

ERBE flexible cryoprobes for bronchoscopic diagnosis and treatment

Medtech innovation briefing

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Summary

ERBE cryoprobes and the associated cryotherapy systems (ERBE Elektromedizin) use freezing technology for diagnostic biopsies and therapeutic interventions such as recanalisation as part of bronchoscopy procedures. The published evidence summarised in this briefing comes from 5 studies in adult populations. Three randomised controlled studies showed that cryobiopsy improved the diagnostic yield when compared with conventional forceps biopsy. Two additional studies examined the safety and efficacy of cryorecanalisation for airway obstruction caused by tumours, which was shown to be successful in most patients. The typical list price for the ERBECRYO 2 system is £10,051, excluding VAT. This includes 1 re-useable cryoprobe.

| Product summary and likely place in therapy | Effectiveness and safety |
|---|---|
| <ul style="list-style-type: none">• ERBE cryotherapy systems for bronchoscopy use freeze-thaw techniques via a flexible cryoprobe for biopsy, recanalisation and selective tissue necrosis for diagnosing and managing diseases that have caused narrowing or obstruction of the trachea or bronchi.• The ERBE cryotherapy system would be used in place of conventional bronchoscopic forceps biopsy and recanalisation techniques. | <ul style="list-style-type: none">• Five studies investigated the use of ERBE flexible cryoprobes and cryotherapy systems.• Three of these were randomised controlled trials in Germany and Iran. They all showed that cryobiopsy improved diagnostic yield when compared with conventional forceps biopsy.• One prospective study and 1 retrospective study, both done in Germany, showed that cryorecanalisation was successful in most patients. |

| Technical and patient factors | Cost and resource use |
|--|---|
| <ul style="list-style-type: none"> • There are 2 ERBE cryotherapy systems and 7 ERBE flexible cryoprobes, which differ in diameter and length. ERBE cryoprobes are compatible with all flexible bronchoscopes. • The cryoprobe is placed on the target tissue through a bronchoscope. Once in position, the cryoprobe is frozen, which then freezes the target tissue. The frozen tissue sticks to the tip of the cryoprobe. It can then be removed, either as part of the treatment or for diagnosis. The cryoprobe can also be used to destroy pathological lung tissue (cryonecrosis). • The procedures would be done in secondary care settings by medical professionals trained in bronchoscopy. | <ul style="list-style-type: none"> • The typical list price of the ERBECRYO 2 system is £10,051, excluding VAT. This includes 1 reuseable cryoprobe. • No evidence on resource use was available. |

Introduction

Several diseases can cause stenosis (narrowing) or obstruction of the trachea (windpipe) or bronchi (the main passages) of the lungs, including tracheal and bronchial tumours. Lung cancer is one of the most common and serious types of cancer. Over 41,000 people are diagnosed with the condition every year in the UK (NHS Choices: Lung cancer). In England and Wales, about 30% of people survive for 1 year or more and about 10% of people survive for 5 years or more after they are diagnosed (Cancer Research UK, 2015). It can start in the trachea, the bronchi or the lung tissue.

Bronchoscopy is a technique used to visualise and examine abnormalities in the respiratory system. It is typically done using a flexible fibre-optic bronchoscope, which is usually about 1 cm wide and 60 cm long and has a small camera at the end. Rigid bronchoscopes may also be used but they require a general anaesthetic and are less able to access distal areas of the lung ([British Thoracic Society guideline](#)). Bronchoscopes have a channel that can be used to pass small instruments or fluid into the lungs to collect lung tissue as part of diagnosis or therapy. Diagnostic and therapeutic procedures that can be done during a bronchoscopy include:

- biopsy – removal of tissue samples for diagnosis
- recanalisation – restoring airway flow by removing an obstruction (such as a foreign body or tumour; surgery to remove parts of a tumour is sometimes called 'debulking')
- selective tissue necrosis – impairing blood and oxygen flow to tissues, with the aim of destroying diseased tissue.

Several methods can be used to carry out these procedures. Forceps are typically used for biopsy samples and can be used to debulk cancerous tumours as part of treatment. However, forceps can cause bleeding and mechanical damage to tissue, and limit the sample size. This can make histological interpretation difficult. Recanalisations are typically done using brachytherapy, laser ablation, photodynamic therapy or stenting. Diseased lung tissue can be destroyed (selective tissue necrosis) using electrocautery or laser ablation.

Cryotherapy is the application of extreme cold to freeze abnormal or diseased tissue. It involves inserting a flexible cryoprobe into the instrument channel of a bronchoscope. Once the bronchoscope is in position, the cryoprobe tip is placed on the target tissue which, when frozen, sticks to the tip. Frozen tissue can then be removed for diagnosis (cryobiopsy) or as part of treatment (cryorecanalisation). Alternatively, diseased lung tissue can be destroyed by alternating between phases of freezing and thawing (cryonecrosis). The destroyed tissue can either be left in the bronchus to be resorbed by the body, be coughed out post-operatively or be removed mechanically.

Biopsy samples taken using cryotherapy are larger and less likely to be elongated or distorted (because of crushing) than those removed with forceps (Hetzl et al. 2008, Hetzel et al. 2012, Schumann et al. 2010a). Also, flexible cryoprobes can be used to approach lesions tangentially (that is, from the side), as well as directly. This increases the number of accessible areas through which the procedure can be done. Finally, the freezing process minimises bleeding after tissue removal.

Flexible cryoprobes are indicated for use in both central and peripheral lung regions, but the scope of this briefing is limited to the use of flexible cryoprobes in the trachea and bronchi.

Technology overview

This briefing describes the regulated use of the technology for the indications specified, in

the settings described, and with any other specific equipment referred to. It is the responsibility of healthcare professionals to check the regulatory status of any intended use of the technology in other indications and settings.

About the technology

CE marking

ERBE flexible cryoprobes and associated systems (ERBE Elektromedizin) received CE marking under the Medical Devices Directive 1993/42/EEC on 24 July 1998 (ERBOKRYO CA) and 15 April 2014 (ERBECRYO 2) as class IIb devices.

Description

ERBE flexible cryoprobes are used for diagnostic biopsies and therapeutic procedures during bronchoscopy. There are 7 ERBE flexible cryoprobes, which differ in diameter and length. They are compatible with all flexible bronchoscopes. ERBE Elektromedizin has 2 system models that connect to ERBE flexible cryoprobes (see table 1).

Table 1 ERBE flexible cryoprobes

| Product number | Length, diameter (mm) | Compatibility with ERBE system models | |
|----------------|-----------------------|---------------------------------------|-------------|
| | | ERBECRYO 2 | ERBOKRYO CA |
| 20402-037 | 900, 1.9 | Yes | No |
| 20402-040 | 1050, 1.9 | Yes | No |
| 20402-032 | 900, 2.4 | Yes | No |
| 20416-038 | 780, 1.9 | No | Yes |
| 20416-037 | 900, 1.9 | No | Yes |
| 20416-033 | 780, 2.4 | No | Yes |
| 20416-032 | 900, 2.4 | No | Yes |

Both systems use the Joule–Thomson effect, in which pressurised gas is forced through a small nozzle within the end of the cryoprobe to produce an extreme drop in temperature.

The low temperature freezes the cryoprobe that, in turn, freezes the target tissue to destroy or remove tissue. The system is closed and gas does not come into direct contact with the tissue.

As well as the flexible cryoprobes, the ERBE systems include:

- An ERBE cryosurgery unit – the ERBOKRYO CA unit has an analogue switch and basic display (lights indicating whether the footswitch is activated and the machine is on), whereas the ERBECRYO 2 has a digital display which shows a timer (showing duration of activation), the effect level (indicating temperature), and a plug-and-play feature that detects and displays the type of cryoprobe (length and item number), footswitch and gas bottle in use. The clinical functionality of the units is the same.
- A single-pedal footswitch to activate and deactivate the freezing process.
- A gas bottle connector.
- A flexible gas hose.

Hospitals must provide the bottles of carbon dioxide or nitrous oxide necessary to operate the systems. The ERBECRYO 2 only uses carbon dioxide whereas the ERBOKRYO CA can use either carbon dioxide or nitrous oxide.

Setting and intended use

ERBE flexible cryoprobes are intended for cryobiopsy, cryorecanalisation and cryonecrosis using bronchoscopy.

The procedures are done in secondary care settings by medical professionals trained in bronchoscopy. Although professionals should read the user manual before using the ERBECRYO system, no additional training is needed. In the UK, the procedure will most commonly be done by a thoracic surgeon or a respiratory/chest physician.

The manufacturer does not list any contraindications for this device.

Current NHS options

According to NICE's guideline on [lung cancer](#), people with known or suspected lung cancer should have a chest CT scan before bronchoscopy or other biopsy procedures. Fibre-optic

bronchoscopy can be used to diagnose and stage lung cancer. NICE's guideline recommends offering this to patients with central lesions shown on a CT scan when nodal staging does not influence treatment.

The [British Thoracic Society \(BTS\)](#) guideline for advanced diagnostic and therapeutic flexible bronchoscopy in adults lists 7 therapeutic procedures for debulking endobronchial tumours via flexible bronchoscope: argon plasma coagulation, brachytherapy, cryorecanalisation, cryotherapy, electrocautery, photodynamic therapy, and thermal laser such as neodymium-doped yttrium aluminium garnet laser. It notes that cryotherapy is mainly indicated as a palliative measure for cancerous airway obstruction, but that it may be indicated for the curative treatment of low-grade cancerous lesions and early cancer. The BTS guideline also states that cryotherapy can be used to remove foreign bodies and blood clots.

Rigid bronchoscopic debulking procedures are also used to treat airway obstructions (see the NICE clinical guideline on [lung cancer](#)).

NICE is not aware of any other CE-marked devices that have a similar function to the ERBE flexible cryoprobes for bronchoscopy.

Costs and use of the technology

The typical list price for the ERBECRYO 2 system is £10,051, excluding VAT. This includes 1 reusable cryoprobe. The manufacturer states that ERBE flexible cryoprobes can be used for up to 100 procedures. The cryoprobes are autoclaved before re-use. The average lifespan of the cryotherapy systems is unknown but the manufacturer estimates it to be at least 10 years. Technical safety checks must be done by the manufacturer at least once per year.

Forceps can be used as an alternative for cryobiopsy or cryorecanalisation. The weighted average cost of bronchoscopy is £734.96 for fibre-optic bronchoscopy in adults aged 19 years and over (NHS reference cost 2013–2014 code DZ07A), fibre-optic bronchoscopy in children aged 18 years and under (DZ07B), rigid bronchoscopy (DZ08Z) and complex bronchoscopy (DZ54Z). If the average cost for forceps and an endobronchial pack (£28.56) is added, the total cost is £763.52.

Brachytherapy can be used as an alternative for recanalisation or debulking of lung tumours (Du Rand et al. 2011). The cost of preparation and delivery of intraluminal

brachytherapy (SC53Z and SC30Z), including the average cost of bronchoscopy (£1787.96), is between £3272.96 and £13,424.96 for 1 to 5 fractions (or treatment sessions) of radiotherapy respectively.

Likely place in therapy

ERBE flexible cryoprobes would be used as an alternative to forceps to provide large-volume lung biopsy specimens. For airway recanalisation and cryonecrosis, they would be used as alternatives to other debulking methods.

Specialist commentator comments

One specialist stated that ERBE cryoprobes are unlikely to be used solely for diagnostic purposes. Instead, their place in therapy is likely to be for recanalisation, cryonecrosis and diagnosis in patients with cancerous airway obstruction, or for treating select cases of non-cancerous endobronchial tumours. Another commentator noted that cryoprobes could be used for iatrogenic granulation tissue overgrowth — a benign tracheal disease — which can occur after the insertion of tracheal or bronchial stents. One commentator explained that cryotherapy is likely to be 1 of several endobronchial techniques used for treating cancerous critical airway obstruction, saying others include stents, argon plasma coagulation or laser treatment. Two specialist commentators stated that cryotherapy is unlikely to be suitable for the treatment of non-cancerous tracheal stenosis.

One specialist commentator stated that positron emission tomography (PET) CT scanning is used to confirm staging and inform the best approach for biopsy. The specialist was of the opinion that endobronchial ultrasound-guided fine needle aspiration (EBUS-FNA) biopsies are increasingly used for diagnosis, so cryoprobes should be compared directly with EBUS-FNA to assess their value. However, there were different views between commentators as to whether EBUS-FNA and cryotherapy were alternative, or complementary, techniques; 1 commentator considered that EBUS-FNA is used to sample lung tissue for a different purpose and so comparison with cryoprobes would not be appropriate.

One commentator explained that experience with cryobiopsy samples has shown that they are more suitable for pathological assessment than those obtained using comparator techniques because they do not have crush artefact, are larger, and permit histopathological assessment (not cytology alone).

All commentators noted that there is little evidence about the cost-effectiveness of cryotherapy and alternative techniques for endobronchial recanalisation or biopsy, and also a lack of evidence about which endobronchial technique is most effective. One commentator stated that the cost of cryotherapy is more modest than other techniques, so it is highly likely that it would be cost effective. Another commentator noted that cryotherapy is likely to cost less than laser therapy.

One specialist commentator remarked on the importance of cryoprobe operators learning under supervision, particularly because of the challenging clinical problems that bleeding can introduce to the procedure. In contrast, another specialist noted that use of the ERBE cryoprobe is easily learned, may be associated with less bleeding than alternative debulking methods, and can be used with fibre-optic bronchoscopes. A third specialist commentator explained that electrocautery is more widely used than neodymium-doped yttrium aluminium garnet laser, is less costly, and does not need safety regulation and training.

Finally, 1 specialist commentator indicated that their experience of cryorecanalisation in the NHS was similar to that reported in the study by Schumann et al. (2010b).

Equality considerations

NICE is committed to promoting equality and eliminating unlawful discrimination. In producing guidance, NICE aims to comply fully with all legal obligations to:

- promote race and disability equality and equality of opportunity between men and women
- eliminate unlawful discrimination on grounds of race, disability, age, sex, gender reassignment, pregnancy and maternity (including women post-delivery), sexual orientation, and religion or belief (these are protected characteristics under the Equality Act 2010).

ERBE flexible cryoprobes may be beneficial for people with poor respiratory function caused by long-term lung diseases such as chronic obstructive pulmonary disease (COPD). Chronic conditions such as COPD may adversely affect activities of daily living to the extent that people may be considered to be disabled. Disability is a protected characteristic under the Equality Act 2010.

Evidence review

Clinical and technical evidence

Regulatory bodies

A search of the Medicines and Healthcare Products Regulatory Agency website revealed no manufacturer Field Safety Notices or Medical Device Alerts for this device.

Four reports of adverse events were identified from a search of the US Food and Drug Administration (FDA) Manufacturer and User Device Facility Experience (MAUDE) database. One event was reported twice, leaving 3 unique events involving an ERBE cryoprobe. It is unclear which cryoprobe or system model was used in each case. Two of the adverse events were listed as device malfunctions (missing probe tip and loud noise near the connection to the ERBE unit) and did not result in patient harm. The remaining adverse event was a patient death. However, this was deemed to be a consequence of the patient's underlying disease state and unrelated to the device.

Clinical evidence

Of the 118 relevant papers identified, 90 were excluded because they were duplicates, case studies, reviews, animal studies, about peripheral lung lesions or did not mention the device used. There were 28 appropriate studies that used an ERBE flexible cryoprobe. This briefing includes only diagnostic randomised controlled trials for cryobiopsy and all cryorecanalisation studies (see [evidence selection](#)). Studies on cryonecrosis were excluded from further assessment on the basis of small sample sizes, date of publication, or because they were reviews.

Diagnostic randomised controlled trials for biopsy

Hetzel et al. (2012) compared the diagnostic yield and safety when using the ERBE flexible cryoprobe for cryobiopsy with conventional sampling methods (forceps) for potentially cancerous endobronchial lesions. The ERBE model used was not stated. Diagnostic yield is the ratio of diagnostic findings and the total number of procedures done using the technique. It is defined as the likelihood that a test or procedure will provide the information needed to establish a diagnosis. The study randomised 593 patients into the

cryoprobe (n=296) or forceps (n=297) groups. There was no statistically significant difference in baseline characteristics between the study groups. The diagnostic yield was 95.0% for cryobiopsy and 85.1% for standard forceps ($p<0.001$). No bleeding occurred in 19.9% of patients in the cryoprobe group and 30.6% of patients in the forceps group ($p=0.009$). Mild bleeding occurred in 61.8% of cryoprobe group patients and 51.5% of forceps group patients (no p-value reported). There was no significant difference in the number of bleeding complications needing intervention between the 2 groups ($p=0.90$). The proportions of non-diagnostic results in patients with non-small cell lung cancer were 11.8% for forceps biopsy and 5.5% for cryobiopsy ($p=0.025$); non-diagnostic results for patients with small cell lung cancer were also lower for cryobiopsy (3.6% versus 16.1% for forceps biopsy, $p=0.024$).

Jabari et al. (2012) compared the diagnostic yield with and safety of endobronchial biopsies using the ERBE flexible cryoprobe (900 mm in length, 2.3 mm diameter) with forceps biopsy. Patients (n=60) with an established endobronchial lesion were included in the study. All patients had 3 biopsies, a forceps biopsy and 2 cryotherapy biopsies (1 for 3 seconds and 1 for 5 seconds), in a random order. The median biopsy size was 0.5 cm for forceps biopsy, 0.8 cm for 3-second cryobiopsy and 1.6 cm for 5-second cryobiopsy. The diagnostic yield was 66.7% for forceps biopsy, 80% for 3-second cryobiopsy and 76.6% for 5-second cryobiopsy; differences in diagnostic yield were not statistically significant ($p>0.05$). However, a combination of both cryobiopsy methods resulted in an increase of diagnostic yield to 90.0% ($p=0.02$). Bleeding complications occurred in 8 cases; there were no differences in the incidence or bleeding type among the 3 sampling methods.

Schumann et al. (2010a) compared the diagnostic yield with, and the feasibility and safety of, endobronchial biopsies using the ERBE flexible cryoprobe (780 mm in length, 2.3 mm diameter) with forceps biopsy. patients (n=296) with an endoscopically visible endobronchial lesion were included in the study. The first 55 patients were randomised consecutively for the order of the biopsy procedures (forceps biopsy followed by cryobiopsy or vice versa). The remaining patients were not randomised and only had cryobiopsy. The diagnostic yield was 89.1% and 65.5% for cryobiopsy and forceps biopsy respectively ($p<0.05$). In addition, tissue samples taken by cryobiopsy were significantly larger and freer from artefacts than tissue obtained from forceps biopsy ($p<0.001$).

Cryorecanalisation

Hetzel et al. (2004) did a prospective study to examine the safety and effectiveness of cryorecanalisation with an ERBE flexible cryoprobe (780 mm in length, 2.3 mm diameter)

in patients with respiratory tract stenosis caused by lung tumours. The study enrolled 60 patients with high-grade stenosis in the central respiratory tract (caused by tumours) or in a segment of a bronchus with post-obstructive pneumonia (as a consequence of lung tumours). Recanalisation was defined as successful if there was no residual stenosis detectable by endoscopy and partially successful if residual stenosis was evident by endoscopy but passable with the bronchoscope. Recanalisation was successful in 61% of the patients and partially successful in 22%. Bleeding that stopped spontaneously within minutes occurred in 54 patients, but 6 patients had more intense bleeding (100–300 ml of blood loss). However, the bleeding was controlled and stopped with intervention in all 6 patients.

Schumann et al. (2010b) investigated the efficacy and safety of the ERBE flexible cryoprobe (length and diameter not stated) for immediate tumour ablation in patients with endobronchial or tracheal tumour obstruction. In a retrospective study of 225 patients, the authors examined the success rate and bleeding complications associated with cryorecanalisation. The intervention was defined as successful if the endobronchial tumour mass could be removed so that either drainage of secretions or reduced airway stenosis led to an improvement in the patient's condition and symptoms. The procedure was successful in 91.1% of patients. Bleeding complications occurred in 27 patients (12.0%). Of these, 9 had mild bleeding (ice-cold sodium chloride or adrenaline solution was needed to treat the bleed) and 18 had moderate bleeding (argon plasma coagulation or a bronchus blocker was needed to treat the bleed).

Recent and ongoing studies

Three ongoing or in-development trials using ERBE cryoprobes were identified in the preparation of this briefing.

- [NCT01475084](#) – the purpose of the study is to compare cryobiopsies using an ERBE flexible cryoprobe (2.4 mm diameter, 900 mm length) and ERBOKRYO CA with forceps biopsies during semi-rigid thoracoscopy. The Slovenia-based study began in November 2011 and its status is unknown.

- [NCT02075762](#) – the objective of this study is to compare the sample size, architectural preservation and diagnostic yield of bronchoscopic cryoprobe lung biopsy with that of standard (using forceps) and video-assisted thoracoscopic surgery lung biopsy for the diagnosis of interstitial lung disease. This USA-based study began in August 2013 and is expected to complete in August 2015. It is a prospective cohort study in which 20 subjects will be enrolled.

Costs and resource consequences

ERBE flexible cryoprobes can be used in place of diagnostic or therapeutic devices for lung biopsy, recanalisation or selective tissue necrosis, including: forceps, electrocautery, neodymium-doped yttrium aluminium garnet laser, argon plasma coagulation or photodynamic therapy. A flexible bronchoscope is needed alongside the technology as well as general or local anaesthesia, sedation and intubation as appropriate. Medical professionals must be trained to use the device according to the instructions for use. The ERBECRYO 2 and the ERBOKRYO CA systems are currently used in the NHS.

No published evidence on the resource consequences of using ERBE flexible cryoprobes was identified in the systematic review of evidence.

Strengths and limitations of the evidence

Three procedures were done in the Jabari et al. (2012) study (forceps biopsy, cryobiopsy in 3 seconds and cryobiopsy in 5 seconds). Although the tissue samples obtained by cryobiopsy in 5 seconds were larger than those obtained by cryobiopsy in 3 seconds, the diagnostic yield of cryobiopsy in 3 seconds was higher. This might be because multiple samples were taken from the same target area and the mechanical damage to the small area may have influenced the results.

In all 3 biopsy randomised controlled trials, diagnostic yield was a primary outcome measure. The studies reported the proportion of patients who were diagnosed as a proportion of the total number of patients assessed. However, none of the studies presented diagnostic accuracy, so it is not possible to discern the proportion of patients who were correctly diagnosed.

Hetzel et al. (2012) was the only included study that did a power calculation for sample size. It is unclear whether the remaining studies had an adequate sample size to draw

reliable conclusions.

The study by Hetzel et al. (2012) also eliminated performance bias by blinding the evaluating pathologist to the intervention technique. In the studies by Schumann et al. (2010a) and Jabari et al. (2012), patients had biopsies via both forceps and flexible cryoprobe procedures. Both studies randomised the order of sampling within each patient to eliminate order-effect bias.

Hetzel et al. (2004) and Schumann et al. (2010b) both examined cryorecanalisation using the cryoprobe over different time periods within the same German healthcare institution. Neither were controlled studies, and both reported the safety and effectiveness of the technique without a reference standard. Schumann et al. (2010b) showed a higher rate of successful recanalisation than Hetzel et al (2004). Schumann et al. (2010b) highlighted that Hetzel et al. (2004) was a feasibility study, and that the increased success rate in their later publication may have been because of the learning gained in the cryorecanalisation procedure. Although neither study provided a sample size calculation, the study by Schumann et al. (2010b) examined a larger sample size of 225 patients, which reduced the likelihood of recanalisation successes occurring by chance when compared with Hetzel et al. (2004), which studied only 60 patients. However, the Hetzel et al. (2004) study was done prospectively, whereas the Schumann et al. (2010b) study was retrospective; sources of error due to confounding and bias are more common in retrospective studies than in prospective studies.

All of the studies use cryoprobes for ERBOKRYO CA. The difference between ERBECRYO 2 and ERBOKRYO CA lies in the updated unit display and design of ERBECRYO 2 rather than the clinical functionality of the device. Therefore, results for the ERBOKRYO CA may be generalisable to the ERBECRYO 2.

None of the studies included in this briefing took place in the UK, so the generalisability of the results to the NHS is unclear. Similarly, although the device is not contraindicated for children, no relevant evidence was found on the safety and effectiveness of ERBECRYO 2 or ERBOKRYO CA in patients under 18 years old.

Finally, Jabari et al. (2012) was the only study without an author related to, or funding from, the ERBE company. The manufacturer directly contributed to the studies by Hetzel et al. (2004) and Hetzel et al. (2012). At least 1 author from Schumann et al. (2010a) and Schumann et al. (2010b) disclosed that they received lecture fees from ERBE. Manufacturer involvement in the project may potentially introduce bias in the reporting of

outcomes.

Relevance to NICE guidance programmes

NICE has issued the following guidance:

- [Diagnosis and treatment of lung cancer](#) (2011) NICE guideline CG121. Date for review: December 2015
- [Cryotherapy for malignant endobronchial obstruction](#) (2005) NICE interventional procedure guidance 142
- [Photodynamic therapy for localised inoperable endobronchial cancer](#) (2005) NICE interventional procedure guidance 137
- [Photodynamic therapy for advanced bronchial carcinoma](#) (2004) NICE interventional procedure guidance 87

References

Cancer Research UK (2015) [Lung cancer statistics](#) (accessed 4 June 2015)

Department of Health (2014) [NHS reference costs 2013 to 2014](#) (accessed 2 June 2015)

Du Rand IA, Barber PV, Goldring J et al. (2011) [British Thoracic Society guideline for advanced diagnostic and therapeutic flexible bronchoscopy in adults](#). *Thorax* 66 (suppl 3): iii1–iii21

Hetzel J, Eberhardt R, Herth FJF et al. (2012) [Cryobiopsy increases the diagnostic yield of endobronchial biopsy: A multicentre trial](#). *European Respiratory Journal* 39: 685–90

Hetzel J, Hetzel M, Hasel C, et al. (2008) [Old meets modern: the use of traditional cryoprobes in the age of molecular biology](#). *Respiration* 76:19–97

Hetzel M, Hetzel J, Schumann C et al. (2004) [Cryorecanalization: a new approach for the immediate management of acute airway obstruction](#). *Journal of Thoracic and Cardiovascular Surgery* 127: 1427–31

McGrath BA, Bates L, Atkinson D et al. (2012) Multidisciplinary guidelines for the management of tracheostomy and laryngectomy airway emergencies. *Anaesthesia* 67: 1025–41

National Institute for Health and Clinical Excellence (2011) Lung cancer (update): full guideline. NICE guideline (CG121)

NHS Choices (2013) Lung cancer (accessed 9 June 2015)

Jabari H, Sami R, Fakhri M et al. (2012) Different protocols for cryobiopsy versus forceps biopsy in diagnosis of patients with endobronchial tumors. *Pneumologia* 61: 230–3

Schumann C, Hetzel J, Babiak AJ et al. (2010a) Cryoprobe biopsy increases the diagnostic yield in endobronchial tumor lesions. *Journal of Thoracic and Cardiovascular Surgery* 140: 417–21

Schumann C, Hetzel M, Babiak AJ et al. (2010b) Endobronchial tumor debulking with a flexible cryoprobe for immediate treatment of malignant stenosis. *Journal of Thoracic and Cardiovascular Surgery* 139: 997–1000

Young E, Pugh R, Hanlon R et al. (2014) Tracheal stenosis following percutaneous dilatational tracheostomy using the single tapered dilator: an MRI study. *Anaesthesia and Intensive Care* 42: 745–51

Search strategy and evidence selection

Search strategy

For the clinical evidence

Embase 1980 to 2015 Week 14, Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations and Ovid MEDLINE(R) 1946 to Present; searched 20 May 2015.

1. erbe.mp. [mp=ti, ab, ot, nm, hw, kf, px, rx, ui, tn, dm, mf, dv, kw]
2. bronchoscop*.mp. [mp=ti, ab, ot, nm, hw, kf, px, rx, ui, tn, dm, mf, dv, kw]

3. cryoprobe.mp. [mp=ti, ab, ot, nm, hw, kf, px, rx, ui, tn, dm, mf, dv, kw]

4. cryo probe.mp. [mp=ti, ab, ot, nm, hw, kf, px, rx, ui, tn, dm, mf, dv, kw]

5. 1 or 2

6. 3 or 4

7. 5 and 6

8. erbekryo.mp. [mp=ti, ab, ot, nm, hw, kf, px, rx, ui, tn, dm, mf, dv, kw]

9. erbokryo.mp. [mp=ti, ab, ot, nm, hw, kf, px, rx, ui, tn, dm, mf, dv, kw]

10. 8 or 9

11. 7 or 10

12. Remove duplicates from 11

13. Limit 12 to yr= "1985-Current"

For the economic evidence

Embase 1980 to 2015 Week 14, Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations and Ovid MEDLINE(R) 1946 to Present; searched 26 May 2015.

1. erbe.mp. [mp=ti, ab, ot, nm, hw, kf, px, rx, ui, tn, dm, mf, dv, kw]

2. bronchoscop*.mp. [mp=ti, ab, ot, nm, hw, kf, px, rx, ui, tn, dm, mf, dv, kw]

3. cryoprobe.mp. [mp=ti, ab, ot, nm, hw, kf, px, rx, ui, tn, dm, mf, dv, kw]

4. cryo probe.mp. [mp=ti, ab, ot, nm, hw, kf, px, rx, ui, tn, dm, mf, dv, kw]

5. 1 or 2

6. 3 or 4

7. 5 and 6

8. erbekryo.mp. [mp=ti, ab, ot, nm, hw, kf, px, rx, ui, tn, dm, mf, dv, kw]

9. erbokryo.mp. [mp=ti, ab, ot, nm, hw, kf, px, rx, ui, tn, dm, mf, dv, kw]

10. 8 or 9

11. 7 or 10

12. Remove duplicates from 11

13. Limit 12 to yr= "1985-Current"

(Cost* or economic*).mp. [mp=ti, ab, ot, nm, hw, kf, px, rx, ui, tn, dm, mf, dv, kw]

13 and 14

Cochrane Database of Systematic Reviews: Issue 5 of 12, May 2015; Cochrane Central Register of Controlled Trials: Issue 4 of 12, April 2015; Database of Abstracts of Reviews of Effect: Issue 2 of 4, April 2015;

Health Technology Assessment Database: Issue 2 of 4, April 2015;

NHS Economic Evaluation Database: Issue 2 of 4, April 2015.

Evidence selection

For the clinical evidence

- Total number of publications reviewed: 118
- Total number of publications considered relevant: 28
- Total number of publications selected for inclusion in this briefing: 5

- Exclusion criteria: case studies, editorials, letters, reviews, animal studies, and non-English language studies, non-randomised cryobiopsy trials, transbronchial biopsy studies, studies with sample size <20 patients receiving flexible cryoprobe, publication before year 2000.

For the economic evidence

- Total abstracts: 5
- Duplicates: 0
- Abstracts reviewed: 5
- Full papers reviewed: 0
- Studies for review: 0

Appendix

Contents

Table 2: Overview of the Hetzel et al. (2012) trial

Table 3: Summary of results of the Hetzel et al. (2012) trial

Table 4: Overview of the Jabari et al. (2012) trial

Table 5: Summary of results of the Jabari et al. (2012) trial

Table 6: Overview of the Schumann et al. (2010a) trial

Table 7: Summary of results of the Schumann et al. (2010a) trial

Table 8: Overview of the Hetzel et al. (2004) study

Table 9: Overview of the Schumann et al. (2010b) study

Table 2 Overview of the Hetzel et al. (2012) trial

| Study component | Description |
|-------------------------------------|--|
| Objectives/ hypotheses | To evaluate the diagnostic yield and safety of cryobiopsy over conventional sampling (forceps) for endobronchial lesions suspicious for malignancy. |
| Study design | Multi-centre single-blinded randomised controlled trial. |
| Setting | 8 centres in Germany; June 2006 to October 2008. |
| Inclusion/ exclusion criteria | <p data-bbox="344 770 488 804">Inclusion:</p> <ul data-bbox="360 853 1369 1099" style="list-style-type: none"> <li data-bbox="360 853 1369 936">• patients with suspected lung lesions based on clinical signs and radiological images <li data-bbox="360 981 735 1014">• patients >18 years old <li data-bbox="360 1059 783 1093">• signed informed consent. <p data-bbox="344 1137 496 1171">Exclusion:</p> <ul data-bbox="360 1220 1437 1467" style="list-style-type: none"> <li data-bbox="360 1220 1358 1254">• patients with bleeding diathesis or who were on anticoagulants <li data-bbox="360 1299 1437 1382">• patients who had oxygen saturation <90% (under delivery of oxygen at $\leq 2 \text{ l} \cdot \text{min}^{-1}$) <li data-bbox="360 1426 1126 1460">• patients with severe underlying cardiac disease. |

| | |
|---------------------|---|
| Primary outcomes | <p>Primary:</p> <ul style="list-style-type: none"> • diagnostic yield of cryobiopsies versus forceps biopsies. <p>Secondary:</p> <ul style="list-style-type: none"> • duration of biopsy procedure • number of samples taken • level of difficulty in positioning the probe • amount of bleeding. |
| Statistical methods | <p>Data were analysed by descriptive methods and endpoints were presented separately for each group.</p> <p>Diagnostic yield was calculated for each biopsy technique as the number of diagnostic procedures divided by the number of non-diagnostic procedures plus the number of diagnostic procedures.</p> <p>Based on an explorative test of diagnostic yield, the study was powered at 90% for a significance of $p=0.05$, for a sample size calculation of $n=278$ patients.</p> <p>Primary comparison of diagnostic rate was evaluated by a two-tailed Chi-square test. secondary endpoints used Chi-square and Mann-Whitney rank tests.</p> <p>All tests used 5% level of significance.</p> |
| Patients included | <p>A total of 593 patients were randomised.</p> <p>Forceps group: $n=297$, age=65.3 ± 9.9, 69.6% male, height 170.9 ± 8.5 cm, weight 74.3 ± 14.7 kg.</p> <p>Cryoprobe group: $n=296$, age=64.8 ± 10.3, 73.4% male, height 170.2 ± 8.9 cm, weight 72.3 ± 15.0 kg.</p> <p>No significant difference existed between the study groups for the above characteristics.</p> |

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| Results | <p>563 patients were diagnosed with malignant disease. Of these, diagnostic yield was 95.0% for cryobiopsy and 85.1% for standard forceps ($p < 0.001$). Exophytic tumours and submucosal tumours showed better diagnostic yield for cryoprobe than forceps ($p = 0.003$ and $p = 0.005$ respectively).</p> <p>There was no bleeding in 30.6% of forceps patients and 19.9% of cryoprobe patients ($p = 0.009$). There was mild bleeding (no intervention used) in 51.5% of forceps patients and 61.8% of cryoprobe patients, and severe bleeding (at least 1 intervention for bleeding control was applied) in 17.8% of forceps patients and 18.2% of cryoprobe patients (no p-value reported). There was no significant difference in the number of bleeding complications needing intervention between the 2 groups ($p = 0.90$).</p> <p>The proportion of non-diagnostic results in patients with NSCLC and SCLC was lower after cryobiopsy than after forceps biopsy: NSCLC, 5.5% (95% CI 2.8–9.6) versus 11.8% (95% CI 7.6–17.2), $p = 0.025$; and SCLC, 3.6% (95% CI 0.4–12.3) versus 16.1% (95% CI 8.0–27.7), $p = 0.024$.</p> |
| Conclusions | Cryobiopsy has a higher diagnostic yield for the diagnosis of endobronchial malignancies when compared with forceps. |
| Abbreviations: CI, confidence interval; n, number of patients; NSCLC, non-small cell lung cancer; SCLC, small cell lung cancer. | |

Table 3 Summary of results from the Hetzel et al. (2012) trial

| | Forceps | Cryobiopsy | Analysis |
|--|-----------------|-----------------|----------------|
| Randomised | n=297 | n=296 | |
| Efficacy | n=297 | n=296 | |
| Primary outcome: Diagnostic biopsy in patients with malignancy | 85.1% (239/297) | 95.0% (268/296) | $p < 0.001$ |
| Selected secondary outcomes: | | | |
| Duration of biopsy procedure | 5.25±4.20 min | 5.05±4.54 min | $p > 0.05$ min |
| Number of samples taken | 3.45±0.95 | 3.24±1.16 | $p < 0.009$ |

| | | | |
|--|--|--|----------------------------------|
| Level of difficulty in positioning the probe | Not reported | Not reported | p=0.068, in favour of cryobiopsy |
| Safety | n=297 | n=296 | – |
| Patients reporting serious adverse events | Not reported | Not reported | – |
| Bleeding | <ul style="list-style-type: none"> • None 30.6% (91/297) • Mild 51.6% (153/297) • Severe 17.8% (53/297) | <ul style="list-style-type: none"> • None 19.9% (59/296) • Mild 61.8% (183/296) • Severe 18.2% (54/296) | No bleeding, p=0.009 |
| Abbreviations: n, number of patients. | | | |

Table 4 Overview of the Jabari et al. (2012) trial

| Study component | Description |
|-----------------------|---|
| Objectives/hypotheses | To evaluate the diagnostic yield and safety of endobronchial biopsies using the flexible cryoprobe. |
| Study design | Single centre, single-blinded randomised controlled trial. |
| Setting | Single-centre in Iran; April 2009 to June 2011. |

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| Inclusion/ exclusion criteria | <p>Inclusion:</p> <ul style="list-style-type: none"> • patients with previously confirmed endobronchial tumour • >20 years of age • satisfactory respiratory function (oxygen saturation >85% with no oxygen supplementation). <p>Exclusion:</p> <ul style="list-style-type: none"> • patients with respiratory failure, hypoxia, or respiratory distress • patients with a positive history of cardiac or hemodynamic instability • abnormality of coagulation. |
| Primary outcomes | Diagnostic yield, biopsy size. |
| Statistical methods | <p>Descriptive statistics used for data. The size of the specimen obtained from each sampling method was compared using Friedman's 2-way Analysis of Variance by Ranks and Wilcoxon signed-rank test. Cochran's Q test was used to compare diagnostic accuracies.</p> <p>p-value <0.05 was considered statistically significant.</p> |
| Patients included | <p>60 patients; 39 male and 21 female; mean age 56.77±13.3 (range 27–76) years.</p> <p>Three samples were obtained from each patient.</p> |

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| Results | <p>Diagnosis was made in 57 cases; 54 cases were diagnosed with malignant lesion.</p> <p>Specimen size obtained (median, range):</p> <ul style="list-style-type: none"> • 5 second cryobiopsy (1.6 cm, 0.9–2.0 cm) • 3 second cryobiopsy (0.8 cm, 0.4–1.7 cm) • Control arm: forceps biopsy (0.5 cm, 0.1–1.2 cm) <p>The specimen size obtained with both cryobiopsy techniques compared with forceps biopsy, as well as 5 second compared with 3 second cryobiopsy were statistically significant ($p < 0.001$).</p> <p>Diagnostic yield was 66.7% for forceps biopsy, 80% for cryobiopsy in 3 seconds and 76.6% for cryobiopsy in 5 seconds, with no significant difference in the methods.</p> <p>Bleeding complications occurred in 8 cases (13.3%). These were regarded as 'no haemorrhage' in 2 cases (3.3%), 'haemorrhage controlled by normal saline' in 4 cases (6.7%), and 'haemorrhage controlled by diluted adrenaline' in 1 case (1.7%), and there was 1 case of bleeding that needed argon plasma coagulation (1.7%).</p> <p>Statistical analysis showed that there were no significant differences in cases of bleeding type among the 3 sampling methods (Cochran's Q test; $p > 0.05$).</p> |
| Conclusions | <p>Diagnostic yield was greater for cryobiopsy when compared with forceps. There was no significant difference in bleeding based on method used.</p> |

Table 5 Summary of results from the Jabari et al. (2012) trial

| | Forceps | Cryobiopsy (3 s) | Cryobiopsy (5 s) | Analysis |
|-----------------------------------|---------------|------------------|------------------|------------|
| Randomised | n=60 | n=60 | n=60 | |
| Efficacy | n=60 | n=60 | n=60 | |
| Primary outcome: diagnostic yield | 66.7% (40/60) | 80.0% (48/60) | 76.7% (46/60) | $p > 0.05$ |

| | | | | |
|---|--|--------------------|--------------------|--------------------------|
| Selected secondary outcomes: | | | | |
| Size of biopsy sample (median, range) | 0.5 cm, 0.1–1.2 cm | 0.8 cm, 0.4–1.7 cm | 1.6 cm, 0.9–2.0 cm | p<0.001 |
| Safety | n=60 | n=60 | n=60 | |
| Patients reporting serious adverse events | Not reported | Not reported | Not reported | – |
| Bleeding | Bleeding occurred in 8 cases, not stratified by intervention | | | Cochran's Q test, p>0.05 |
| Abbreviations: n, number of patients; s, seconds. | | | | |

Table 6 Overview of the Schumann et al. (2010a) trial

| Study component | Description |
|------------------------|---|
| Objectives/ hypotheses | To evaluate the diagnostic yield, feasibility, and safety of endobronchial biopsies using the flexible cryoprobe. |
| Study design | Single-centre, prospective, including randomised 2-arm study. |
| Setting | Germany, 6 year study (dates not mentioned). |

| | |
|-------------------------------------|--|
| Inclusion/ exclusion criteria | <p>Inclusion:</p> <ul style="list-style-type: none"> • exophytic endobronchial tumour (endoscopically visible lesion) • signed informed consent form in the first cohort • sufficient respiratory function (oxygen saturation >90% with 2 litre of supplementary oxygen). <p>Exclusion:</p> <ul style="list-style-type: none"> • previous cancer-specific treatment or endobronchial diagnostic procedure • suspected connection of the lesion to large pulmonary blood vessels as seen on chest computed tomography scan • thrombocyte count less than 100 G/litre and abnormal plasma clotting • age less than 18 years. |
| Primary outcomes | Diagnostic yield, biopsy area. |
| Statistical methods | Descriptive statistics were used for quantitative image analysis data. Comparisons of biopsy sample size between FB and CB were made using the Wilcoxon signed-rank test. Significance was determined by contingency tables and Fisher's exact test. |
| Patients included | In total, 296 patients were included: 225 males and 71 females; age 63.4±11.8 years, range 20–84. The first 55 patients were randomised consecutively for the sequence of the biopsy procedure (receiving forceps biopsy followed by cryobiopsy or vice versa). All other patients had cryobiopsy only. No demographics were included for the 55 patients. |

| | |
|---|--|
| Results | <p>Diagnostic yield of cryobiopsy was 89.1% (49/55) and 65.5% (36/55) for forceps biopsy ($p < 0.05$). Subgroup analysis showed no influence on these results by the sampling order or by localisation of tumour lesion within the bronchial tree.</p> <p>The mean total area of each tissue section in the cryobiopsy slides was 10.4 mm^2, significantly larger than the mean total area of forceps biopsy (5.2 mm^2, $p < 0.0001$). The artefact-free tissue areas of each slide were significantly greater with cryobiopsy than with forceps biopsy (9.6 mm^2 versus 3.6 mm^2, $p < 0.0001$).</p> <p>Bleeding was not reported for the randomised cohort of this trial. Of the 296 patients receiving cryobiopsy, bleeding complications occurred in 15 cases (11 mild, 3 moderate, and 1 severe). Bleeding was graded as mild if ice-cold water or epinephrine solution was necessary to stop bleeding; moderate if additional techniques (argon plasma coagulator, bronchus blocker) were used; and severe if additional systemic treatment was needed (transfusion of red blood cells, platelets, fresh-frozen plasma or coagulation factors, fluid resuscitation, use of vasopressors) to stabilise a patient's condition.</p> |
| Conclusions | Cryobiopsy obtained higher diagnostic yield, larger tissue size and better tissue quality when compared with forceps biopsy. |
| Abbreviations: CB, cryobiopsy; FB, forceps biopsy; G/litre, giga per litre (10^9 cells/litre). | |

Table 7 Summary of results from the Schumann et al. (2010a) trial*

| | Forceps | Cryobiopsy | Analysis |
|-----------------------------------|---------------------|--------------------|-------------|
| Randomised | n=55 | n=55 | |
| Efficacy | n=55 | n=55 | |
| Primary outcome: Diagnostic yield | 65.5% (36/55) | 89.1% (49/55) | $p < 0.05$ |
| Selected secondary outcomes: | | | |
| Mean total area of tissue | 10.4 mm^2 | 5.2 mm^2 | $P < 0.001$ |
| Safety | n/a | n=296 | |

| | | | |
|--|---------------|---------------|---|
| Patients reporting serious adverse events | None reported | None reported | – |
| Abbreviations: n, number of patients. *Results from randomised cohort only. | | | |

Table 8 Overview of the Hetzel et al. (2004) study

| Study component | Description |
|-------------------------------------|--|
| Objectives/ hypotheses | To investigate the effectiveness of CR with a cryoprobe in patients with respiratory tract stenosis caused by exophytic tumours. |
| Study design | Prospective, single centre. |
| Setting | Germany, January 2002 to May 2003. |
| Inclusion/ exclusion criteria | <p>Inclusion:</p> <ul style="list-style-type: none"> High-grade stenosis in the area of the central respiratory tracts from exophytic tumours with clinical symptoms; high-grade stenosis was defined as an airway narrowing that could not be passed with an Olympus bronchoscope despite pressure exerted on the bronchoscope stenosis-closure of a lobe or segment of a bronchus with post-obstructive pneumonia. <p>Exclusion:</p> <ul style="list-style-type: none"> patients with airway stenoses caused by extrinsic compression thrombocyte count less than 100 G/litre abnormal plasma clotting. |
| Primary outcomes | Success, defined as having no residual stenosis detectable by endoscopy. |
| Statistical methods | Descriptive statistics used, no analysis. |

| | |
|---|---|
| Patients included | 60 patients, age 19–81 years; 23 had complete bronchial obstruction and 37 had high-grade airway stenosis. |
| Results | <p>CR was achieved in 37 patients (61%). The procedure was partially successful in 13 patients (22%), meaning that there was residual stenoses that were easily passible with a bronchoscope. CR was unsuccessful in 10 patients (17%).</p> <p>The procedure lasted 9–81 minutes (41 ± 16 minutes); on average, 13 applications of the cryoprobe were needed during 1 intervention (range 3–31).</p> <p>Of 57 patients with malignant airway disease, 14 presented again with symptoms of recurrent airway obstruction. Average time between interventions was 18 ± 4 weeks, median 16 weeks, range 10–24 weeks.</p> <p>After a mean follow-up time of 25 weeks (range 24–71 weeks), 14 patients were alive without symptoms from airway stenosis. All of these patients had additional chemotherapy, radiation therapy, or both.</p> <p>No patients died during the procedure. Fifty-four patients exhibited light bleeding that stopped spontaneously within minutes. The remainder of the patients ($n=6$) had more intense bleeding (100–300 ml of blood loss), but bleeding was controlled with suction with the flexible bronchoscope and was stopped in all patients.</p> |
| Conclusions | CR was successful or partially successful in 83% of patients. |
| Abbreviations: CR, cryorecanalisation; G/litre, giga per litre (10^9 cells/litre). | |

Table 9 Overview of the Schumann et al. (2010b) study

| Study component | Description |
|-----------------------|--|
| Objectives/hypotheses | To evaluate the efficacy and safety of the ERBECRYO flexible cryoprobe (length and diameter not stated) for immediate tumour ablation in patients with exophytic endobronchial or tracheal tumour obstruction. |
| Study design | Single-centre, retrospective study. |
| Setting | Germany, February 2001 to September 2007. |

| | |
|-------------------------------------|--|
| Inclusion/ exclusion criteria | <p>Inclusion:</p> <ul style="list-style-type: none"> patients who had bronchoscopic intervention with a flexible cryoprobe because of an exophytic tumour of the trachea or bronchi with subsequent airway stenosis. <p>Exclusion:</p> <ul style="list-style-type: none"> patients with platelet count <100 G/litre abnormal coagulation parameters (partial thromboplastin time >40 seconds and prothrombin ratio <70%). |
| Primary outcomes | <p>Success rate of CR, defined as successful if the endobronchial tumour mass could be ablated so that either drainage of secretion or reduced airway stenosis led to an improvement in the patient's condition and symptoms. CR was not successful if the primary goal of the intervention (i.e. target bronchus reopening) could not be reached.</p> <p>Safety: severity of bleeding, need for a rescue operation, or prolonged mechanical ventilation >2 hours after the intervention.</p> |
| Statistical methods | Descriptive statistics used for patient population. No statistical analysis. |
| Patients included | 225 patients, 156 men (69.3%); mean age 63.9±12.9 years (range 19–83 years); 193 (85.8%) inpatients. |

| | |
|---|--|
| Results | <p>197/225 (87.6%) had malignant airway stenosis; 147 (74.6%) had lung cancer.</p> <p>CR was successful in 205/225 patients (91.1%). In 20 patients (8.9%), the intervention was not successful and did not reopen the obstructed bronchus. The main reason for unsuccessful interventions was longer length of the complete bronchial obstruction.</p> <p>Most of the interventions were done only with the flexible technique (194 patients). Additional techniques were used in 48 patients: 37 (16.4%) had APC and 11 (4.9%) had stent implantation.</p> <p>Bleeding complications occurred in 27 (12%) patients. Bleeding was defined as mild if the application of cold NaCl 0.9% solution (2–4°C) or epinephrine solution (1 mg/10 ml saline water) applied topically was sufficient to stop bleeding (9 patients experienced mild bleeding). Bleeding was defined as moderate if additional techniques (APC or a bronchus blocker) had to be used (18 patients experienced moderate bleeding).</p> |
| Conclusions | CR was successful in most patients. |
| <p>Abbreviations: APC, argon plasma coagulation; CR, cryorecanalisation; G/litre, giga per litre (10⁹ cells/litre); NaCl, sodium chloride.</p> | |

About this briefing

Medtech innovation briefings summarise the published evidence and information available for individual medical technologies. The briefings provide information to aid local decision-making by clinicians, managers and procurement professionals.

Medtech innovation briefings aim to present information and critically review the strengths and weaknesses of the relevant evidence, but contain no recommendations and **are not formal NICE guidance**.

Development of this briefing

This briefing was developed for NICE by King's Technology Evaluation Centre. The [interim process & methods statement](#) sets out the process NICE uses to select topics, and how the briefings are developed, quality-assured and approved for publication.

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Declarations of interest

No relevant interests declared.

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