted to reflect time preference (discount rate = r). QALYs during year 1 were not discounted. The total discounted QALYs was the sum of the discounted QALYs per cycle.

$$\text{Total discounted QALYs} = \sum_{t=1}^i \frac{Q(t)}{(1+r)^{t-1}}$$

Where: t = cycle number; i = maximum cycle number; $Q(t)$ = QALYs in cycle t ; r = discount rate

Total costs were calculated from the above information as follows. Each cycle, the time spent (i.e. 1 year) in each state of the model was multiplied by the maintenance costs for that state and the relevant drug cost. The number of non-hospitalised and hospitalised exacerbations that occurred was multiplied by the respective costs. These were combined to give the costs per cycle, $C(t)$, and discounted to reflect time preference (discount rate = r). Costs during year 1 were not discounted. The total discounted costs was the sum of the discounted costs per cycle.

$$\text{Total discounted costs} = \sum_{t=1}^i \frac{C(t)}{(1+r)^{t-1}}$$

Where: t = cycle number; i = maximum cycle number; $C(t)$ = Costs in cycle t ; r = discount rate

The widely used cost-effectiveness metric is the incremental cost-effectiveness ratio (ICER). This is calculated by dividing the difference in costs associated with two alternatives by the difference in QALYs. The decision rule then applied is that if the ICER falls below a given cost per QALY threshold the result is considered to be cost effective. If both costs are lower and QALYs are higher the option is said to dominate and an ICER is not calculated.

$$\text{ICER} = \frac{\text{Costs}(B) - \text{Costs}(A)}{\text{QALYs}(B) - \text{QALYs}(A)}$$

Where: $\text{Costs}/\text{QALYs}(X)$ = total discounted costs/QALYs for option X

Cost-effective if: $\text{ICER} < \text{Threshold}$

When there are more than two comparators, as in this analysis, options must be ranked in order of increasing cost then options ruled out by dominance or extended dominance before calculating ICERs excluding these options.

It is also possible, for a particular cost-effectiveness threshold, to re-express cost-effectiveness results in terms of net benefit (NB). This is calculated by multiplying the total QALYs for a comparator by the threshold cost per QALY value (for example, £20,000) and then subtracting the total costs. The decision rule then applied is that the comparator with the highest NB is the most cost-effective option at the specified threshold. That is the option that provides the highest number of QALYs at an acceptable cost. For ease of computation NB is used to identify the optimal strategy in the probabilistic analysis simulations.

$$\text{Net Benefit}(X) = \text{QALYs}(X) \times D - \text{Costs}(X)$$

Where: $\text{Costs}/\text{QALYs}(X)$ = total discounted costs/QALYs for option X; D = threshold

The probabilistic analysis was run for 5000 simulations. Each simulation, mean discounted costs and mean discounted QALYs were calculated for each treatment option. The net benefit was also calculated and the most cost-effective option identified (that is, the one with the highest net benefit), at a threshold of £20,000 and £30,000 per QALY gained. The results of the probabilistic analysis are summarised in terms of mean costs, mean QALYs and mean net benefit for each treatment option, where each is the average of the 5000 simulated estimates. The option with the highest mean net benefit (averaged across the 5000 simulations) is the most cost-effective at the specified threshold. The percentage of simulations where each strategy was the most cost-effective gives an indication of the strength of evidence in favour of that strategy being cost-effective.

Results are also presented on the cost-effectiveness plane where the difference in mean costs and the difference in mean QALYs between treatment options are plotted. All differences are calculated relative to LABA+ICS and so LABA+ICS is always at the origin of the cost-effectiveness plane. Results could have equally been presented with differences calculated relative to LAMA or triple therapy. This would make no difference to the cost effectiveness results it would simply mean that the axis would move so that a different treatment option is at zero. Comparisons not ruled out by dominance or extended dominance are joined by a line on the graph where the slope represents the incremental cost-effectiveness ratio, the magnitude of which is labelled.

> Results

Detailed results are presented over the next few pages for the basecase scenario and various sensitivity analyses including the alternative treatment effect analyses. All results are means from the probabilistic analysis unless otherwise specified.

Basecase analysis – exacerbation effect only

In the basecase analysis only exacerbations (non-hospitalised and hospitalised) varied between treatment options. A four-year treatment period was considered. Three analyses were undertaken using different pairs of clinical trials to calculate relative treatment effects.

The results of these analyses are presented in Table 12 and Figure 4. A break down of costs is presented in Table 13. LAMA or LABA+ICS was found to be the most cost-effective strategy depending on the clinical trial data used to calculate relative treatment effects.

When INSPIRE and UPLIFT subgroup data were used, LAMA was found to be the most cost-effective option. Triple therapy was the most effective (that is it had the highest number of QALYs) but had a high ICER when compared with LAMA at £187,697 per QALY gained. LABA+ICS was more effective than LAMA (higher QALYs) but also with higher costs and was ruled out by extended dominance. LAMA was the optimal strategy at a threshold of £20,000 per QALY gained in 84% of simulations, LABA+ICS in 16% and triple therapy in 0%. When INSPIRE and OPTIMAL data were used instead results were similar although the ICER for triple therapy compared to LABA+ICS was lower at £93,737 per QALY gained.

When UPLIFT subgroup and OPTIMAL data were used LABA+ICS was found to be the most cost-effective option. LAMA was ruled out by dominance – it was more expensive with lower QALYs than LABA+ICS. Triple therapy was the most effective (that is, it had the highest number of QALYs) but had a high ICER when compared with LABA+ICS at £159,353 per QALY gained. LABA+ICS was the optimal strategy at a threshold of £20,000/QALY in 92% of simulations, LAMA in 8% and triple therapy in 0%.

The results indicate fairly low uncertainty within individual analyses. However, the fact that between analyses there is a disagreement about the most cost-effective option indicates considerable uncertainty based on the available clinical evidence.

Table 12: Basecase results (exacerbation effect only; 4 years)

	Mean Cost	Mean QALYs	Net benefit* (threshold= £20,000 per QALY)	Probability that strategy is most cost-effective (threshold= £20,000 per QALY)	Net benefit* (threshold= £30,000 per QALY)	Probability that strategy is most cost-effective (threshold= £30,000 per QALY)
1. INSPIRE, UPLIFT data						
LABA+ICS	£5296	2.350	£41,709	16%	£65,211	17%
LAMA	£4896	2.349	£42,087	84%	£65,579	83%
Triple	£6426	2.357	£40,721	0%	£64,294	0%
2. INSPIRE, OPTIMAL data						
LABA+ICS	£5296	2.350	£41,709	15%	£65,211	16%
LAMA	£4896	2.349	£42,087	84%	£65,579	81%
Triple	£5764	2.358	£41,405	1%	£64,989	3%
3. UPLIFT, OPTIMAL data						
LABA+ICS	£5296	2.350	£41,709	92%	£65,211	92%
LAMA	£6260	2.345	£40,643	8%	£64,094	8%
Triple	£6426	2.357	£40,721	0%	£64,294	0%

*Highest net benefit = most cost effective option at stated threshold

Figure 4: Basecase results on the cost-effectiveness plane (exacerbation effect only; 4 years)

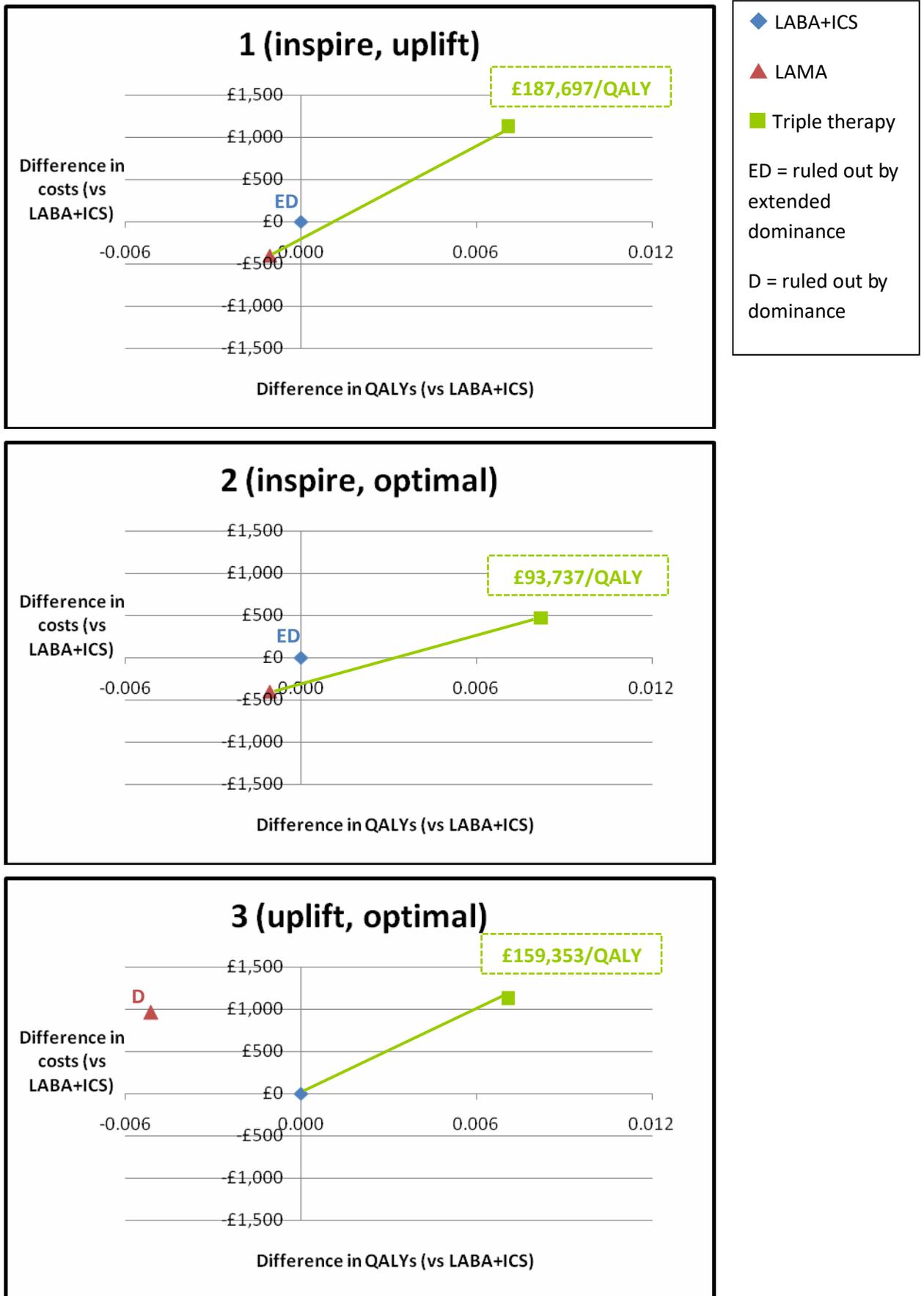


Table 13: Basecase cost breakdown (exacerbations effect only; 4 years) – totals for a cohort of 1000 people (deterministic analysis)

	Exacerbations			Cost of treating exacerbations				COPD maintenance cost	Total cost	
	Total	<i>Non-hospitalised</i>	<i>Hospitalised</i>	Drug costs (intervention)	Total	<i>Non-hospitalised</i>	<i>Hospitalised</i>		Undiscounted	Discounted
1. INSPIRE, UPLIFT data										
LABA+ICS	4161	3370	791	£1,753,181	£2,015,084	£114,403	£1,900,681	£1,866,173	£5,634,438	£5,364,238
LAMA	4286	3551	735	£1,417,488	£1,888,152	£120,519	£1,767,633	£1,866,173	£5,171,814	£4,923,524
Triple	3537	2833	704	£3,170,669	£1,787,775	£96,169	£1,691,606	£1,866,173	£6,824,617	£6,498,454
2. INSPIRE, OPTIMAL data										
LABA+ICS	4161	3370	791	£1,753,181	£2,015,084	£114,403	£1,900,681	£1,866,173	£5,634,438	£5,364,238
LAMA	4286	3551	735	£1,417,488	£1,888,152	£120,519	£1,767,633	£1,866,173	£5,171,814	£4,923,524
Triple	3643	3253	390	£3,170,669	£1,047,273	£110,427	£936,846	£1,866,173	£6,084,115	£5,793,414
3. UPLIFT, OPTIMAL data										
LABA+ICS	4161	3370	791	£1,753,181	£2,015,084	£114,403	£1,900,681	£1,866,173	£5,634,438	£5,364,238
LAMA	4149	2832	1317	£1,417,488	£3,263,358	£96,122	£3,167,235	£1,866,173	£6,547,019	£6,232,870
Triple	3537	2833	704	£3,170,669	£1,787,775	£96,169	£1,691,606	£1,866,173	£6,824,617	£6,498,454

Sensitivity analyses

Alternative analysis one – exacerbation and stable quality of life effects

In this alternative analysis stable utility is differentially impacted between comparators as well as exacerbations. As in the basecase a four-year treatment period was considered and three analyses were undertaken using different pairs of clinical trials to calculate relative treatment effects.

Results of these analyses are presented in Table 14 and Figure 5. Triple therapy was found to be the most effective (highest number of QALYs) and most cost-effective strategy irrespective of the clinical trial data used to calculate relative treatment effects. LABA+ICS was found to be the next most effective and cost-effective option also irrespective of clinical data used. LAMA was less effective but also less expensive than LABA+ICS, except for when the data pair of UPLIFT and OPTIMAL was used and it was dominated. The ICER for triple therapy compared to LABA+ICS was in the range £7000 to £15,000 depending on the clinical trial data pair used. At a threshold of £20,000 per QALY gained, triple therapy was optimal in 71% to 76% of simulations, LABA+ICS was optimal in the majority of the remaining simulations and LAMA was very rarely optimal.

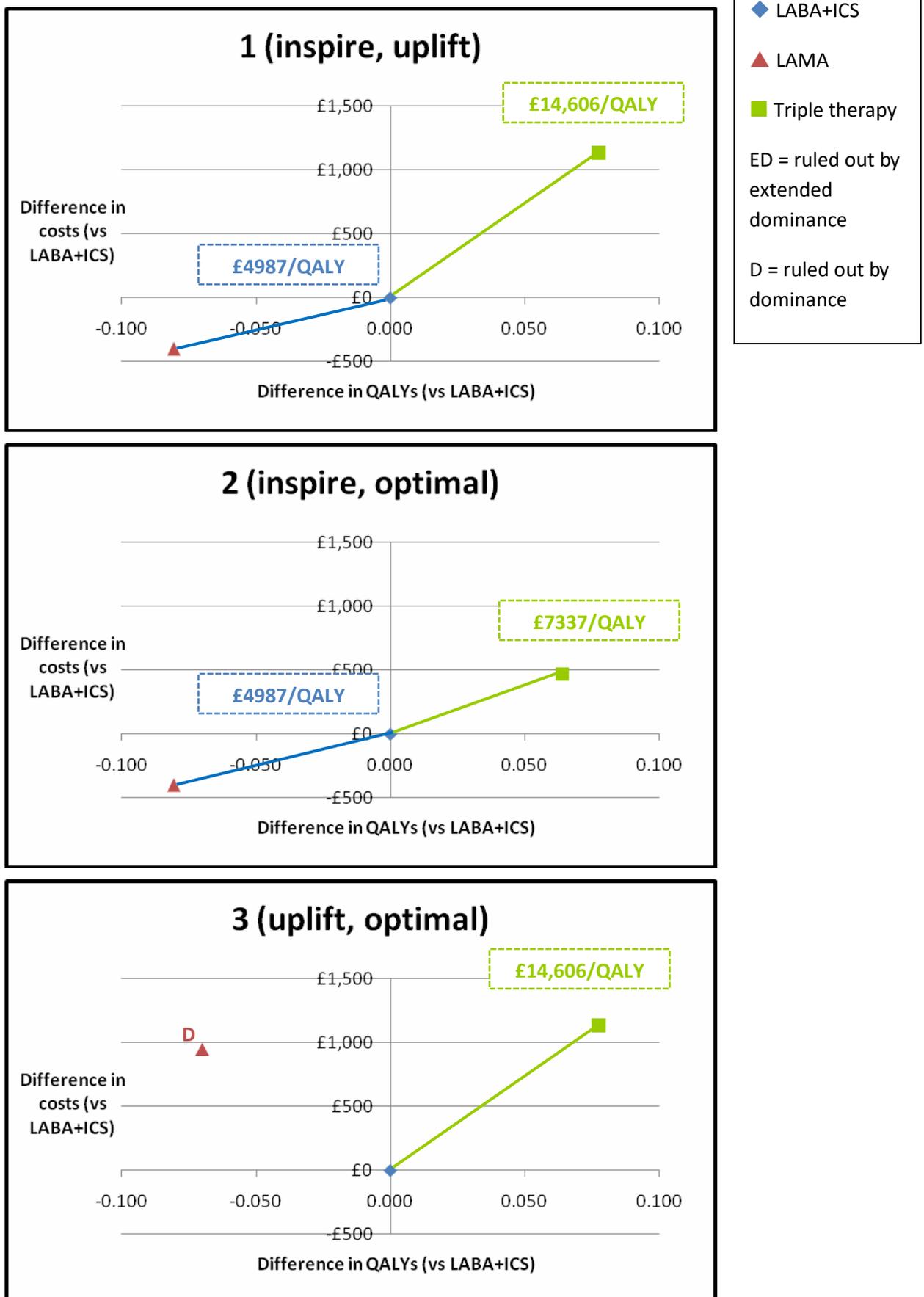
In this sensitivity analysis there was fairly low uncertainty within and between analyses that triple therapy is the optimal strategy. That is it provided the greatest health gain at an acceptable cost.

Table 14: Alternative analysis 1 results (exacerbation and stable quality of life effects; 4 years)

	Mean Cost	Mean QALYs	Net benefit* (threshold= £20,000 per QALY)	Probability that strategy is most cost-effective (threshold= £20,000 per QALY)	Net benefit* (threshold= £30,000 per QALY)	Probability that strategy is most cost-effective (threshold= £30,000 per QALY)
1. INSPIRE, UPLIFT data						
LABA+ICS	£5298	2.349	£41,688	21%	£65,180	6%
LAMA	£4895	2.268	£40,475	4%	£63,160	1%
Triple	£6429	2.427	£42,105	76%	£66,373	93%
2. INSPIRE, OPTIMAL data						
LABA+ICS	£5298	2.349	£41,688	29%	£65,180	25%
LAMA	£4895	2.268	£40,475	0%	£63,160	0%
Triple	£5766	2.413	£42,496	71%	£66,628	75%
3. UPLIFT, OPTIMAL data						
LABA+ICS	£5298	2.349	£41,688	22%	£65,180	6%
LAMA	£6244	2.279	£39,340	2%	£62,131	1%
Triple	£6429	2.427	£42,105	76%	£66,373	93%

*Highest net benefit = most cost effective option at stated threshold

Figure 5: Alternative analysis 1 results on the cost-effectiveness plane (exacerbation and stable quality of life effects; 4 years)



Alternative analysis two – exacerbations and mortality effects

In this second alternative analysis mortality is differentially impacted between comparators as well as exacerbations. As in the basecase a four-year treatment period was considered and three analyses were undertaken using different pairs of clinical trials to calculate relative treatment effects.

Results of these analyses are presented in Table 15 and Figure 6.

When INSPIRE and UPLIFT subgroup data were used LABA+ICS was the the most cost-effective option. LAMA was less effective but also with lower costs. The ICER for LABA+ICS versus LAMA was low at £4302. Triple therapy was the most effective (that is it had the highest number of QALYs) but had an ICER of £40,722 when compared to the next most effective strategy, LABA+ICS, and so was not considered cost-effective. LABA+ICS was the optimal strategy at a threshold of £20,000 per QALY gained in 89% of simulations, LAMA in 4% and triple therapy in 7%.

When INSPIRE and OPTIMAL data were used instead results were quite different. LABA+ICS was still the most cost-effective option but was now also the most effective option (highest QALYs). LAMA was again less effective and with lower costs than LABA+ICS, and the ICER for LABA+ICS vs LAMA was low. Triple therapy was however now dominated by LAMA as it was less effective (lower QALYs) with higher costs. LABA+ICS was the optimal strategy at a threshold of £20,000 per QALY gained in 92% of simulations, LAMA in 3% and triple therapy in 5%.

When UPLIFT subgroup and OPTIMAL data were used results were again different. LAMA was now the most effective (that is it had the highest number of QALYs) and cost-effective option. LABA+ICS was less effective and less costly than LAMA and triple therapy was ruled out by extended dominance. The ICER for LAMA versus LABA+ICS was £15,566. LAMA was the optimal strategy in 64% of simulations, LABA+ICS in 34% and triple therapy in 2%.

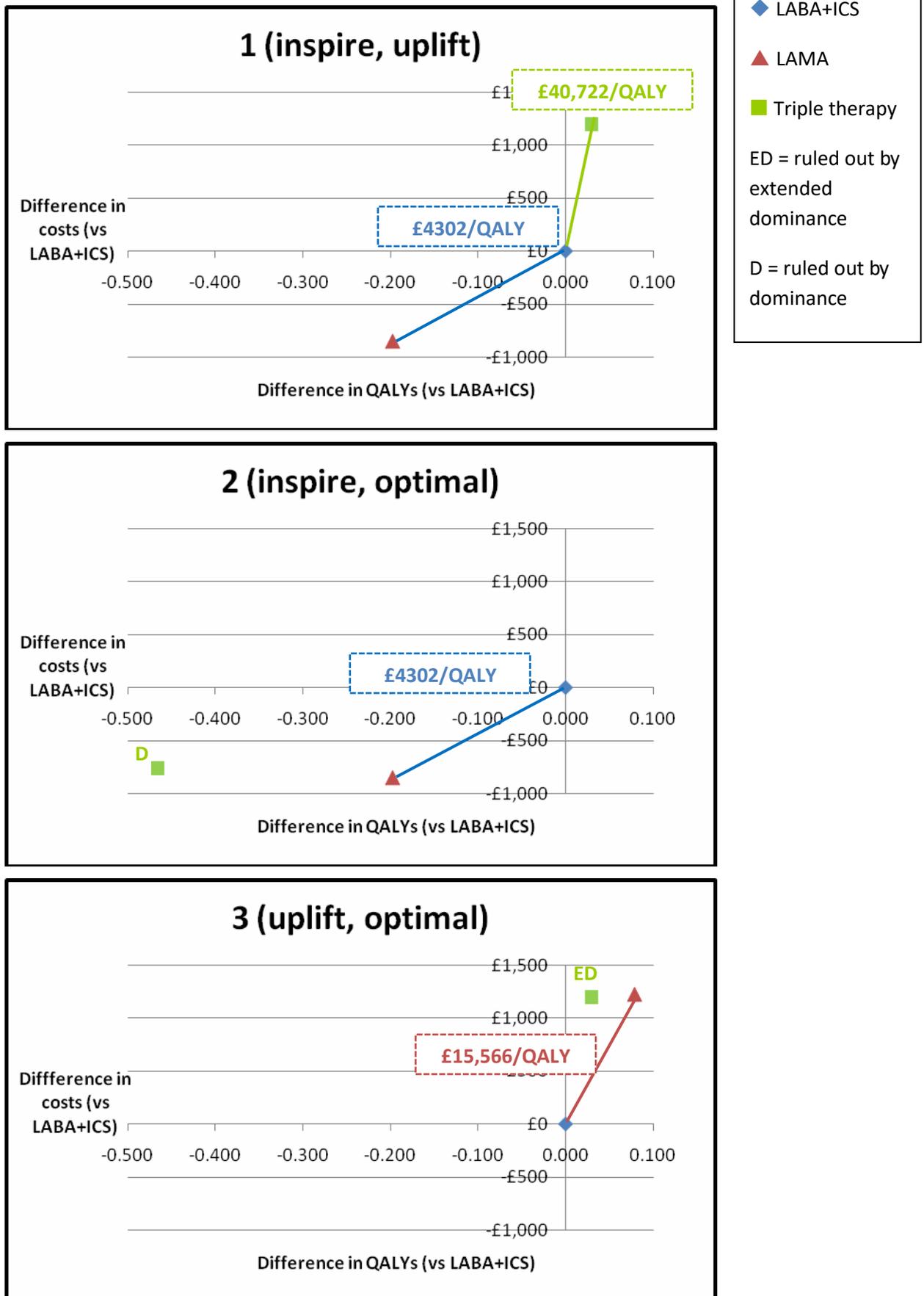
Results indicate fairly low uncertainty within individual analyses. However, there are considerable differences between results based on difference clinical data indicating high uncertainty in this sensitivity analysis.

Table 15: Alternative analysis 2 results (exacerbation and mortality effects; 4 years)

	Mean Cost	Mean QALYs	Net benefit* (threshold= £20,000 per QALY)	Probability that strategy is most cost-effective (threshold= £20,000 per QALY)	Net benefit* (threshold= £30,000 per QALY)	Probability that strategy is most cost-effective (threshold= £30,000 per QALY)
1. INSPIRE, UPLIFT data						
LABA+ICS	£5293	2.350	£41,714	89%	£65,218	66%
LAMA	£4443	2.153	£38,614	4%	£60,142	2%
Triple	£6491	2.380	£41,104	7%	£64,902	31%
2. INSPIRE, OPTIMAL data						
LABA+ICS	£5293	2.350	£41,714	92%	£65,218	93%
LAMA	£4443	2.153	£38,614	3%	£60,142	2%
Triple	£4531	1.885	£33,166	5%	£52,014	5%
3. UPLIFT, OPTIMAL data						
LABA+ICS	£5293	2.350	£41,714	34%	£65,218	22%
LAMA	£6519	2.429	£42,064	64%	£66,355	69%
Triple	£6491	2.380	£41,104	2%	£64,902	8%

*Highest net benefit = most cost effective option at stated threshold

Figure 6: Alternative analysis 2 results on the cost-effectiveness plane (exacerbation and mortality effects; 4 years)



Time horizon

Sensitivity analysis explored the impact of the time horizon on results. The time horizon did not greatly impact results for the base case analysis or the first alternative analysis described above and conclusions remained the same. There was a small decrease in the magnitude of the ICERs as the time horizon increased.

The time horizon had a greater impact in the second alternative analysis where a treatment effect on mortality was incorporated. Results for this analysis for a 1 year, 4 year and lifetime analysis are summarised in Table 16.

In the 4-year analysis of option 1, LABA+ICS was the most cost-effective option; triple therapy had the highest QALY but was not cost-effective. However when this 4-year treatment period was extrapolated to a lifetime impact triple became a cost-effective option.

In the 4-year analysis of option 3, LAMA was the most effective option (highest QALYs) and the most cost-effective option. When the time horizon was reduced to 1 year LAMA was still the most effective but was no longer the most cost-effective and LABA+ICS was.

Table 16: Time horizon sensitivity analysis: alternative analysis 2 results (exacerbation and mortality effects)

	1 (inspire, uplift):			2 (inspire, optimal):			3 (uplift, optimal):		
	Cost	QALYs	Probability that strategy is most cost-effective (threshold= £20,000 per QALY)	Cost	QALYs	Probability that strategy is most cost-effective (threshold= £20,000 per QALY)	Cost	QALYs	Probability that strategy is most cost-effective (threshold= £20,000 per QALY)
1 year									
LABA+ICS	£1,483	0.681	79%	£1,483	0.681	78%	£1,483	0.681	75%
LAMA	£1,337	0.666	21%	£1,337	0.666	20%	£1,770	0.685	25%
Triple	£1,815	0.684	0%	£1,520	0.642	2%	£1,815	0.684	0%
4 years									
LABA+ICS	£5,293	2.350	89%	£5,293	2.350	92%	£5,293	2.350	34%
LAMA	£4,443	2.153	4%	£4,443	2.153	3%	£6,519	2.429	64%
Triple	£6,491	2.380	7%	£4,531	1.885	5%	£6,491	2.380	2%
Lifetime (4-years differential treatment period with lifetime extrapolation)*									
LABA+ICS	£11,788	4.972	38%	£11,788	4.972	93%	£11,788	4.972	11%
LAMA	£9,729	4.311	1%	£9,729	4.311	2%	£13,590	5.267	75%
Triple	£13,133	5.057	61%	£8,470	3.509	6%	£13,133	5.057	14%
Lifetime (lifetime differential treatment period)*									
LABA+ICS	£11,772	4.965	34%	£11,772	4.965	92%	£11,772	4.965	9%
LAMA	£7,976	3.751	1%	£7,976	3.751	1%	£18,431	6.293	76%
Triple	£14,845	5.197	65%	£7,449	3.026	6%	£14,845	5.197	15%

*Minor discrepancies in LABA+ICS figures between the two lifetime analyses are due to them being generated by different runs of the probabilistic model.

Exacerbation rate

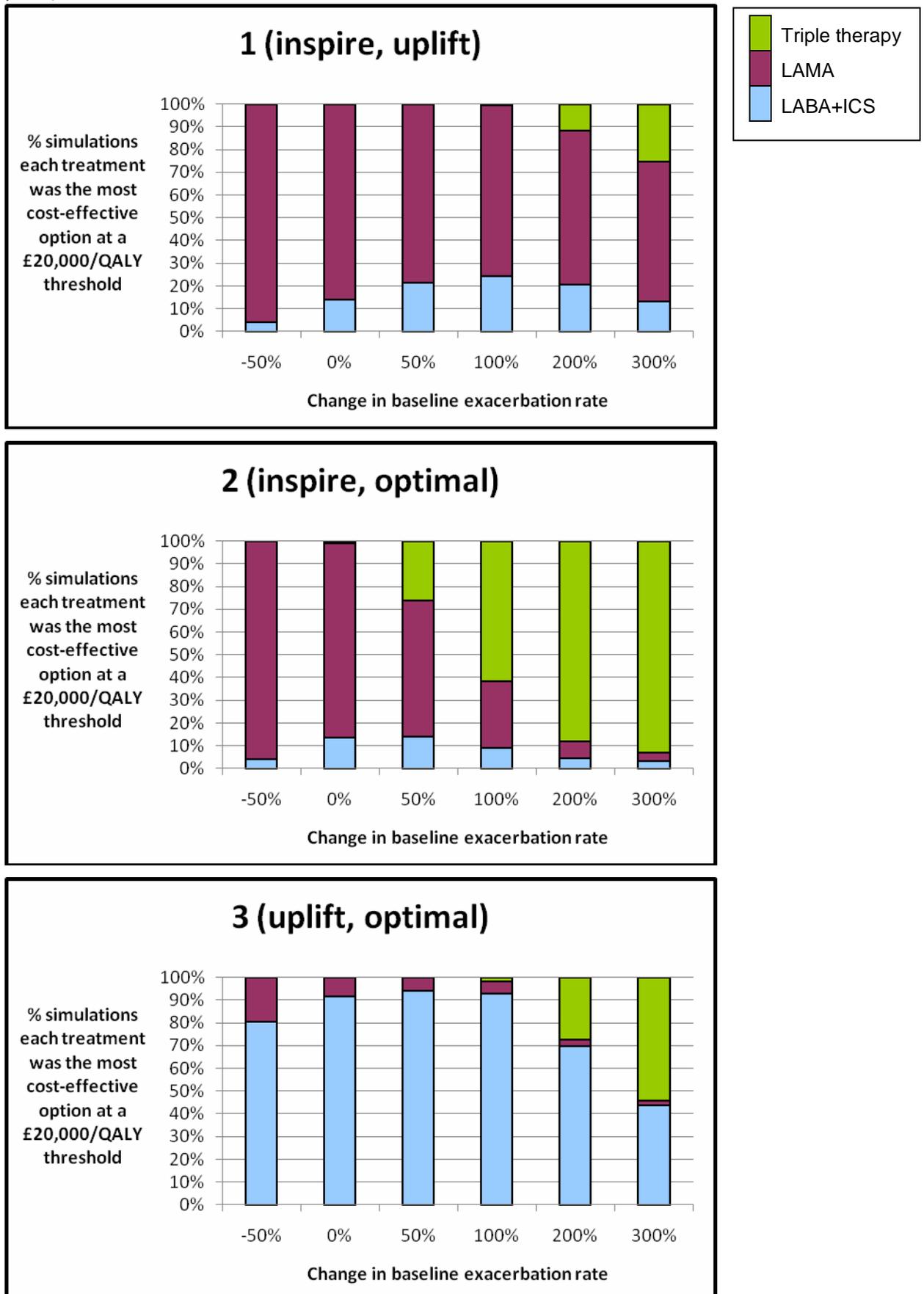
A sensitivity analysis was undertaken to look at the impact of varying the baseline exacerbation rate on the basecase analysis. Rates were varied by a factor of -50% to +300% – the resulting baseline exacerbation rates used in the sensitivity analysis are presented in Table 17. Results are presented in Figure 7. We found that as the exacerbation rate increases so the percentage of simulations where triple therapy was optimal increased.

Table 17: Exacerbation rates used in sensitivity analysis

Change from baseline exacerbation rate	COPD stage	Exacacerbations/ year	Hospitalisations/ year
-50%	Severe	0.46	0.09
	Very severe	0.77	0.15
0% (baseline)	Severe	0.91	0.17
	Very severe	1.54	0.29
100%	Severe	1.82	0.35
	Very severe	3.08	0.59
200%	Severe	2.73	0.52
	Very severe	4.62	0.88
300%	Severe	3.64	0.69
	Very severe	6.16	1.17

Severe = FEV₁ 30% to <50% predicted; Very severe = FEV₁ <30% predicted

Figure 7: Exacerbation rate sensitivity analysis: basecase analysis (exacerbation effect only; 4 years)



Cost of non-hospitalised exacerbations

Sensitivity analysis around the cost of a non-hospitalised exacerbation was undertaken due to uncertainty about the cost being too low. In one analysis the cost was doubled from £34 to £68. This had very little impact on the basecase analysis results.

A threshold analysis was also undertaken (using the deterministic analysis) to see at what cost of a non-hospitalised exacerbation would triple therapy become the favoured option (i.e. with an ICER of under £20,000/QALY) in the basecase analysis. The result was that triple therapy was cost-effective only when the cost of treating a non-hospitalised exacerbation was assumed to be around £2000 or higher. The exact threshold varied depending on the clinical trial data pair used.

> Discussion

Summary and GDG interpretation

The aim of this analysis was to evaluate which was the most cost-effective option from LABA+ICS, LAMA and triple therapy for initial management of people with COPD and an FEV₁ <50%.

The base case analysis, which is driven by differences in exacerbations between treatments, found that LABA+ICS or LAMA was the most cost-effective option depending on which clinical data was used to inform the differences between treatments. Triple therapy was the most effective option (highest QALYs) but was not cost-effective. The GDG considered this analysis to be the most robust in terms of the available data. However, it was also considered likely to be conservative in terms of the benefits of treatment and may underestimate the value of triple therapy. The fact that either LABA+ICS or LAMA was the favoured option depending on the clinical data used in the analysis highlights an inconsistency in the clinical data but one that could not be resolved and so therefore was considered to represent an uncertainty over the preferred option.

In the sensitivity analysis which also incorporates a difference between treatments in terms of stable utility (quality of life), triple therapy was found to be the most effective (highest QALYs) and the most cost-effective option, irrespective of which clinical data was used to inform the differences between treatments. The GDG considered that a scenario where treatment impacted utility due to stable symptom improvement as well as exacerbations to be a realistic one but given the limitations of the estimate of treatment effect on stable utility they interpreted the results with caution.

A sensitivity analysis that looked at the impact of exacerbation rates found that as the baseline exacerbation rate increased so did the probability that triple therapy was cost-effective.

In the sensitivity analysis where a treatment effect in terms of mortality was incorporated, results varied greatly depending on the clinical data used and were sensitive to the time horizon taken. This reflected considerable inconsistency in the clinical data for this outcome.

The GDG concluded that this result was difficult to interpret and it was not used to inform decision making.

Limitations

The availability of utility data to inform the estimation of QALYs was somewhat limited. EQ-5D utility data was identified for the initial impact of hospitalised and non-hospitalised exacerbations. Mapping of SGRQ data to EQ-5D utility was used to supplement this where necessary. GDG members indicated that they were aware of problems with mapping SGRQ to EQ-5D and were generally not in favour of an approach that primarily based QALY impact on this. For this reason, in the base case analysis we attributed a QALY loss to hospitalised and non-hospitalised exacerbations, which minimised the reliance on mapped data. This lack of direct utility data impacts most analyses in the area of COPD. A notable exception being a cost-utility analysis using patient level TORCH data where EQ5D utility data was collected at various time points throughout the trial and so could be used as a basis for QALY calculations.

In the model we assumed that an exacerbation impacted a patient (to a diminishing extent) for 3 months but then stable utility will return to the same level as prior to the exacerbation. The GDG noted that there is evidence that exacerbations may permanently impact quality of life and this assumption is likely to be somewhat conservative. It was however accepted as a reasonable simplification for modelling purposes.

As described in the model input section, there was discussion regarding whether the cost of a non-hospitalised exacerbation identified in the literature was too low. Sensitivity analysis showed however that the model was not especially sensitive to the cost of a non-hospitalised exacerbation and this uncertainty was therefore not considered a major limitation.

Note that other more minor data limitations were discussed throughout the model inputs section.

Conclusions

The GDG considered that while triple therapy was potentially effective and cost-effective, the evidence was not strong enough to warrant a recommendation that all patients with an FEV₁ <50% be routinely started on triple therapy. Triple therapy was instead recommended if symptoms or exacerbations persisted. They noted that triple therapy was most likely to be cost-effective in patients who will obtain a benefit in terms of exacerbation reduction and symptom relief.

25 Appendix N NEW 2010 COPD update GDG declarations of interest register

GDG declarations of Interest Register

GDG MEMBER	Declarations of Interest
Margaret Barnard	
24/08/2008	I have COPD
Graham Burns	
07.08.08 x1 GDG deputy	I have received fees for delivering educational lectures to respiratory specialists, GPs and nurses from a number of companies: Passtest BMJ, TEVA, GSK, AZ, Pfizer and Boehringer-Ingelheim. I received subsistence (hotel/food) from Boehringer-Ingelheim allowing me to attend the British Thoracic Society summer meeting in York (June 2008). GSK and MSD have supported meetings of the North of England Thoracic Society in the form of unrestricted educational grants.
Peter Calverley	
28.08-08	In the last 12 months I have attended one advisory board for AstraZeneca to consider future drug treatments in COPD, one for Daxas to review progress on an unlicensed therapy in development and one for Roche to design a study for testing retinoids in emphysema. I have agreed to be the UK principal investigator for a study comparing inhaled corticosteroids plus bronchodilators with bronchodilators alone which is supported by Boehringer-Ingelheim. I have led a research team supported by Chiesi comparing long-acting beta-agonists with and without inhaled corticosteroids. This project ends this autumn. I have spoken at 3 meetings (one UK, 2 overseas) about current drug treatment, all supported by GSK. I do not have any regular paid employment by any party other than the University of Liverpool and I hold no shares or other pecuniary interests in the pharmaceutical or medical suppliers industries. My department currently receives funds from GSK to conduct a non-commercial prospective study evaluating the phenotypic differences in COPD. This supports a medical research fellows salary. At present we do not receive funding from any other pharmaceutical or company source.
Barbara Foggo	
22.04.09 x1 GDG deputy	Dec 08 - GSK One-day Nurse Advisory Board for pulmonary arterial hypertension. Dec 08 - Pfizer one-hour talk on sildenafil/congenital heart disease associated pulmonary arterial hypertension. Honorariums paid.

Kevin Gruffydd Jones	
25.07.08	In the last 12 months I have carried out advisory work and educational talks for the following pharmaceutical companies; Astra Zeneca, Glaxo Smith Kline, Boehringer Ingelheim, Galen, MSD, Novartis, Trinita Chiesi. My practice has carried out commercial trial work for Astra Zeneca, Boehringer Ingelheim (cardiovascular drug), Servier (vaccine). I have been sponsored by Astra Zeneca and Boehringer Ingelheim to attend the International Primary Care Respiratory Congress and European Respiratory Congress respectively. Astra Zeneca have provided a research grant for a study to validate the Asthma Control questionnaire in Children (no direct product involvement). I am a member of the British Thoracic Society and General Practice Airways Group.
Erica Haines	
12.1.09 x1GDG deputy	Attended ATS conference in May 2008 on GPIAG respiratory leaders programme sponsored by GSK. Attended speaker meetings in current role for AstraZeneca and BPIAG. Attended Novartis Head Office in Basel Switzerland as Advisory Board Member (November 2008). Currently working with GSK to develop 10 roadshows across the UK about asthma management. Starts next week.
David Halpin (Invited expert)	
23.7.08	I have received sponsorship to attend international meetings, and honoraria for lecturing, attending advisory boards and preparing educational materials from Altana, AstraZeneca, GlaxoSmithKline and Boehringer Ingelheim. I am the principle investigator of study of the efficacy of health forecasting which is being funded by AstraZeneca.
Karen Heslop	
Date? 2008	I provide consultancy for training in psychological management of anxiety and depression, which is common in COPD. Consultancy fees have been received in the last 12 months. I also provide non-promotional training for COPD management e.g. to practice nurses on behalf of the pharmaceutical industry. I have received travel fellowships from GSK in May to attend the American Thoracic Society meeting.
24.06.09	Boehringer Ingelheim - consultancy work for workshop on CBT in COPD; Astra Zeneca - consultancy fee for workshop on CBT.
16.9.09	Presentation on CBT in COPD for GSK on 11.9.09. Presentation on oxygen guidelines and inhaler workshop on 23.9.09 for AZ
Kevin Holton	
07.01.09 x1 GDG	NONE

Melvyn Jones		
	22.05.09	The practice has joined Assura GP co, which will potentially benefit from primary care commissioned services. As yet no services have been commissioned. I work for UCL as a senior lecturer. This organisation I suspect receives grant income from the health sector, but I have no direct involvement or benefits from this. I have published a letter in the BMJ which was critical of implementation of a NICE guideline (<i>Mannan R, Jones M. What's the evidence that NICE guidance has been implemented? Maybe NICE Needs to do more to ensure implementation of guidelines. BMJ 2005;330:1085</i>)
	10.12.08	Family member is a consultant radiologist who reports CT scans for the GSK emphysema trial, but she has no financial or academic involvement in the trial
Katherine Leach		
	8.10.08	NONE
Christine Loveridge		
	24.10.08	I regularly speak or take part in advisory boards for the following companies as part of my role in education for health and in recognition of my experience on a personal level. They include GSK, AZ, Teva, Boehringer Ingelheim, Pfizer. Education for Health as a not for profit charity work with the healthcare industry in an advisory and educational capacity. These include GSK, AZ, Teva, Trinity Chieri, Boehringer Ingelheim, Pfizer.
Phyo Kyan Myint		
	17.10.08	NONE
John O'Reilly		
	05.08.08	NONE
	19.09.08	I have received honoraria for lectures at educational meetings from Boehringer Ingelheim, TEVA, GSK, AstraZeneca, Cephalon, UCB, Respiroics prior to September 2007. I have subsequently received support for travel and accommodation to attend educational conferences but not honoraria or other payments for COPD-related meetings.
Fiona Phillips		
	12.07.09 x2 GDGs	NONE

COPD (update)

Michael Rudolf	
31.07.08	I have received support for travel and accommodation to attend international meetings from Boehringer Ingelheim and TEVA. I have received payment for chairing/speaking at educational meetings sponsored by AstraZeneca, GSK, Pfizer, Novartis, MSD, Boehringer Ingelheim & TEVA. My department has received financial support for running departmental meetings from AstraZeneca and TEVA. From 1997-2004 I was chairman of the BTS COPD Consortium which helped to raise awareness of COPD and played a major role in implementing both the BTSCOPD Guidelines and the NICE COPD Guidelines.
Sally Singh	
07.08.08	NONE
Jadwiga Wedzicha	
9.08.08	In the past 12 months I have received honoraria for lectures or participation in advisory boards from the following pharmaceutical companies: Novartis, Kyorin Japan, GSK, AstraZeneca, Wyeth, Boehringer Ingelheim. Grant from GSK for ECLIPSE cohort study - approx £500,000 over 4 years from 2006-2010. Grant from AstraZeneca for study of susceptibility to COPD exacerbation - approx £225,000 from 2007-2009.

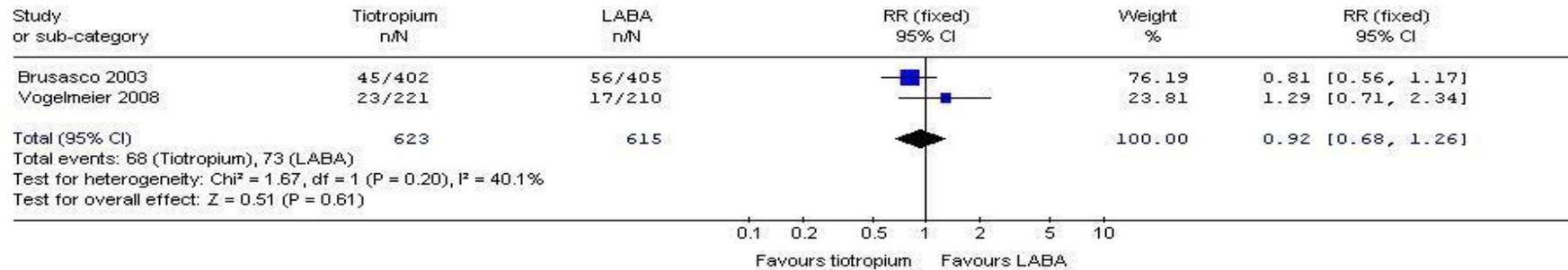
26 Appendix O NEW 2010 COPD update forest plots

From section 7.3.4 Long-acting anticholinergics (long-acting muscarinic antagonists or LAMA)

LAMA versus LABA

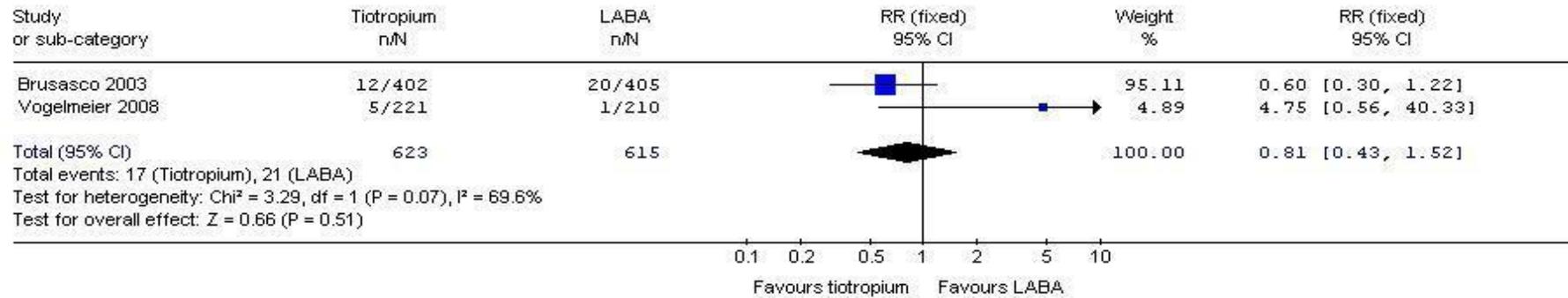
Number of people with COPD exacerbations requiring additional therapy

Review: DRUG 1: LABA vs LAMA
 Comparison: 01 tiotropium versus LABA
 Outcome: 01 COPD Exacerbations requiring treatment



Number of people with COPD exacerbations requiring hospitalisation

Review: DRUG 1: LABA vs LAMA
 Comparison: 01 tiotropium versus LABA
 Outcome: 02 COPD exacerbations requiring hospitalisation

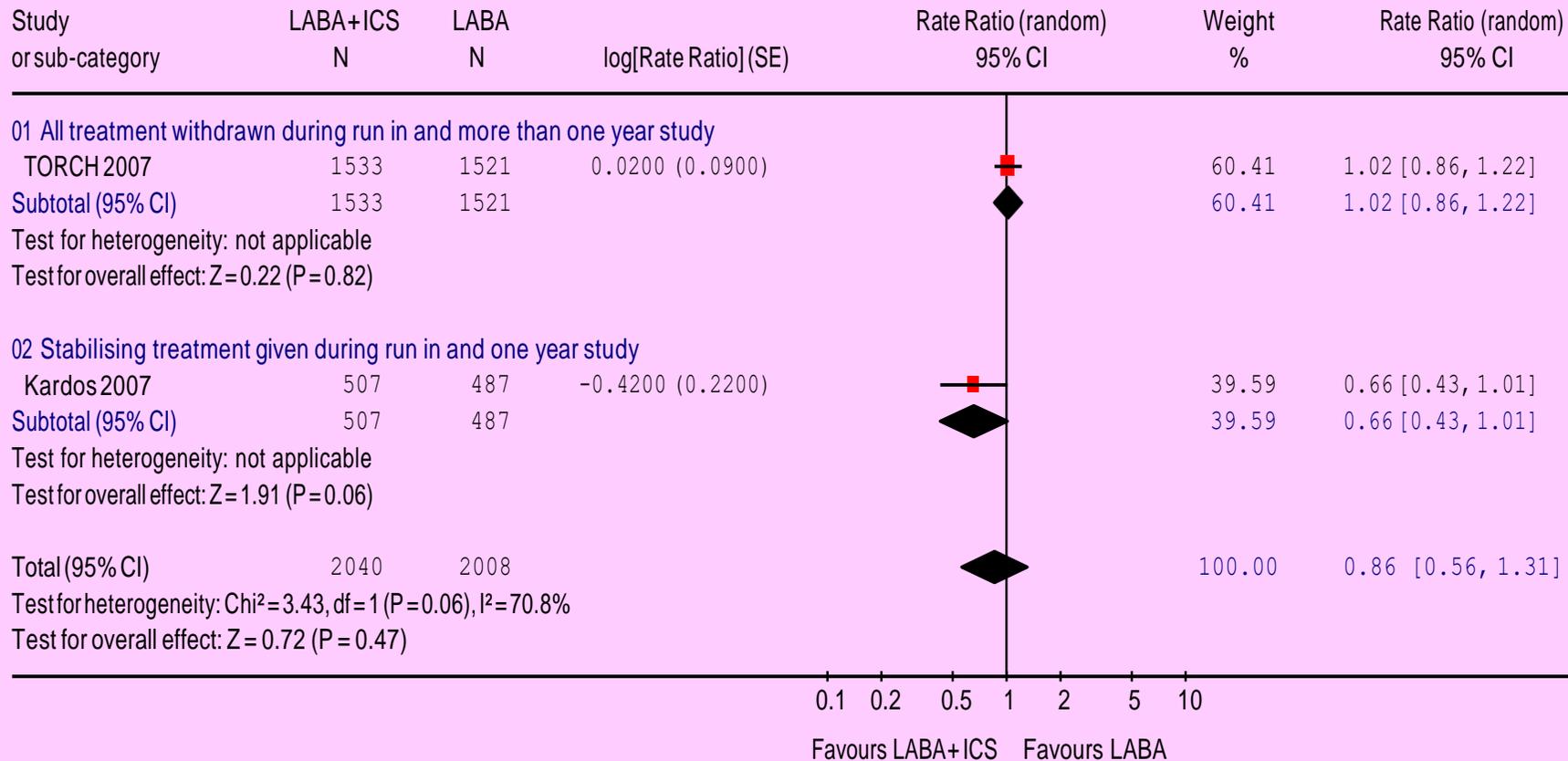


From section 7.3.6.1 Long-acting beta₂ agonists (LABA) and inhaled corticosteroids (ICS)

Drug 3a LABA + ICS versus LABA

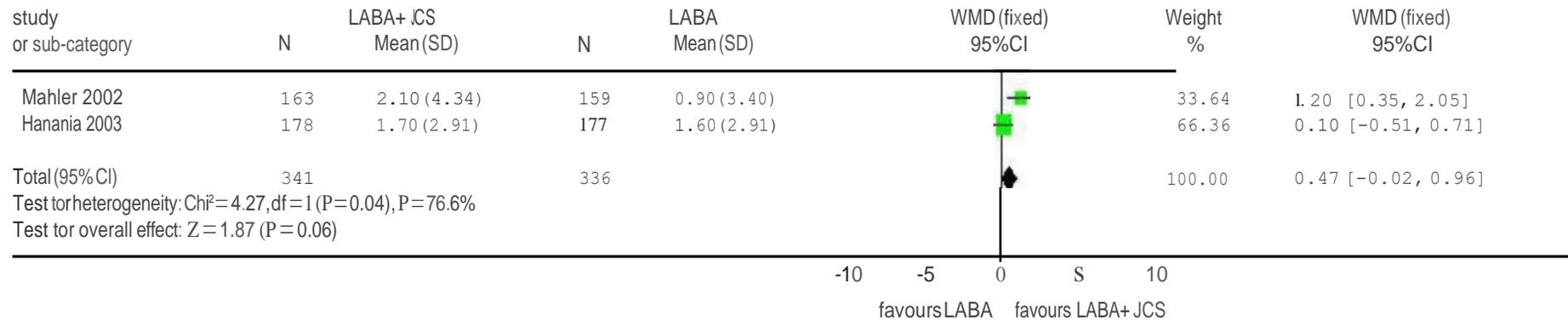
Exacerbations requiring hospitalisation

Review: Drug 3a: LABA + ICS vs. LABA (Cochrane) (latest 300309)
 Comparison: 01 LABA + ICS vs. LABA
 Outcome: 07 Exacerbations requiring hospitalisation



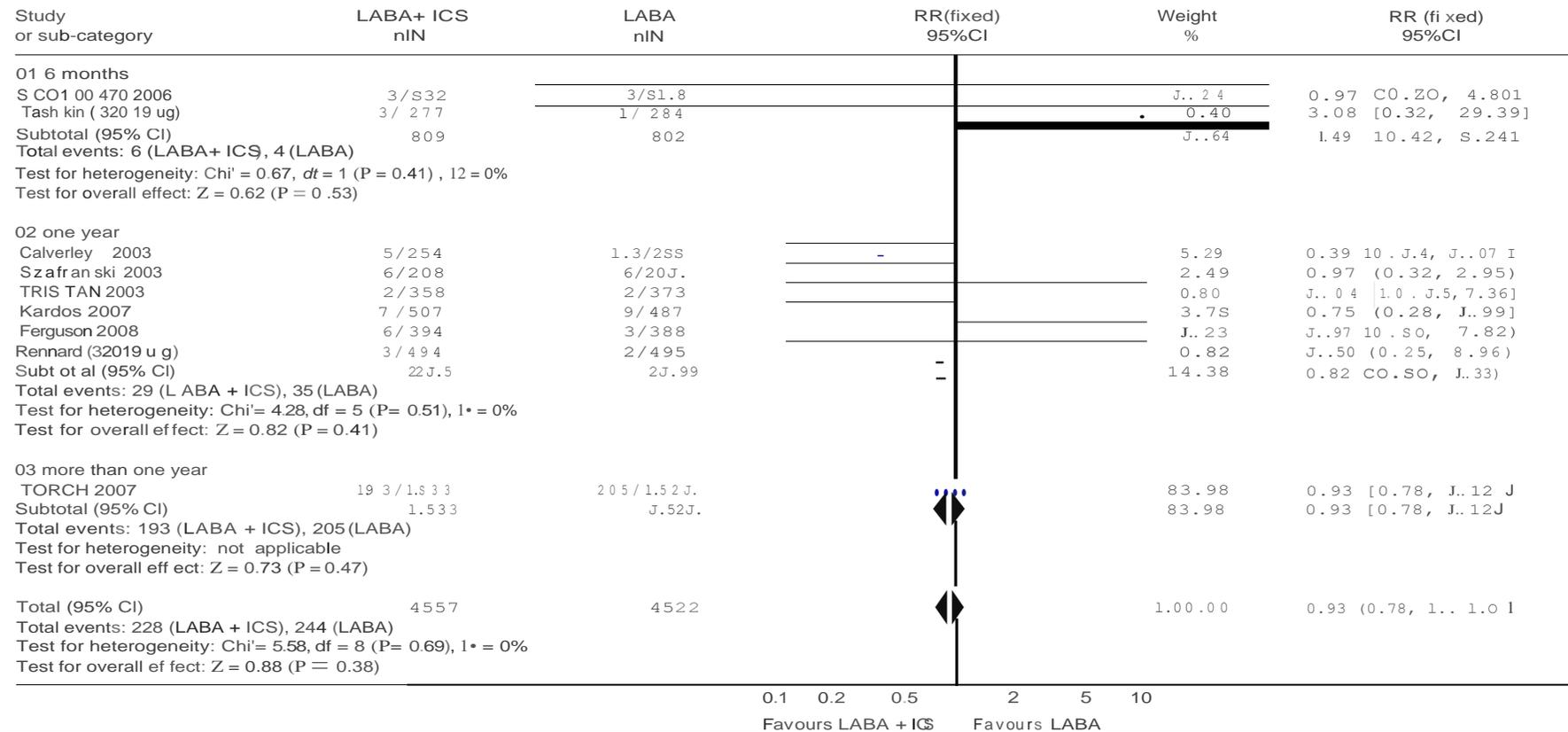
Change from baseline in breathlessness score (TDI)

Review: Drug 3a: LABA+ ICS vs. LABA (Cochrane) (130809)
 Comparison: 01 LABA+ ICS vs. LABA
 Outcome: 09 Change from baseline in TOI



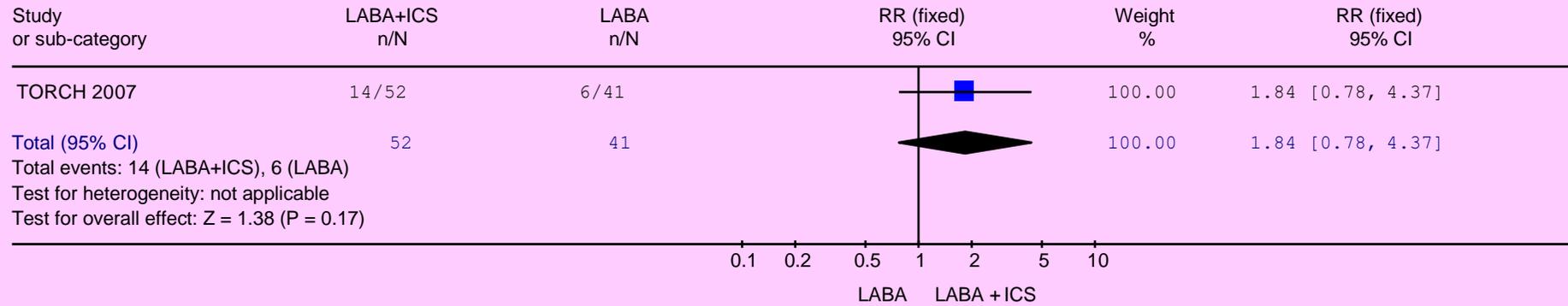
Mortality

Review: Drug 3a: LABA+ ICSvs. LABA (Cochrane) (130809)
 Comparison: 01 LABA + ICS vs. LABA
 Outcome: 12 Mortality - duration of study split



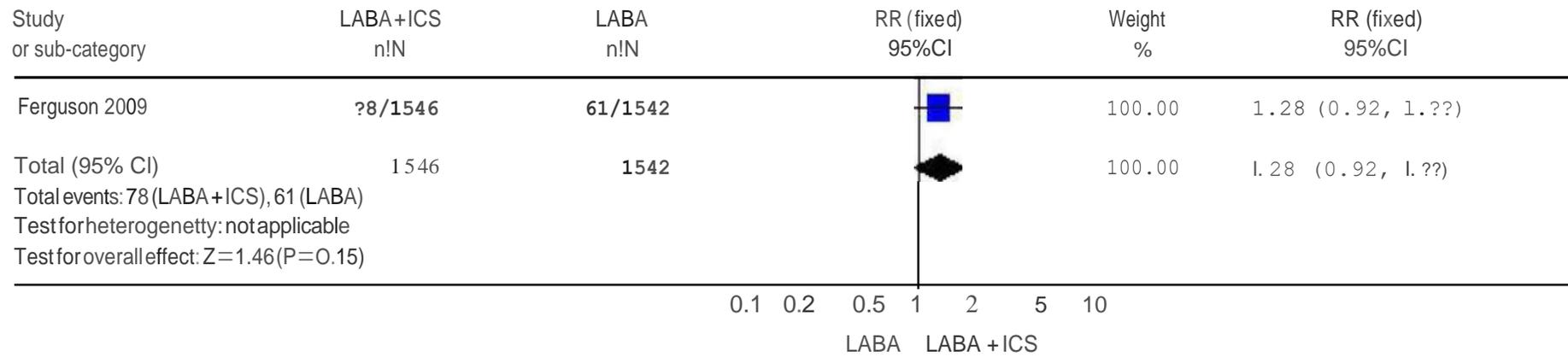
Cataracts

Review: Drug 3a: LABA + ICS vs. LABA (Cochrane) (latest 300309)
 Comparison: 01 LABA + ICS vs. LABA
 Outcome: 18 Cataracts



Fractures

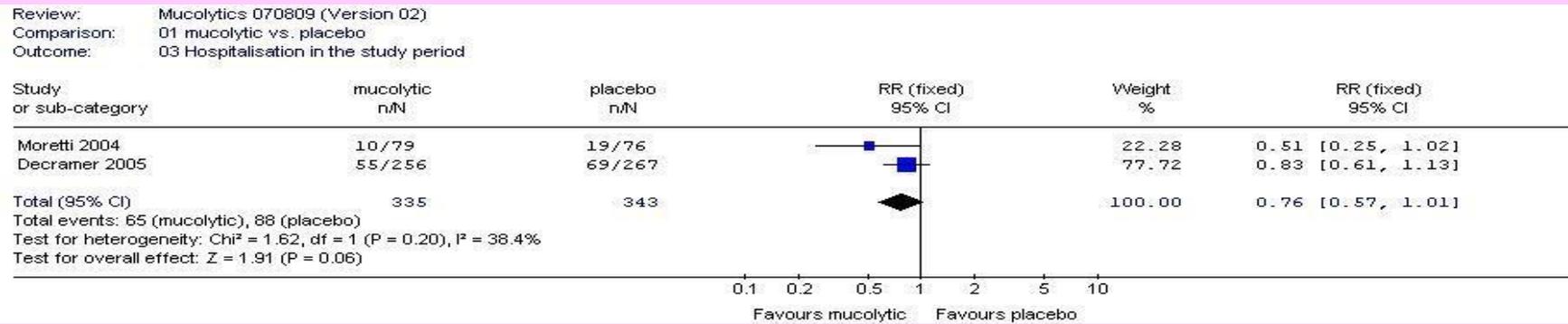
Review: Drug3a:LABA+ICSvs.LABA(Cochrane)(130809)
 Comparison: 01 LABA + ICS vs. LABA
 Outcome: 19 Fractures (total)



From section 7.4.4 Oral mucolytics

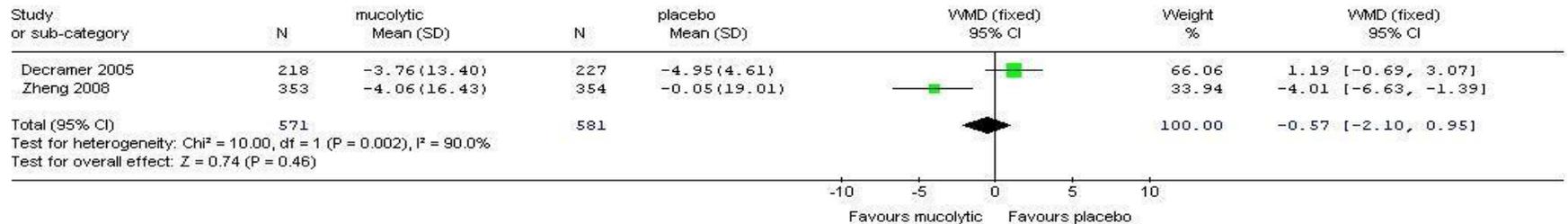
Mucolytics versus Placebo

Number of people hospitalised



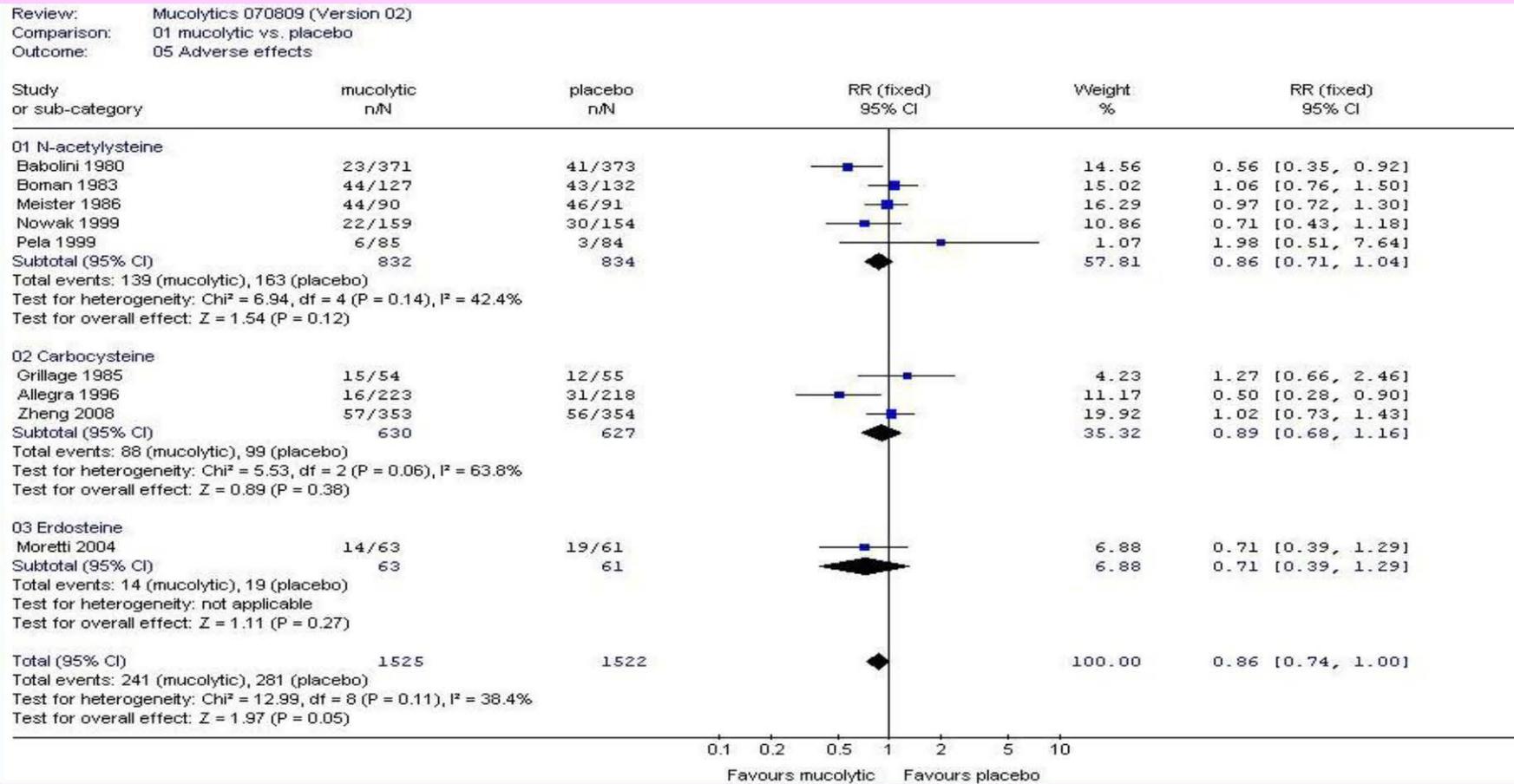
Change from baseline in health related quality of life (total SGRQ score)

Review: Mucolytics 070809 (Version 02)
 Comparison: 01 mucolytic vs. placebo
 Outcome: 08 Change in SGRQ



Total who completed SGRQ in Decramer study is 445. Assumed that the 78 drop outs were evenly distributed between the intervention and placebo arms. NCC calculated SD from the mean and 95% CI that were provided in the paper.

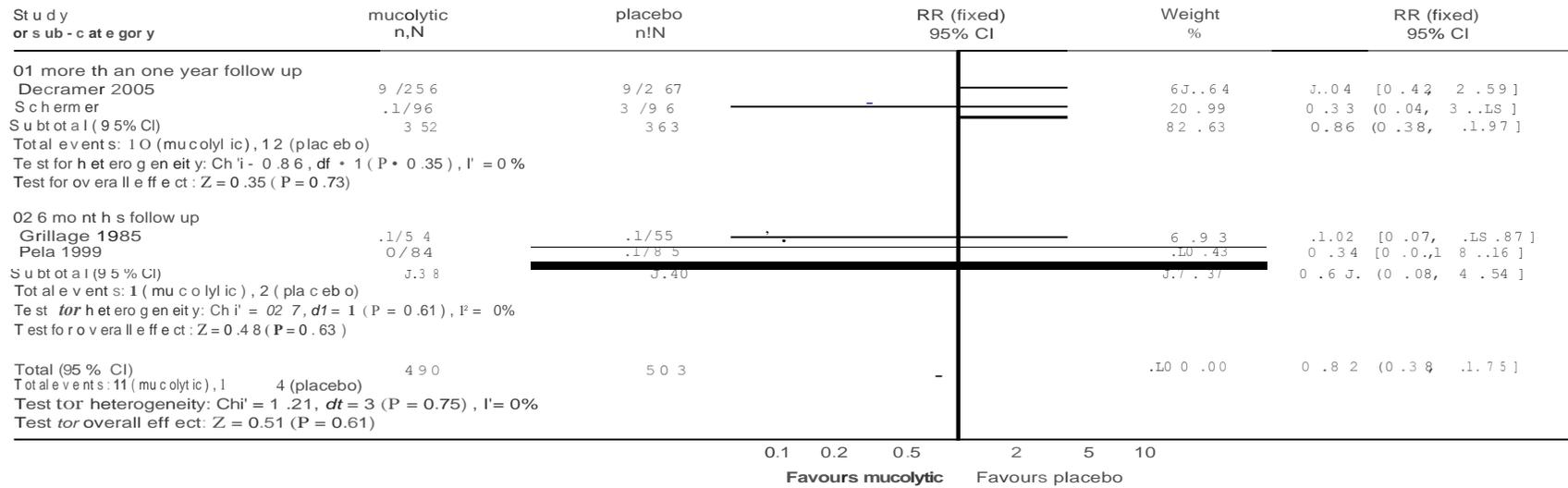
Adverse events



COPD (update)

Mortality

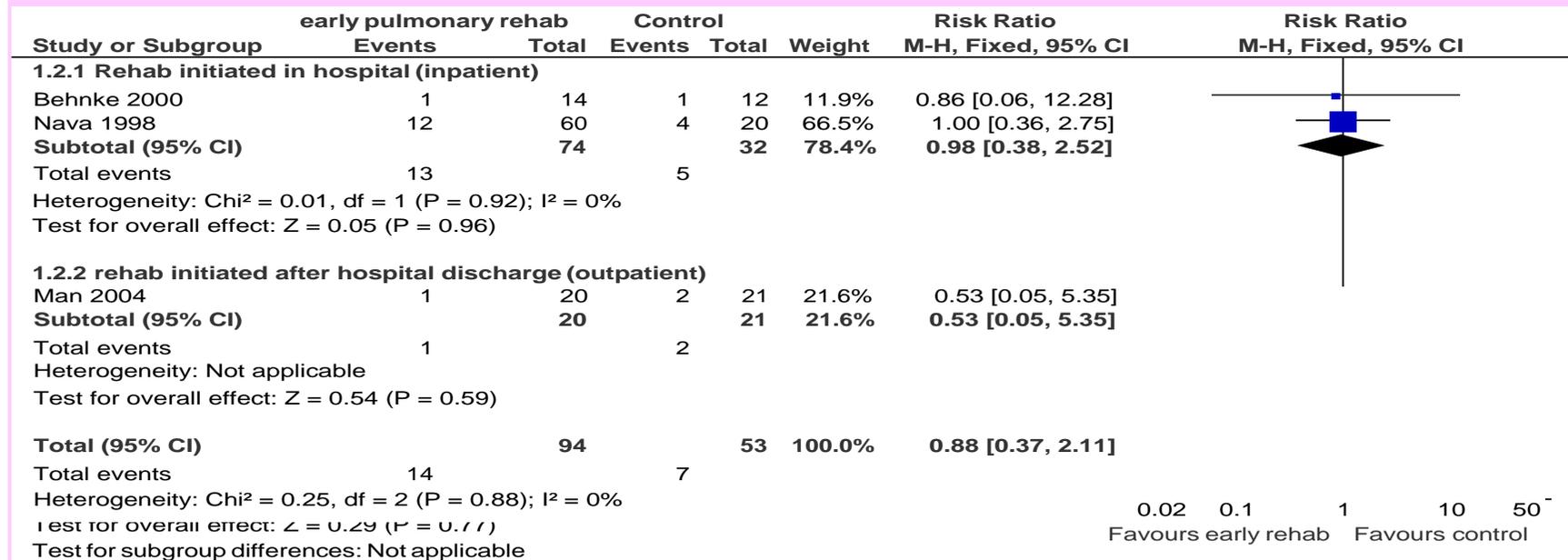
Review: Mucolytic s 070809 (Version 02)
 Comparison: 01 mucolytic vs . placebo
 Outcome: 06 Death during study period



From section 7.9.5 Timing of rehabilitation programmes

Early pulmonary rehabilitation post exacerbation compared with usual care/control

Mortality



Exacerbations

Study or Subgroup	early pulmonary rehab Events	Control Total Events	Total Weight	Risk Ratio M-H, Fixed, 95% CI	Risk Ratio M-H, Fixed, 95% CI
1.3.1 Rehab initiated in hospital (inpatient)					
Behnke 2000	1	23	23 37.5%	0.33 [0.04, 2.97]	
Subtotal (95% CI)		23	23 37.5%	0.33 [0.04, 2.97]	
Total events	1	3			
Heterogeneity: Not applicable					
Test for overall effect: Z = 0.98 (P = 0.33)					
1.3.2 rehab initiated after hospital discharge (outpatient)					
Murphy 2005	2	13	13 62.5%	0.40 [0.09, 1.70]	
Subtotal (95% CI)		13	13 62.5%	0.40 [0.09, 1.70]	
Total events	2	5			
Heterogeneity: Not applicable					
Test for overall effect: Z = 1.24 (P = 0.22)					
Total (95% CI)		36	36 100.0%	0.38 [0.11, 1.26]	
Total events	3	8			
Heterogeneity: Chi ² = 0.02, df = 1 (P = 0.89); I ² = 0%					
Test for overall effect: Z = 1.58 (P = 0.11)					
Test for subgroup differences: Not applicable					

0.01 0.1 1 10 100
Favours early rehab Favours control

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