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Acutely ill patients in hospital

Recognition of and response to acute illness in adults in hospital

NICE clinical guideline 50
Developed by the Centre for Clinical Practice at NICE

NICE clinical guideline 50
Acutely ill patients in hospital: recognition of and response to acute illness in adults in hospital

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Minor updates since publication

April 2019: Recommendation 1.4 has been updated to add details of the NEWS2 tool. This change can be seen in the short version of the guideline at http://www.nice.org.uk/guidance/ng51

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Contents

Contents **3**
Foreword **5**
1 Summary **7**
1.1 Patient-centred care 7
1.2 List of recommendations and care pathway 8
1.2.1 Key priorities for implementation *8*
1.2.2 All recommendations *11*
1.2.3 Care pathway *18*
1.3 Overview 19
1.3.1 Recognition of and response to acute illness in adults in hospital *19*
1.3.2 The NICE short clinical guidelines programme *21*
1.3.3 Using this guideline *22*
1.3.4 Using recommendations and supporting evidence *22*
1.3.5 Using flowcharts *23*
2 Evidence review and recommendations **23**
2.1 Identification and evaluation of risk scoring tools 23
2.1.1 Introduction *23*
2.1.2 Overview *24*
2.1.3 Physiological observations in acute hospital settings *26*
2.1.4 Identifying patients whose clinical condition is deteriorating or is at risk of deterioration *28*
2.1.5 Choice of physiological track and trigger system *32*
2.1.6 Physiological parameters to be used by track and trigger systems *40*
2.1.7 Issues relating to assessing the cost effectiveness of physiological track and trigger systems *43*
2.2 Response strategies for patients identified as having a deteriorating clinical condition 45
2.2.1 Introduction *45*
2.2.2 Overview *46*
2.2.3 Critical care outreach services for patients whose clinical condition is deteriorating *50*
2.3 Transfer of patients from critical care areas 64
2.3.1 Introduction *64*
2.3.2 Overview *65*
2.3.3 Timing of transfer of patient from critical care areas to general wards *68*
2.3.4 Elements of care on the general ward viewed as important by patients following transfer *73*
2.3.5 Interventions on general wards following transfer from critical care areas *77*
2.4 Research recommendations 77
3 Methods **79**
3.1 Scope and purpose 79
3.1.1 Scope *79*
3.1.2 Areas covered by this guideline *79*
3.1.3 Areas outside the remit of this guideline *79*

3.1.4 Disclaimer 80
3.2 Contributors 80
3.2.1 The Guideline Development Group 80
3.2.2 The Short Clinical Guidelines Technical Team 82
3.2.3 Acknowledgements 83
3.3 Development methods 83
3.3.1 Developing the guideline scope 84
3.3.2 Forming and running the Short Clinical Guideline Development Group 85
3.3.3 Developing key clinical questions 85
3.3.4 Developing recommendations 85
3.3.5 Literature search 86
3.3.6 Reviewing the evidence 87
3.3.7 Grading the evidence 88
3.3.8 Evidence to recommendations 90
3.3.9 Health economics 91
3.3.10 Relation between this guideline and ongoing national research in the field of critical care outreach 92
3.3.11 Relation between this guideline and ongoing work on this area by the National Patient Safety Agency 93
3.3.12 Piloting and implementation 94
3.3.13 Audit methods 94
3.3.14 Scheduled review of this guideline 94
3.4 Declarations 95
3.4.1 Authorship and citation 95
3.4.2 Declarations of Interest 95
4 References, glossary and abbreviations 95
4.1 Reference list 95
4.2 Glossary 102
4.3 Abbreviations 106
5 Appendices……available as a separate document

Foreword

Patients who are admitted to hospital believe that they are entering a place of safety, where they, and their families and carers, have a right to believe that they will receive the best possible care. They feel confident that, should their condition deteriorate, they are in the best place for prompt and effective treatment.

Yet there is evidence to the contrary. Patients who are, or become, acutely unwell in hospital may receive suboptimal care. This may be because their deterioration is not recognised, or because – despite indications of clinical deterioration – it is not appreciated, or not acted upon sufficiently rapidly. Communication and documentation are often poor, experience might be lacking and provision of critical care expertise, including admission to critical care areas, delayed.

We have endeavoured to produce practical guidance with recommendations for the measurement and recording of a set of physiological observations, linked to a 'track and trigger' system (see section 2.1.1). We have emphasised the importance of a full clinical assessment, and of tailoring the written monitoring and management plans to the individual patient's clinical circumstances. Throughout the document we have emphasised the importance of training; by ensuring that routine measurements are accurately taken and recorded by staff that understand their clinical relevance, and by linking these observations to a graded track and trigger system, care can be escalated appropriately. The foundations for patient safety are laid through doing and recording simple measurements well and having agreed response strategies in place.

The Guideline Development Group struggled with the lack of evidence to identify any one best model of response. It needed to balance making clear recommendations about the level and nature of the response with the absence of evidence regarding optimal configuration. Given this, the Guideline Development Group considered that the optimal configuration of response should be agreed and delivered locally. Whatever model of care is agreed, the

clinical team must have the necessary competencies. Where admission to a critical care area is considered necessary, we have emphasised the importance of involving both critical care consultants and the team caring for the patient on the ward.

The Guideline Development Group recognised the pressure on both critical care beds and inpatient hospital beds, and the difficulties of ensuring smooth, planned transfer from critical care areas back to the wards. Nevertheless, we have set out recommendations to avoid transfer out of critical care areas between the hours of 22.00 and 07.00. If this occurs, it should be documented as an adverse incident. We have been prescriptive about the need for a formal, structured handover of care between the transferring and receiving teams, recognising the understandable anxiety of patients and their carers and the need to provide reassurance and information to them at this time.

This is the first National Institute for Health and Clinical Excellence (NICE) short clinical guideline to be developed. The methodology is of the same rigour as for the standard NICE clinical guidelines, but the scope is narrower, and the development and consultation phases have been compressed. The Guideline Development Group recognises the importance of producing guidance rapidly in an area in which patients and clinicians need advice urgently to ensure patient safety. This philosophy sits well with our emphasis on a timely and rapid response to the acutely ill hospital patient. We hope that the guideline will be welcomed by all who plan, deliver, or experience hospital inpatient clinical care.

Dr Mary Armitage
Guideline Development Group Chair

1 Summary

1.1 Patient-centred care

This guideline offers best practice advice on the care of adult patients within the acute hospital setting.

Treatment and care should take into account patients' needs and preferences. People with an acute illness should, if appropriate, have the opportunity to make informed decisions about their care and treatment, in partnership with their healthcare professionals. If patients do not have the capacity to make decisions, healthcare professionals should follow the Department of Health (2001) guidelines – 'Reference guide to consent for examination or treatment' (available from www.dh.gov.uk). From April 2007 healthcare professionals will need to follow a code of practice accompanying the Mental Capacity Act (summary available from www.dca.gov.uk/menincap/bill-summary.htm).

Good communication between healthcare professionals and patients is essential. It should be supported by evidence-based written information tailored to the patient's needs. Treatment and care, and the information patients are given about it, should be culturally appropriate. It should also be accessible to people with additional needs such as physical, sensory or learning disabilities, and to people who do not speak or read English.

If the patient agrees, carers and relatives should have the opportunity to be involved in decisions about treatment and care.

Carers and relatives should also be given the information and support they need.

1.2 List of recommendations and care pathway

1.2.1 Key priorities for implementation

- Adult patients in acute hospital settings, including patients in the emergency department for whom a clinical decision to admit has been made, should have:
  - physiological observations recorded at the time of their admission or initial assessment
  - a clear written monitoring plan that specifies which physiological observations should be recorded and how often. The plan should take account of the:
    - ◊ patient's diagnosis
    - ◊ presence of comorbidities
    - ◊ agreed treatment plan.

  Physiological observations should be recorded and acted upon by staff who have been trained to undertake these procedures and understand their clinical relevance.

- Physiological track and trigger systems should be used to monitor all adult patients in acute hospital settings.
  - Physiological observations should be monitored at least every 12 hours, unless a decision has been made at a senior level to increase or decrease this frequency for an individual patient.
  - The frequency of monitoring should increase if abnormal physiology is detected, as outlined in the recommendation on graded response strategy.

- Staff caring for patients in acute hospital settings should have competencies in monitoring, measurement, interpretation and prompt response to the acutely ill patient appropriate to the level of care they are providing. Education and training should be provided to ensure staff have these competencies, and they should be assessed to ensure they can demonstrate them.

- A graded response strategy for patients identified as being at risk of clinical deterioration should be agreed and delivered locally. It should consist of the following three levels.
  - Low-score group:
    - Increased frequency of observations and the nurse in charge alerted.
  - Medium-score group:
    - Urgent call to team with primary medical responsibility for the patient.
    - Simultaneous call to personnel with core competencies for acute illness. These competencies can be delivered by a variety of models at a local level, such as a critical care outreach team, a hospital-at-night team or a specialist trainee in an acute medical or surgical specialty.
  - High-score group:
    - Emergency call to team with critical care competencies and diagnostic skills. The team should include a medical practitioner skilled in the assessment of the critically ill patient, who possesses advanced airway management and resuscitation skills. There should be an immediate response.

- If the team caring for the patient considers that admission to a critical care area is clinically indicated, then the decision to admit should involve both the consultant caring for the patient on the ward and the consultant in critical care.

- After the decision to transfer a patient from a critical care area to the general ward has been made, he or she should be transferred as early as possible during the day. Transfer from critical care areas to the general ward between 22.00 and 07.00 should be avoided whenever possible, and should be documented as an adverse incident if it occurs.

- The critical care area transferring team and the receiving ward team should take shared responsibility for the care of the patient being transferred. They should jointly ensure:
  - there is continuity of care through a formal structured handover of care from critical care area staff to ward staff (including both medical and nursing staff), supported by a written plan
  - that the receiving ward, with support from critical care if required, can deliver the agreed plan.

  The formal structured handover of care should include:

  - a summary of critical care stay, including diagnosis and treatment
  - a monitoring and investigation plan
  - a plan for ongoing treatment, including drugs and therapies, nutrition plan, infection status and any agreed limitations of treatment
  - physical and rehabilitation needs
  - psychological and emotional needs
  - specific communication or language needs.

1.2.2 All recommendations

Physiological observations in acute hospital settings (section 2.1.3)

1.2.2.1 Adult patients in acute hospital settings, including patients in the emergency department for whom a clinical decision to admit has been made, should have:

- physiological observations recorded at the time of their admission or initial assessment
- a clear written monitoring plan that specifies which physiological observations should be recorded and how often. The plan should take account of the:
  - patient's diagnosis
  - presence of comorbidities
  - agreed treatment plan.

Physiological observations should be recorded and acted upon by staff who have been trained to undertake these procedures and understand their clinical relevance.

1.2.2.2 As a minimum, the following physiological observations should be recorded at the initial assessment and as part of routine monitoring:

- heart rate
- respiratory rate
- systolic blood pressure
- level of consciousness
- oxygen saturation
- temperature.

Identifying patients whose clinical condition is deteriorating or is at risk of deterioration (section 2.1.4)

1.2.2.3 Physiological track and trigger systems should be used to monitor all adult patients in acute hospital settings.

- Physiological observations should be monitored at least every 12 hours, unless a decision has been made at a senior level to increase or decrease this frequency for an individual patient.
- The frequency of monitoring should increase if abnormal physiology is detected, as outlined in the recommendation on graded response strategy (recommendation 1.2.2.10).

Choice of physiological track and trigger system (section 2.1.5)

1.2.2.4 Track and trigger systems should use multiple-parameter or aggregate weighted scoring systems, which allow a graded response. These scoring systems should:

- define the parameters to be measured and the frequency of observations
- include a clear and explicit statement of the parameters, cut-off points or scores that should trigger a response.

Physiological parameters to be used by track and trigger systems (section 2.1.6)

1.2.2.5 Multiple-parameter or aggregate weighted scoring systems used for track and trigger systems should measure:

- heart rate
- respiratory rate
- systolic blood pressure
- level of consciousness
- oxygen saturation
- temperature.

1.2.2.6 In specific clinical circumstances, additional monitoring should be considered; for example:

- hourly urine output
- biochemical analysis, such as lactate, blood glucose, base deficit, arterial pH
- pain assessment.

Critical care outreach services for patients whose clinical condition is deteriorating (section 2.2.3)

1.2.2.7 Staff caring for patients in acute hospital settings should have competencies in monitoring, measurement, interpretation and prompt response to the acutely ill patient appropriate to the level of care they are providing. Education and training should be provided to ensure staff have these competencies, and they should be assessed to ensure they can demonstrate them.

1.2.2.8 The response strategy for patients identified as being at risk of clinical deterioration should be triggered by either physiological track and trigger score or clinical concern.

1.2.2.9 Trigger thresholds for track and trigger systems should be set locally. The threshold should be reviewed regularly to optimise sensitivity and specificity.

Graded response strategy (section 2.2.3)

No specific service configuration can be recommended as a preferred response strategy for individuals identified as having a deteriorating clinical condition.

1.2.2.10 A graded response strategy for patients identified as being at risk of clinical deterioration should be agreed and delivered locally. It should consist of the following three levels.

- Low-score group:
  - Increased frequency of observations and the nurse in charge alerted.
- Medium-score group:
  - Urgent call to team with primary medical responsibility for the patient.
  - Simultaneous call to personnel with core competencies for acute illness. These competencies can be delivered by a variety of models at a local level, such as a critical care outreach team, a hospital-at-night team or a specialist trainee in an acute medical or surgical specialty.
- High-score group:
  - Emergency call to team with critical care competencies and diagnostic skills. The team should include a medical practitioner skilled in the assessment of the critically ill patient, who possesses advanced airway management and resuscitation skills. There should be an immediate response.

1.2.2.11 Patients identified as ‘clinical emergency’ should bypass the graded response system. With the exception of those with a cardiac arrest, they should be treated in the same way as the high-score group.

1.2.2.12 For patients in the high- and medium-score groups, healthcare professionals should:

- initiate appropriate interventions
- assess response
- formulate a management plan, including location and level of care.

1.2.2.13 If the team caring for the patient considers that admission to a critical care area is clinically indicated, then the decision to admit should involve both the consultant caring for the patient on the ward and the consultant in critical care.

Transfer of patients from critical care areas to general wards (section 2.3.3)

1.2.2.14 After the decision to transfer a patient from a critical care area to the general ward has been made, he or she should be transferred as early as possible during the day. Transfer from critical care areas to the general ward between 22.00 and 07.00 should be avoided whenever possible, and should be documented as an adverse incident if it occurs.

Care on the general ward following transfer (section 2.3.4)

1.2.2.15 The critical care area transferring team and the receiving ward team should take shared responsibility for the care of the patient being transferred. They should jointly ensure:

- there is continuity of care through a formal structured handover of care from critical care area staff to ward staff (including both medical and nursing staff), supported by a written plan
- that the receiving ward, with support from critical care if required, can deliver the agreed plan.

The formal structured handover of care should include:

- a summary of critical care stay, including diagnosis and treatment

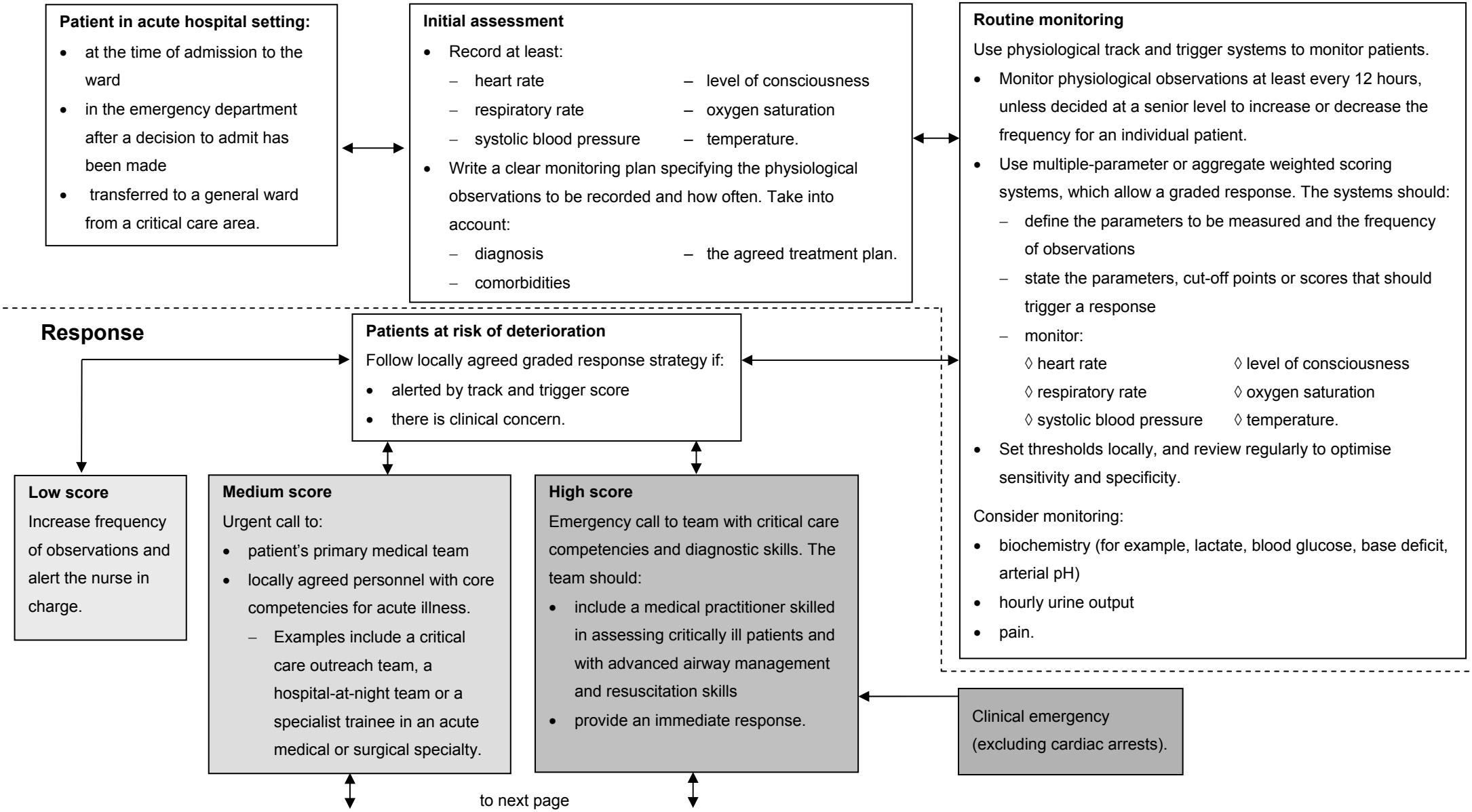
- a monitoring and investigation plan
- a plan for ongoing treatment, including drugs and therapies, nutrition plan, infection status and any agreed limitations of treatment
- physical and rehabilitation needs
- psychological and emotional needs
- specific communication or language needs.

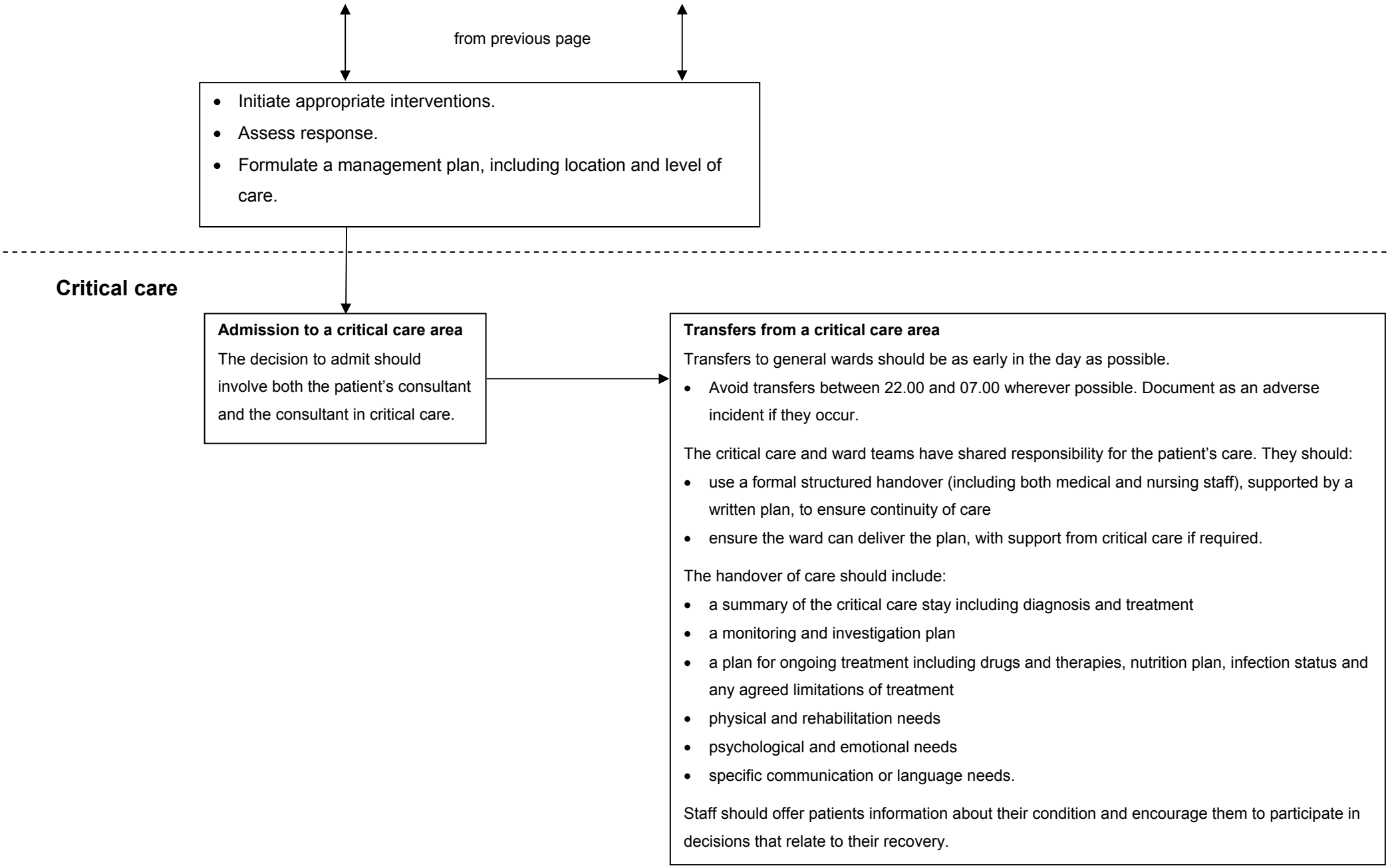
1.2.2.16 When patients are transferred to the general ward from a critical care area, they should be offered information about their condition and encouraged to actively participate in decisions that relate to their recovery. The information should be tailored to individual circumstances. If they agree, their family and carers should be involved.

1.2.2.17 Staff working with acutely ill patients on general wards should be provided with education and training to recognise and understand the physical, psychological and emotional needs of patients who have been transferred from critical care areas.

1.2.3 Care pathway

Assessment and monitoring

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Initiate appropriate interventions.
Assess response.
Formulate a management plan, including location and level of care.
Critical care
Admission to a critical care area
The decision to admit should involve both the patient's consultant and the consultant in critical care.
Transfers from a critical care area
Transfers to general wards should be as early in the day as possible.
Avoid transfers between 22.00 and 07.00 wherever possible. Document as an adverse incident if they occur.
The critical care and ward teams have shared responsibility for the patient's care. They should:
use a formal structured handover (including both medical and nursing staff), supported by a written plan, to ensure continuity of care
ensure the ward can deliver the plan, with support from critical care if required.
The handover of care should include:
a summary of the critical care stay including diagnosis and treatment
a monitoring and investigation plan
a plan for ongoing treatment including drugs and therapies, nutrition plan, infection status and any agreed limitations of treatment
physical and rehabilitation needs
psychological and emotional needs
specific communication or language needs.
Staff should offer patients information about their condition and encourage them to participate in decisions that relate to their recovery.

1.3 Overview

1.3.1 Recognition of and response to acute illness in adults in hospital

The care of the acutely ill patient in hospital may require input from critical care. Critical care in the NHS is provided within the continuum of secondary and tertiary care, with the majority of services delivered in the secondary care setting. The Department of Health in 2000 recommended that this care should be classified based on the level of care that individual patients need, regardless of location. It identified four levels of care. Level 0: patients whose needs can be met through normal ward care in an acute hospital; level 1: patients at risk of their condition deteriorating, or those recently relocated from higher levels of care, whose needs can be met on an acute ward with additional advice and support from the critical care team; level 2: patients requiring more detailed observation or intervention, including support for a single failing organ system or postoperative care and those 'stepping down' from higher levels of care; and level 3: either patients requiring advanced respiratory monitoring and support, or patients needing monitoring and support for two or more organ systems, one of which may be basic or advanced respiratory support.

The aging population, increasing complexity of medical and surgical interventions, and shorter length of hospital inpatient stays have meant that patients in hospital are at increasing risk of becoming acutely ill and may require admission to critical care areas. This has led to increasing demand for level 1 and level 2 care. Clinical deterioration can occur at any stage of a patient's illness, although there will be certain periods during which a patient is more vulnerable, such as at the onset of illness, during surgical or medical interventions and during recovery from critical illness. Patients on general adult wards and emergency departments who are at risk of deteriorating may be identified before a serious adverse event by changes in physiological observations recorded by healthcare staff. The interpretation of these changes, and timely institution of appropriate clinical management once

physiological deterioration is identified, is of crucial importance to minimise the likelihood of serious adverse events, including cardiac arrest and death. Should a patient be admitted to critical care areas for further care, then care on general adult wards following transfer from critical care areas may also have a significant impact on patient outcomes.

There is, however, a consistent body of evidence that shows that patients who become, or who are at risk of becoming, acutely unwell on general hospital wards receive suboptimal care (McQuillan et al. 1998; NCEPOD 2005; Seward et al. 2003). The National Confidential Enquiry into Patient Outcome and Death (NCEPOD 2005) identified the prime causes of the substandard care of the acutely unwell in hospital as being delayed recognition, and institution of inappropriate therapy that subsequently culminated in a late referral. The report found that on a number of occasions these factors were aggravated by poor communication between the acute and critical care medical teams. It also identified examples in which there was a lack of awareness by medical consultants of their patients' deteriorating health and their subsequent admission to critical care. Admission to an intensive care unit (ICU) was thought to have been avoidable in 21% of cases, and the authors felt that suboptimal care contributed to about a third of the deaths that occurred.

Any intervention delivered to patients in hospital who deteriorate clinically, or who show signs that they may deteriorate unexpectedly, should aim to reduce patient mortality, morbidity and length of stay both in the hospital overall and in a critical care area should they be admitted to critical care. Such interventions could have substantial health economic implications through, for example, reductions in ICU admission and re-admission. A level-3 ICU bed, for example, costs approximately £1716 per day (Department of Health 2006). In addition, a ward bed has been estimated to cost £220 per day (Harrison et al. unpublished).

This guideline aims to improve the care of the acutely ill in hospital by making evidence-based recommendations on the best way to identify and manage this group of patients. It is intended that its implementation will improve the

quality of care received by these patients and address the shortcomings in care identified by the NCEPOD report.

1.3.2 The NICE short clinical guidelines programme

'Acutely ill patients in hospital: recognition of and response to acute illness in adults in hospital' (NICE clinical guideline 50) is the first NICE short clinical guideline.

The Institute has established a 'short' clinical guidelines programme that will allow the rapid (9–11 month) development of clinical guidelines that address only part of a care pathway for which the NHS requires guidance rapidly.

Short clinical guidelines are developed by an internal NICE technical team (the Short Clinical Guidelines Technical Team) to the same rigorous methods as existing clinical guidelines developed by NICE's national collaborating centres. This will be achieved by narrowing down the scope of the guideline so that it addresses a small number of key clinical questions. This will allow the Short Clinical Guidelines Technical Team to prepare evidence reviews of the same high quality as those produced in standard clinical guidelines, but in a shorter time. These reviews will be presented to the Guideline Development Group and used to make recommendations for clinical practice.

The short clinical guidelines programme consists of four phases that follow those of the standard guidelines programme.

1. Referral of topic to NICE by the Department of Health.
2. Scoping the guideline topic.
3. The development phase, which begins with the first meeting of the Guideline Development Group and ends when a draft document is submitted by the Guideline Development Group for stakeholder consultation.
4. The validation phase, which consists of consultation with stakeholders and the public on the draft guidance, receiving advice from the Guideline Review Panel and expert reviewers, preparation of the final draft, sign off by Guidance Executive and publication.

To meet the time requirements and minimise the complexity of development, key stages of the scoping and development phase of the standard guidelines process have been adapted. An interim process guide to the short clinical guidelines programme, setting out in detail the short guideline development methods, has been the subject of public consultation. It is intended that the revised version of the interim process guide, which will take account of the public consultation comments, will be incorporated into the 2008 update of the 'The guidelines manual' (see www.nice.org.uk).

1.3.3 Using this guideline

This document is intended to be relevant to healthcare professionals within acute hospitals who have direct contact with patients. The target population is adult patients in hospitals. This includes patients in the accident and emergency department, once a decision to admit the patient has been made.

The full version of the guideline is available to download free of charge from the NICE website (www.nice.org.uk). NICE will also make available summary versions of this guideline on the website, including 'Understanding NICE guidance' (a version for patients) and a quick reference guide.

1.3.4 Using recommendations and supporting evidence

The Guideline Development Group took into consideration the overall benefits, harms and costs of the evidence it reviewed. It also considered equity and the practicality of implementation when drafting the recommendations set out within this guideline. However, healthcare professionals need to use their general medical knowledge and clinical judgement when applying recommendations that may not be appropriate in all circumstances. Decisions to adopt any particular recommendation should be made in the light of the individual patient's views and circumstances as well as available resources. To enable patients to participate in the process of decision-making to the extent that they are able and willing, clinicians need to be able to communicate information provided in this guideline. To this end, recommendations are often supported by evidence statements that provide summary information to help clinicians and patients discuss options.

1.3.5 Using flowcharts

Deriving an evidence-based rationale for care for acutely ill patients in hospital brings together an understanding of healthcare delivery and a vast literature providing evidence about tests and treatments. Flowcharts are inevitably a simplification and cannot capture all the complexities and permutations affecting the clinical care of individuals managed within the hospital setting. Flowcharts presented in this guideline are designed to help communicate the key elements of treatment, but are not intended for rigid use or as protocol.

2 Evidence review and recommendations

2.1 Identification and evaluation of risk scoring tools

2.1.1 Introduction

Physiological track and trigger warning systems are widely used within acute hospitals in the NHS. They are used to identify patients on general wards (outside critical care areas) at risk of clinical deterioration. Their main function is to ensure recognition of all patients with potential or established critical illness, so that timely attendance from appropriately skilled staff can be ensured (Gao et al. 2007). Their use has also been shown to increase the frequency of recording of physiological parameters on general wards (McBride et al. 2005).

Physiological track and trigger systems rely on periodic observation of selected basic physiological signs ('tracking') with predetermined calling or response criteria ('trigger') for requesting the attendance of staff who have specific competencies in the management of acute illness and/or critical care. These systems allow a large number of patients to be monitored without a large increase in workload. A number of physiological track and trigger systems are used internationally to detect patients at risk of deteriorating, some of which are shown in the table below.

Table 1 Types of track and trigger system

System	Characteristics
Single parameter system	Periodic observation of selected vital signs that are compared with a simple set of criteria with predefined thresholds, with a response algorithm being activated when any criterion is met.
Multiple parameter system	Response algorithm requires more than one criterion to be met, or differs according to the number of criteria met.
Aggregate scoring system	Weighted scores are assigned to physiological values and compared with predefined trigger thresholds.
Combination system	Single or multiple parameter systems used in combination with aggregate weighted scoring systems.

2.1.2 Overview

The Gao and coworkers (2007) review, a substudy of the work commissioned by the National Institute for Health Research Service Delivery and Organisation (SDO) from the Intensive Care National Audit and Research Centre (ICNARC) (see section 3.3.10), was used as the basis of this evidence review. This review included 36 papers, and reported the results of one primary study of data from acute hospitals in England and Wales. The search strategies developed by Gao and coworkers (2007) were obtained from the authors and re-run to identify studies from 2004 onwards. The updated literature search identified a further 11 studies that met our inclusion criteria (see appendices), making a total of 47 papers. The systematic review classified these papers either as concerned with the development and testing of a track and trigger system, or as describing the use of such a system. From the latter category, we identified studies that looked at the effect of introducing a track and trigger system on patient outcomes, and considered these as a third category (intervention studies). Hence there were three categories of study included in this review.

- Development/validation. These studies were analysed as diagnostic studies. Studies were included in this category only if they included patients both with and without the reference outcome (such as cardiac arrest, ICU admission or mortality). Studies in which the population included patients

with the reference outcome only were classified as descriptive. A key distinction between development and validation is that in development studies identification of parameters, cut-offs, and/or design of scoring systems are determined based on the outcomes of the study sample (for example, through the use of receiver operating characteristics [ROC] curves); for validation studies, these criteria have already been determined and their predictive ability is evaluated in a new sample of patients. Several of the studies included fall into both categories.

- Intervention. These studies considered the effect on patient outcomes of introducing a scoring tool (either alone or in combination with a critical care response team). Studies were included in this category only if they permitted a comparison of outcomes both with and without the scoring tool, for example randomised controlled trials, non-randomised controlled trials, before-and-after studies, cohort studies with historical control. Studies that reported the implementation of a scoring tool but did not permit this comparison were classified as descriptive.
- Descriptive. These were studies included in the systematic review (Gao et al. 2007) that described the use of a scoring tool, but did not fit into the categories outlined above. An overview of these studies is presented in the evidence table for the review of track and trigger systems (see appendix 5.4).

In terms of health economics, no published or unpublished health economic evidence on physiological track and trigger systems was identified. The best available clinical evidence could not support robust de novo economic modelling. Consequently, the recommendations in this section of the guideline are based in large part on informal consensus. Section 2.1.5 presents a discussion of the issues relating to assessing the cost effectiveness of track and trigger systems.

2.1.3 Physiological observations in acute hospital settings

Recommendation 1.2.2.1

Adult patients in acute hospital settings, including patients in the emergency department for whom a clinical decision to admit has been made, should have:

- physiological observations recorded at the time of their admission or initial assessment
- a clear written monitoring plan that specifies which physiological observations should be recorded and how often. The plan should take account of the:
  - patient's diagnosis
  - presence of comorbidities
  - agreed treatment plan.

Physiological observations should be recorded and acted upon by staff who have been trained to undertake these procedures and understand their clinical relevance.

Recommendation 1.2.2.2

As a minimum, the following physiological observations should be recorded at the initial assessment and as part of routine monitoring:

- heart rate
- respiratory rate
- systolic blood pressure
- level of consciousness
- oxygen saturation
- temperature.

Evidence review

The evidence relating to whether or not physiological abnormalities are a marker for clinical deterioration was not subjected to formal review in this guideline. It is well recognised that abnormal physiology is associated with adverse clinical outcomes. A multicentre, prospective, observational study (Kause et al. 2004) found that the majority (60%) of primary events (deaths, cardiac arrests and unplanned ICU admissions) were preceded by documented abnormal physiology, the most common being hypotension and a fall in Glasgow coma scale. In the NCEPOD report (2005), the majority (66%) of inpatients who had been in hospital for more than 24 hours before ICU admission exhibited physiological instability for more than 12 hours. Another study (Goldhill and McNarry 2004) found that mortality increased with the number of physiological abnormalities ($p < 0.001$), being 0.7% with no abnormalities, 4.4% with one, 9.2% with two and 21.3% with three or more.

Evidence statement

(IV) Physiological abnormalities are a marker for clinical deterioration.

(For a full definition of how the evidence is graded, please see section 3.3.7)

Evidence to recommendations

Through informal consensus of opinion, the Guideline Development Group agreed that measurement of physiological observations was important and all adult patients should receive a minimum set of physiological observations and a clear written monitoring plan at time of admission or initial assessment. Such measurements provide the necessary input data for the physiological track and trigger systems reviewed in the next section.

The Guideline Development Group considered that it was important to specify what physiological monitoring should be provided to adult patients in acute hospital settings so as to ensure prompt identification of those at risk of clinical deterioration.

It is important to note that most physiological track and trigger systems draw data from the routine observations of physiology (vital signs) carried out by

ward and emergency department staff. These observations are carried out on admission and/or initial assessment and repeated as indicated.

The Guideline Development Group considered it important to specify what physiological observations should be recorded and what the frequency of recording should be, in advance of considering specific physiological track and trigger systems.

2.1.4 Identifying patients whose clinical condition is deteriorating or is at risk of deterioration

Recommendation 1.2.2.3

Physiological track and trigger systems should be used to monitor all adult patients in acute hospital settings.

- Physiological observations should be monitored at least every 12 hours, unless a decision has been made at a senior level to increase or decrease this frequency for an individual patient.
- The frequency of monitoring should increase if abnormal physiology is detected, as outlined in the recommendation on graded response strategy (recommendation 1.2.2.10).

Evidence review

Twelve (Bell et al. 2006; Cuthbertson et al. 2007; Duckitt et al. 2007; Gao et al. 2007; Goldhill et al. 1999b; Goldhill et al. 2005; Goldhill & McNarry. 2004; Garcea et al. 2006; Hodgetts et al. 2002; Lam et al. 2006; Subbe et al. 2001; Subbe et al. 2006) studies were identified that were concerned with the development and/or testing of track and trigger systems. All studies were cohort designs, with two exceptions: one (Gao et al. 2007) was a cohort study embedded in a systematic review and the other (Hodgetts et al. 2002) was a case–control design. Another eleven studies were identified that evaluated the effect on patient outcomes of introducing a physiological track and trigger system (Bellomo et al. 2004; Bristow et al. 2000; Buist et al. 2002; DeVita et al. 2004; Foraida et al. 2003; Hillman et al. 2005; Odell et al. 2002; Paterson

et al. 2006; Pittard 2003; Priestley et al. 2004; Subbe et al. 2003). There were two cluster-randomised controlled trials (Hillman et al. 2005; Priestley et al. 2004), and the rest of the studies were observational studies (the majority used a before-and-after study design).

Evidence statements

(III) Physiological track and trigger systems (single parameter, multiple parameter, aggregate weighted scoring and combination) have been developed and evaluated in selected patient populations.

The majority of identified studies were set on hospital wards. Three studies had a hospital-wide setting (including critical care areas) (Gao et al. 2007; Goldhill et al. 2005; Hodgetts et al. 2002), three studies were based on a medical admissions unit (Duckitt et al. 2007; Subbe et al. 2001; Subbe et al. 2003) and two on an accident and emergency department observation ward (Lam et al. 2006; Subbe et al. 2006). Fifteen studies were based in the UK (Cuthbertson et al. 2007; Duckitt et al. 2007; Gao et al. 2007; Garcea et al. 2006; Goldhill et al. 1999b; Goldhill et al. 2005; Goldhill and McNarry 2004; Hodgetts et al. 2002; Odell et al. 2002; Paterson et al. 2006; Pittard 2003; Priestley et al. 2004; Subbe et al. 2001; Subbe et al. 2003; Subbe et al. 2006), five in Australia (Bellomo et al. 2004; Bristow et al. 2000; Buist et al. 2004; Buist et al. 2002; Hillman et al. 2005), two in the United States (DeVita et al. 2004; Foraida et al. 2003), one in Hong Kong (Lam et al. 2006) and one in Sweden (Bell et al. 2006).

(II) Physiological track and trigger systems, as currently used, have variable performance in measures of diagnostic test accuracy for detecting the following key outcomes:

- *hospital mortality*
- *cardiac arrest*
- *admission to critical care.*

There were seven UK-based diagnostic studies (Duckitt et al. 2007; Gao et al. 2007; Garcea et al. 2006; Goldhill et al. 1999b; Goldhill and McNarry 2004; Hodgetts et al. 2002; Subbe et al. 2001). One study, a systematic review (Gao

et al. 2007), investigated the diagnostic accuracy of various track and trigger systems in detecting 'composite outcomes' of mortality, critical care admission, do-not-resuscitate orders or the need for cardiopulmonary resuscitation. Two studies (Goldhill et al. 1999b; Subbe et al. 2001) used critical care admission as an outcome measure, three (Garcea et al. 2006; Goldhill and McNarry 2004; Subbe et al. 2001) used mortality, one (Hodgetts et al. 2002) used the need for cardiopulmonary resuscitation and one (Duckitt et al. 2007) used mortality and cardiac arrest. There was also one study from Hong Kong (Lam et al. 2006) that used mortality and critical care admission as outcome measures, and two studies (Buist et al. 2004 from Australia and Bell et al. 2006 from Sweden) that used mortality as a key outcome. In summary, considerable variation exists in the published literature among the type of systems evaluated, physiological parameters included, choice of trigger and the chosen patient outcomes (reference criteria).

(III) Physiological track and trigger systems, as currently used in the NHS in England and Wales, have low sensitivity and positive predictive values but high specificity and negative predictive values. The low sensitivity can be improved by reducing the trigger threshold.

Five specific diagnostic studies carried out in the UK were identified (Garcea et al. 2006; Goldhill et al. 1999b; Goldhill and McNarry 2004; Hodgetts et al. 2002; Subbe et al. 2001). One case–control study (Hodgetts et al. 2002) assessed the ability of a track and trigger system (based on 10 parameters) to predict in-hospital cardiac arrest. The study was carried out to inform the development of medical emergency team (MET) calling criteria. A panel of experts grouped and weighted the activation criteria and a cumulative scoring system was developed. A ROC analysis determined that a score of four has 89% sensitivity and 77% specificity for cardiac arrest; a score of eight has 52% sensitivity and 99% specificity. All patients scoring greater than 10 suffered a cardiac arrest.

A second study (Goldhill et al. 1999b) evaluated the ability of a patient-at-risk team (PART) to predict admission to ICU in hospital ward patients. Patients triggered the system if they had three out of six abnormal physiological

parameters (or reduced consciousness with increased heart or respiratory rate). Sensitivity and specificity for patients with three abnormal observations were 27% and 57% respectively. For patients with one abnormal observation only, sensitivity was 97% (specificity 18%) and for two abnormal observations, sensitivity was 80% (specificity 41%). In a third study (Goldhill and McNarry 2004), also based on the PART calling criteria, stepwise multiple regression identified five significant predictors of 30-day mortality (consciousness, heart rate, age, blood pressure and respiratory rate), sensitivity and positive predictive value of the model were 7.7% and 66.7% respectively. Specificity was 99.8%.

There were also two studies that evaluated aggregate scoring systems. One study (Subbe et al. 2001) evaluated the modified early warning system (MEWS) and found that a trigger score (of five or more) was associated with increased risk of death (odds ratio [OR] 5.4, 95% confidence interval [CI] 2.8 to 10.7), ICU admission (OR = 10.9, 95% CI 2.2 to 55.6) and high dependency unit (HDU) admission (OR = 3.3, 95% CI 1.2 to 9.2). However, diagnostic test accuracy data were not reported. The other study (Garcea et al. 2006) looked at the ability of the early warning score (EWS) to predict mortality in a sample of 110 patients admitted with acute pancreatitis. Sensitivities for the tool on days 1, 2 and 3 following admission were 85.7%, 71.4% and 100%. Specificities were 28.3%, 67.4% and 77.4% respectively.

(II) There is inter-rater and intra-rater variation in the measurement of the physiological variables, although better agreement exists in the thresholds to trigger.

One study (Subbe et al. 2007) evaluated the reproducibility of MET (single parameter), MEWS (aggregate scoring system) and ASSIST (assessment score for sick patient identification and step-up in treatment – aggregate scoring system) for identifying at-risk patients on the ward. It found that there was significant variation in the reproducibility of the three systems examined, and that all three showed better agreement on triggers than aggregate scores. In summary, the study found that MET achieved higher percentage agreement than ASSIST, and ASSIST higher than MEWS; and the intra-rater reliability

was better than inter-rater reliability. The results on triggers in the sub-inter-rater analysis were MET: Kappa = −0.03, 95% CI −0.05 to 0.00; MEWS: Kappa = 0.18, 95% CI 0.09 to 0.27; ASSIST: Kappa = 0.20, 95% CI 0.04-0.38. The results in the sub-intra-rater analysis were MET: Kappa = −0.01, 95% CI −0.02 to −0.01; MEWS: Kappa = 0.64, 95% CI 0.46 to 0.84; ASSIST: Kappa = 0.66, 95% CI 0.04 to 0.38. The study also showed that simpler systems were more reliable.

Evidence to recommendations

The Guideline Development Group discussed whether the evidence for physiological track and trigger systems could be generalised to all acutely ill patients in acute hospital settings. Although the primary studies were from selected population groups, the effects seen were consistent across groups. In addition, the cohort studies used routine data collected from a wide range of settings, including general wards or medical admissions units.

The use of a physiological track and trigger system increases the number of observations made by healthcare professionals (McBride et al. 2005), which the Guideline Development Group considered increased the likelihood of healthcare professionals identifying and acting on abnormal observations.

The Guideline Development Group considered that this recommendation would not be difficult to implement, because the majority of acute hospitals in England and Wales already use physiological track and trigger systems.

2.1.5 Choice of physiological track and trigger system

Recommendation 1.2.2.4

Track and trigger systems should use multiple-parameter or aggregate weighted scoring systems, which allow a graded response. These scoring systems should:

- define the parameters to be measured and the frequency of observations
- include a clear and explicit statement of the parameters, cut-off points or scores that should trigger a response.

Evidence review

Single parameter systems

Two studies (Bell et al. 2006; Buist et al. 2004) evaluated the MET track and trigger tools with a single parameter trigger. One of these (Buist et al. 2004) evaluated a system, based on the MET calling criteria, to predict in-hospital mortality in general ward patients. The MET responded to all abnormal observations. The study reported positive predictive values for mortality with a trigger of one abnormal observation only (positive predictive value = 16.2%), one or more abnormal observations (positive predictive value = 35%) and four or more abnormal observations (positive predictive value = 88.2%). The second study (Bell et al. 2006) considered the accuracy of a system based on four physiological parameters to predict mortality at 30 days and 6 months in general ward patients. If a patient obtained a trigger score on any of the parameters observed, the nurse in charge was informed. For 30-day mortality the system had a sensitivity of 33.3% and specificity of 96.5%; positive predictive value = 33.3% and negative predictive value = 33.3%. For 6-month mortality the system correctly identified 37.5% of patients (sensitivity = 37.5%, positive predictive value = 12.1%; specificity = 87.3%, negative predictive value = 96.8%). In summary, a single parameter system tends to have low sensitivity (range between 16.2% and 37.5% depending on trigger thresholds) and high specificity (range between 87.3% and 96.5%).

A further intervention study (Hillman et al. 2005) (cluster randomised controlled trial) showed that because of the low sensitivity of the MET system, its introduction in 12 Australian hospitals substantially increased call-out rates for the MET when compared with traditional cardiac arrest team (cardiac arrest team = 3.1, 1.3 standard deviation [SD]; MET = 8.7, 3.5 SD; $p = 0.0001$), and the mean number of calls not associated with an adverse event was also significantly higher in hospitals with the MET system (cardiac arrest team = 1.2, 0.8 SD; MET = 6.3, 2.4 SD; $p < 0.0001$).

Multiple parameter systems

Multiple parameter systems were evaluated in three studies (Goldhill et al. 1999b; Goldhill et al. 2005; Goldhill and McNarry 2004), all three studies were based on the PART calling criteria. One of these studies (Goldhill et al. 1999b)

evaluated the ability of the system to predict admission to ICU in hospital ward patients. Patients triggered the system if they had three out of six abnormal physiological parameters (or reduced consciousness with increased heart or respiratory rate). Sensitivity and specificity for patients with three abnormal observations were 27% and 57% respectively. For patients with one abnormal observation only sensitivity was 97% (specificity 18%) and for two abnormal observations sensitivity was 80% (specificity 41%). The second study (Goldhill and McNarry 2004), also based on the PART calling criteria stepwise multiple regression, identified five significant predictors of 30-day mortality (consciousness, heart rate, age, blood pressure and respiratory rate), Sensitivity and positive predictive value of the model were 7.7% and 66.7% respectively (specificity 99.8%). In the third study (Goldhill et al. 2005), the patient-at-risk (PAR) scoring system was tested for its association with the patient's need for intervention and with hospital mortality. The findings showed significant association between PAR score (of > 0) and hospital mortality (chi-squared for trend, $p < 0.0001$), and its ability to discriminate between patients who needed intervention and those who did not (area under ROC curve = 0.822).

Aggregate weighted scoring systems

Five studies (Duckitt et al. 2007; Garcea et al. 2006; Hodgetts et al. 2002; Lam et al. 2006; Subbe et al. 2001) used track and trigger tools with aggregate scoring systems, one of which was based on EWS and two on MEWS. There was also one study that validated a newly developed scoring system – the Worthing Physiological Scoring System (Duckitt et al. 2007). The first study (Garcea et al. 2006) looked at the ability of EWS to predict mortality in a sample of 110 patients admitted with acute pancreatitis. Sensitivities for the tool on days 1, 2 and 3 following admission were 85.7%, 71.4% and 100%; specificities were 28.3%, 67.4% and 77.4% respectively. A ROC curve analysis found that EWS was the best predictor of adverse outcomes (defined as death, pancreatic necrosectomy or critical care admission) in the first 24 hours after admission compared with APACHE (acute physiology and chronic health evaluation) scores, ASA grade, Ranson score, Imrie score, and CT grades.

The second study (Lam et al. 2006) evaluated the ability of a five-parameter MEWS to predict serious outcome (ICU admission and/or death) in a sample of patients on an accident and emergency department observation ward. A score of four or more triggered the system, with a sensitivity of 60% and specificity of 97%. A ROC curve analysis suggested that the system performed best with a score of more than three: sensitivity 100%, specificity 97%.

The third study (Subbe et al. 2001) also evaluated the MEWS system on its ability to predict ICU/HDU admission, attendance of cardiac arrest team and 60-day mortality, in patients in an acute medical admissions unit. Diagnostic test accuracy data were not reported, but a trigger score (of five or more) was associated with increased risk of death (OR = 5.4, 95% CI 2.8 to 10.7), ICU admission (OR = 10.9, 95% CI 2.2 to 55.6), and HDU admission (OR = 3.3, 95% CI 1.2 to 9.2).

The fourth study had a case–control design (Hodgetts et al. 2002) (case–control designs have been shown to result in biased, usually inflated, estimates of test accuracy). A track and trigger system based on 10 parameters was assessed for its ability to predict in-hospital cardiac arrest (defined as cardiopulmonary resuscitation attempted) in hospital patients (including both wards and critical care areas). The study was carried out to inform the development of MET calling criteria. A panel of experts grouped and weighted the activation criteria and a cumulative scoring system was developed. A ROC analysis determined that a score of four had 89% sensitivity and 77% specificity for cardiac arrest; a score of eight had 52% sensitivity and 99% specificity. All patients scoring greater than 10 suffered cardiac arrest.

The fifth study had a prospective observational population based design (single-centre study) (Duckitt et al. 2007). A track and trigger system based on six parameters was validated to investigate the relative contributions of respiratory rate, pulse rate, arterial blood pressure, temperature, oxygen saturation and consciousness level to hospital mortality. The Worthing Physiological Scoring System was devised, with cut off points set at ≥ 2 (be

alert and increase frequency of observations) and ≥ 5 (urgent review). A ROC analysis showed that this scoring system was significantly better than the EWS (Worthing system: area under the ROC = 0.74, 95% CI: 0.71 to 0.77; EWS: area under the ROC = 0.68, 95% CI: 0.65 to 0.71; $p < 0.001$).

Furthermore, there was one cohort study embedded in a systematic review (Gao et al. 2007) that looked at the ability of 15 physiological track and trigger systems, used within acute NHS hospitals in England and Wales, to predict a composite outcome, which was the presence of critical illness (defined as death, admission to critical care, do-not-resuscitate orders, or cardiopulmonary resuscitation). Ten systems used an aggregate scoring system, one used a single parameter system, and four used combination systems. All included heart rate, respiratory rate, systolic blood pressure and level of consciousness, but systems varied in terms of the other physiological parameters assessed, assignment of scores to physiological values and the trigger thresholds used. There were also considerable differences in the response initiated if a patient had a trigger score. The diagnostic accuracy of the systems differed widely. Sensitivities and positive predictive values were low (median sensitivity = 43.3%, interquartile [IQ] range 25.4 to 69.2%; median positive predictive value = 36.7%, IQ range 29.3 to 43.8%). Specificities and negative predictive values were higher (median specificity = 89.5%, IQ range 64.2 to 95.7%; median negative predictive value = 94.3%, IQ range 89.5 to 97.0%). Within hospitals there were some differences in the discrimination of track and trigger systems in different age groups, wards and specialities, but these were not consistent across hospitals. A random-effects meta-regression was used to explore the heterogeneity amongst the datasets. Differences in diagnostic accuracy were not explained by the physiological parameters included in the system, the outcome variables recorded in the dataset, or the inclusion of critical care follow-up versus all ward/medical admissions unit patients.

Evidence statements on alternative track and trigger systems

(II) Single parameter systems, as used by MET systems, have low sensitivity, low positive predictive values but high specificity.

(II) Multiple parameter systems require the presence of one or more abnormal physiological variables. These systems have high sensitivity but low specificity when one abnormal observation is present. Sensitivity reduces and specificity increases as the number of abnormal variables increase.

(II) Multiple parameter systems require the presence of one or more abnormal physiological variables. These systems have comparatively high sensitivity but relatively low specificity when one abnormal observation is present (that is, at low scores). Sensitivity reduces and specificity increases as the number of abnormal variables increase.

(II) Aggregate weighted scoring systems demonstrate a range of sensitivities and specificities depending on the cut-off score used. It is possible to achieve high sensitivity and specificity at defined cut-off scores.

Physiological track and trigger systems have been examined in a variety of settings to determine their ability to identify patients at risk of deterioration. Considerable variation exists between the type of systems evaluated, physiological parameters included, choice of trigger and the patient outcomes (reference criteria) considered. No physiological track and trigger system was identified that had been validated in a variety of populations and settings. However, it could be summarised that:

(II) Single parameter systems trigger a single response strategy. Multiple parameter and aggregate warning systems allow for monitoring of a patient's condition and allow for a graded response strategy to be triggered, depending on the score.

See table 2 for a comparison of the advantages and disadvantages of different types of track and trigger system.

Table 2: Advantages and disadvantages of different types of track and trigger system

Track and trigger system	Advantages	Disadvantages
Single parameter (MET calling criteria)	• Simple to use • Simple system with better reproducibility	• Does not allow a patient's progress to be tracked • Does not allow a graded response strategy • Current evidence suggested that the system has low sensitivity, low positive predictive value but high specificity. This could potentially cause increased triggers that are not related to an adverse event • Not widely adopted in UK hospitals
Multiple parameter (PART)	• Allow monitoring of clinical progress • Allow for a graded response strategy • Widely used in UK hospitals	• May lack reproducibility and reliability because systems are prone to human calculation errors • These systems have high sensitivity but low specificity when one abnormal observation is present, but sensitivity reduces and specificity increases as the number of abnormal variables increase
Aggregate scoring system (EWS, MEWS, The Worthing Physiological Scoring System)	• Allow monitoring of clinical progress • Allow for a graded response strategy • Widely used in UK hospitals	• May lack reproducibility and reliability because systems are prone to human calculation errors • A range of sensitivities and specificities depending on the cut-off score used, but it is possible to achieve high sensitivity and specificity at defined cut-off point

(II) Simpler scoring systems may have better reproducibility than more complex ones.

One study (Subbe et al. 2007) showed that simpler track and trigger systems such as MET calling criteria have better reproducibility than more complex systems such as PART, EWS and MEWS. Another study (Prytherch et al. 2006) also showed that more complex systems such as EWS were prone to human calculation errors. However, the study also showed that this problem could be rectified by adopting electronic devices to calculate and chart EWS. In this study, a classroom comparison study of traditional 'pen and paper' method and 'hand-held computer' method on calculating and charting EWS was carried out. The findings suggested that the 'pen and paper' method resulted in more errors than the 'hand-held computer' method (pen and paper: error = 28.6% [24/84], computer: error = 9.5% [8/84]; pen and paper: incorrect clinical action = 14.3% [12/84], computer: incorrect clinical action = 4.8% [4/84]. The study also showed that the average time for participants to calculate and chart a set of EWS scores was significantly faster in the 'hand-held computer' group compared with the 'pen and paper' group (mean difference of average time for participants to calculate and chart = 24.5 ±12.2s, 95% CI 19.3 to 29.8, $p < 0.0001$).

Evidence to recommendations

The ROC curve plots all types of physiological track and trigger systems along a curve that suggests that all track and trigger systems have similar sensitivities, positive predictive value, specificities and negative predictive value once allowance is made for trigger threshold.

The decision to recommend one system over another depends, among other factors, on the systems' clinical utilities. Multiple parameter systems and aggregate scoring systems have the advantage of allowing tracking of a patient's condition and allow for a graded response strategy, depending on score.

The Guideline Development Group considered that recommendations 1.2.2.3 and 1.2.2.4 would not be difficult to implement, because the majority of acute

hospitals in England and Wales already use physiological track and trigger systems.

The Guideline Development Group noted that automated/electronic systems allow for better recording of data and may result in increased reproducibility. However, the Group identified a need for further research that evaluates the effectiveness and cost-effectiveness of automated/electronic systems before their widespread use could be recommended.

2.1.6 Physiological parameters to be used by track and trigger systems

Recommendation 1.2.2.5

Multiple-parameter or aggregate weighted scoring systems used for track and trigger systems should measure:

- heart rate
- respiratory rate
- systolic blood pressure
- level of consciousness
- oxygen saturation
- temperature.

Recommendation 1.2.2.6

In specific clinical circumstances, additional monitoring should be considered; for example:

- hourly urine output
- biochemical analysis, such as lactate, blood glucose, base deficit, arterial pH
- pain assessment.

Evidence review

Thirteen of the identified studies (Bell et al. 2006; Buist et al. 2004; Cuthbertson et al. 2007; Duckitt et al. 2007; Gao et al. 2007; Garcea et al. 2006; Goldhill et al. 1999b; Goldhill et al. 2005; Goldhill and McNarry 2004; Hodgetts et al. 2002; Lam et al. 2006; Subbe et al. 2001; Subbe et al. 2006) were concerned with the development and/or testing of track and trigger systems. The number of physiological parameters included by the systems within these studies ranged from 4 to 10. All of the track and trigger systems evaluated included heart rate, respiratory rate and systolic blood pressure, and all but one (Hodgetts et al. 2002) also included level of consciousness. Temperature and/or oxygen saturation were often included in systems. Urine output was less frequently included (only 4 out of 13 studies used this as a parameter).

Evidence statements

(III) The following parameters were used in the majority of systems reviewed:

- *heart rate*
- *respiratory rate*
- *systolic blood pressure*
- *level of consciousness*
- *temperature*
- *oxygen saturation*
- *urine output.*

All 13 validation/development studies included heart rate, respiratory rate and systolic blood pressure as parameters. One study (Subbe et al. 2001) had level of evidence Ib, seven studies (Bell et al. 2006; Buist et al. 2004; Cuthbertson et al. 2007; Goldhill et al. 2005; Goldhill and McNarry 2004; Hodgetts et al. 2002; Lam et al. 2006) had level of evidence II and five studies (Duckitt et al. 2007; Gao et al. 2007; Garcea et al. 2006; Goldhill et al. 1999a; Subbe et al. 2006) had level of evidence III. One of the studies (Cuthbertson et al. 2007) also addressed the question as to the performance of individual physiological observations. It found that heart rate and respiratory rate could

differentiate between patients in a surgical HDU that would or would not require ICU admission, up to 7–8 hours before admission.

Twelve studies included level of consciousness as a parameter: one of these (Subbe et al. 2001) was graded Ib, six (Bell et al. 2006; Buist et al. 2004; Cuthbertson et al. 2007; Goldhill et al. 2005; Goldhill and McNarry 2004; Lam et al. 2006) were graded II and five (Duckitt et al. 2007; Gao et al. 2007; Garcea et al. 2006; Goldhill et al. 1999b; Subbe et al. 2006) were graded III.

There were nine studies that included temperature as a parameter. Of these there was one study graded Ib (Subbe et al. 2001), five studies graded II (Cuthbertson et al. 2007; Goldhill et al. 2005; Goldhill and McNarry 2004; Hodgetts et al. 2002; Lam et al. 2006) and three studies graded III (Duckitt et al. 2007; Garcea et al. 2006; Subbe et al. 2006).

Eight studies included oxygen saturation in the systems evaluated. Five of them were graded II (Buist et al. 2004; Cuthbertson et al. 2007; Goldhill et al. 2005; Goldhill and McNarry 2004; Hodgetts et al. 2002) and three were graded III (Duckitt et al. 2007; Goldhill et al. 1999b; Subbe et al. 2006). One of the studies (Cuthbertson et al. 2007) also addressed the question of the performance of individual physiological observations. It found that oxygen saturation could differentiate between patients in a surgical HDU who would or would not require ICU admission, up to 48 hours before admission.

Urine output was the least frequently included parameter in the review, used by only four studies. Two were graded II (Goldhill et al. 2005; Goldhill and McNarry 2004) and two were graded III (Goldhill et al. 1999b; Subbe et al. 2006).

Evidence to recommendations

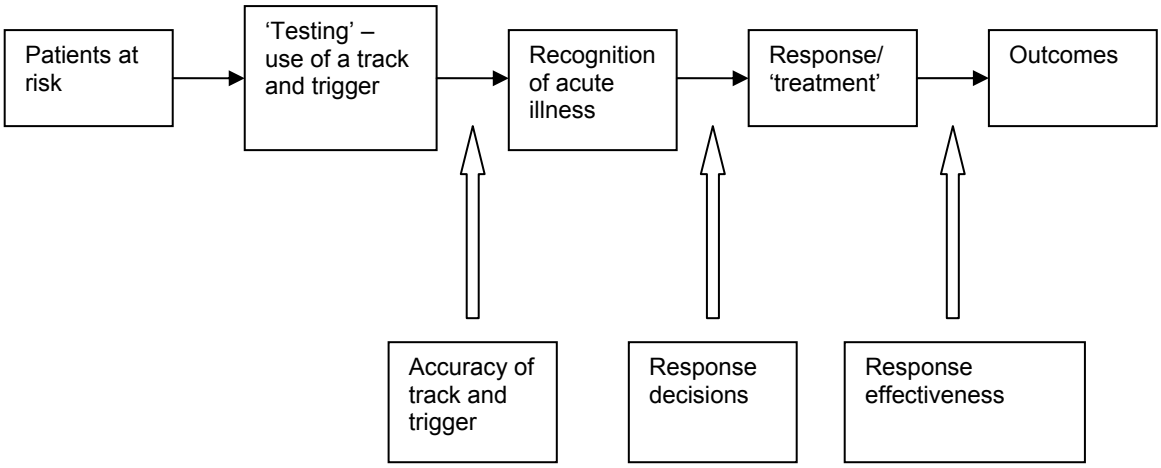
The Guideline Development Group considered that the chosen scoring system should measure a core set of physiological parameters. The evidence reviewed above was discussed and the consensus view of the Guideline Development Group was that heart rate, respiratory rate, systolic blood pressure, level of consciousness, oxygen saturation and temperature should be included. It was decided that although some multiple-parameter or

aggregate weighted scoring systems did not include oxygen saturation, this was an important early predictor of deterioration and should be included as a core parameter. Conversely, although it was noted that some multiple-parameter or aggregate weighted scoring systems included urine output, the consensus of the Guideline Development Group was that urine output should not be a core parameter because reliable assessment of urine output requires bladder catheterisation, and this is performed only in specific clinical circumstances.

2.1.7 Issues relating to assessing the cost effectiveness of physiological track and trigger systems

Track and trigger systems can be viewed as diagnostic technologies. The clinical effectiveness of a diagnostic technology is determined by the extent to which incorporating it into clinical practice improves health outcomes. So, in most instances, the effectiveness of the technology will depend on whether the overall accuracy of identification is improved by its inclusion, its impact on therapeutic decisions and the effectiveness of the treatments subsequently chosen (in this instance, the response strategies). A simplified clinical/evidence pathway for this guideline is shown in figure 1.

Figure 1 Simplified clinical/evidence pathway



Ideally, randomised controlled trials (such as cluster randomised controlled trials in this instance, randomised by hospital rather than ward) of a diagnostic

technology's ability to improve outcomes should be conducted. If such direct evidence is unavailable, it may be possible to link together separate pieces of evidence from the pathway. As noted above, in many cases, physiological track and trigger systems have been introduced in combination with a response strategy, such as outreach services. Section 2.2 discusses more fully the evidence available on response strategies, and an unpublished cost effectiveness analysis of critical care outreach services is described.

One approach to assessing the economic implications of track and trigger systems is to develop a model to estimate the incremental cost per correct 'diagnosis' for each type of system. At it simplest, there will be a limited range of costs included, for example, the cost of monitoring (that is, clinical contact time) and the cost of any tests or measurements necessary, such as costs related to the use of thermometers and other equipment. The costs of clinical contact time (such as healthcare professional time spent collecting and recording data) may be very important in terms of NHS resources. Multiple/aggregate parameter systems are likely to be more resource intensive in this respect than simpler systems.

The basic model described above needs data about the prevalence of the outcome of interest: relevant diagnostic outcomes could be mortality, admission to critical care or some composite measure such as 'established critical illness' (as in the 2007 Gao et al. review). The model also needs to include estimates of sensitivity and specificity. Cost effectiveness may also be influenced by the 'trigger' threshold. However, the evidence is insufficient to distinguish between the available track and trigger systems. The cost effectiveness estimates produced would be highly speculative and difficult to interpret from a decision maker's perspective.

To meaningfully address the issue of the cost effectiveness of track and trigger systems, data on the link between the track and trigger system and the associated response needs to be incorporated into an analysis, together with an estimate of the effectiveness of that response in improving patient outcomes.

2.2 Response strategies for patients identified as having a deteriorating clinical condition

2.2.1 Introduction

Response strategies for patients identified as having a deteriorating clinical condition on general medical and surgical wards and emergency departments in the NHS fall into two groups. Firstly, a ward level response, which ranges from an increased level of physiological monitoring by ward staff to call out of the medical or surgical staff responsible for the patient's care. Secondly, the use of a dedicated hospital team with specific skills in managing the critically ill patient.

In the NHS, dedicated hospital teams – called critical care outreach services (CCOS) – were identified as an important component of future critical care services in 'Comprehensive critical care' (Department of Health 2000). These services aim to prevent admission to critical care or ensure admission is appropriate, to enable discharges from critical care and to share skills with ward and community staff. Critical care networks and NHS trust critical care delivery groups were encouraged to develop their own locally customised service. Since 2000, a wide range of CCOS have been introduced at local level in the NHS (Department of Health and NHS Modernisation Agency 2003). In a recent survey of NHS acute hospitals in England that routinely provide care for level 1 patients, 73% had a formal CCOS (McDonnell et al. in press).

CCOS cover a wide range of activities undertaken for critically ill patients, including:

- education and training for general ward staff on the recognition of critical illness
- the introduction of and response to physiological track and trigger warning systems in general wards
- telephone 'hotline' advice for ward staff
- follow-up of patients on general wards after discharge from critical care

- direct bedside clinical support on general wards
- audit and evaluation of critical care outreach activity
- delivery of rehabilitation programmes (inpatient and outpatient) for patients after a period of critical illness.

2.2.2 Overview

The Esmonde and coworkers (2006) review, a substudy of the work commissioned by the SDO programme from ICNARC (see section 3.3.10), was used as the basis of the NICE evidence review. Critical care outreach services were defined broadly (as above) and the search strategy allowed papers that offered as their 'intervention' both CCOS (as defined above) and ward-level responses to be identified. The Esmonde and coworkers (2006) review included 23 published and unpublished papers: 15 were set in England and Wales, seven in Australia and one in the USA. After further study selection, six papers were excluded from the review because they were unpublished (one unpublished paper, two abstracts, three presentations). The search strategies developed by Esmonde and coworkers (2006) were obtained from the authors and re-run to identify studies from 2004 onwards. The updated literature search (see appendices) identified three extra studies that met our inclusion criteria (see appendices), making a total of 20 papers (10 England and Wales, nine Australia, one USA) to be included in the review.

The systematic review analysed the reported outcomes in the included papers, regardless of the type of outreach services or track and trigger system they used. For instance, the outcomes analyses in the review included impact on mortality, on length of stay, on cardiac arrest rate, on unplanned admissions to the critical care unit and on readmissions to the critical care unit. The study design, track and trigger system used, composition of outreach services and interventions provided by outreach services within the 19 studies and a service evaluation study that were identified by the update search differed widely. These are presented in table 3 and are also summarised in the following section.

- Randomised controlled trials (RCTs). There were two RCTs that used a cluster-randomised design. One study was set in England and Wales (critical care outreach team [CCOT] with a PAR score track and trigger system – multiple parameter system) and the other was set in Australia (MET with single parameter system). The outcomes measured in these two studies were: cardiac arrest rate, unplanned ICU admissions, hospital mortality and hospital length of stay. The quality of information on composition of the team and interventions provided by the team differed between the two studies.
- Observational studies. There were 17 observational studies (uncontrolled before-and-after). Nine were set in the UK (five studies were CCOT using MEWS; one was PART; one was MET; two other studies were CCOT but type of track and trigger system not mentioned), seven were set in Australia (six with MET using single parameter system and one looking at the effectiveness of CCOT on top of MET) and one was set in the USA (MET with single parameter system). The outcomes that were measured in these studies were: hospital mortality, ICU mortality, ICU mortality for unplanned admissions, surgical mortality, cardiac arrest mortality, hospital mortality associated with readmissions, hospital mortality after cardiac arrest, critical care mortality associated with readmissions, 30-day mortality associated with readmissions, 30-day surgical mortality, ICU mortality with tracheotomy tube in situ, cardiac arrest, hospital length of stay, ICU length of stay, hospital length of stay after cardiac arrest, ICU length of stay after cardiac arrest, hospital length of stay following readmissions, ICU length of stay following readmissions, length of stay after major surgery, unplanned ICU admissions and ICU readmissions.
- Service evaluation. There was one service evaluation study from Australia. The study looked at the effect of an education programme on the utilisation of MET.

Overall, the quality of the evidence was poor, and only two RCTs (using a cluster randomised design) were identified. These two studies were of acceptable quality (level of evidence 1+) and provided the evidence statements that formed the basis for the recommendations. The majority of

the other reported studies were retrospective uncontrolled before-and-after studies. These are susceptible to a large number of biases that make it very difficult to ascribe causality to the intervention. These have been graded as meriting an evidence level of 2−. Such studies are reported in the evidence tables but not used as the basis for making clinical guideline recommendations (National Institute for Health and Clinical Excellence 2006).

There were particular challenges in summarising and presenting the evidence of effectiveness of response strategies. CCOS is a complex intervention, with a variety of different components delivered at different times during the care pathway. It is therefore difficult to ascribe any observed effect to any particular part of the intervention and, conversely, to determine which aspects of the intervention may be ineffective. Considering the intervention in terms of population, intervention, comparison group and outcomes, the following issues were identified. The populations reviewed tended to be set in either England and Wales or Australia. In the Australian studies the intervention involved a multidisciplinary MET delivering CCOS responding to a single parameter track and trigger system. In the studies set in England and Wales the intervention was more variable, involving multidisciplinary teams that were often nurse led, and was initiated by the use of a multiple parameter (PART) or an aggregate scoring system (MEWS) track and trigger system. There was also variability in terms of the timing of the evaluation, particularly in the before-and-after studies reported. The literature on ward-level response – as opposed to CCOS – was very limited, with only one study identified as eligible for inclusion in the review.

In addition, the NICE technical team had access to the following unpublished SDO-commissioned ICNARC work (see also section 3.3.10).

- Substudy 4 (McDonnell et al. in press) – survey of outreach services.
- Substudy 5 (Baker et al. unpublished) – qualitative study of a number of case studies of different models of outreach services.
- Substudy 6 (Gao et al. unpublished) – interrupted time series analysis of the impact of outreach services on critical care admissions at the unit level.

- Substudy 7 (Harrison et al. unpublished) – a non-randomised, matched cohort analysis of outreach care at the patient level, within which an economic evaluation forms an important part.

The unpublished substudies 6 and 7 met the inclusion criteria for consideration as a quasiexperimental evaluation of CCOS, and are therefore summarised in this review. The provisional findings were also presented to the Guideline Development Group.

In terms of economic evaluations, a systematic search was carried out for any publications that considered the costs or cost-effectiveness of response strategies including outreach services. The criteria for inclusion were comparatively broad but no relevant published evaluation studies were identified, although some limited data were found on the costs of outreach services. An unpublished economic evaluation of outreach services was identified (part of ICNARC's substudy 7 mentioned above) and made available to the Guideline Development Group.

The limited available evidence on the effectiveness of CCOS has been highlighted by other researchers in the field (Winters et al. 2006). A particular area of concern has been that the implementation of CCOS or rapid response systems in various healthcare systems (including the UK) has occurred in the absence of clear evidence of effectiveness (Price et al. 2007; Teplick and Anderson 2006; Winters et al. 2006).

2.2.3 Critical care outreach services for patients whose clinical condition is deteriorating

Recommendation 1.2.2.7

Staff caring for patients in acute hospital settings should have competencies in monitoring, measurement, interpretation and prompt response to the acutely ill patient appropriate to the level of care they are providing. Education and training should be provided to ensure staff have these competencies, and they should be assessed to ensure they can demonstrate them.

Recommendation 1.2.2.8

The response strategy for patients identified as being at risk of clinical deterioration should be triggered by either physiological track and trigger score or clinical concern.

Recommendation 1.2.2.9

Trigger thresholds for track and trigger systems should be set locally. The threshold should be reviewed regularly to optimise sensitivity and specificity.

Graded response strategy

No specific service configuration can be recommended as a preferred response strategy for individuals identified as having a deteriorating clinical condition.

Recommendation 1.2.2.10

A graded response strategy for patients identified as being at risk of clinical deterioration should be agreed and delivered locally. It should consist of the following three levels.

- Low-score group:
  - Increased frequency of observations and the nurse in charge alerted.
- Medium-score group:
  - Urgent call to team with primary medical responsibility for the patient.
  - Simultaneous call to personnel with core competencies for acute illness. These competencies can be delivered by a variety of models at a local level, such as a critical care outreach team, a hospital-at-night team or a specialist trainee in an acute medical or surgical specialty.
- High-score group:
  - Emergency call to team with critical care competencies and diagnostic skills. The team should include a medical practitioner skilled in the assessment of the critically ill patient, who possesses advanced airway management and resuscitation skills. There should be an immediate response.

Recommendation 1.2.2.11

Patients identified as ‘clinical emergency’ should bypass the graded response system. With the exception of those with a cardiac arrest, they should be treated in the same way as the high-score group.

Recommendation 1.2.2.12

For patients in the high- and medium-score groups, healthcare professionals should:

- initiate appropriate interventions
- assess response
- formulate a management plan, including location and level of care.

Recommendation 1.2.2.13

If the team caring for the patient considers that admission to a critical care area is clinically indicated, then the decision to admit should involve both the consultant caring for the patient on the ward and the consultant in critical care.

Evidence review

Two good quality cluster-RCT studies (Hillman et al. 2005; Priestley et al. 2004) with the level of evidence (1+) were included as the basis for recommendations.

One cluster RCT (Hillman et al. 2005) (randomised at hospital level) was set in Australia using a MET, with a single parameter track and trigger system. This study included 23 hospitals in Australia (12 with MET – intervention group, 11 without MET – control group) with a study period of 6 months. There was education/training for all staff within the intervention group before the introduction of the MET system. The composition of the MET differed among the 12 participating hospitals but it was required to be at least the equivalent of the pre-existing cardiac arrest team and to consist of at least one doctor and one nurse from the emergency department or ICU. The type of interventions provided by the MET was not reported in this study.

The other cluster RCT (Priestley et al. 2004) used a stepped wedge trial design (Brown and Lilford 2006) and was set in an acute hospital in England using a nurse-led CCOT with a multiple parameter track and trigger system

(using PAR score). Education/training was introduced to staff sequentially, based on ward level, before the implementation of CCOT with PAR score to that particular ward. The composition of the CCOT in this study was a 24-hour service with one nurse consultant and a team of experienced nurses. In this study ward staff used PAR score to trigger referral to CCOT and involvement of the admitting team's consultant. CCOT would also to be called if there was concern about a patient, irrespective of PAR scores. The level of CCOT involvement was determined by the ward staff and the admitting team. As circumstances required, CCOT might support and advise ward staff, remain with the patient and provide individual nursing care on the ward during a crisis period or facilitate admission to ICU. The study design used (stepped wedge trial design) in this study is a pragmatic design, hence the findings of this study might be subject to bias and contamination.

Review findings

Composite outcomes

One cluster RCT (Hillman et al. 2005) had as its primary outcome the following composite outcomes: incidence of cardiac arrest, unplanned ICU admission (without do-not-resuscitate order) and unexpected death (without do-not-resuscitate order). However, the study found no difference in composite outcome (per 1000 admissions: control = 5.86, intervention = 5.31, difference = −0.264 [95% CI: −2.449 to 1.921], adjusted p = 0.640, adjusted OR = 0.98, 95% CI 0.83 to 1.16).

Mortality rates

One cluster RCT (Priestley et al. 2004) from the UK investigated the effectiveness of CCOT on hospital mortality using PAR scores (multiple parameter system) as calling criteria. There was an education/training phase before the implementation of the CCOT in the intervention group. The trial found a significant reduction in hospital mortality in patients in the intervention wards at cluster level (OR = 0.523, 95% CI 0.322 to 0.849). The cluster RCT from Australia (Hillman et al. 2005) found no difference in unexpected death (without do-not-resuscitate order) (secondary outcome) between control group and intervention group (per 1000 admissions: control = 1.18,

intervention = 1.06, difference = −0.093 [−0.423 to 0.237], 95% CI: −0.423 to 0.237; adjusted p = 0.752, adjusted OR = 1.03, 95% CI 0.84 to 1.28).

Cardiac arrest rates

Only the MERIT study (Hillman et al. 2005) included cardiac arrest rates as a secondary outcome measure. The other cluster RCT from the UK did not include cardiac arrest as a variable. In the MERIT study (Hillman et al. 2005), the analysis showed no significant difference in cardiac arrest rates between the control group and intervention group (control = 1.64, intervention = 1.31, difference = −0.208 [95% CI: −0.620 to 0.204], adjusted p = 0.736, adjusted OR = 0.94, 95% CI 0.79 to 1.13).

Length of stay

Only the UK cluster RCT (Priestley et al. 2004) included hospital length of stay as an outcome measure. The MERIT study did not investigate hospital length of stay. In the Priestley and coworkers (2004) study, the findings showed a possible increased hospital length of stay associated with outreach services but the results were not fully supported by confirmatory and sensitivity analyses. Consequently, hospital length of stay adjusted for clustering in this study was reported as yielding a non-significant effect.

Unplanned intensive care unit admissions

Only the MERIT study (Hillman et al. 2005) included unplanned ICU admissions as a secondary outcome measure. The Priestley and coworkers (2004) study did not include unplanned ICU admission as an outcome measure. The MERIT (Hillman et al. 2005) study showed no significant difference in the rates of unplanned ICU admission (without do-not-resuscitate order) between the control group and intervention group (control = 4.68, intervention = 4.19, difference = −0.135 [95% CI: −2.330 to 2.060], adjusted p = 0.599, adjusted OR = 1.04, 95% CI 0.89 to 1.21).

Number of call-outs to an outreach service

In the process data reported in the MERIT study (Hillman et al. 2005), there was a significant increase in the number of call outs to the MET after the implementation of the team (control = 3.1, 1.3 SD; intervention = 8.7, 3.5 SD;

p = 0.0001). The mean number of call outs not associated with an event – that is, admission to critical care – was also statistically significantly higher in the intervention group than in the control group (per 1000 admissions: control = 1.2, 0.8 SD; intervention = 6.3, 2.4 SD; p < 0.0001). The process measures were not reported in the Priestley and coworkers (2004) study.

Educational training

Both studies have a component of education/training preceding the implementation of CCOS. In the MERIT study (Hillman et al. 2005) the education programme was provided to all staff (over a 4-month period before introduction of the MET) using lectures, a MET video explaining the concept and process and books. The content of the education programme included the identification of patients at risk, the use of calling criteria, the need to call quickly if criteria were met and how to call the MET. A 4-week training programme facilitated by the CCOT was also given to all nurses and doctors in the Priestley and coworkers (2004) study. This training preceded the formal implementation of the CCOT. The training programme included formal and informal sessions on the use of an in-house 'patient-at-risk' score (PAR) as calling criteria.

Composition of, and the interventions provided by, the critical care outreach services

The composition of the MET and CCOT differed in the two studies. In the MERIT study (Hillman et al. 2005) the METs in the 12 intervention hospitals were different from each other but each was required to be at least the equivalent of the pre-existing cardiac arrest team and to consist of at least one doctor and one nurse from emergency department or ICU. In the Priestley and coworkers (2004) study, the composition of the CCOT consisted of a team led by a nurse consultant with five nurses (4.5 whole time equivalents) from various specialities and eight sessions per week of support from consultant anaesthetists with special interest in critical care. The five nurses were all senior and experienced and were seconded into the team from their posts in critical care, theatre recovery, general surgery, medicine and orthopaedics. Ward staff and the admitting team's consultant were also involved at ward-level during the calling process.

The type of interventions provided by the MET in the MERIT study (Hillman et al. 2005) was not reported. In the Priestley and coworkers (2004) study the level of CCOT involvement was determined by ward staff and the admitting team. As circumstances required, CCOT might support and advise ward staff, remain with the patient and provide individual nursing care on the ward during crisis period, or facilitate the admission to ICU. There was also emphasis on sharing skills, collaboration with the admitting team and provision of practical 'hands-on' help to ward staff.

Evidence statements

(1+) The two included studies differed from each other with regard to the population under study, baseline and study design, what was delivered as an intervention, the control group and outcomes under study. The intervention in each case was a complex intervention.

(1+) Both included studies delivered training on how to recognise and manage the acutely ill patient to ward staff before the implementation of CCOS. In addition, both studies delivered CCOS by healthcare professionals with appropriate training and competencies in the management of critically ill patients.

(1+) One study (MERIT) reported a composite outcome, which comprised the incidence of cardiac arrest, unplanned ICU admission (without NFR) and unexpected death (without NFR). It found no difference between the intervention group and the control group for this composite outcome.

(1+) There were conflicting findings in the two included studies on mortality rates: the Priestley and coworkers study found a significant reduction in mortality (but failed to report do-not-resuscitate orders), but MERIT found no difference between the two arms of the study for this outcome.

(1+) The MERIT study reported cardiac arrest data, finding no difference in arrest rates between the intervention group and the control group. In addition, MERIT showed no difference in 'unplanned intensive care unit admissions' between the intervention group and the control group. The Priestley and

coworkers study did not include unplanned ICU admission as an outcome measure.

(1+) The MERIT study reported a large increase in the number of call outs to the critical care outreach service (MET has single parameter calling criteria) that did not require admission to critical care areas.

(1+) Only the Priestley and coworkers study reported data on length of stay: it showed no difference in the length of stay between the intervention group and the control group.

No studies were identified as being of sufficient quality to be included as the basis for clinical recommendations on the use of ward-level interventions as a response strategy.

Unpublished National Institute for Health Research Service Delivery and Organisation work

Because the work from the National Institute for Health Research Service Delivery and Organisation (SDO) was unpublished and not yet accepted for peer-reviewed publication at the time of the going to press, the findings of substudy 6 (Gao et al. unpublished) and substudy 7 (Harrison et al. unpublished) were viewed as provisional.

Substudy 6 (Gao et al. unpublished) was a multicentre interrupted time-series analysis examining the impact of the introduction of CCOS in England. The method adopted aimed to control for long term trends and seasonality in the data. The introduction of outreach services at different times and at different locations provided a natural experiment that could be used to minimise (but not completely eliminate) the impact of historical biases. The analysis was based on population-level effects and it is important to emphasise that causality cannot be attributed to the observed associations.

This study found that the presence of formal outreach service was associated with a significant decrease in cardiopulmonary resuscitation rates during the 24 hours before admission, in out-of-hours admission and in mean ICNARC

physiology score for admissions from the ward. However, no sustained effect was seen on mortality or readmission rates for patients discharged alive from CCU.

Substudy 7 (Harrison et al. unpublished) was a matched cohort analysis of the impact of outreach services at the patient level, as characterised by the case mix, outcome and activity of patients admitted to/discharged from critical care units participating in the Case Mix Programme. An economic evaluation formed part of this substudy. Fifty two outreach services were included in the analyses, and the median period of prospective data collection was 9 months.

For each case (that is, included hospital outreach service) three sets of matched controls were selected.

- Match 1: historic control before the introduction of a CCOS.
- Match 2: a concurrent admission to different hospital with no outreach service.
- Match 3: an admission to the same hospital during the study period but not seen by the outreach team.

In addition, a propensity model was built for each cohort by using logistic regression to model the factors predictive of receiving critical care outreach visits before admission or after discharge. Sensitivity and subgroup analyses were undertaken.

In terms of outreach activity prior to admission, the primary analysis on the difference in mean ICNARC physiology score found a statistically significant difference for match 1, but not for matches 2 and 3 (see table 3). With respect to outreach activity following discharge from the critical care unit, the primary analysis on the difference in hospital mortality found that it was lower for cases than controls: the difference was statistically significant in match 2 (see table 4). The propensity model produced similar results to those from the individually-matched analyses.

Table 3 Individually-matched results for outreach before admission: primary outcome – difference in mean ICNARC physiology score

Match	Mean (standard deviation)		Difference in means	
	Case	Control	Δ (95%confidence interval)	p value
1	21.3 (9.8)	22.3 (10.4)	−1.00 (−1.81 to −0.19)	0.016
2	21.9 (10.1)	21.9 (10.9)	0.03 (−0.61 to 0.67)	0.93
3	22.2 (10.1)	21.8 (10.4)	0.35 (−0.36 to 1.06)	0.34

Table 4 Individually-matched results for outreach after discharge: primary outcome – hospital mortality

Match	Deaths (percentage)		Matched pairs risk ratio	
	Case	Control	Relative risk (95% confidence interval)	p value
1	174 (10.3)	220 (12.7)	0.85 (0.70 to 1.02)	0.085
2	426 (10.2)	497 (11.7)	0.87 (0.78 to 0.98)	0.022
3	156 (8.9)	158 (9.0)	1.01 (0.82 to 1.25)	0.90

Overall, the results from matches 1 and 2 were broadly consistent with each other both before and after transfer from the critical care unit. The main inconsistency was in match 3, and this was probably the result of severe selection biases.

Health economics

Response strategies can be quite complex and are often introduced alongside a track and trigger system, although responses can be initiated in the absence of a track and trigger score if there is adequate concern. Ideally an economic evaluation would therefore wish to link the effectiveness of the track and trigger system with the appropriate response and estimate incremental costs per quality-adjusted life year (QALY) gained. At a basic level, an economic model could consider three alternatives:

- track and trigger plus outreach
- track and trigger plus ward level response
- conventional management.

Because many track and trigger systems allow for graded responses, typically increasing the frequency of observations at a relatively low threshold and informing more senior staff or an outreach team at higher thresholds, it would be important to incorporate this aspect of response into any model. Important parameters in this model would include length of hospital stay, the risk of cardiac arrest and death, and quality of life.

However, the data to convincingly inform such a model are largely absent, at least in the published literature. Of the effectiveness studies reviewed, the overwhelming majority considered the impact of introducing some form of outreach service. Only one identified study (a 'before-and-after' investigation by Paterson and coworkers, 2006) considered a form of ward-level response. However, because of the substantial risks of bias in that study, it would be impossible to draw any robust conclusions from its findings. Ward-level responses are not 'simple' interventions because, as noted above, the precise details will depend on, among other things, the thresholds put in place during patient monitoring. No study was identified that assessed the impact of the use of a particular response strategy on health-related quality of life.

Outreach services are complex interventions with no apparently consistent typology. Generalisability is therefore a significant problem based on the available data. Any data on the effectiveness of such a service is likely to be specific to the particular characteristics of the intervention in an individual study. Because outreach services as assessed in the studies have multiple components (that is, a track and trigger system, educational elements and the outreach team itself), it is unclear how these individual components might separately influence outcomes.

In terms of the costs of CCOS, Whiting and Edbrook (2006) cited mean annual outreach nursing and physiotherapy costs of £4427.20 per ICU bed (2003–4 prices) based on audit data sourced from the Medical Economics and Research Centre, Sheffield. There was considerable variation around that estimate, however. In addition, the mean cost of medical staff input into an outreach service was estimated at £456 per ICU bed per year.

ICNARC undertook an economic evaluation of outreach services following discharge from the critical care unit. In this analysis (part of the unpublished substudy 7 (Harrison et al. unpublished) described in 'Unpublished National Institute for Health Research Service Delivery and Organisation work, section 2.2.3), the estimated direct costs of an outreach service were based on whole time equivalent staff with dedicated time allocated to the particular outreach service. The mean cost per visit for each outreach service was calculated as the annual staff costs divided by the annual number of visits, and was estimated to be £115 for the hospitals participating in the prospective cohort analysis.

The other costs considered in the analysis that applied to both cases (the intervention group) and controls, related to intensive care after the original discharge from critical care (at a cost of £1716 per day), and the number of days of ward care following the original discharge from critical care (at a cost of £220 per day). The mean number of days in intensive care after the original discharge from the critical care unit was found to be higher for cases than matched controls, but the mean number of days in hospital not in intensive care was lower for cases than for controls. In terms of overall costs, for matches 1 and 2 cases were on average less costly than controls (that is, the existence of a CCOT appears to be associated with overall cost savings). In contrast, the mean costs were higher for cases than for controls in match 3. However, none of the cost differences reached statistical significance.

Incremental costs were plotted against incremental benefits (absolute risk reduction for mortality before ultimate discharge from an acute hospital) for 10,000 bootstrap samples of the original data. ('Bootstrapping' is a statistical method based on repeated random sampling with replacement from an original sample, allowing a sampling variance to be empirically estimated). The paper also showed cost-effectiveness acceptability curves.

In terms of the individually matched results in the base case analysis, it was found that for matches 1and 2 there was an apparent high probability that outreach visits after transfer from CCU are cost effective, regardless of willingness to pay. Outreach services dominated (were less expensive and

more effective) in 82% of bootstrap samples in match 1; in match 2 CCOS dominated in 57% of samples. However, in match 3 the control arm dominated in 44% of bootstrap samples. The outcomes were similar when using the propensity model results and also after undertaking certain sensitivity analyses (for example, altering the unit cost of hospitalisation).

It is important to note that this economic analysis was based on observational patient level data. It considered only outreach activity after discharge from the critical care unit, over a comparatively short time horizon. The authors had sufficiently detailed data only on the patients that were admitted to critical care. The evidence presented in substudy 7 (Harrison et al. unpublished) appeared not to favour outreach services before admission to critical care, at least in terms of ICU mortality, length of stay and hospital mortality. However, these were secondary outcomes in the authors' analysis, and should be cautiously interpreted.

The economic results were partly sensitive to the estimate of mean effectiveness (and the degree of uncertainty around this estimate), although match 3 could be considered an extreme and unlikely scenario. The effectiveness outcome measure used in the analysis – hospital death averted – is not ideal. No estimate was made of the incremental (discounted) life years gained. The impact on health-related quality of life is unknown. It is unclear whether extrapolation beyond hospital survival would have significantly altered the conclusions of the analysis.

The weight of evidence is equivocal with respect to the effectiveness of outreach services on patient outcomes such as mortality, although aspects of its subcomponents (such as education and training, and use of a track and trigger system) may be very important. Interpreting the evidence is further complicated by the diversity of outreach service configurations. On this basis, the overall cost-effectiveness of outreach services compared with conventional care in its absence remains unknown.

Evidence to recommendations

The Guideline Development Group noted that response strategies in the included studies were triggered by both physiological track and trigger scores and by 'clinical concern' on the part of the relevant healthcare professional.

The Guideline Development Group noted that the two included studies that evaluated the effectiveness of a response strategy (critical care outreach) provided education and training on the recognition and response to critical illness to ward staff as well as delivering a specific response strategy. The Guideline Development Group considered the delivery of education and training of ward staff of key importance. The Guideline Development Group considered this to be a factor that underpins the correct measurement of physiological variables, the correct use of track and trigger systems and the correct response to a patient at risk of clinical deterioration.

The Guideline Development Group considered that there should be a graded response strategy. The details of the strategy might differ according to the type of multiple or aggregate track and trigger system used. The recommendations in this section were developed by group consensus because of the difficulties with current evidence on the effectiveness of response strategies, which are documented below.

The Guideline Development Group noted the conflicting findings of the two included studies on response strategies. It considered on the basis of the two included studies that there was no firm evidence of effectiveness and an absence of evidence of cost-effectiveness of CCOS. The Guideline Development Group was therefore unable to recommend any specific service configuration for the care of patients whose clinical condition is deteriorating.

The Guideline Development Group reviewed the unpublished SDO-funded ICNARC work (substudy 6 [Gao et al. unpublished] and substudy 7 [Harrison et al. unpublished]) with the aim of determining whether these data were likely to lead to a change in the recommendations based on the two included studies. The Guideline Development Group's view was that this work did not

offer firm evidence of effectiveness and cost-effectiveness of CCOS, and that the recommendations should stand.

The Guideline Development Group also considered that the components of the complex intervention in both included studies – education of ward staff and a response strategy – should form the basis of its consensus recommendations in this area. It considered that a range of service configurations could deliver these components, and that NHS trusts should decide which configuration was most appropriate to local NHS service needs.

2.3 Transfer of patients from critical care areas

2.3.1 Introduction

Critical care area transfer planning ought to seek safe and efficient transition from the critical care area to general medical and surgical wards. Poor planning may result in discontinuity of care, delayed recovery, adverse health outcomes and re-admission to critical care areas. The timing of transfer from critical care areas to general wards is an important issue in this planning and is specifically included in the scope for this guideline. Thus the first part of this evidence review specifically considers whether the timing of transfer from critical care areas to the general ward, specifically 'in hours' as opposed to 'out of hours' or 'night' transfer, has an impact on health outcomes for patients. This question is asked in the context of the decision to transfer on clinical grounds having already been made. The decision to transfer a patient from critical care areas is outside the scope of this guideline.

Patients being treated in a critical care area will be recovering from a serious illness and will have required a level of dependency on medical, nursing and allied healthcare professionals that is much greater than that found on general wards. Consequently the transition back to the general wards can be anxiety provoking for many patients. The situation can be exacerbated if healthcare professionals on the general wards are not fully aware of the patient's physical, emotional and psychological condition. A period of critical illness can have a significant impact on a patient's quality of life and functional status. The longer the period of illness and the greater the complexity of care

required in critical care, the greater the potential for residual physical, emotional and psychological morbidity. Any ongoing care issues related to the original reason for admission to the critical care area will also need to be addressed in planning the transfer back to the general ward.

Unfortunately the step down of nursing care from 'one-to-one' to 'one-to-many' is sometimes also accompanied by a lack of continuity of care from the critical care and parent teams and a reduction in the depth and breadth of care provided. These factors commonly lead to patient distress. It is therefore important to consider what elements of care on general wards are viewed as important by patients and healthcare professionals following transfer from critical care areas. The second part of this evidence review specifically addresses the evidence of patients' experiences of care received, and focuses on the period immediately after transfer from the critical care area.

As well as the timing of transfer and patients' experiences of care, it is also important to establish whether there are any interventions, such as routine ward-based follow-up from CCOTs or other response strategies, that can be delivered to this particular group of patients on general wards following transfer and that have been shown to improve health outcomes. Therefore, the third key clinical question this evidence review sought to address was what interventions can be delivered to patients who have been transferred from critical care areas in the immediate post-transfer phase on general wards.

A systematic review of the economic literature was undertaken where relevant.

2.3.2 Overview

Seven studies were identified that investigated the effect on patient outcomes of the time of transfer from a critical care area to the general ward. All seven were observational studies (cohort studies) and no randomised control trials were identified. After full review of the paper, one study (Hixson et al. 2005) was excluded because its study population was not covered by the guideline scope (age range of study population was 0–21, and specific data on age

range 16–21 was not available in the study). Consequently, there were six studies included in this review. Two were set in the UK (one is a single hospital study, the other is a study using national databases), two in Australia, one in Canada and one in Finland. The patient outcomes that were measured were hospital mortality, ICU length of stay and unplanned ICU readmission. However, hospital mortality was the only outcome that was analysed after case-mix adjustment and hence this narrative summary focuses on this particular patient outcome. All studies were of acceptable quality (level of evidence: 2+). These six studies provided the evidence statements that formed the basis for the recommendations.

For the second review, on patients' experiences of care, six studies were identified on the basis of title and abstract as addressing aspects of care considered important by patients following transfer from critical care areas. All studies used a qualitative design. After full review of these papers, four were excluded from the review because they addressed care given in critical care areas and concerns regarding transfer, rather than providing accounts of the care on general wards after transfer. Both included studies were set in the UK. A further relevant unpublished study was identified by the NICE Patient and Public Involvement Unit from the Database of Individual Patient Experiences team (DIPEx). Qualitative studies were assigned evidence level 3 in accordance with NICE technical guidance (National Institute for Health and Clinical Excellence 2006).

Economic evaluation was not viewed as directly relevant with respect to the timing of transfer from the critical care unit, and the elements of care on the general ward viewed as important by patients following transfer. Economic analyses were neither identified in the literature nor prepared de novo. The timing of transfer may have important patient-related and economic consequences, although no study was identified that specifically examined this issue. It appears from the evidence that issues related to 'premature transfer' and bed availability may be important factors influencing outcomes. An economic analysis would therefore be best focused on interventions (such as outreach services) that may have an impact on premature discharge and

the timing of discharge. Similarly, the current review did not directly address strategies or interventions (such as informational booklets) that might further improve patient experience following transfer and whose cost effectiveness could be estimated.

The final evidence review in this section investigated what interventions should be delivered to patients who have been transferred from critical care areas in the immediate post-transfer phase on general wards. The search strategy for section 2.2, 'Does a specific response strategy improve outcomes for patients identified as having a deteriorating clinical condition?', identified a subgroup of studies that looked specifically at patients transferred from critical care areas. Four studies (Ball et al. 2003; Bellomo et al. 2004; Garcea et al. 2004; Pittard 2003) were identified that investigated the impact or effect of critical care services on mortality rates and ICU readmission for this patient subgroup. Three studies were from the UK and one from Australia. All four were uncontrolled before-and-after studies with level of evidence of grade (2−). Such intervention studies were considered to have a high risk of bias and confounding factors, and therefore could not be used to make recommendations for clinical practice in this guideline. An unpublished SDO-commissioned ICNARC study (Substudy 7; Harrison et al. unpublished) also investigated the impact of CCOS on mortality, ICU readmission and length of stay in hospital for patients post-discharged from ICU. However, due to the inconsistent findings within different matches and different analysis models in this particular study, the unpublished evidence provided could not be used to make recommendations for clinical practice in this guideline. All of these studies are therefore presented in the relevant evidence table but not in this review.

As described in 'Unpublished National Institute for Health Research Service Delivery and Organisation work', section 2.2.3, a single unpublished study was identified that undertook an economic analysis of outreach services following ICU transfer. No other economic evidence is available.

2.3.3 Timing of transfer of patient from critical care areas to general wards

Recommendation 1.2.2.14

After the decision to transfer a patient from a critical care area to the general ward has been made, he or she should be transferred as early as possible during the day. Transfer from critical care areas to the general ward between 22.00 and 07.00 should be avoided whenever possible, and should be documented as an adverse incident if it occurs.

Evidence review

Six studies were identified for this particular key clinical question. Five out of six studies (Beck et al. 2002; Duke et al. 2004; Goldfrad and Rowan 2000; Priestap and Martin 2006; Tobin and Santamaria 2006) (with level of evidence: 2+) found that the timing of transfer from ICU to general ward was associated with increased hospital mortality. Two of the studies were from the UK (Beck et al. 2002; Goldfrad and Rowan 2000), one from Canada (Priestap and Martin 2006) and two from Australia (Duke et al. 2004; Tobin and Santamaria 2006). The study from Finland (Uusaro et al. 2003) found no associations between times of transfer and death.

Apart from hospital mortality, two studies (Duke et al. 2004; Priestap and Martin 2006) also found that the timing of transfer had an impact on ICU re-admission.

Evidence statement

(2+) The timing of transfer of patients from critical care areas (ICU) to general wards is associated with adverse patient outcomes. Transfer at night is associated with:

- *an increased hospital mortality rate*
- *a higher ICU re-admission rate.*

All six studies have hospital mortality as an outcome measure, but only two include ICU re-admission as an outcome measure. One cohort study

(Goldfrad and Rowan 2000) from the UK investigated hospital mortality with night-time transfers from intensive care. This study used data from a national database (Intensive Care National Audit and Research Centre's Case Mix Programme Database – CMPD) from 1995 to 1998 to examine hospital mortality rates with night transfers compared with day transfers. There were two definitions of 'night transfer' in the study: from 22:00 to 06:59 and from 00:00 to 04:59. Both 'night' definitions were analysed as separate variables.

The analysis showed that both night transfers (from 22:00 to 06:59 and from 00:00 to 04:59) had significantly higher unadjusted odd ratios of hospital mortality compared with day transfers. After case-mix adjustment using the APACHE II method, the study found that both definitions of night transfer had a higher hospital mortality rate compared with day transfer ('22:00 to 06:59': adjusted OR = 1.33, 95% CI 1.06 to 1.65; '00:00 to 04:59': adjusted OR = 1.53, 95% CI 1.11 to 2.13). When looking at the data on 'direct transfer to the wards', both definitions of night transfer had a higher case-mix adjusted hospital mortality rate compared with day transfer ('22:00 to 06:59': adjusted OR = 1.37, 95% CI 1.06 to 1.78; '00:00 to 04:59': OR = 1.73, 95% CI 1.19 to 2.53). However, when further adjustment was made for 'premature transfer', the findings were statistically not significant for either group (overall transfer: '22:00 to 06:59': adjusted OR = 1.17, 95% CI 0.92 to 1.49; '00:00 to 04:59': adjusted OR = 1.33, 95% CI 0.95-1.87; direct transfer to the wards: '22:00 to 06:59': adjusted OR = 1.18, 95% CI 0.90 to 1.56; '00:00 to 04:59': adjusted OR = 1.47, 95% CI 0.97 to 2.17). It should be noted that 'premature transfer' in this particular study was based on an analysis of the data collected under the heading of 'reason for transfer from ICU' and was based on a clinician's subjective assessment of a patient's readiness for transfer in the light of the needs of other patients for the ICU beds. There was no attempt made to impose standard explicit criteria for this variable. The decision to transfer is a clinical judgement based on physiological variables, concurrent treatment and clinical assessment. This model of care could potentially be strengthened by statistical modelling of physiological, organ dysfunction and other clinical data (Daly et al. 2001).

In another single-hospital UK cohort study (Beck et al. 2002), the findings showed that both crude (unadjusted) mortality risk and adjusted mortality risk were significantly higher for 'late' transfer compared with 'early' transfer. In this study, 'early' transfer was defined as from 08:00 to 19:59 and 'late' transfer was defined as from 20:00 to 07:59. The results of the study after adjusting for disease severity suggested that 'late' transfers from ICU would increase the mortality risk of patients ('late' transfers compared with 'early' transfers: adjusted relative risk [RR] = 1.70, 95% CI 1.28 to 2.25). Looking at the adjusted mortality risk for patients 'transferred directly to general wards', the study also found 'late' transfer increased the mortality risk of patients compared with 'early' transfer (adjusted RR = 1.87, 95% CI 1.36 to 2.56). On the other hand, the difference in mortality risk of patients 'transferred directly to HDU' did not reach statistical significance ('late' transfers compared with 'early' transfers: adjusted RR = 1.35, 95% CI 0.77 to 2.36).

The third cohort study (Priestap and Martin 2006) was a Canadian study. Data was extracted from a Canadian national database that involved 31 Canadian hospitals. Again, both crude (unadjusted) and adjusted in-hospital mortality rates were significantly higher for night-time transfer compared with day-time discharge. The definition of 'day-time' transfer was from 07:00 to 20:59. There were two different definitions for 'night-time' transfer (from 21:00 to 06:59 and from 00:00 to 06:59) and both 'night-time' definitions were analysed as separate variables. After adjusting for severity of illness, the analysis of the study indicated that patients transferred from ICU at night have an increased risk of dying in hospital compared with those transferred during the day (adjusted $OR_{21:00–06:59}$ = 1.22 (95% CI 1.10-1.36); adjusted $OR_{00:00–06:59}$ = 1.26, 95% CI 1.07 to 1.49).

There were two single-hospital cohort studies from Australia. In one (Duke et al. 2004) the times of transfer were defined as 'day' (from 07:30 to 15:00), 'evening' (from 15:00 to 22:00) and 'night' (from 22:00 to 07:30). The crude (unadjusted) analysis showed that the case-fatality rate for 'night' transfer was significantly higher than for 'day' transfer and 'evening' transfer. After adjusting for severity of illness, limitation of medical treatment (LMT) status

and premature or delayed ICU transfer, logistic regression analysis found that 'night' transfer, together with APACHE II predicted mortality and LMT order were significant predictors for hospital death ('night' discharge: adjusted RR = 1.7, 95% CI 1.03 to 2.9, p = 0.03; APACHE II predicted mortality : adjusted RR = 3.3, 95% CI 1.3 to 7.6, p < 0.001; LMT order: adjusted RR = 5.1, 95% CI 2.2 to 12, p < 0.001). The findings of this study suggested that the timing of ICU transfer, in addition to the (initial) severity of illness and LMT order, influenced ICU survival.

In the second Australian study (Tobin and Santamaria 2006), the times of transfer were defined as morning shift (07:00 to 14:59), afternoon shift (from 15:00 to 21:59) and night shift (from 22:00 to 06:59). Unadjusted odd ratios showed that both afternoon shift and night shift had significantly higher hospital mortality than morning shift. After adjusting for severity of illness, multivariate analysis also showed that hospital mortality was significantly higher for afternoon shift and night shift than for morning shift (afternoon: adjusted OR = 1.36, 95% CI 1.08 to 1.70; night: adjusted OR = 1.63, 95% CI 1.03 to 2.57).

The Finish study was a cohort study of 18 ICUs (Uusaro et al. 2003). There were two 'time of transfer' categories. Category one defined times of transfer as 'out of office hours' (from 16:00 to 08:00) and 'office hours' (from 08:00 to 16:00); category two defined them as 'weekday' (from 00:01 Monday to 15:59 Friday) and 'weekend' (from 16:00 Friday to 24:00 Sunday). In category one, analysis showed that crude (unadjusted) hospital mortality rate was significantly higher for 'out of office hours' transfer than for 'office hours' transfer. However, logistic regression analysis (after adjustment) showed no difference between 'office hours' transfer and 'out of office hours' transfer on hospital mortality rate (adjusted OR = 1.11, 95% CI 0.93 to 1.31, p = 0.24). Both crude (unadjusted) and logistic regression analysis (after adjustment) showed no differences on hospital mortality rate between 'weekday' and 'weekend' transfer (logistic regression: adjusted OR with 'weekend' transfer = 0.88, 95% CI 0.73 to 1.07, not significant, p-value not reported).

Apart from hospital mortality rate, two studies (Duke et al. 2004; Priestap and Martin 2006) also included unplanned ICU re-admission as an outcome measure. In Priestap and Martin's (2006) study, the crude (unadjusted) unplanned ICU re-admission rate within 48-hours of ICU transfer to the ward was significantly higher for night-time transfer (from 21:00 to 06:59) than for day-time transfer (from 07:00 to 20:59) (day = 1.7%, night = 2.4%, $p < 0.001$). In another study (Duke et al. 2004), crude (unadjusted) unplanned ICU re-admission rate for day transfer to the ward was also significantly lower than for evening and night transfer (day 3.5%, evening 5.1%, night 7.5%, $p = 0.015$).

Evidence to recommendations

The Guideline Development Group noted that discharge at night was consistently associated with increased mortality in the reviewed studies and considered this justified a recommendation not to transfer patients out of critical care areas at night whenever possible. However, it also noted that 'night transfer' is generally viewed by UK clinicians as a consequence of pressure for ICU beds and is a proxy for premature transfer. This is supported by one UK study (Goldfrad and Rowan 2000) that specifically used transfer at night as a proxy measure to investigate pressure on ICU beds and found that night transfer was not significantly associated with increased mortality once adjustment was made for premature transfer.

The Guideline Development Group considered that it was possible to specify a 'core' night-time range on the basis of the evidence reviewed, during which one could be reasonably certain that there was a likelihood of adverse outcomes.

2.3.4 Elements of care on the general ward viewed as important by patients following transfer

Recommendation 1.2.2.15

The critical care area transferring team and the receiving ward team should take shared responsibility for the care of the patient being transferred. They should jointly ensure:

- there is continuity of care through a formal structured handover of care from critical care area staff to ward staff (including both medical and nursing staff), supported by a written plan
- that the receiving ward, with support from critical care if required, can deliver the agreed plan.

The formal structured handover of care should include:

- a summary of critical care stay, including diagnosis and treatment
- a monitoring and investigation plan
- a plan for ongoing treatment, including drugs and therapies, nutrition plan, infection status and any agreed limitations of treatment
- physical and rehabilitation needs
- psychological and emotional needs
- specific communication or language needs.

Recommendation 1.2.2.16

When patients are transferred to the general ward from a critical care area, they should be offered information about their condition and encouraged to actively participate in decisions that relate to their recovery. The information should be tailored to individual circumstances. If they agree, their family and carers should be involved.

Recommendation 1.2.2.17

Staff working with acutely ill patients on general wards should be provided with education and training to recognise and understand the physical, psychological and emotional needs of patients who have been transferred from critical care areas.

Evidence review

Three studies were found that addressed the question 'What elements of care on the general ward are viewed as important by patients following discharge?' All three used a qualitative design (phenomenological approach with purposive sampling) and all were set in the UK (two in Northern Ireland and one in England). The findings of these three studies were reviewed and synthesised into four themes.

Evidence statements

(3) Patients identified four areas that they considered to require specific attention during the period immediately after transfer from the critical care area to general wards.

- *Continuity of care between critical care area staff and ward staff (patients felt that problems arose because of poor communication).*
- *Help with managing their physical and emotional experiences.*
- *Help with managing the transition from one-to-one care in critical care areas to the lower staffing levels on general wards.*
- *Information on their condition and process of recovery that was tailored to their individual circumstances.*

The four themes that were identified were continuity of care and coordination on the ward, physical and emotional experiences, provision of care on the ward and information for patients. Patients reported in two studies (DIPEx; Strahan and Brown 2005) that a lack of continuity of care was caused by inadequate communication between ICU staff and those in the general wards, and had led to unnecessary stress for the patients. For instance, some patients said that communication was poor between ICU staff and ward staff,

and occasionally – for example when nurses on the ward were unaware of their medications or dietary restrictions – they felt this had affected their treatment and progress. However, there were also positive experiences: a few patients recalled being visited by outreach nurses, and felt that this had made the transition easier.

All three studies (DIPEx; McKinney and Deeny 2002; Strahan and Brown 2005) presented details on patients' physical and emotional experiences. In terms of physical experiences following transfer from ICU to a general ward, patients generally reported physical weakness/frailty, lack of mobility, sleep disturbances, minor to moderate pain, bowel complications and feelings of sickness, nausea and lack of appetite. In terms of emotional experiences, there were mixed positive and negative feelings among patients following transfer from ICU. Some patients were very positive about being transferred to a general ward because it was associated with progression towards physical recovery and equipped patients with a feeling of control. However, following transfer some patients also felt anxious, lonely and isolated, depressed, insecure, exhausted, confused and worried because they were extremely weak physically.

Patients in all three studies also reported their experiences of the differences in level of care between ICU and general wards. Overall, patients commented that attitude, attention and organisation were important aspects of care management on the ward and they desired a high quality of individualised care. Many patients felt that ward nurses had unrealistic expectations about how much they could do for themselves (for example, ward nurses were reported as lacking understanding about the degree of physical weakness/frailty of patients following transfer from ICU). In general, patients acknowledged the differences in staffing levels between ICU and general wards but they still found it difficult to adjust to the transition from 'one-to-one care' in ICU to 'one patient among many' on a general ward, and less monitoring (either by ward staff or monitoring machines). Some patients felt 'abandoned' and some experienced being left unattended for varying lengths of time when they needed to go to the toilet or be washed or cleaned on the

general ward. Patients found these experiences hard to cope with and some reported that they felt themselves 'go downhill'.

Two of the studies (DIPEx; Strahan and Brown 2005) also reported the patients' desire for information. Patients stressed the importance of information about their own critical illness and the need for an explanation of the recovery process (information at different stages of illness and recovery and on different topics). For example, some patients were given information about recovery before they were discharged from hospital, particularly on diet, exercise and drug management; others said that the only information they really wanted was to know whether they were improving. Moreover, most patients who had been given diaries of their ICU stay, either when leaving the hospital or at a follow-up appointment, said they learnt a lot more about their stay after reading these, including information about the illness, treatments, changes and improvements, family reactions and visitors.

Evidence to recommendations

The Guideline Development Group considered that the transition of care between critical care areas and general ward settings needed a specific recommendation. It was considered important that patients receive continuity of care and that patients should not be transferred from critical care areas unless the receiving ward has the resources to be able to deliver the agreed care plan.

The Guideline Development Group considered that a formal structured handover of care would address the patient needs identified in the reviewed qualitative evidence.

The Guideline Development Group noted that the need for information tailored to individual circumstances was a consistent finding of the reviewed qualitative literature.

The Guideline Development Group considered that the reported experiences of patients on general wards following their discharge from critical care areas justified a specific recommendation on educational and training needs for relevant healthcare staff.

2.3.5 Interventions on general wards following transfer from critical care areas

No specific recommendation has been made regarding what interventions can be delivered to patients on general wards following transfer from critical care areas to improve health outcomes.

Evidence review

No evidence is presented because no studies were of sufficient quality to be used as the basis for making evidence-based clinical guideline recommendations.

Evidence to recommendations

The Guideline Development Group noted the lack of good quality evidence on the effectiveness of specific interventions in the immediate post-transfer phase on general wards to improve health outcomes for patients who have been transferred from critical care areas.

The Guideline Development Group considered that all the recommendations made in section 2.2 applied to this subgroup of patients.

2.4 Research recommendations

Identification and evaluation of risk scoring tools (see section 2.1)

- What is the clinical effectiveness and cost effectiveness of automated (electronic) monitoring systems compared with manual recording systems in identifying people at risk of clinical deterioration in general hospital ward settings?
- What are the sensitivities and specificities of track and trigger systems in different clinical settings?
- Can track and trigger systems that have higher sensitivities and specificities than existing scores be developed and validated?

Response strategies for patients identified as having a deteriorating clinical condition (see section 2.2)

- What is the clinical and cost effectiveness of a structured educational programme to improve recognition of and response to acute illness compared with no structured programme in improving outcomes for people who clinically deteriorate in general hospital ward settings?
- What is the clinical and cost effectiveness of CCOS compared with usual care or educational outreach in improving health outcomes for patients who clinically deteriorate in general hospital ward settings? Such research should:
  - use a cluster RCT design conducted on multiple sites, with analysis of the cluster at hospital level rather than ward level
  - investigate a range of health outcomes, including mortality, morbidity, quality of life measures and patient satisfaction
  - include a parallel qualitative process evaluation to help establish which components of outreach (a complex intervention) are likely to be most effective
  - consider 24-hour critical care outreach as well as daytime outreach.

Transfer of patients from critical care areas (see section 2.3)

- What is the clinical and cost effectiveness of providing structured educational advice (such as an information booklet) compared with usual care to patients who have been transferred from critical care areas back to general hospital ward settings?
- What is the clinical and cost effectiveness of a transfer facilitator for patients transferred from critical care to a general ward environment? Such research could include outcome measures on:
  - patient satisfaction
  - time to discharge from acute hospital
  - destination when transferred.

3 Methods

3.1 Scope and purpose

3.1.1 Scope

NICE guidelines are developed in accordance with a scope that defines what the guideline will and will not cover (see appendix 5.1). The aim of this guideline is to provide evidence-based recommendations to guide healthcare professionals in the appropriate care of acutely ill patients in hospital.

3.1.2 Areas covered by this guideline

This guideline provides guidance on:

- Identification of patients who are at risk of clinical deterioration or whose clinical condition is deteriorating. This includes assessment of:
  - scoring tools that record physiological parameters and neurological state
  - the level of monitoring needed and the recording and interpretation of the data obtained.
- Response strategies to manage patients who are at risk of clinical deterioration or whose clinical condition is deteriorating, including:
  - the timing of response and patient management
  - the communication of monitoring results to relevant healthcare professionals, including the interface between critical care and acute specialties.
- Transfer of patients from critical care areas. This includes:
  - monitoring requirements.
  - timing of transfer.

3.1.3 Areas outside the remit of this guideline

This guideline does not address care that should be provided to: children, dying patients receiving palliative care or patients in critical care areas who are directly under the care of critical care consultants. It does not address the decision to discharge a patient from a critical care area.

3.1.4 Disclaimer

The guideline development group assumes that the healthcare professionals will use general medical knowledge and clinical judgement in applying the general principles and specific recommendations of this document to the management of individual patients. Recommendations may not be appropriate in all circumstances. Decisions to adopt any particular recommendation must be made by the practitioner in light of the circumstances presented by individual patients and available resources. Clinicians will need to share appropriately the information within this guideline to enable patients to participate in the decision making to the extent that they are able and willing.

3.2 Contributors

3.2.1 The Guideline Development Group

The Guideline Development Group was composed of relevant healthcare professionals, patient representatives and NICE technical staff.

The members of the Guideline Development Group are listed below.

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Nurse Consultant in Critical Care

Dr Mary Armitage (Guideline Development Group Chair)
Consultant Physician

Mr Peter Brewer
Patient/carer representative

Dr Brian Cuthbertson
Clinical Senior Lecturer and Consultant in Intensive Care

Dr Jane Eddleston (Guideline Development Group Clinical Adviser)
Consultant in Intensive Care Medicine

Mr Peter Gibb
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Dr Paul Glynne

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Dr David Goldhill

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Dr John Hindle

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Dr Simon Mackenzie

Consultant in Critical Care

Dr Patrick Nee

Consultant in Emergency Medicine and Intensive Care Medicine

Professor Brian J Rowlands

Consultant Surgeon

Mrs Kirsty Ward

Registered Nurse

The following individuals were not full members of the guideline development group but were co-opted onto the group as expert advisers

Dr David Harrison

Statistician and Health Services Researcher

Professor Gary Smith

Consultant in Critical Care

3.2.2 The Short Clinical Guidelines Technical Team

The Short Clinical Guidelines Technical Team was responsible for this guideline throughout its development. It was responsible for preparing information for the Guideline Development Group, for drafting the guideline and for responding to consultation comments. The following people, who are employees of NICE, formed the Short Clinical Guidelines Technical Team for this guideline.

Dr Tim Stokes
Guideline Lead and Associate Director – Centre for Clinical Practice (from December 2006)

Nicole Elliott
Commissioning Manager

Michael Heath
Project Manager (from December 2006)

Toni Tan
Technical Analyst, (from January 2007)

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Dr Philippa Davies
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Technical Adviser (until December 2007)

3.2.3 Acknowledgements

In addition to the healthcare professionals, patient representatives and NICE staff mentioned above, we would like to thank the Patient and Public Involvement Programme (PPIP), Communications and Implementation Directorates of NICE for their help in the production of this guideline. We would also like to thank the Guideline Review Panel (GRP) for its work on this guideline. The GRP consisted of:

- Mike Drummond
- Dr Graham Archard
- Barry Stables
- Karen Cowley
- David Gillen.

We would like to thank all the stakeholders who took the time to register and comment on the scope and the final draft of the guideline. For full details of registered stakeholders please see the NICE website (www.nice.org.uk).

Finally, we would like to offer our condolences to Peter Brewer's family; sadly, Peter died during the development of this guideline. Peter was a great help during the development phase of this guideline and always had a friendly word to say to everyone. Peter will be sadly missed by his family and colleagues alike.

3.3 Development methods

This section sets out in detail the methods used to generate the recommendations for clinical practice that are presented in the previous chapters of this guideline. The methods used to develop the recommendations are in accordance with those set out by the National Institute for Health and Clinical Excellence ('NICE' or the 'the Institute') in 'The guidelines manual: an overview for stakeholders, the public and the NHS' (2006, available at www.nice.org.uk) . As noted in section 1.3.2, the interim process for the short clinical guidelines programme has been the subject of public consultation and the revised version will be incorporated into the 2008 update of 'The guidelines manual'.

3.3.1 Developing the guideline scope

The draft scope, which defined the areas the guideline would and would not cover, was prepared by the Short Clinical Guidelines Technical Team on the basis of the remit from the Department of Health, consultation with relevant experts and a preliminary search of the literature to identify existing clinical practice guidelines, key systematic reviews and other relevant publications. The literature search facilitated an overview of the issues likely to be covered by the guideline – the clinical need for the guideline and the clinical management of the acutely ill patient – and helped define key areas. It also informed the Short Clinical Guidelines Technical Team of the volume of literature likely to be available in the topic area, and therefore the amount of work required.

The draft scope was tightly focused and covered three clinical topic areas. It was presented to a representative group of stakeholders and potential Guideline Development Group members at a 1-day workshop. The workshop consisted of presentations in the morning and facilitated parallel-running working groups in the afternoon. The aim was to obtain detailed feedback on the draft scope and agree core areas of care to be covered in the guidance, to seek input about the composition of the Guideline Development Group and to request the attendees' help in encouraging applications for Guideline Development Group membership.

The draft scope was amended to address issues raised by the workshop and the revised scope was signed off by the Director of the Centre for Clinical Practice at NICE. Stakeholders were notified once the final version of the scope was available on the NICE website. On this occasion the scope was not the subject of public consultation, but this is planned for subsequent short guideline scopes (see interim process guide for the short clinical guidelines programme).

3.3.2 Forming and running the Short Clinical Guideline Development Group

The short clinical guideline for acutely ill patients in hospital was developed by a unique Guideline Development Group consisting of 14 members, two co-opted experts who attended two of the Guideline Development Group meetings, and the Short Clinical Guidelines Technical Team. The Guideline Development Group had a chair, and healthcare professional members and patient/carer members who were recruited through open advertisement. A clinical adviser, who had specific content expertise, was also appointed. Development took 4 months and the Guideline Development Group met on three occasions, every 6 weeks.

3.3.3 Developing key clinical questions

The third step in the development of the guidance was to refine the scope into a series of key clinical questions. These questions formed the starting point for the subsequent evidence reviews and facilitated the development of recommendations by the Guideline Development Group.

The key clinical questions were developed by the Guideline Development Group with assistance from the Short Clinical Guidelines Technical Team. As necessary, the questions were refined into specific research questions by the project teams to aid literature searching, appraisal and synthesis. The full list of key clinical questions is shown in appendix 5.2.

The Guideline Development Group and Short Clinical Guidelines Technical Team agreed appropriate review parameters (inclusion and exclusion criteria) for each question or topic area. A full table of the included and excluded studies is shown in appendix 5.5.

3.3.4 Developing recommendations

For each question, recommendations were derived from the evidence summaries and statements presented to the Guideline Development Group.

3.3.5 Literature search

The evidence reviews used to develop the guideline recommendations were underpinned by systematic literature searches following the methods described in 'The guidelines manual' (National Institute for Health and Clinical Excellence 2006). The purpose of systematically searching the literature is to attempt to comprehensively identify the published evidence to answer the key clinical questions developed by the Guideline Development Group and Short Clinical Guidelines Technical Team.

The Gao and coworkers (2007) and Esmonde and coworkers (2006) reviews – substudies of the work commissioned by the SDO from ICNARC (see section 3.3.10) – were used as the basis of two of the evidence reviews. The search strategies underpinning these systematic reviews were obtained from the authors and re-run across a number of databases to identify studies indexed from 2004 onwards.

The search strategies for the evidence reviews on discharge from critical care areas were developed by the Short Clinical Guidelines Technical Team, in consultation with the Guideline Development Group. Structured clinical questions were developed using the PICO (population, intervention, comparison, outcome) model and were translated in to search strategies using subject heading and free text terms. The strategies were run across a number of databases, with no date restrictions imposed on the searches.

To identify economic evaluations the NHS Economic Evaluation Database (NHS EED) and the Health Economic Evaluations Database (HEED) were searched, and search filters to identify economic evaluations were appended to the strategies developed by Gao and coworkers (2007) and Esmonde and coworkers (2006) to interrogate a range of bibliographic databases. There were no date restrictions imposed on the searches.

In addition to the systematic literature searches, the Guideline Development Group was asked to alert the Short Clinical Guidelines Technical Team to any additional evidence, published, unpublished or in press, that met the inclusion criteria.

The searches were undertaken between October 2006 and February 2007. Full details of the systematic search, including the sources searched and the MEDLINE strategies for each evidence review are presented in appendix 5.3.

3.3.6 Reviewing the evidence

The aim of the literature review was to systematically identify and synthesise relevant evidence in order to answer the questions developed from the guideline scope. The guideline recommendations were evidence based where possible; if evidence was not available, informal consensus of opinion within the Guideline Development Group was used. The need for future research was also specified. The review process consisted of four main tasks: selection of relevant studies; assessment of study quality; synthesis of the results; and grading of the evidence. The Technical Analyst had primary responsibility for reviewing the evidence but was supported by the Project Lead, Information Scientist and Health Economist.

After the scope was finalised, searches based on individual key clinical questions were undertaken. The searches were first sifted by the Short Clinical Guidelines Technical Team using title and abstract to exclude papers that did not address the specified key clinical question. After selection based on title and abstract, the full texts of the papers were obtained and reviewed by the Short Clinical Guidelines Technical Team in order to determine which studies should be included in the literature review. Studies suggested or submitted by the Guideline Development Group and expert advisers were also reviewed for relevance to the key clinical questions and included if they met the inclusion criteria.

The papers chosen for inclusion were then critically appraised by the Short Clinical Guidelines Technical Team for their methodological rigour against a number of criteria that determine the validity of the results. These criteria differed according to study type and were based on the checklists included in 'The guidelines manual' (2006) (available from www.nice.org.uk). The checklists that were used in this particular guidance included checklist C for randomised control trials, checklist B for cohort studies, checklist F for diagnostic studies, and checklist F for qualitative studies. 'The data collection

checklist' by the Effective Practice and Organisation of Care Group on controlled before-and-after studies was also used where relevant.

The data were extracted to standard evidence table templates. The findings were summarised by the Short Clinical Guidelines Technical Team into both a series of evidence statements and an accompanying narrative summary.

3.3.7 Grading the evidence

Intervention studies

Studies that meet the minimum quality criteria were ascribed a level of evidence to help the guideline developers and the eventual users of the guideline understand the type of evidence on which the recommendations have been based.

There are many different methods of assigning levels to the evidence and there has been considerable debate about what system is best. A number of initiatives are currently underway to find an international consensus on the subject. NICE has previously published guidelines using different systems and is now examining a number of systems in collaboration with its national collaborating centres and academic groups throughout the world to identify the most appropriate system for future use.

A decision has not yet been reached on the most appropriate system for NICE guidelines, so the Short Clinical Guidelines Technical Team used the system shown in table 5.

Table 5 Levels of evidence for intervention studies
Reproduced with permission from the Scottish Intercollegiate Guidelines Network; for further information, see 'The guidelines manual'.

Level of evidence	Type of evidence
1^{++}	High-quality meta-analyses, systematic reviews of RCTs, or RCTs with a very low risk of bias
1^{+}	Well-conducted meta-analyses, systematic reviews of RCTs, or RCTs with a low risk of bias
1^{-}	Meta-analyses, systematic reviews of RCTs, or RCTs with a high risk of bias[a]
2^{++}	High-quality systematic reviews of case–control or cohort studies High-quality case–control or cohort studies with a very low risk of confounding, bias or chance and a high probability that the relationship is causal
2^{+}	Well-conducted case–control or cohort studies with a low risk of confounding, bias or chance and a moderate probability that the relationship is causal
2^{-}	Case–control or cohort studies with a high risk of confounding, bias, or chance and a significant risk that the relationship is not causal[a]
3	Non-analytic studies (for example, case reports, case series)
4	Expert opinion, formal consensus
[a] Studies with a level of evidence '–' should not be used as a basis for making a recommendation	

It was the responsibility of the Guideline Development Group to endorse the final levels given to the evidence.

Diagnostic studies

The system described above covers studies of treatment effectiveness. However, it is less appropriate for studies reporting diagnostic tests of accuracy. In the absence of a validated ranking system for this type of test, NICE has developed a hierarchy for evidence of accuracy of diagnostic tests that takes into account the various factors likely to affect the validity of these studies (table 6). Because this hierarchy has not been systematically tested, NICE recommends that the national collaborating centres use the system when appropriate, on a pilot basis, and report their experience to us.

This evidence grading system was applied to the evidence review of track and trigger systems set out in section 2.1.

Table 6 Hierarchy for evidence of accuracy of diagnostic tests

Levels of evidence	Type of evidence
Ia	Systematic review (with homogeneity)[a] of level-1 studies[b]
Ib	Level-1 studies[b]
II	Level-2 studies[c] Systematic reviews of level-2 studies
III	Level-3 studies[d] Systematic reviews of level-3 studies
IV	Consensus, expert committee reports or opinions and/or clinical experience without explicit critical appraisal; or based on physiology, bench research or 'first principles'

[a] Homogeneity means there are no or minor variations in the directions and degrees of results between individual studies that are included in the systematic review.

[b] Level-1 studies are studies:
- that use a blind comparison of the test with a validated reference standard (gold standard)
- in a sample of patients that reflects the population to whom the test would apply.

[c] Level-2 studies are studies that have **only one** of the following:
- narrow population (the sample does not reflect the population to whom the test would apply)
- use a poor reference standard (defined as that where the 'test' is included in the 'reference', or where the 'testing' affects the 'reference')
- the comparison between the test and reference standard is not blind
- case–control studies.

[d] Level-3 studies are studies that have **at least two or three** of the features listed for level-2 studies.

3.3.8 Evidence to recommendations

The evidence tables and narrative summaries for the key clinical questions being discussed were sent to the Guideline Development Group 1 week before the Guideline Development Group meeting.

All Guideline Development Group members were expected to have read the evidence tables and narrative summaries before attending each meeting. The review of the evidence had three components. First, the Guideline Development Group discussed the evidence tables and narrative summaries and corrected any factual errors or incorrect interpretation of the evidence. Second, evidence statements drafted by the Short Clinical Guidelines Technical Team were presented to the Guideline Development Group, who agreed the correct wording of these. Third, from a discussion of the evidence statements and the experience of Guideline Development Group members, recommendations were drafted. The Short Clinical Guidelines Technical Team

explicitly stated that the Guideline Development Group should consider the following criteria (considered judgement) when developing the guideline recommendations from the evidence presented:

- internal validity
- consistency
- generalisability (external validity)
- clinical impact
- cost effectiveness
- ease of implementation
- patients' perspective
- overall synthesis of evidence.

The Guideline Development Group was able to agree recommendations through informal consensus. The process by which the evidence statements informed the recommendations is summarised in an 'evidence to recommendations' section in the relevant evidence review. Each recommendation was linked to an evidence statement if possible. If there was a lack of evidence of effectiveness, but the Guideline Development Group was of the view that a recommendation was important based on the Guideline Development Group members' own experience, this was noted in the 'evidence to recommendations' section.

3.3.9 Health economics

An economic evaluation aims to integrate data on the benefits (ideally in terms of quality adjusted life years, or QALYs), harms and costs of alternative options. An economic appraisal will consider not only whether a particular course of action is clinically effective, but also whether it is cost-effective (that is, value for money). If a particular treatment strategy were found to yield little health gain relative to the resources used, then it could be advantageous to redirect resources to other activities that yield greater health gain.

To assess the cost-effectiveness of strategies associated with the identification and response to acute illness, a systematic review of the economic literature relating to acutely ill patients was conducted. In addition,

the Guideline Development Group and expert advisers were questioned over any potentially relevant unpublished data. The search of the published literature yielded no relevant economic studies, save for one book chapter that simply cited some cost estimates of outreach services. However, relevant ongoing and unpublished data were identified (ICNARC substudy 7: See section 3.3.10 for further details) and made available to the Guideline Development Group and the Short Clinical Guidelines Technical Team at NICE.

Despite limitations of the unpublished research (for example, its focus on outreach activity after ICU discharge), further economic modelling by the NICE health economist was considered unnecessary. The key features of this research are presented within the relevant clinical chapter.

Health economics statements are made in the guideline in sections in which the use of NHS resources is considered.

3.3.10 Relation between this guideline and ongoing national research in the field of critical care outreach

In July 2004 the NHS National Institute for Health Research Service Delivery and Organisation Programme commissioned the ICNARC to undertake a rigorous, scientific evaluation of outreach services in critical care (SDO/74/2004). The findings of this research programme were submitted to the funding body on 31 March 2007 and are due to be published later in 2007.

A member of the ICNARC research team (Dr David Harrison) was co-opted onto the Guideline Development Group as a technical expert and the agreement of ICNARC and the funding body was sought and granted for the incorporation of published and unpublished work from this research programme into this guideline.

The following substudies from the SDO work have been incorporated into this guideline:

- Substudy 1 (a systematic review of the evidence base for outreach services). This published review (Esmonde et al. 2006) forms the basis for the review of CCOS presented in section 2.2.
- Substudies 2 and 3 (a systematic review of the evidence base for current 'early warning systems' and an analysis of available databases on 'early warning systems'). This review (Gao et al. 2007) forms the basis for the review of track and trigger systems presented in section 2.1. The primary research study (Subbe et al. 2007) is also used in the review.
- Substudy 4 (survey of outreach services). This survey (McDonnell et al. in press) is cited in the introduction section to section 2.3.
- Substudy 5 (qualitative study of a number of case studies of different models of outreach services), substudy 6 (interrupted time series analysis of the impact of outreach services on critical care admissions at the unit level) and substudy 7 (a non-randomised, case mix adjusted comparison of outreach care at the patient level, within which an economic evaluation forms an important part). When the first draft of this guideline was submitted for consultation these studies were unpublished and in the process of being written up. Permission was obtained for the use of selected parts of the health economic analysis in the draft guideline. It is intended that the final published version of this guideline will present the results of these three substudies in section 2.

3.3.11 Relation between this guideline and ongoing work on this area by the National Patient Safety Agency

The National Patient Safety Agency has analysed reported data on incidents, and other data sources, which further support the need for guidance and changes in practice. It has facilitated an ongoing multidisciplinary and multiagency working group, of which Dr Mary Armitage and Dr Jane Eddleston are members. This work seeks to bring together and offer mutual support across the several strands of work related to improvements in addressing deterioration of the acutely ill patient. Further exploration of

contributory and causal factors on the failure to detect or act upon deteriorating patients will support the implementation of this guideline.

3.3.12 Piloting and implementation

It is beyond the scope of the work to pilot the contents of this guideline or validate any approach to implementation. However, every effort has been made to maximise the relevance of recommendations to the intended audience through the use of a guideline development group with relevant professional and patient involvement, by use of relevant experienced expert reviewers and the stakeholder process facilitated by the NICE Short Clinical Guidelines Technical Team. Implementation support tools for this guideline will be available from the Implementation Team at NICE.

3.3.13 Audit methods

The guideline recommendations have been used to develop clinical audit criteria for use in practice. An audit criterion can be defined as 'a systematically developed statement that can be used to assess the appropriateness of specific healthcare decisions, services and outcomes' (Institute of Medicine, Field MJ and Lohr KN eds. 1992). Audit criteria are essential implementation tools for monitoring the uptake and impact of guidelines and thus need to be clear and straightforward for organisations and professionals to use.

NICE has commissioned the Clinical Accountability, Service Planning and Evaluation (CASPE) Research Unit and Health Quality Service to develop the audit criteria for all its guidance as part of its implementation strategy. CASPE will draft audit criteria for all guidelines for which stakeholder consultation starts on or after 1 April 2006.

3.3.14 Scheduled review of this guideline

The guidance has been developed in accordance with the NICE guideline development process for short clinical guidelines. This has included allowing registered stakeholders the opportunity to comment on the draft guidance. In addition, the first draft was reviewed by an independent Guideline Review Panel established by NICE.

The comments made by stakeholders, peer reviewers and the Guideline Review Panel were collated and presented anonymously for consideration by the Guideline Development Group. All comments were considered systematically by the Guideline Development Group and the Short Clinical Guidelines Technical Team recorded the agreed responses.

This guideline will be considered for an update after 2 years. However, if the evidence available has not changed we will not update it. Any agreed update would be carried out by the Short Clinical Guidelines Technical Team in conjunction with the Guideline Development Group. Alternatively the topic may be referred to the NICE Topic Selection Panel for it to consider developing a standard clinical guideline.

3.4 Declarations

3.4.1 Authorship and citation

Authorship of this full guideline document is attributed to the NICE Short Clinical Guidelines Technical Team and members of the Guideline Development Group under group authorship.

The guideline should be cited as:

NICE Short Clinical Guidelines Technical Team (2006) Acutely ill patients in hospital: recognition of and response to acute illness in adults in hospital. London: Natioanl Institute for Health and Clinical Excellence.

3.4.2 Declarations of Interest

A full list of all declarations of interest made by this Guideline Development Group is available on the NICE website (www.nice.org.uk).

4 References, glossary and abbreviations

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4.2 Glossary

Before-and-after study

A study design that involves selection of intervention and control groups other than by a random process, and inclusion of a baseline period of assessment of main outcomes. There are two minimum criteria for this study design: that pre- and post-intervention periods for study and control sites should be the same; and that if studies use a second site as a control, the sites should be

comparable with respect to dominant reimbursement system, level of care, setting of care and academic status.

Case–control study
Comparative observational study in which the investigator selects individuals who have experienced an event (for example, developed a disease), known as the 'case' and others who have not (controls), and then collects data to determine previous exposure to a possible cause.

Cohort study (also known as follow-up, incidence, longitudinal, or prospective study)
An observational study in which a defined group of people (the cohort) is followed over time. Outcomes are compared in subsets of the cohort who were exposed or not exposed (or exposed at different levels) to an intervention or other factor of interest.

Comorbidity
Two or more diseases or conditions occurring at the same time, such as depression and anxiety.

Confidence interval
The range within which the 'true' values (for example, size of effect of an intervention) are expected to lie with a given degree of certainty (for example, 95% or 99%).

Note: confidence intervals represent the probability of random errors, but not systematic errors or bias.

Cost-effectiveness analysis
An economic evaluation that compares alternative options for a specific patient group looking at a single effectiveness dimension measured in a non-monetary (natural) unit. It expresses the result in the form of an incremental (or average or marginal) cost-effectiveness ratio.

Economic evaluation
Technique developed to assess both costs and consequences of alternative health strategies and to provide a decision-making framework.

Generalisability

The degree to which the results of a study or systematic review can be extrapolated to other circumstances, particularly routine healthcare situations in the NHS in England and Wales.

Guideline Development Group

An independent group set up on behalf of NICE to develop a guideline. It includes academic experts, healthcare professionals and patient and carer representatives.

Heterogeneity

A term used to illustrate the variability or differences between studies in the estimates of effects.

Kappa

Kappa coefficient is a statistical measure of inter-rater reliability. It is generally thought to be a more robust measure than simple percent agreement calculation because kappa takes into account the agreement occurring by chance.

Negative predictive value

The proportion of patients with negative test results who do not have the disease.

Odds ratio

A measure of treatment effectiveness. The odds of an event happening in the intervention group, divided by the odds of it happening in the control group. The 'odds' is the ratio of non-events to events.

Phenomenological approach

A type of qualitative research that examines the lived experiences of humans. Phenomenological researchers hope to gain understanding of the essential 'truths' (that is, essences) of a phenomenon as experienced by people.

Positive predictive value

The proportion of people with a positive test result who actually have the disease.

Purposive sampling
A purposive sample is one which is selected by the researcher subjectively. The researcher attempts to obtain sample that appears to him/her to be representative of the population and will usually try to ensure that a range from one extreme to the other is included.

Quality-adjusted life year (QALY)
A measure of health outcome that assigns to each period of time a weight, ranging from 0 to 1, corresponding to the health-related quality of life during that period, where a weight of 1 corresponds to optimal health, and a weight of 0 corresponds to a health state judged equivalent to death; these are then aggregated across time periods.

Randomised controlled trial (also called a randomised clinical trial)
An experiment in which investigators randomly allocate eligible people into groups to receive or not to receive one or more interventions that are being compared. The results are assessed by comparing outcomes in the different groups. The groups should be similar in all aspects apart from the treatment they receive during the study.

Relative risk (also known as risk ratio)
The ratio of risk in the intervention group to the risk in the control group. The risk (proportion, probability or rate) is the ratio of people with an event in a group to the total in the group. A relative risk (RR) of 1 indicates no difference between comparison groups. For undesirable outcomes, an RR that is less than 1 indicates that the intervention was effective in reducing the risk of that outcome.

ROC curve
In signal detection theory, a receiver operating characteristic (ROC), or ROC curve, is a graphical plot of the sensitivity against (1 − specificity) for a binary classifier system as its discrimination threshold is varied. The ROC can also be represented equivalently by plotting the fraction of true positives (TP) against the fraction of false positives (FP). ROC analysis provides tools to

select possibly optimal models and to discard suboptimal ones independently from (and before specifying) the cost context or the class distribution.

Sensitivity (of a test)
The proportion of people classified as positive by the gold standard test who are correctly identified by the study test.

Specificity (of a test)
The proportion of people classified as negative by the gold standard test who are correctly identified by the study test.

Systematic review
Research that summarises the evidence on a clearly formulated question according to a pre-defined protocol using systematic and explicit methods to identify, select and appraise relevant studies, and to extract, collate and report their findings. It may or may not use statistical meta-analysis.

Track and trigger systems
Physiological 'track and trigger' systems rely on periodic observation of selected basic physiological signs ('tracking') with predetermined calling or response criteria ('trigger') for requesting the attendance of staff who have specific competencies in the management of acute illness and/or critical care.

4.3 Abbreviations

APACHE	Acute physiology and chronic health evaluation
ASSIST	Assessment score for sick patient identification and step-up in treatment
CASPE	Clinical Accountability, Service Planning and Evaluation
CCOS	Critical care outreach services
CCOT	Critical care outreach team
CI	Confidence interval
DIPEx	Database of individual patient experiences
EWS	Early warning score
HDU	High dependency unit
HEED	Health Economic Evaluations Database
ICNARC	Intensive Care National Audit and Research Centre

ICU	Intensive care unit
LMT	Limitation of medical treatment
MET	Medical emergency team
MEWS	Modified early warning score
NCEPOD	National Confidential Enquiry into Patient Outcome and Death
NHS EED	NHS Economic Evaluation Database
OR	Odds ratio
PART	Patient-at-risk team
PAR	Patient-at-risk score
PICO	Population, intervention, comparison, outcome
QALY	Quality-adjusted life year
RCT	Randomised controlled trial
RR	Relative risk
ROC	Receiver operating characteristic
SD	Standard deviation
SDO	National Institute for Health Research Service Delivery and Organisation