British Thoracic Society guidelines on diagnostic flexible bronchoscopy

British Thoracic Society Bronchoscopy Guidelines Committee, a Subcommittee of the Standards of Care Committee of the British Thoracic Society

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Introduction

These guidelines have been developed at the request of the Standards of Care Committee of the British Thoracic Society (BTS). Two particular problems have emerged since the previous BTS guidelines were published.[1 2] Firstly, there have been many cases reported recently of atypical mycobacteria causing contamination of bronchoscopes leading to pseudoinfections. Secondly, toxicity from glutaraldehyde has become a significant problem as it has been implicated in cases of occupational asthma among some nursing and technical staff working in endoscopy units (the term "endoscopy unit" is used in these guidelines as most bronchoscopy services are now carried out within such units). The previous BTS bronchoscopy guidelines were brief and were not based on a formal search of published evidence.

A Working Group was formed at the request of the BTS with instructions to develop formal evidence-based guidelines for flexible bronchoscopy. The Committee consisted of individuals with a wide range of backgrounds including nurses, a microbiologist, an infection control expert, as well as respiratory physicians including one with a special interest in intensive care medicine. Full details are given in Appendix 1.

The aim of the Committee was to produce evidence-based guidelines for subsequent use by medical, nursing, and technical staff. The areas to be covered were carefully defined and were primarily to advise on bronchoscopy in adults, although the sections of the guidelines concerned with staff safety and instrument decontamination would also be relevant to paediatric flexible bronchoscopy.

The areas covered by these guidelines are as follows:

- complications, contraindications and precautions;
- sedation and anaesthesia/analgesia;
- cleaning and disinfection including glutaraldehyde usage;
- staff safety;
- bronchoscopy in the intensive care unit;
- data collection and staff training;
- patient satisfaction.

Indications for bronchoscopy and therapeutic aspects are not covered by these guidelines.

A comprehensive search of several databases was carried out in 1998 and updated in 1999 using subject terms or MeSH headings (medical subject headings) and also controlled vocabulary search terms. The electronic databases used were Medline (searched from 1966 onwards), EmBase (from 1980), Biological Abstracts (from 1988), CINAHL (a nursing literature database searched from 1983), Psychlit (from 1967), and the Cochrane Controlled Trial Register.

The criteria for assessing the levels of evidence and grading of recommendations were based on those recommended in the Scottish Intercollegiate Guidelines Network,[3] as have also been used in some other BTS guidelines (table 1).

The papers were rigorously assessed by members of the committee and decisions on levels of evidence for each paper were made by two or more members of the group. The draft guidelines were presented at the December 1998 meeting of the BTS and were subsequently circulated to the members of the BTS, discussed in detail with the Standards of Care Committee and Training Committee, and sent for comments to the Department of Health (including the Medical Devices Agency and Microbiology Advisory Committee), Intensive Care Society, Medical Defence Union, Medical Protection Society, Cancer BACUP Support Service, and the patient representatives' group of the British Lung Foundation. Liaison with the Royal College of Nursing was carried out by their nominee, Adrienne Brewin.

These guidelines should be reviewed and updated in 2003.

Table 1 Levels of evidence and grading of recommendations[3]

Level	*Type of evidence*
Ia	Evidence obtained from meta-analysis of randomised controlled trials
Ib	Evidence obtained from at least one randomised controlled trial
IIa	Evidence obtained from at least one well designed controlled study without randomisation
IIb	Evidence obtained from at least one other type of well designed quasi-experimental study
III	Evidence obtained from well designed non-experimental descriptive studies such as comparative studies, correlation studies, and case controlled studies
IV	Evidence obtained from expert committee reports of opinions and/or clinical experiences of respected authorities
Grade	*Type of recommendations*
A (levels Ia, Ib)	Requires at least one randomised controlled trial as part of a body of literature of overall good quality and consistency addressing the specific recommendation
B (levels IIa, IIb, III)	Requires availability of well conducted clinical studies but no randomised clinical trials on the topic of recommendation
C (level IV)	Requires evidence from expert committee reports or opinions and/or clinical experience of respected authorities. Indicates absence of directly applicable studies of good quality

Recommendations

Patient safety

BEFORE BRONCHOSCOPY

- Verbal and written patient information improves tolerance of the procedure by the patient and should be provided. **[B]**
- Patients with suspected chronic obstructive pulmonary disease (COPD) should have spirometric parameters checked before bronchoscopy and, if the COPD is found to be severe (FEV_1 <40% predicted and/or Sao_2 <93%), should also have arterial blood gas tensions measured. **[C]**
- Oxygen supplementation and/or intravenous sedation may lead to an increase in the arterial CO_2 level and hence sedation should be avoided where the pre-bronchoscopy arterial CO_2 is raised and oxygen supplementation given only with extreme caution. **[C]**
- Prophylactic antibiotics should be given before bronchoscopy to patients who are asplenic, have a heart valve prosthesis, or a previous history of endocarditis. **[C]**
- Bronchoscopy should be avoided if possible within 6 weeks of a myocardial infarction. **[C]**
- Asthmatic subjects should be premedicated with a bronchodilator before bronchoscopy. **[B]**
- Routine preoperative checks of the platelet count and/or prothrombin time are only required in those patients with known risk factors having routine bronchoscopy without transbronchial biopsy. **[B]**
- If it is anticipated that biopsy specimens may be required at bronchoscopy, oral anticoagulants should be stopped at least 3 days before bronchoscopy or they should be reversed with low dose vitamin K. **[B]**
- On the rare occasions when it is necessary to continue with anticoagulants, the international normalised ratio (INR) should be reduced to <2.5 and heparin should be started. **[C]**
- Platelet count, prothrombin time, and partial thromboplastin time should be checked before performing transbronchial biopsies. **[C]**
- It is sufficient for patients to have no food by mouth for 4 hours and to allow clear fluids by mouth up to 2 hours before bronchoscopy. **[B]**
- Intravenous access should be established in all patients before bronchoscopy is commenced (and before sedation, if given) and left in place until the end of the postoperative recovery period. **[C]**
- Sedation should be offered to patients where there is no contraindication. **[B]**
- Atropine is not required routinely before bronchoscopy. **[B]**

DURING BRONCHOSCOPY

- Patients should be monitored by oximetry. **[B]**
- Oxygen supplementation should be used to achieve an oxygen saturation of at least 90% to reduce the risk of significant arrhythmias during the procedure and also in the postoperative recovery period. **[B]**
- The total dose of lignocaine (lidocaine) should be limited to 8.2 mg/kg in adults (approximately 29 ml of a 2% solution for a 70 kg patient) with extra care in the elderly or those with liver or cardiac impairment. **[B]**
- Lignocaine gel (2%) is preferred to lignocaine spray for nasal anaesthesia. **[B]**
- The minimum amount of lignocaine necessary should be used when instilled through the bronchoscope. **[B]**
- Sedatives should be used in incremental doses to achieve adequate sedation and amnesia. **[B]**
- Fluoroscopic screening is not required routinely during transbronchial biopsy in patients with diffuse lung disease, but should be considered in those with localised lung lesions. **[B]**
- At least two endoscopy assistants should be available at bronchoscopy, and at least one of these should be a qualified nurse. **[C]**
- Routine ECG monitoring during bronchoscopy is not required but should be considered in those patients with a history of severe cardiac disease and those who have hypoxia despite oxygen supplementation. **[C]**
- Resuscitation equipment should be readily available. **[C]**

AFTER BRONCHOSCOPY

- Postoperative oxygen supplementation may be required in some patients, particularly those with impaired lung function and those who have been sedated. **[B]**
- A chest radiograph should be carried out at least 1 hour after transbronchial biopsy to exclude a pneumothorax. **[B]**
- Patients who have had transbronchial biopsies should be given verbal and written advice about the possibility of developing a pneumothorax after leaving hospital. **[C]**
- Patients who have been sedated should be advised verbally and in writing not to drive, sign legally binding documents, or operate machinery for 24 hours after the procedure. **[C]**
- It is preferable that day case patients who have been sedated should be accompanied home and that higher risk patients such as the elderly or those from whom transbronchial biopsy specimens have been taken should have someone to stay with them at home overnight. **[C]**

Bronchoscope cleaning and disinfection

- Compatibility of decontamination methods should be checked with the manufacturers of bronchoscopic instruments and accessories.
- Decontamination and disinfection should be carried out at the beginning and end of a list and between patients. **[B]**
- Cleaning and disinfection of bronchoscopes should be undertaken by trained staff in a dedicated room. **[C]**
- Thorough cleaning with detergent remains the most important initial stage of the process. **[B]**
- When 2% glutaraldehyde is used for manual and automated disinfection, immersion for 20 minutes is recommended for bronchoscopes at the beginning and end of a session and between patients. **[B]**

- Longer immersion times of 60 minutes are recommended for known or suspected atypical mycobacterial infections and patients known to be HIV positive with respiratory symptoms as they may be infected with *Mycobacterium avium intracellulare* or other atypical mycobacteria which are more resistant to glutaraldehyde. **[B]**
- Patients with suspected tuberculosis should undergo bronchoscopy at the end of the list. **[C]**
- Automated washer disinfectors are recommended to minimise staff contact with disinfectants and their fumes. **[B]**
- Automated washer disinfectors must have facilities for disinfecting tanks, immersion trays, and all fluid pathways. **[B]**
- It is essential that sterile or bacteria free water is used for rinsing bronchoscopes; autoclaved or filtered water (using 0.2 μm filters) may be used. **[B]**
- All rinse water pathways (tanks, filters, and pipework) must be accessible for regular, preferably sessional, cleaning and disinfection. **[B]**
- Some water-borne mycobacteria such as *Mycobacterium chelonae* are extremely resistant to glutaraldehyde and a chlorine releasing agent or peracetic acid may have to be used via the water filters. **[B]**
- A record should be kept of which bronchoscope and other re-usable equipment are used on an individual patient and also of the decontamination procedure. **[C]**
- The quality of the rinse water should be assured, but if this is in doubt then external surfaces of the bronchoscope should be wiped and the lumen flushed with 70% alcohol. This will destroy non-sporing bacteria including mycobacteria and will rapidly evaporate, leaving surfaces dry. This is also recommended at the end of a session and/or before storage. **[B]**
- Glutaraldehyde, although widely used for endoscopes, is only slowly effective against mycobacteria. Peracetic acid, chlorine dioxide, and superoxidised water are more rapidly effective (within 5 minutes or less) but are more damaging to instruments and processing equipment, are less stable, and are more expensive. **[B]** They may, however, be less irritant than glutaraldehyde.

Staff safety

- All staff should be vaccinated against hepatitis B and tuberculosis, and immunity and tuberculin status should be checked as appropriate. **[B]**
- During bronchoscopy staff should wear protective clothing (gowns or plastic aprons, masks/visors, and gloves). **[C]**
- High grade particulate masks should be worn when patients known to have multidrug resistant tuberculosis or those at high risk undergo bronchoscopy and the procedure should be carried out in a negative pressure facility. **[C]**
- Non-powdered latex or non-latex gloves should be worn instead of powdered latex gloves. **[B]**
- Injection needles should not be re-sheathed, and spiked biopsy forceps require careful cleaning. **[C]**
- Pre-employment health checks should be carried out on all staff working with aldehydes according to COSHH recommendations, and regular periodic screening with regard to lung function and occurrence of symptoms should be carried out by the occupational health department. **[C]**
- Bronchoscopes should be disinfected ideally in a dedicated room using well ventilated automated systems, preferably inside a fume cabinet, to prevent unnecessary exposure to disinfectants. **[C]**
- During cleaning and disinfection staff need to wear protective clothing (nitrile gloves and plastic aprons with eye and respiratory protection, where appropriate) to protect them from splashes, aerosols, and vapour. **[C]**
- The use of disposable accessories, especially injection needles, may reduce the risk of infection which may occur during the cleaning of equipment. **[C]**
- Wherever possible, autoclavable or disposable accessories should be used to prevent unnecessary exposure to disinfectants. **[C]**
- Bronchoscopy staff need to be trained in patient care, infection control, and instrument decontamination including the safe use of aldehydes and the potential health risks. **[C]**

Bronchoscopy in the intensive care unit (ICU)

- The internal diameter of the endotracheal tube, through which the bronchoscope is inserted, must be taken into consideration before bronchoscopy.
- Intensive care units should have the facility to perform urgent and timely flexible bronchoscopy for a range of therapeutic and diagnostic indications. **[C]**
- Patients in ICU should be considered at high risk from complications when undergoing fibreoptic bronchoscopy. **[B]**
- Continuous multi-modal physiological monitoring must be continued during and after fibreoptic bronchoscopy. **[B]**
- Care must be exercised to ensure adequate ventilation and oxygenation is maintained during fibreoptic bronchoscopy via an endotracheal tube. **[B]**
- More profound levels of sedation/anaesthesia can be achieved in ventilated patients provided the clinician performing the procedure is acquainted with the use of sedative/anaesthetic agents. **[C]**

Standards and performance of diagnostic techniques

- At least five bronchial biopsy specimens should be taken in cases of suspected bronchial malignancy. **[B]**
- Biopsies, brushings and washings should all be obtained in cases of suspected endobronchial malignancy. **[B]**
- A minimum diagnostic level of at least 80% should be obtained from a combination of biopsies, brushings, and washings in cases of endoscopically visible malignancy. **[B]**
- When taking transbronchial lung biopsy specimens in patients with diffuse lung disease, an attempt should be made to obtain 4–6 samples from one lung. **[B]**

Patient care

- Verbal and written patient information improves tolerance of the procedure and should be provided. **[B]**
- It is sufficient for patients to have no food by mouth for 4 hours and to allow clear fluids by mouth up to 2 hours before bronchoscopy. **[B]**
- Patients who have been sedated should be advised not to drive, sign legally binding documents, or operate machinery for 24 hours after the procedure. **[C]**

Complications, precautions and contraindications

FITNESS FOR THE PROCEDURE

There are no controlled studies of the factors which may make a patient unfit for bronchoscopy so a decision to carry out the procedure is a balance between the likely benefit of obtaining diagnostic material (including therapeutic benefit) and an assessment of the likely risk in that individual patient.

Flexible bronchoscopy is an extremely safe procedure as long as some basic precautions are taken.[4] One study reported a mortality rate of 0.01% and a major complication rate of 0.08% in a series of 24 521 procedures,[5] and another a 0.02% mortality and 0.3% major complication rate in a series of around 48 000 cases.[6] A survey in the UK found a mortality rate of 0.04% and a major complication rate of 0.12% in about 40 000 procedures.[7] These three were retrospective studies. Smaller prospective studies have reported slightly higher rates.[8 9] A more recent retrospective study of over 4000 cases, including 2000 lavages and 173 transbronchial biopsies, showed no deaths and overall major and minor complication rates of 0.5% and 0.8%, respectively.[10] Flexible bronchoscopy with topical anaesthesia has been shown to be safer than rigid bronchoscopy.[11]

Major life threatening complications include respiratory depression, pneumonia, pneumothorax, airway obstruction, cardiorespiratory arrest, arrhythmias, and pulmonary oedema. Minor non-life threatening complications include, in order of frequency, vasovagal reactions, fever, cardiac arrhythmias, haemorrhage, airway obstruction, pneumothorax, nausea and vomiting.[9]

Complication rates relating specifically to the procedure of transbronchial biopsies are higher—for example, pneumothorax occurred in 1–5% of cases[12] and haemorrhage in 9%,[13] which was usually mild. Haemorrhage is more likely in uraemic or immunosuppressed patients.[14] Overall mortality has been reported as 0.1%.[12] Major complications occurred in 6.8% in another series.[10]

SIDE EFFECTS FROM LOCAL ANAESTHESIA (SEE ALSO SECTION ON "SEDATION AND LOCAL ANAESTHESIA")

Lignocaine (lidocaine) is the topical agent usually used. Toxic side effects include seizures and cardiac suppression. A threshold above which these side effects become more likely has been put at a plasma level of 5 mg/l.[15] Lignocaine is mainly metabolised in the liver and this has led to worries about potential toxicity in patients with metastatic malignancy involving the liver. A study of a small number of such patients showed no increased risk in toxic blood levels, however caution should still be stressed because none of their patients had hyperbilirubinaemia or clinical evidence of hepatocellular failure.[16] Lignocaine instilled directly into the endobronchial tree is rapidly absorbed and a correlation has been reported between the dose given and the serum level.[17] A variable amount of lignocaine is, however, re-aspirated through the bronchoscope, individual hepatic metabolism varies, and other drugs such as cocaine may delay absorption. Clinical toxicity is seldom observed, even in doses above 8 mg/kg.[17] However, particular care should be taken in those patients with hepatic or cardiac insufficiency in whom lignocaine metabolism may be impaired; a maximum dose of 5 mg/kg has been suggested in such cases.[17] One study, which also took into account levels of an active metabolite of lignocaine, concluded that the total dose of lignocaine should not exceed 7 mg/kg.[17] A more recent study has recommended a maximum dose of 8.2 mg/kg,[18] which is equivalent to 29.3 ml 2% lignocaine for a 70 kg patient.

Recommendations

- **The total dose of lignocaine (lidocaine) should be limited to 8.2 mg/kg in adults (approximately 29 ml of a 2% solution for a 70 kg patient) with extra care in the elderly or those with liver or cardiac impairment. [B]**
- **The minimum amount of lignocaine necessary should be used when instilled through the bronchoscope. [B]**

HYPOXAEMIA

Hypoxaemia has been shown to occur during flexible bronchoscopy in several studies. A fall in arterial oxygen tension (Pa_{O_2}) of about 2.5 kPa during the procedure is common.[19 20] This can be more pronounced if bronchoalveolar lavage is performed and is more common with larger volumes of lavage fluid.[21] The mechanisms causing hypoxia include ventilation-perfusion imbalance and hypoventilation secondary to sedation. Ventilation-perfusion mismatch may occur as a result of partial airway obstruction caused by the bronchoscope, suction, and due to anaesthetic solutions or lavage fluid in the alveoli. Correction of anaemia should be considered before bronchoscopy. The hypoxaemia has been linked to an increased risk of arrhythmias; pulse oximetry increases the safety of bronchoscopy and has been recommended for routine use.[22] Stridor can occur during the procedure and may lead to serious hypoxaemia. A safety oxygen saturation (Sa_{O_2}) threshold of 90% (at rest breathing room air) has been proposed, normally equivalent to a Pa_{O_2} of 8 kPa.[22] If sedation is given well before bronchoscopy (for example, peroral diazepam), monitoring by oximetry will be required before bronchoscopy is started.

Hypoxaemia may last for a considerable time after bronchoscopy has been completed. Oxygen supplementation after bronchoscopy has been found to be beneficial, particularly in subjects with impaired lung function.[23] The duration of postoperative oxygen supplementation partly depends on the type of sedation previously given[23]; a longer period of supplementation (1–2 hours) is required if the patient has had oral diazepam rather than intravenous midazolam, or if the patient has received an amnesic dose of midazolam.

Oxygen supplementation via nasal cannulae should be at a flow rate of at least 2 l/min.[22] Care should be taken, however, to be alert to signs of respiratory failure in patients on oxygen supplementation who may have "safe" oximetry readings but who may be developing carbon dioxide retention. Particular care should be taken in those patients at higher risk of carbon dioxide retention and monitoring of transcutaneous carbon dioxide and oxygen pressures may be useful.[24] Preoperative arterial blood gas assessment is usually required in such patients. In high risk hypoxaemic patients requiring bronchoscopy and lavage, non-invasive positive pressure ventilation via a face mask can be used.[25]

Recommendations

- **Oxygen supplementation should be used to achieve an oxygen saturation of at least 90% to reduce the risk of significant arrhythmias during the procedure and also in the postoperative recovery period. [B]**
- **Postoperative oxygen supplementation may be required in some patients, particularly those with impaired lung function and those who have been sedated. [B]**
- **Patients should be monitored by oximetry. [B]**

CARDIAC ARRHYTHMIAS

Arrhythmias and cardiac arrest have been described during fibreoptic bronchoscopy.[5 6] Several studies have involved continuous ECG monitoring during the procedure and some also monitored pre and postoperatively. A marked tachycardia during bronchoscopy was found in many patients in one study.[26] Another found that hypoxia at the end of the procedure correlated with occurrence of major arrhythmias,[27] 11% of patients developing significant but self-limiting arrhythmias. The authors recommended ECG monitoring during the procedure in those patients with an abnormal 12-lead ECG and preoperative hypoxaemia (P_{O_2} <8 kPa).[27] Routine cardiac monitoring is not recommended.[28] Some authors have suggested that all patients with severe cardiovascular disease should have ECG monitoring[9 29] but others have suggested that it is only required for those with unstable angina.[30] The risk of arrhythmias is particularly likely during passage of the bronchoscope through the vocal cords.[31] The same authors also found an incidence of 40% of "significant" arrhythmias during bronchoscopy and an association with oxygen desaturation (see also section on "Bronchoscopy after myocardial infarction").

Recommendations

- **Oxygen supplementation should be used to achieve an oxygen saturation of at least 90% to reduce the risk of significant arrhythmias during the procedure and also in the postoperative recovery period. [B]**
- **Routine ECG monitoring during bronchoscopy is not required but should be considered in those patients with a history of severe cardiac disease and those who have hypoxia despite oxygen supplementation. [C]**
- **Resuscitation equipment should be readily available. [C]**
- **Intravenous access should be established in all patients before bronchoscopy is commenced (and before sedation, if given) and left in place until the end of the postoperative recovery period. [C]**

BLEEDING COMPLICATIONS

Significant haemorrhage during or after fibreoptic bronchoscopy is uncommon (0.7% in one study[9]). A large study showed that profuse bleeding was more likely after transbronchial than endobronchial biopsies and no death was directly attributable to bleeding.[32] Significant haemorrhage (>50 ml) occurred in 1.6–4.4% of patients with diffuse lung disease from whom transbronchial biopsy specimens were taken.[33 34] The risk of bleeding during transbronchial biopsies seems to be unrelated to size of forceps[35] but is slightly higher in those being mechanically ventilated.[36]

Some patients are known to be at increased risk of bleeding, including those who have uraemia, immunosuppression, pulmonary hypertension, liver disease, coagulation disorders, or thrombocytopenia.[37 38] Concern is often expressed about performing a bronchoscopic examination in patients with evidence of superior vena caval obstruction, particularly because of worries about a possible increased risk of bleeding. However, no studies on this subject were found in the literature. Routine preoperative coagulation screening is unjustified in those with no risk factors who undergo routine bronchoscopy.[39] Conversely, in patients with a potential increased risk of bleeding—for example, those with abnormal liver function tests—platelet count, prothrombin time, and partial thromboplastin time should be checked before bronchoscopy. Information is unclear about their value when transbronchial biopsy specimens are taken,[40] although many physicians routinely check the preoperative platelet count and prothrombin and partial thromboplastin times. There is no information about what constitutes a "safe" level for clotting in this context. If persistent bleeding occurs, turning the patient onto the side of the bleeding and topical instillation of cocaine or small amounts of 1:10 000 adrenaline solution should be considered.

If a patient is taking oral anticoagulants, published guidelines for managing anticoagulation in the perioperative period are relevant.[41] These state that "the short term risk of thromboembolism in patients with mechanical heart valves when not anticoagulated is very small".

Recommendations

- **Routine preoperative checks of the platelet count and/or prothrombin time are only required in those patients with**

known risk factors having routine bronchoscopy without transbronchial biopsy. [B]
- **If it is anticipated that biopsy specimens may be required at bronchoscopy, oral anticoagulants should be stopped at least 3 days before bronchoscopy or they should be reversed with low dose vitamin K. [B]**
- **On the rare occasions when it is necessary to continue with anticoagulants, the international normalised ratio (INR) should be reduced to <2.5 and heparin should be started. [C]**
- **Platelet count, prothrombin time, and partial thromboplastin time should be checked before performing transbronchial biopsies. [C]**

PNEUMOTHORAX

Pneumothorax is very uncommon after bronchoscopy; however, a major pneumothorax requiring drainage occurred in 3.5% of those from whom transbronchial biopsy specimens were taken.[42] The incidence of pneumothorax was reported to be 14% in a group of patients having transbronchial biopsies while being mechanically ventilated.[36] About 50% of patients with a pneumothorax after transbronchial biopsy required drainage.[10] In patients with diffuse lung disease the incidence of pneumothorax was 3% after transbronchial biopsy specimens were taken without fluoroscopic screening,[43 44] and another study found in a review of similar patients that fluoroscopy did not appear to reduce the frequency of pneumothorax.[45] The place of transbronchial biopsies in diffuse parenchymal lung diseases is covered elsewhere.[46] Information from a postal questionnaire suggested that pneumothorax was less common after transbronchial biopsies if fluoroscopic screening was used, but no information was given about whether these patients had diffuse or localised peripheral lung lesions.[7] There are potential advantages of fluoroscopy when performing transbronchial biopsies in subjects with localised peripheral lesions.

Symptoms and/or signs of a pneumothorax may be delayed after transbronchial biopsies but it is known that a pneumothorax developing more than 1 hour after a transbronchial biopsy is very uncommon.[47 48]

Recommendations
- **A chest radiograph should be carried out at least 1 hour after transbronchial biopsy to exclude a pneumothorax. [B]**
- **Fluoroscopic screening is not required routinely during transbronchial biopsy in patients with diffuse lung disease, but should be considered in those with localised lung lesions. [B]**
- **Patients who have had transbronchial biopsies should be given verbal and written advice about the possibility of developing a pneumothorax after leaving hospital. [C]**

INFECTION/FEVER

Fever may occur uncommonly after bronchoscopy without lavage (1.2% in one series[9]). It is much more common after bronchoalveolar lavage (10–30% in one study[49]) and there is a correlation with the volume of bronchoalveolar lavage fluid used.[50] The fever is thought to be caused by the release of pro-inflammatory cytokines from alveolar macrophages.[51] Fever was also reported in 15% of patients who had transbronchial biopsies but none had positive blood cultures.[45] It occurred in 10% of patients who had transbronchial needle aspiration but again no positive blood cultures were found.[52]

Bacteraemia was thought to be rare after bronchoscopy[53 54] but a recent study found a bacteraemia rate of 6.5% during bronchoscopy.[55] Prophylactic antibiotics are not thought to be required[56] except possibly in patients who are asplenic and in those who have a prosthetic valve or a previous history of endocarditis.[37 57] Rare cases of serious respiratory infection have been reported several days after bronchoscopy in the segment from which the biopsy or brush specimens were taken.[58] Details of prophylactic antibiotic regimes are available.[59 60]

Recommendation
- **Prophylactic antibiotics should be given before bronchoscopy to patients who are asplenic, have a heart valve prosthesis, or a previous history of endocarditis. [C]**

STAFFING LEVELS

Patient safety also depends on the availability of adequate numbers of suitably trained staff. The importance of training has been shown in a national audit of standards in bronchoscopy departments.[61] In common with recommendations from the British Society of Gastroenterology,[62] we recommend that at least two endoscopy assistants should be available at bronchoscopy, and at least one of these should be a qualified nurse.

Recommendation
- **At least two endoscopy assistants should be available at bronchoscopy, and at least one of these should be a qualified nurse. [C]**

COMPLICATIONS IN SPECIFIC MEDICAL CONDITIONS

After myocardial infarction

Bronchoscopy can produce ischaemic changes, especially in those over 60 years of age.[63] The occurrence of arrhythmias during fibreoptic bronchoscopy and the increased risk of hypoxia have led to extreme caution in carrying out the procedure soon after a myocardial infarction. A recent retrospective study[64] of 20 patients in whom a bronchoscopy was performed a mean of 12 days after an acute myocardial infarction showed that it was safer than anticipated but that continuous oxygen, ECG monitoring, and adequate sedation should be used, and that bronchoscopy should not be carried out during acute ischaemia.[30] A low complication rate was

reported in another recent retrospective study.[65] Others have emphasised extreme caution[66] and have stressed the increased risk in the presence of poor left ventricular function and congestive cardiac failure.[67] The risks of bronchoscopy are thought to be reduced 4–6 weeks after myocardial infarction.[68]

Recommendation

- **Bronchoscopy should be avoided if possible within 6 weeks of a myocardial infarction. [C]**

Patients with asthma

Generally, bronchospasm complicating fibreoptic bronchoscopy is rare (0.02% in one series[10]). However, another study of 216 asthmatic subjects reported that 8% developed laryngospasm or bronchospasm during the procedure.[69] Lignocaine may produce bronchoconstriction in patients with asthma and this is attenuated by preoperative treatment with atropine.[70]

A more pronounced postoperative fall in forced expiratory volume in one second (FEV_1) compared with normal subjects was found in patients with mild asthma during bronchoscopy, and this fall in FEV_1 was inversely correlated with the preoperative concentration of methacholine provoking a fall in FEV_1 of 20% or more (PC_{20}).[71] Sedation should therefore be used with particular care in asthmatic patients because of the risk that the bronchoscopic procedure may exacerbate bronchoconstriction.

Another study showed no difference in the degree of intraoperative fall in Sao_2 between normal subjects and asthmatic patients (with a spectrum of severity) but the falls in both FEV_1 and forced vital capacity (FVC) were greater in the asthmatic patients after a sequence of bronchoalveolar lavage and bronchial biopsies.[72] The preoperative use of a bronchodilator was associated with no fall in the postoperative FEV_1 in a study of patients with mild asthma in whom bronchoalveolar lavage was performed.[73]

Recommendation

- **Asthmatic subjects should be premedicated with a bronchodilator before bronchoscopy. [B]**

Patients with chronic obstructive pulmonary disease

The presence of chronic obstructive pulmonary disease (COPD) has been shown to increase the complication rate of bronchoscopy (where FEV_1/FVC <50% or FEV_1 <1 litre and FEV_1/FVC <69%).[74] A complication rate of 5% occurred in the patients with severe COPD compared with 0.6% in those with normal lung function. It would seem prudent to check arterial blood gas tensions before bronchoscopy in patients with severe COPD (see also section on "Hypoxaemia"). The use of sedation in patients with severe COPD has increased risks relating to potential carbon dioxide retention.

Recommendations

- **Patients with suspected chronic obstructive pulmonary disease (COPD) should have spirometric parameters checked before bronchoscopy and, if the COPD is found to be severe (FEV_1 <40% predicted and/or Sao_2 <93%), should also have arterial blood gas tensions measured. [C]**
- **Oxygen supplementation and/or intravenous sedation may lead to an increase in the arterial CO_2 level and hence sedation should be avoided where the pre-bronchoscopy arterial CO_2 is raised and oxygen supplementation given only with extreme caution. [C]**

Elderly patients

Elderly patients are potentially at increased risk of complications for a number of reasons. There may be an increased risk of underlying ischaemic heart disease and therefore of arrhythmias. Hepatic metabolism of drugs such as lignocaine and midazolam may be less efficient than in younger patients and hence cause an increased risk of drug toxicity. However, several studies have shown that elderly patients tolerate the procedure well[75 76] with no observed increased incidence of complications.

Patients with raised intracranial pressure

Bronchoscopy can cause a rise in intracranial pressure in some patients with head injuries, however cerebral perfusion pressure is maintained.[77] A review of the literature and of 132 patients showed that fibreoptic bronchoscopy only carries a low risk in patients with raised intracranial pressure.[78]

Patients with haemoptyses

Bronchoscopy is widely used for the investigation of haemoptyses. Early bronchoscopy[79] increases the likelihood of a bleeding source being found. A history of large volumes of haemoptysis makes it more likely that a cause will be found at bronchoscopy.[80] However, although there are no comparative studies, when patients are actively bleeding the suction capacity of the flexible bronchoscope may be exceeded and rigid bronchoscopy may be safer.

Sedation and local anaesthesia during flexible bronchoscopy

SEDATION

Are sedatives necessary?

The purpose of sedation is to improve patient comfort for what can be an unpleasant procedure. Sedation may also make the procedure easier for the bronchoscopist to perform and the patient more willing to accept a repeat procedure (if necessary). It is the perception of physicians and nurses (but not always patients) that bronchoscopy is better tolerated with sedatives than without. Two studies have compared intravenous diazepam with no sedation.[81 82] In a recent Malaysian study which examined common fears of patients undergoing bronchoscopy the authors concluded that careful explanation of the sensations experienced did more to allay anxiety than describing the procedure itself.[83] The same study reported that 80% of patients preferred to be sedated.

Although bronchoscopy can be carried out without sedation,[84 85] most are performed under sedation.[7 86 87] However, the routine use of sedation is not a prerequisite based on the available evidence.[88] Sedation should benefit the patient who is particularly anxious or who expresses a strong preference for sedation. Conversely, sedation should be avoided or used with extreme caution in patients such as those with severe COPD who have an increased risk of responding adversely (see section on "Complications, precautions and contraindications"). It is essential that all syringes are carefully labelled.

In a few of the randomised controlled studies of sedation in bronchoscopy a significant proportion of patients receiving midazolam were poorly sedated.[88 89] If sedation is inadequate, up to 60% of patients may find the procedure unpleasant[90] and up to 25% are unwilling to undergo repeat investigation.[76] When sedation is titrated to induce a light sleep, patient acceptance of bronchoscopy is high.[91]

Arguments against sedation cite reduced patient safety, although this can be largely obviated by appropriate monitoring and the availability of proper resuscitation equipment.[91 92] Combinations of benzodiazepines and narcotics, although widely used,[61] are prone to induce hypoxia and CO_2 retention.[24 93]

Which sedative?

Although premedication with oral lorazepam does have a significant amnesic effect compared with placebo,[94] most sedation regimens are based upon a single dose or incremental doses of an intravenous sedative agent administered at the time of bronchoscopy.

MIDAZOLAM

Midazolam is a water soluble benzodiazepine with an elimination half life of about 2 hours and is generally preferred to diazepam. Its onset is rapid and duration of action brief in healthy individuals. Less than 10% of the population exhibit prolonged effects due to impaired metabolism.[95] Many investigators have used a dose of 0.07 mg/kg midazolam before bronchoscopy. However, sedation cannot be assured by single dose sedation regimens.[96] A better approach is incremental dosing which achieves improved tolerance of bronchoscopy, induces amnesia, and therefore patients are more willing to undergo repeat bronchoscopy if necessary.[91] In this latter study the dose of midazolam ranged from 0.07 to 0.67 mg/kg. Particular care is required in those with severe COPD or those with neuromuscular diseases. However, adequate sedation and amnesia can be achieved by smaller doses such as an initial dose of 2 mg followed after 2 minutes by increments of 1 mg/min if required.[97] Although amnesia may be important for patient acceptance of bronchoscopy,[91 94] there are no studies that directly compare sedative drugs in doses sufficient to produce complete amnesia with lower doses producing a lesser degree of sedation.

FLUMAZENIL

Flumazenil is a specific benzodiazepine antagonist that can reverse oversedation and should be available in the endoscopy unit. However, its short elimination time means that re-sedation may occur unless repeated doses or an infusion are given. Flumazenil can induce withdrawal and seizures in patients on long term benzodiazepine therapy. The usual initial dosage is 250–500 μg. Specific antagonists are no substitute for careful observation in an appropriately equipped recovery area.

PROPOFOL

Propofol (2,6 di-isopropylphenol) is an emulsion formulation suitable for induction and maintenance of anaesthesia. In three randomised controlled studies propofol has been shown to produce adequate sedation, which is of rapid onset and resolution. It appears to offer advantages over midazolam and diazepam/alfentanil in combination.[97–100] The average sedative dose administered in one study was 155 mg, equivalent to an anaesthetic induction dose.[97] In that study a microprocessor controlled infusion device was used to achieve target blood levels. Propofol does appear to offer advantages over some other sedative agents but is expensive and requires expertise and experience in its administration.

COMBINATIONS INCLUDING NARCOTIC DRUGS

A combination of a benzodiazepine and narcotic has been widely used.[101 102] Combining the amnesic effects of a benzodiazepine with the analgesic and antitussive effects of a narcotic is rational. Unfortunately, such a combination may be associated with more arterial desaturation and CO_2 retention than when using midazolam alone.[24 93] Morphine is commonly used but synthetic shorter acting narcotics may be preferred. The combination of nalbuphine (0.2 mg/kg) and midazolam (0.05 mg/kg) produced slightly higher CO_2 levels than midazolam alone.[102] Alfentanil is a synthetic, potent and short lived narcotic which, when used alone in doses of 0.05–1.0 mg, achieves equivalent levels of sedation to midazolam with greater antitussive effects.[93]

Recommendations

- **Sedation should be offered to patients where there is no contraindication. [B]**
- **Sedatives should be used in incremental doses to achieve adequate sedation and amnesia. [B]**

LOCAL ANAESTHESIA (SEE ALSO SECTION ON "COMPLICATIONS")

Lignocaine (lidocaine)

Lignocaine (lidocaine) is the most common local anaesthetic for use in fibreoptic bronchoscopy and has a better safety profile than cocaine.[103] Anaesthesia of the anterior nares can be achieved using 10% or 4% w/v lignocaine aerosol or a 2% w/v gel. The gel preparation may be better accepted by patients and yield lower blood levels.[104–106] The oropharynx can be anaesthetised with 10% lignocaine spray,[107] or by sucking a 60 mg amethocaine

lozenge. Anaesthesia of the vocal cords can be achieved in several ways. Having introduced the bronchoscope through the nose and nasopharynx, the visualised vocal cord can be sprayed under direct vision with 2–4% lignocaine ("spray as you go"). Thereafter, having traversed the cords, anaesthesia of the carina and bronchi can be achieved using 1–2% boluses sprayed via the bronchoscope. Alternatively, a transcricoid injection of 5 ml 2% lignocaine will anaesthetise the vocal cords as effectively as under direct vision with a lower dose of anaesthetic.[108 109] However, almost a third of the patients undergoing transcricoid injection found the procedure unpleasant.[108] Inhalation of 4 ml 4% nebulised lignocaine via a mouthpiece can also produce satisfactory anaesthesia of the oropharynx and vocal cords.[109]

Toxic blood levels (>5 mg/l) or signs of toxicity are uncommon when using topical lignocaine during bronchoscopy.[17 105] The maximum dose of 8.2 mg/kg body weight suggested in a recent study[19] is higher than that recommended when infiltrating lignocaine (<3 mg/kg) and probably reflects the partial absorption across the mucous membranes. A proportion of the administered lignocaine is either re-aspirated or swallowed.

Recommendation

- **Lignocaine gel (2%) is preferred to lignocaine spray for nasal anaesthesia. [B]**
- **The total dose of lignocaine (lidocaine) should be limited to 8.2 mg/kg in adults (approximately 29 ml of a 2% solution for a 70 kg patient) with extra care in the elderly or those with liver or cardiac impairment. [B]**

Anticholinergic agents

The anticholinergic agents atropine and glycopyrrolate have been commonly used as premedication for fibreoptic bronchoscopy.[61 110] Their purpose is to reduce bronchial secretions and suppress vagal overactivity (vasovagal episodes), although much of the use of these agents was based on traditional anaesthetic practice for rigid bronchoscopy. With fibreoptic bronchoscopy there may be only marginal improvement in sedation and patient acceptance of bronchoscopy.[110] In another study patients premedicated with atropine needed less lignocaine analgesia, although there were no other apparent advantages.[111] Pretreatment with anticholinergic agents may also attenuate bronchoconstriction caused by local anaesthetics.[87] It is therefore of potential value in asthmatic subjects.

Atropine can cause tachycardia and be pro-arrhythmogenic,[112] it can produce blurred vision, precipitation of glaucoma and dryness of the mouth.

Recommendation

- **Atropine is not required routinely before bronchoscopy. [B]**

Cleaning and disinfection of bronchoscopes

In 1989 a Working Party of the BTS reviewed infection control risks associated with bronchoscopy and produced guidelines on the cleaning and disinfection of bronchoscopes and lung function associated equipment.[1] These recommendations have not been universally adopted in the UK.[61] Working parties of other professional societies have also produced guidance on endoscope decontamination.[113–116] In addition to these procedural specific guidelines, the Medical Devices Agency of the Department of Health has reviewed the problems associated with endoscope decontamination and has produced similar but more general guidance on decontamination for endoscope users, processors and manufacturers.[117]

Details of the cleaning and disinfection process are presented in Appendix 2.

RISK OF INFECTION

The number of bronchoscopies has substantially increased in recent years and yet reported incidents of infection following the procedure remain surprisingly low.[118 119] In a survey of 24 521 bronchoscopic procedures the complication rate was only 0.08% with a mortality of 0.01%.[5] Fever following bronchoscopy was reported in eight patients and pneumonia in two. This may reflect the thoroughness of the decontamination procedure or inadequacies in post procedural surveillance. Most patients who undergo bronchoscopy attend hospitals for short periods only and follow up is often difficult.

Most of the microorganisms recovered from bronchoscopes are acquired either from patients undergoing endoscopy or from the environment—for example, from contaminated cleansing agents, rinse water, or washer disinfectors.[120] Failure to remove or destroy these microorganisms, tissue deposits, mucus, blood, and other body fluids may result in subsequent infection, instrument malfunction, and misdiagnosis. Flexible bronchoscopes are heat labile, complex, and difficult to clean. If they become damaged during use they may become even more difficult to decontaminate.

The risk of infection can be classified in accordance with the degree of invasiveness of the procedure.[117] Non-invasive instruments such as bronchoscopes should be decontaminated by thorough cleaning followed by high level disinfection. This includes bronchoscopes which are inserted into a normally sterile area where it is essential to destroy respiratory pathogens which may include mycobacteria and spores. Instruments that intentionally penetrate intact skin and mucous membranes (such as biopsy forceps) or enter normally sterile body cavities should preferably be sterilised since the risk of infection is high.

Careful cleaning is also important because of concerns regarding the remote risk of transmission of variant Creutzfeld-Jacob disease by medical instruments.[121]

The microorganisms most likely to cause infection or pseudoinfection following bron-

choscopy are Gram negative bacilli, mycobacteria, and viruses.

Gram negative bacilli

Gram negative bacilli, particularly *Pseudomonas aeruginosa*, are most frequently responsible for respiratory infections and pseudoinfections in those undergoing bronchoscopy.[122–124] These organisms flourish in warm moist sites such as sinks, water bottles, and aspiration and cleaning equipment. In addition to their presence in the environment, *P aeruginosa* colonises several body sites and is isolated from throat swabs, sputum, and faeces. Other Gram negative bacilli associated with bronchoscope contamination and occasionally infection are *Serratia marcescens* and *Proteus* spp. Inadequate cleaning, the use of an inappropriate disinfectant, and contaminated rinse water are the most likely causes.[125–127]

A pseudoepidemic of *Legionella pneumophila* serogroup 6 contaminating bronchoalveolar lavage specimens has also been traced to tap water used to rinse bronchoscopes after disinfection.[128]

Mycobacteria

The emergence of multidrug resistant strains of *Mycobacterium tuberculosis* and the much greater incidence of infections with *M avium intracellulare* among HIV infected patients, particularly in the USA, has led to a greater awareness of the risk of transmission of mycobacteria during bronchoscopy, particularly in HIV infected or severely immunocompromised patients.[129] Other species of mycobacteria are also being incriminated in human infection with increasing frequency.

Reports of the transmission of *M tuberculosis* and other patient associated mycobacteria are few[130–133] and have largely been attributed to a failure to clean the bronchoscope, particularly the suction valve, or to introduce a suitably efficacious disinfectant into the lumen of the instrument. Non-tuberculous mycobacteria such as *M chelonae*, *M kansasii*, and *M fortuitum* are most likely to be transmitted via contaminated washer disinfectors and rinse water.[134–137] Although these organisms appear to be less pathogenic than *M tuberculosis*, they occasionally cause infections, particularly in severely immunocompromised patients. Some isolates of *M chelonae* have been shown to be extremely resistant to glutaraldehyde, the disinfectant most widely used for bronchoscopes.[138]

A misdiagnosis of tuberculosis is made if contaminated water is used to remove disinfectant residues as acid fast bacilli are deposited on surfaces and within the lumen of the bronchoscope. These may have been acquired from the water supply or from the washer disinfector. If such contamination is suspected, parallel samples should be sent for microscopic examination and culture. Mycobacteria, particularly *M avium intracellulare*,[139] are more resistant to disinfectants than other non-sporing bacteria and viruses and this must be considered when selecting disinfectants and formulating policy.[140]

Viruses

Blood-borne viruses such as hepatitis B (HBV), C (HBC), and HIV may be present in blood and most body fluids including saliva and alveolar fluid. In spite of the high degree of infectivity of Hb_eAg positive patients, documented transmission of HBV during endoscopy is rare with only one convincing case having so far been reported.[141] In this case the endoscope was immersed in glutaraldehyde for 21 hours but the air and water channels were not disinfected by adequate irrigation with disinfectant. The possible transmission of hepatitis C virus has been reported after colonoscopy but guidance on instrument decontamination was not followed.[142]

HIV has been isolated from endoscopes after use in patients with AIDS. In one study bronchoscopes were sampled after use for the presence of HIV using polymerase chain reaction techniques and culture infectivity assays.[143] All seven bronchoscopes sampled immediately after use showed the presence of HIV but, after cleaning with a detergent, only two of 88 sites sampled yielded HIV and numbers were small. No cases of HIV transmission have so far been reported following endoscopy.

Miscellaneous organisms

Bacillus spp and fungi have been recovered from bronchial washings,[144 145] none of which were associated with clinical infection. The probable sources were a contaminated suction valve and contaminated medicaments.

Recommendations

- **Decontamination and disinfection should be carried out at the beginning and end of a list and between patients. [B]**
- **Cleaning and disinfection of bronchoscopes should be undertaken by trained staff in a dedicated room. [C]**
- **Thorough cleaning with detergent remains the most important initial stage of the process. [B]**
- **When 2% glutaraldehyde is used for manual and automated disinfection, immersion for 20 minutes is recommended for bronchoscopes at the beginning and end of a session and between patients. This will destroy most vegetative bacteria including *Mycobacterium tuberculosis* and viruses. [B]**
- **Longer immersion times of 60 minutes are recommended for known or suspected atypical mycobacterial infections and patients known to be HIV positive with respiratory symptoms as they may be infected with *Mycobacterium avium intracellulare* or other atypical mycobacteria which are more resistant to glutaraldehyde. [B]**
- **Patients with suspected tuberculosis should undergo bronchoscopy at the end of the list. [C]**
- **Automated washer disinfectors are recommended to minimise staff contact with disinfectants and their fumes. [B]**

- **Automated washer disinfectors must have facilities for disinfecting tanks, immersion trays, and all fluid pathways. [B]**
- **It is essential that sterile or bacteria free water is used for rinsing bronchoscopes; autoclaved or filtered water (using 0.2 μm filters) may be used. [B]**
- **All rinse water pathways (tanks, filters, and pipework) must be accessible for regular, preferably sessional, cleaning and disinfection. [B]**
- **Some water-borne mycobacteria such as *Mycobacterium chelonae* are extremely resistant to glutaraldehyde and a chlorine releasing agent or peracetic acid may have to be used via the water filters. [B]**
- **The quality of the rinse water should be assured, but if this is in doubt then external surfaces of the bronchoscope should be wiped and the lumen flushed with 70% alcohol. This will destroy non-sporing bacteria including mycobacteria and will rapidly evaporate, leaving surfaces dry. This is also recommended at the end of a session and/or before storage. [B]**
- **Glutaraldehyde, although widely used for endoscopes, is only slowly effective against mycobacteria. Peracetic acid, chlorine dioxide, and superoxidised water are more rapidly effective (within 5 minutess or less) but are more damaging to instruments and processing equipment, are less stable, and are more expensive. [B] They may, however, be less irritant than glutaraldehyde.**
- **Compatibility of decontamination methods should be checked with the manufacturers of bronchoscopic instruments and accessories. [C]**
- **A record should be kept of which bronchoscope and other re-usable equipment are used on an individual patient and also of the decontamination procedure. [C]**

Staff safety

Bronchoscopy poses a risk for staff both during the procedure and during disinfection of the instruments.

RISK OF INFECTION DURING BRONCHOSCOPY

Staff are potentially at risk of infections during bronchoscopy, particularly with regard to hepatitis, HIV, and *M tuberculosis*. Needle stick injuries are potential sources of blood-borne infections, while cough inducing procedures such as bronchoscopy pose a risk from airborne *M tuberculosis*. Accidental needle stick injuries are the greatest risk to endoscopy staff[146] and can occur during re-sheathing of needles, cleaning of spiked biopsy forceps, and the removal of biopsy specimens from the forceps. Biopsy material can be removed from the biopsy forceps by carefully shaking in the biopsy pot with formalin. The use of hypodermic needles should be discouraged and suitable clean and sterile alternatives should be sought—for example, sterile tooth picks. Single use accessories should be employed wherever possible.[121]

Staff involved with hazardous procedures must be provided with protective clothing/equipment and instructed in its correct use.[147] Cross infection can also occur from surfaces and from poor hand hygiene.[148 149] Good hygiene—such as appropriate hand washing, cleaning and disinfection of surfaces—will protect staff and patients from potential cross infection such as methicillin resistant *Staphylococcus aureus* (MRSA).

Enhanced protection against tuberculosis should be shown to be present by either a positive tuberculin test or the presence of a definite BCG scar.[150] Immunity to hepatitis B needs to be demonstrated by the presence of surface antibody.[151]

Recommendations

- **Injection needles should not be resheathed, and spiked biopsy forceps require careful cleaning. [C]**
- **The use of disposable accessories, especially injection needles, may reduce the risk of infection which may occur during the cleaning of equipment. [C]**
- **All staff should be vaccinated against hepatitis B and tuberculosis, and immunity and tuberculin status should be checked as appropriate. [B]**

PROTECTIVE CLOTHING

Examination gloves protect staff from potential contamination but may not protect patients and must be changed after each procedure. Appropriate selection of gloves should be made available for those workers who have developed an allergy to latex.[152] Individually sterilised gloves are generally unnecessary unless dealing with immunocompromised patients. Latex sensitisation is an occupational hazard in healthcare workers.[153] Powdered latex gloves are recognised as a major cause of latex in the air as latex binds to starch particles.[154] The risks of latex sensitisation to staff and patients should be reduced by using non-powdered latex gloves[155] or non-latex gloves.

Cough inducing procedures such as bronchoscopy may be associated with a high risk of exposure to microorganisms including *M tuberculosis*.[156] Previous recommendations for respiratory protection during bronchoscopy therefore have included the wearing of face masks or high grade particulate face masks ("respirators").[156] There is a lack of data regarding the effectiveness of personal respiratory protection in stopping transmission of infections in the health care setting. Visors may protect the face of staff from splashes coughed up during bronchoscopy, although they may not adequately protect staff from inhaling aerosols of *M tuberculosis*. Similarly, there is a lack of data in the literature about the relative merits of eye protectors.

High grade particulate face masks have been recommended where there is thought to be a risk of multidrug resistant tuberculosis.[150] A

recent audit[61] showed that face masks were predominantly worn by operating theatre staff, but less often in other departments. However, medical prudence would suggest that masks/visors are a reasonable approach to provide some protection to healthcare workers.[156] If bronchoscopy is required for a patient with known or suspected multiresistant tuberculosis, this should be carried out in a room fitted with negative pressure ventilation.[157]

Gowns or waterproof aprons may protect staff uniforms from contamination. Long sleeve gowns may provide further protection although there are no studies to confirm this.

Recommendations

- **During bronchoscopy staff should wear protective clothing (gowns or plastic aprons, masks/visors, and gloves). [C]**
- **Non-powdered latex or non-latex gloves should be worn instead of powdered latex gloves. [B]**
- **High grade particulate masks should be worn when patients known to have multidrug resistant tuberculosis or those at high risk undergo bronchoscopy and the procedure should be carried out in a negative pressure facility. [C]**

GLUTARALDEHYDE SAFETY

Glutaraldehyde is a highly effective, low cost disinfectant which is non-damaging to instruments and processing equipment. However, it does pose a potential risk to hospital staff. Aldehydes are irritants and sensitisers and the vapour can cause rhinitis, conjunctivitis, and asthma, while contact with the disinfectant can cause dermatitis.[117] It has been stated that, if the smell of glutaraldehyde is detectable, the limits are likely to be exceeded and action may need to be taken.[117] A new legally enforceable maximum exposure limit of 0.05 ppm has now been published[158] to take the place of the previous occupational exposure standard (0.2 ppm expressed as a 15 minute reference period[159]). It should be stressed that no safe level of exposure has been identified.

Staff and patients are exposed to aldehydes during bronchoscopy if the instruments have been inadequately rinsed, and risks from accessory disinfection and exposure can be reduced if exhaust vented automated systems are used and accessories are autoclaved or disposable accessories are used. The disinfection process needs to be carried out in a dedicated well ventilated environment with local exhaust ventilation,[117] preferably in a fume cabinet in an area separate from the main endoscopy room. Only in the absence of adequate control measures should personal protective equipment be used.[160] Personal protective equipment such as nitrile gloves, impermeable aprons, respiratory protective equipment, and eye protection should be worn when mixing aldehydes and dealing with spillages. All other processes including filling of machines and disposal of the chemical should be carried out with local exhaust ventilation,[161] preferably directly from the automated system into the drains.

All staff should be informed of the potential health risks associated with glutaraldehyde use[160] and must receive training in the safe use of the disinfectant. Safe working procedures have to be established in writing and given to all staff concerned. Only trained and competent staff should be authorised to use aldehydes.[117]

Recommendations

- **Pre-employment health checks should be carried out on all staff working with aldehydes according to COSHH recommendations, and regular periodic screening with regard to lung function and occurrence of symptoms should be carried out by the occupational health department. [C]**
- **Bronchoscopes should be disinfected ideally in a dedicated room using well ventilated automated systems, preferably inside a fume cabinet, to prevent unnecessary exposure to disinfectants. [C]**
- **During cleaning and disinfection staff need to wear protective clothing (nitrile gloves and plastic aprons with eye and respiratory protection, where appropriate) to protect them from splashes, aerosols, and vapour. [C]**
- **Wherever possible, autoclavable or disposable accessories should be used to prevent unnecessary exposure to disinfectants. [C]**
- **Bronchoscopy staff need to be trained in patient care, infection control, and instrument decontamination including the safe use of aldehydes and the potential health risks. [C]**

Flexible bronchoscopy in the intensive care unit

The flexible bronchoscope facilitates the inspection of the upper airways and bronchial tree in critically ill patients in an intensive care unit (ICU). In non-intubated patients the risks of bronchoscopy are those described in the section on "Complications". However, bronchoscopy in the ICU commonly involves intubated patients supported by mechanical ventilation. The specifications of a bronchoscope suitable for general ICU work requires a degree of compromise. The internal diameter of the endotracheal tube may restrict the size of bronchoscope, while efficient suctioning requires a larger bronchoscope with a wide suction channel.

Recommendation

- **Intensive care units should have the facility to perform urgent and timely flexible bronchoscopy for a range of therapeutic and diagnostic indications. [C]**

INDICATIONS

Fibreoptic bronchoscopy may be performed in the ICU for a wide range of diagnostic or therapeutic indications.[92 162] Often, bronchoscopy is used to investigate and rectify lobar

collapse that has failed to respond to measures such as physiotherapy.[92 163–165] Retained bronchial secretions may obstruct major airways and predispose towards infection. Local directed suctioning, particularly with a wide channel bronchoscope, combined with saline or acetylcysteine instillation is very effective at removing these secretions. Similarly, some foreign bodies such as food material or tooth fragments can be removed with a wire basket or grasped with bronchoscopy forceps.

Minor endotracheal bleeding is a common finding during routine tracheal suctioning and may result from tracheal epithelial abrasions. If bleeding becomes persistent or excessive, bronchoscopy may identify the source and extent of the haemorrhage and assist in developing a management plan.[92 166] Massive haemorrhage renders fibreoptic inspection difficult and rigid bronchoscopy is then generally preferred.

Some ICUs use bronchoscopically directed lavage or brushing techniques to obtain microbiological samples in patients with pneumonia.[167 168] Whether directed techniques offer substantial advantages over non-directed methods has not been conclusively demonstrated.[168 169] Bronchial lavage for microbiological specimens appears to be a relatively safe procedure without lasting or serious sequelae.[170] One report has suggested that the physical appearance of secretions welling up from distal airways after suctioning is characteristic of pneumonia, in contrast to bronchitis.[169]

Transbronchial biopsy may be required for histological diagnosis.[171] In the ventilated patient there is a significant risk of pneumothorax (approximately 10%) and haemorrhage (approximately 5%), and histological diagnosis may only be achieved in about one third of cases.[36]

PRECAUTIONS

Risk assessment

Critically ill patients represent a high risk group for most invasive procedures. They will often present with hypoxia, electrolyte disturbances, clotting abnormalities and arrhythmias.[170] It is therefore important that the potential benefits of bronchoscopy outweigh the risks. Elevated prothrombin time, increased activated partial thromboplastin time (APTT), reduced fibrinogen titre, or thrombocytopenia indicate clotting dysfunction making biopsy procedures hazardous. Brushing or lavage for cytological and microbiological examinations may offer a safer alternative.[167 170] The same reservations apply to patients with renal failure in whom platelets may be dysfunctional. Critically ill patients may be more susceptible to the toxic effects of local anaesthetics[172]; however, in the ventilated patient intravenous sedation or anaesthesia is probably the most appropriate alternative.

Recommendation

- **Patients in ICU should be considered at high risk from complications when undergoing fibreoptic bronchoscopy. [B]**

Monitoring

A full range of physiological monitoring will generally be available in the ICU. This should include ECG (for heart rate and rhythm), continuous intra-arterial blood pressure or intermittent cuff blood pressure measurement, and pulse oximetry (Spo_2). Setting appropriate alarm limits for heart rate, blood pressure and Spo_2 and requesting other attendant staff to monitor physiological variables during the bronchoscopy improves safety. Adverse events require immediate withdrawal of the bronchoscope and resuscitation of the patient. The clinician must then weigh the benefits against the risks of proceeding further.

Monitoring intracranial pressure (ICP) in head injured patients is essential if sudden rises in ICP are to be avoided due to CO_2 retention or other causes. Monitoring endotracheal CO_2 in such patients may also help to detect falls in minute ventilation caused by the presence of the bronchoscope within the endotracheal tube.[77] Profound anaesthesia, including effective neuromuscular blockade, is required in patients with head injury while undergoing bronchoscopy.

Recommendation

- **Continuous multi-modal physiological monitoring must be continued during and after fibreoptic bronchoscopy. [B]**

Ventilator settings

Pre-oxygenation should be achieved by increasing the inspired oxygen concentration to 100%. 100% oxygen should be given during bronchoscopy and in the immediate recovery period. The ventilator should be adjusted to a mandatory setting. Triggered modes such as pressure support or assist control will not reliably maintain ventilation during fibreoptic bronchoscopy. The ventilator pressure limit should be increased to ensure that adequate tidal volumes are delivered during each respiratory cycle and the ventilator rate increased if necessary. Most modern microprocessor controlled ventilators will monitor tidal volume and minute ventilation.

A special swivel connector (Portex, Hythe, UK) with a perforated diaphragm, through which the bronchoscope can be inserted, allows continued ventilation and maintenance of PEEP/CPAP. This is particularly important when performing a bronchoscopy in hypoxic patients with adult respiratory distress syndrome (ARDS).[173]

Recommendation

- **Care must be exercised to ensure adequate ventilation and oxygenation is maintained during fibreoptic bronchoscopy via an endotracheal tube. [B]**

Endotracheal tube size

The internal diameter of the tracheal tube relative to the external diameter of the bronchoscope is an important consideration. Bronchoscopes in the non-intubated patient occupy only 10–15% of the cross sectional area of the trachea. In contrast, a 5.7 mm bronchoscope

occupies 40% of a 9 mm endotracheal tube and 66% of a 7 mm tracheal tube. Failure to recognise this may lead to inadequate ventilation of the patient and impaction of or damage to the bronchoscope. Tracheostomy tubes are also prone to damage the bronchoscope, particularly during withdrawal when the rigid edge of the end of the tracheostomy tube can abrade the covering of the bronchoscope. Lubrication is essential to facilitate passage of the bronchoscope.

Recommendation

- **The internal diameter of the endotracheal tube, through which the bronchoscope is inserted, must be taken into consideration before bronchoscopy.**

Sedation and analgesia

The clinical status of the patient will often determine the type and level of sedation. Unstable hypoxic patients with ARDS may require deep sedation, analgesia, or even muscle relaxation to maintain oxygenation and prevent the patient "fighting" the ventilator.[162] Synthetic narcotics such as alfentanil or fentanyl will suppress cough and provide profound analgesia. Sedation can be induced using incremental doses of a benzodiazepine or propofol. Some patients may only require light sedation for comfort during mechanical ventilation. In such cases bronchoscopy can be undertaken with supplemental topical anaesthesia with lignocaine injected through the bronchoscope. Usually the dose of lignocaine is small compared with that used for awake, non-intubated patients. However, care must be exercised in patients with combinations of renal failure, liver dysfunction, and congestive heart failure when accumulation of lignocaine and seizures has been reported.[172]

Recommendation

- **More profound levels of sedation/anaesthesia can be achieved in ventilated patients provided the clinician performing the procedure is acquainted with the use of sedative/anaesthetic agents. [C]**

Cleaning/disinfection

To ensure that all staff comply with appropriate standards of cleaning and disinfection, written policies and procedures should be developed (see Appendix 2).

Data collection

While it has always been valuable to record flexible bronchoscopic procedures for later data retrieval and audit, following the Calman-Hine report[174] it is becoming more important to be able to audit lung cancer management in detail. A core data set has been recommended for audit of lung cancer services.[175] There is therefore a need for careful recording and feedback of information relating to flexible bronchoscopy. A computer database provides the ideal tool for data storage and retrieval. Currently only one database is commercially available in the UK, although a number of others have been developed and used in various hospitals.[176]

The use of a computerised database in bronchoscopic reporting provides the following advantages:

(1) It is a uniform reporting tool.
(2) It avoids the need for a separate letter to the referring doctor.
(3) It may be used for internal or wider audit.
(4) It may provide minimal data sets required for the Cancer Intelligence Unit and information for audit of waiting times.
(5) It may provide completed report and laboratory request forms.
(6) It may be used to help in the assessment of the competency of the bronchoscopist.
(7) It may provide more complete data on lung cancer management including staging, type of treatment, and outcomes.
(8) It provides a record for the trainee.

It is important for any reporting system to have a minimum data set. Such a set should be sufficiently simple to be collected with the resources available in most NHS hospitals.

Training

Flexible bronchoscopy is a complex and potentially hazardous procedure requiring trained personnel (medical, nursing, and paramedical) to minimise the risk to both patient and staff.

TRAINING FOR THE BRONCHOSCOPIST

The optimal number of procedures which should be undertaken under direct supervision (trainer in bronchoscopy unit) and indirect supervision (trainer able to assist if called) before undertaking bronchoscopy alone will vary, depending on the competency of the trainee and the complexity of the procedure being undertaken. The importance of experience has been shown, for instance, to influence the yield of positive biopsy material from visible tumours.[177]

It would seem reasonable to undertake a minimum of 50 procedures under direct supervision and a further 50 under indirect supervision, although the trainer or other competent bronchoscopist should be available to give advice if needed for any trainee bronchoscopist.[178]

The trainee bronchoscopist should be able to:

- Describe bronchoscopy procedures to the patient in appropriate terms and obtain informed consent
- Administer appropriate sedation to the patient
- Maintain an adequate airway and adequate oxygenation at all times
- Introduce a flexible bronchoscope via the nose, mouth, tracheostomy, and endotracheal tube
- Complete a flexible bronchoscopic examination of the entire bronchial tree, naming all the main segmental bronchi, and directing the tip of the bronchoscope into any given segment of the bronchial tree

- Carry out the following diagnostic procedures: bronchial brushing, bronchial lavage, endobronchial biopsy and transbronchial biopsy
- Manage the complications of haemorrhage, tenacious secretions, hypoxaemia, and pneumothorax if necessary.

It is desirable that the trainee bronchoscopist should have the opportunity to see the following procedures: rigid bronchoscopy, endobronchial tumour ablation with laser or diathermy, and stent insertion.

These recommendations are partly based on the training guidelines developed by the American College of Chest Physicians.[179]

TRAINING FOR NURSING AND PARAMEDICAL STAFF

Training on external courses has been shown to improve practice.[61] Training in the safe use of glutaraldehyde is a legal requirement under COSHH.

Training should cover the following areas:

- Preoperative assessment of patients
- Communication with patients and relatives about the procedure and aftercare
- Appropriate use of protective clothing/equipment (in accordance with COSHH)
- Adequate hand washing[148 149]
- Appropriate patient monitoring[180]
- Dealing with patients from the high risk group
- Possible complications and how to deal with them (for example, bronchospasm, vasovagal attacks, haemorrhage, respiratory or cardiac arrests)
- Collection and processing of specimens
- Adequate cleaning of both endoscopes and accessories (contaminated equipment not only poses an infection risk but may also lead to a false positive diagnosis[133 135])
- Appropriate rinsing of bronchoscopes after disinfection to remove traces of glutaraldehyde which otherwise may cause irritation to the respiratory tract[181]
- Post-procedure observations and management of potential complications.

Patient satisfaction

Patient satisfaction appears to be influenced by many factors—including patient characteristics, their previous health care experience, their expectations, and how well they are prepared[88 182 183]—and to address this satisfactorily bronchoscopy should be viewed in the context of its surrounding care.

Some patients find bronchoscopy unpleasant, whether sedation is given or not.[76 84 88 184] There are several factors which improve acceptability by reducing the patient's anxiety—for example, careful explanation and relaxing tranquil music has been found to calm the nerves of patients and also of the staff.[185 186]

Planning and careful attention to detail are required to follow national recommendations,[174] to streamline the patient's journey through referral, bronchoscopy, diagnosis, bad news, onward referral for surgery, radiotherapy or chemotherapy, and palliative care.[187] Efficiency in running the service is vital, with appointments and instructions being given clearly in advance with as few changes as possible, clerical help to ensure notes and radiographs are available for the procedure and collection of data for audit, and a good liaison between all the healthcare professionals in the hospital and community.

Many patients who undergo a bronchoscopy are fearful of a malignant diagnosis and so need individualised care which should be provided in an empathic and caring way.[183 188] They and their relatives may have many queries, both about the procedure and later management, and adequate time should be available for this. A lung cancer care nurse may be used to fulfil this role.

The need to provide relevant and understandable patient information before diagnostic and therapeutic procedures is being increasingly recognised, and improves the patient's tolerance of the procedure.[189 190] A tendency for doctors to explain "why" rather than also "how" may contribute to patients' fears.[83] In most settings the information includes verbal explanation before, during, and after the procedure, backed up with written information to include date, time, place with map if necessary, description of the procedure, the possible after effects, and the need to be collected afterwards and not drive home, even if intravenous sedation is not given.[191] These instructions can be tailor made for the hospital so that all information is correct, with inpatients also being given a full explanation.[192]

Recommendation

- **Verbal and written patient information improves tolerance of the procedure and should be provided. [B]**

Studies have shown that preoperative fasting times have been unnecessarily long.[193] It is sufficient to starve for 4 hours before bronchoscopy, allowing clear fluids up to 2 hours beforehand, depending on the list organisation.[194–196]

Recommendation

- **It is sufficient for patients to have no food by mouth for 4 hours and to allow clear fluids by mouth up to 2 hours before bronchoscopy. [B]**

The recovery time for the return of an adequate gag reflex will vary between patients. Return of the gag reflex and the ability to swallow clear fluids safely (normally 60–90 minutes after the bronchoscopy) should be established before discharge from hospital.

After the procedure the patient should be given some idea of what the next stage of management will be, an appointment for follow up, and a brief written explanation that they have had a bronchoscopy, may cough up small amounts of blood, and where to contact if they develop a significant haemoptysis or pyrexia. It is preferable that day case patients who have been sedated should be accompanied home and that higher risk patients such as the elderly and those who have had transbronchial biopsies should have someone to stay with them at

home overnight.[76] A post-bronchoscopy information leaflet may be helpful to patients and their attendants.[180]

Recommendation

- **Patients who have been sedated should be advised not to drive, sign legally binding documents, or operate machinery for 24 hours after the procedure. [C]**

CONSENT

Patients have a right to information about their condition and the treatment options open to them.[197] The amount of information to be provided varies[198] and, in the UK, it is for the doctor to determine, for the particular individual patient, how much information is disclosed. However, doctors must answer truthfully and directly any specific questions put by a patient,[198] but may be entitled to withhold information if he or she reasonably believes that to provide it would be detrimental to the health of the patient. Further explanation may be given by nursing staff.[199]

To proceed without consent may lead to legal proceedings for assault and battery. To fail to provide adequate information to a patient, including information about risks and adverse outcomes, may lead to a negligence action against the doctor for failure to warn. The amount of information to be provided in the UK is a matter for the doctor's judgement.[200] He or she should follow a course which commands support from a responsible body of professional opinion.[201] There is no duty in this country for the doctor to point out remote risks.[202]

It is the responsibility of the clinician who performs the procedure to ensure that valid consent has been obtained.[197] For a patient to give valid consent he/she must have the capacity—that is, be capable of giving consent, be in possession of sufficient information,[203] and act entirely voluntarily.[204 205]

Standards and performance of diagnostic techniques

Diagnostic yield is known to be related to the appearances at bronchoscopy in patients with suspected lung cancer. A recent study involving five bronchoscopy centres[178] showed an 82% positive rate for malignancy with bronchial biopsies in cases where malignancy was judged to be present on appearances through the bronchoscope. This compares with 76%[206] and 77%[207] in other studies. The combined use of bronchial washings and brushings increased the diagnostic rates to 87%.[178]

For the maximum diagnostic yield in both bronchoscopically visible tumours and tumours with normal or non-specific appearances, a combination of biopsy material, brushings, and washings should be obtained,[206] although the number of tumours diagnosed by washings alone is relatively small.[206] The relative yield from washings and brushings compared with biopsies appears to be higher in cases where the tumour is not definitely visible.[178] The optimum sequence of obtaining these three types of samples is uncertain and requires further studies.

The number of bronchial biopsy specimens required to obtain a high diagnostic rate has been studied. In order to achieve at least a 90% probability of a positive malignant biopsy, at least five samples were required in cases where there was a visible tumour.[207] Another study has suggested that a minimum of four biopsy specimens are required.[208] It would seem reasonable to expect a bronchoscopist to achieve a diagnosis in at least 80% of cases where a tumour is visible at bronchoscopy using the combined methods of biopsies, brushings, and washings.[209] The diagnostic yield will also be affected by the quality of the pathology services. More data are required to determine minimum standards at various stages of higher professional training.

Transbronchial needle aspiration (TBNA) has recently been used more widely. For visible tumours the yield from TBNA and forceps biopsy is similar.[210] However, TBNA may be more sensitive than forceps biopsy in carcinomas which are infiltrating the submucosa and peribronchial areas.[211] TBNA can be used to sample the hilar-mediastinal lymph glands. Obviously the node from which the biopsy material is to be taken should be closely adjacent to the airway. The sensitivity of TBNA for node sampling varies widely in the literature but is higher (38% of cases) where there is radiological confirmation of lymph gland enlargement.[212] One study has shown improved sensitivity when using a larger (22 gauge) needle.[213]

For peripheral pulmonary lesions transbronchial biopsy has a sensitivity that varies according to the number of biopsy specimens taken and also the underlying disease. Fluoroscopy appears to be unnecessary in patients with diffuse lung disease[46] but is advisable for localised lesions. The type of forceps used does not seem to influence the diagnostic yield.[214] About one third of attempted transbronchial biopsy samples consisted of bronchial rather than alveolar tissue in one study.[215] Diagnostic yields are high in patients with stages II or III sarcoidosis (about 75%) and in those with lymphangitis carcinomatosis (66%), moderate in patients with stage I sarcoidosis (58%), but lower in those with interstitial pulmonary fibrosis (27%).[215] Transbronchial biopsy is not useful for the diagnosis or staging of cryptogenic fibrosing alveolitis and the advantages of alternative biopsy techniques, including open lung biopsy or video-assisted thoracoscopic lung biopsy, are detailed elsewhere.[46] For diffuse lung diseases 4–6 transbronchial biopsy samples should be obtained from one lung.[46 215] In cases of suspected sarcoidosis endobronchial biopsy samples should also be taken.[46] For localised lung lesions 7–8 transbronchial biopsy samples have been proposed.[215] In all patients the clinician will need to assess the likely balance between the risk of complications and the diagnostic yield, and also the possibility of alternative diagnostic approaches. For localised peripheral lesions a transthoracic

needle biopsy under imaging control may offer advantages over a transbronchial biopsy.

Comprehensive guidelines are available in the literature regarding the performance of bronchoalveolar lavage and interpretation of the results.[216 217]

Recommendations

- **At least five bronchial biopsy specimens should be taken in cases of suspected bronchial malignancy. [B]**
- **Biopsies, brushings and washings should all be obtained in cases of suspected endobronchial malignancy. [B]**
- **A minimum diagnostic level of at least 80% should be obtained from a combination of biopsies, brushings, and washings in cases of endoscopically visible malignancy. [B]**
- **When taking transbronchial lung biopsy specimens in patients with diffuse lung disease, an attempt should be made to obtain 4–6 samples from one lung. [B]**

Appendix 1: Details of the BTS Flexible Bronchoscopy Guidelines Working Party

John Babb, scientist with a special interest in disinfection and decontamination, Hospital Infection Research Laboratory, City Hospital NHS Trust, Dudley Road, Birmingham. Member of the Microbiology Advisory Committee of the Medical Devices Agency of the Department of Health and member of the Endoscopy Guideline Working Party of the British Society of Gastroenterology.

Pippa Bowie, research assistant in the Clinical Effectiveness Unit at Kettering General Hospital, Northamptonshire, and MSc student who carried out the literature search while a student in the Department of Evidence Based Medicine at the University of Oxford.

Adrienne Brewin, respiratory nurse specialist at the Kent and Sussex Hospital, Tunbridge Wells. Nominee of the Royal College of Nursing.

Adam Fraise, consultant in medical microbiology at the City Hospital NHS Trust, Dudley Road, Birmingham. Member of the Microbiology Advisory Committee of the Medical Devices Agency of the Department of Health.

Christopher Garrard, consultant physician and director of the Intensive Care Unit at the John Radcliffe Hospital, Oxford.

John Harvey, consultant physician at Southmead Hospital, Bristol.

Table 2 Glutaraldehyde disinfectant contact times*

	Patient category	
When	*Low risk*	*High risk (e.g. tuberculosis (TB), immunosuppressed, symptomatic HIV)*
Start of list	20 min	20 min
Between patients	20 min	1 hour after TB and before and after immunosuppressed patients†
End of list	20 min	1 hour after TB and after immunosuppressed patients†

*2% glutaraldehyde at room temperature.
†Includes symptomatic HIV patients.
Twenty minutes disinfection with 2% glutaraldehyde is sufficient to kill most non-sporing bacteria, including *Mycobacterium tuberculosis*, and blood-borne viruses. Longer contact times of 1 hour are recommended for some other mycobacteria such as *Mycobacterium avium intracellulare*, encysted parasites, and spores. Thorough cleaning will remove most problematic and pathogenic microorganisms.
If an alternative disinfectant is used, advice should be sought from the disinfectant manufacturers and your Infection Control Team/Committee.

David Honeybourne (Chairman), consultant physician at Birmingham Heartlands Hospital.

Richard Lewis, consultant physician at Worcester Royal Infirmary.

Christiane Neumann, clinical nurse specialist in endoscopy at the City Hospital NHS Trust, Dudley Road, Birmingham. General secretary of the European Society of Gastroenterology and Endoscopy Nurses and Associates.

Christopher G Wathen, consultant physician at Wycombe Hospital, High Wycombe, Buckinghamshire.

Tim Williams, consultant physician at Kettering General Hospital, Northamptonshire.

Appendix 2: Cleaning and disinfection procedure

Bronchoscopes are a potential source of infection and must be cleaned, disinfected, and rinsed before use, between patients, and at the end of a list. This requires special training and knowledge. Always refer to the manufacturers' instructions for specific instrument advice.

For a detailed description of endoscope cleaning and disinfection procedures see the Medical Devices Agency device bulletin 9607 "*Decontamination of endoscopes*".[117] This section summarises the decontamination procedures for bronchoscopes. A record should be kept of which bronchoscope is used on an individual patient and also of the decontamination procedure.[121]

Immersible instruments should be leak tested to ensure instruments are water tight before processing.

CLEANING

Wear suitable protective clothing (gloves, plastic aprons and eye protection) if splashing is likely (see section on Staff safety).

1. Wipe clean external surfaces with detergent.
2. Remove and dismantle the suction valve for separate cleaning.
3. Clean the channel and port with a suitable cleaning brush.
4. Flush the channel through with detergent followed by air.

DISINFECTION

1. Use automated systems whenever possible as they protect the user from hazardous processing chemicals. (NB: If an automated system is used, ensure that machine disinfection is carried out at the start of each session/day. This includes filters and pipework for rinse water.)
2. Immerse the bronchoscope in glutaraldehyde (see table 2 for contact times) or an alternative disinfectant (for example, peracetic acid, chlorine dioxide, superoxidised water, or ethylene oxide), ensuring that the channel is irrigated and all air is expressed.
3. Change the disinfectant when the manufacturer's recommended use life is reached.
4. Rinse the instrument with sterile or filtered tap water (0.2 μm).
5. Change the detergent and rinse water regularly (ideally after each cycle) if reused.
6. Dry the instrument with air and/or alcohol. A 70% alcohol rinse may be used for the channel if the quality of the rinse water cannot be assured. Wipe dry the insertion tube.
7. Accessories should be cleaned, preferably using ultrasonics, and, wherever possible, sterilised by autoclaving.

ALTERNATIVES TO GLUTARALDEHYDE

Alternatives to glutaraldehyde include peracetic acid, chlorine dioxide, superoxidised water, and ethylene oxide.[113 117]

For advice on the safe use of glutaraldehyde and other processing chemicals see section on "Cleaning and disinfection" in these guidelines.

ENDOSCOPE WASHER DISINFECTORS

Advice is available on the selection and use of endoscope washer disinfectors.[117 218 219] Automated systems are preferred as they reduce the likelihood of exposure to hazardous processing chemicals and are more easily validated than manual processes. It is essential that the machine selected effectively cleans, disinfects, and rinses all channels and external surfaces without damaging the instrument. If glutaraldehyde or irritant processing chemicals are used, fumes must be contained or removed to protect processing staff. Sterile or bacteria free water (0.2 μm filter) must be used for rinsing bronchoscopes. Machines should be equipped with a "self disinfect" facility which includes filters and all rinse water pathways. Water filters should be changed regularly in accordance with the manufacturers' instructions and more frequently if water quality is poor. Low water quality should be suspected if filters block, which may then lead to inadequate water pressure in the machine. Consideration should be given to flushing the disinfected bronchoscope with sterile water for microbiological analysis in order to monitor the adequacy of the disinfection process.

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