

## POSITION PAPER

# Fibre-optic bronchoscopy in adults: a position paper of The Thoracic Society of Australia and New Zealand

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### Abstract

Fibre-optic bronchoscopy in adults is a common procedure in clinical respiratory practice. Under controlled conditions it is safe, resulting in relatively few significant adverse events. The present position paper updates guidelines previously published by The Thoracic Society of Australia and New Zealand and is based on evidence obtained by searching the Medline and Embase databases. The level of evidence to

support recommendations is indicated in the text. Where no evidence has been found, the guidelines reflect the opinions of the authors. Specific recommendations are made regarding sedation and anaesthesia, the cleaning of bronchoscopes and the training of bronchoscopists. (Intern Med J 2001; 31: 479–487)

**Key words:** adult bronchoscopy.

## INTRODUCTION

This document updates guidelines previously published by The Thoracic Society of Australia and New Zealand on aspects of bronchoscopy.<sup>1–4</sup> These guidelines refer to flexible fibre-optic bronchoscopy unless indicated in the text. The guidelines are based, whenever possible, on evidence obtained from the literature by searching Medline and Embase databases. The level of evidence to support recommendations is indicated in the text and has been allocated according to the grading of Cook *et al.*<sup>5</sup> Where no evidence has been found the guidelines reflect the opinions of the authors.

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*The present paper addresses the performance of bronchoscopy in adults. A separate publication has been prepared for the performance of bronchoscopy in children. This position paper has a currency of 5 years from the date of publication unless otherwise published in the Journal.*

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## INDICATIONS

While there are no set criteria for performing bronchoscopy, several indications are widely accepted.<sup>6–8</sup> These may be broadly divided into the following categories:

### Diagnostic

- Evaluation of symptoms (e.g. haemoptysis, localized wheeze, unexplained cough).
- Evaluation of endobronchial disease (tumour, foreign body, stricture, fistula, mucous plug, thermal injury).
- Evaluation of an abnormal chest radiograph (lung mass, focal or diffuse pulmonary infiltrates, lung atelectasis, pleural effusion).
- Evaluation of mediastinal and hilar lymph nodes by endobronchial ultrasound.

### Monitoring disease process

- Lung transplantation.
- Staging lung cancer.

### Therapeutic/interventional

- Removal of foreign body.
- Assisted intubation.
- Endobronchial laser treatment.
- Brachytherapy.
- Delivery of endobronchial stents.

Some of these procedures require expertise in rigid bronchoscopy.

### Research

Fibre-optic bronchoscopy has been and may also be used for research purposes, for example:

- Bronchoalveolar lavage in diffuse lung disease.
- Endobronchial biopsies and brushings in asthma.

## PATIENT ASSESSMENT

### Clinical assessment

There are no published criteria regarding the utility of clinical history and examination before bronchoscopy. It is recommended that the bronchoscopist clinically assess each patient before bronchoscopy. Bronchoscopies can be carried out as an inpatient or outpatient procedure and the safety of the latter has been well established.<sup>9-11</sup> Chest radiography is considered essential for all patients.

### Respiratory function assessment

Routine lung function testing or arterial blood gas analysis is not required unless patients are suspected of having significant impairment or respiratory failure on clinical grounds.

### Coagulation assessment

Routine coagulation studies and platelet counts are not required, but it is suggested these be carried out before transbronchial biopsy because of the increased risk of bleeding. At-risk patients identified during clinical assessment, particularly those with renal impairment, should be tested. Anticoagulants should be ceased and reversed before bronchoscopy involving biopsy procedures. The risk associated with anti-platelet drugs is not known, but it is preferable that non-steroidal anti-inflammatory drugs be withheld for at least 1 week before bronchoscopic biopsy.<sup>12-15</sup>

### Other assessment

There are no data to support the role of routine testing, other than those detailed earlier.

### High-risk procedures

The following situations are considered to represent high-risk bronchoscopies and the risk : benefit ratio should be considered carefully before proceeding:<sup>16,17</sup>

- Cardiac: life-threatening arrhythmias, myocardial infarction within the last 4 weeks, unstable angina.
- Respiratory: refractory hypoxaemia.
- Clotting abnormalities: platelet count of less than 50 000, uncorrected coagulopathy, severe renal impairment.<sup>15,18</sup>
- Infective: patient with transmissible infection (e.g. active pulmonary tuberculosis).
- Uncooperative patient.

In addition, while prophylaxis for bacterial endocarditis is not recommended for routine flexible bronchoscopy, it is recommended for patients undergoing rigid bronchoscopy. This is particularly so for patients with high-risk cardiac lesions; a history of previous endocarditis, prosthetic valves, complex cyanotic congenital heart disease, left-sided major valve abnormalities or surgically constructed systemic pulmonary shunts or conduits.<sup>19,20</sup>

### Research subjects

All volunteers undergoing bronchoscopy for research purposes should have screening tests to ensure their safety.<sup>21</sup> Bronchial responsiveness should be measured in asthmatic volunteers because there is a direct correlation between the provocative concentration (PC<sub>20</sub>) of methacholine and the percentage fall in forced expiratory volume in 1 s (FEV<sub>1</sub>) during the procedure when compared with values measured before the procedure.<sup>22</sup> A PC<sub>20</sub> of less than 2 mg/mL is associated with a significant risk of a fall in FEV<sub>1</sub> of greater than 20% (grade C).<sup>22</sup>

### Informed consent

After considering the indications, risks and outcome of the patient assessment, the bronchoscopist should discuss the procedure with the patient. This should include provision of information on possible risks, likelihood of achieving a diagnosis and alternative approaches, followed by written consent. This is particularly so when transbronchial biopsy is anticipated because this carries higher risks of bleeding and pneumothorax.<sup>20</sup> Where an unanticipated bronchoscopy is required (e.g. intubated and sedated patients), discussion should be with the next of kin. Patients and their relatives should have the

opportunity to ask any questions before written consent is obtained. Failure to obtain consent is a contraindication to bronchoscopy.

## PROCEDURE

It is recommended that all procedural matters be documented in an appropriate procedure manual specific to the bronchoscopy facility under consideration. Most bronchoscopies in Australia and New Zealand will be conducted within a hospital complex. It may be appropriate to conduct procedures in a facility remote from a hospital, but only if it is fully equipped with access to resuscitation equipment. Bronchoscopies may be carried out in a variety of settings within a hospital (e.g. dedicated bronchoscopy suite, general endoscopy suite, operating theatre or radiology department). The important features of the facility are:

- Adequate space in the procedure room.
- Equipment for delivery of oxygen and for suctioning.
- Full cardiopulmonary resuscitation equipment.
- Ancillary space for patient preparation and recovery, equipment cleaning, storage and clerical areas.

Other features that are preferred include:

- Negative pressure exhaust ventilation or high efficiency particulate air filtration.
- System specific safety requirements (e.g. lead lining, laser).<sup>23</sup>

## Staff

### *Bronchoscopist*

Only medical practitioners with appropriate training should perform bronchoscopies (see later).

### *Assistants*

Throughout the procedure, the bronchoscopist should have one or two assistants (see also later). These will usually be nurses who have specific training and expertise in all aspects of bronchoscopy procedures and the care of the equipment and are experienced in resuscitation procedures. Assistants are also essential in the preparation and recovery phases of the bronchoscopy procedure.

### *Ancillary staff*

Additional expertise may be required in the bronchoscopy suite from time to time. Examples include

cytologist/pathologist, radiographer/radiologist and biomedical engineer.

## Equipment

The following lists include most of the commonly used equipment in a bronchoscopy suite.

### *Routine bronchoscopy equipment*

- Fibre-optic bronchoscopes and light source/video processor.
- Video monitor.
- Biopsy forceps, cytology brush, transbronchial needles, foreign body snares.
- Cleaning and maintenance equipment (see later).

### *Monitoring equipment*

- Pulse oximeter.
- Electrocardiogram.

### *Resuscitation equipment*

- Oxygen, suction, *in vitro* sets.
- Intubation equipment, including a laryngoscope, airways and endotracheal tubes.
- Bag and masks with a non-rebreathing circuit and means of inflating the lungs with oxygen for ventilation.
- Defibrillator.
- Appropriate drugs; these should include adrenaline, atropine, metaraminol, ephedrine, salbutamol, hydrocortisone, naloxone, flumazenil, dextrose 50% and phenytoin.
- Equipment for intercostal catheter insertion and pneumothorax drainage.

In addition, a range of special equipment may be required for some procedures including the following.

### *Special bronchoscopy equipment*

- Rigid bronchoscopes, light source, forceps.
- Yttrium Argon Garnet laser unit.
- Endobronchial stents and introducers.

### *X-ray equipment*

- Image intensifier.
- X-ray aprons and monitoring devices.

## Types of procedures

A variety of bronchoscopic procedures may be carried out and these will vary between institutions depending on the available facilities and the

experience of the bronchoscopist. The following are broad guidelines.

#### *Standard bronchoscopic procedures*

- Visual examination of the upper and lower respiratory tract.
- Endobronchial sampling of visualized areas with biopsy forceps, cytology brush and saline washes collected in a suction trap.
- Transbronchial sampling of non-visualized areas (with or without radiological guidance) with all the sampling defined earlier, plus transbronchial needle aspirates and bronchoalveolar lavage when appropriate.

#### *Specialized bronchoscopic procedures*

- Foreign body removal.
- Stent placement.
- Laser ablation.
- Balloon dilatation.
- Endobronchial brachytherapy.

## ANAESTHESIA/SEDATION

Fibre-optic bronchoscopy should not be an unpleasant experience for patients. Various measures are necessary, therefore, to ensure patient comfort. Excessive coughing can be reduced by the application of topical local anaesthetic to the upper airway, larynx and tracheobronchial tree. Many patients require intravenous sedation, while a general anaesthetic is rarely needed.<sup>24</sup>

### Premedication

It is most important that the bronchoscopy procedure is carefully explained and that the patient is reassured. A friendly and calm atmosphere is desirable. Premedication is usually unnecessary and should be avoided if at all possible because it may potentiate decreases in conscious state both during and following the procedure. If required for a highly anxious hospital inpatient, an agent, such as the benzodiazepine lorazepam given orally, is useful because it has significant amnesic and anxiolytic properties.

For patients with a history of asthma or airway hyper-responsiveness, a nebulized beta-2 agonist, such as salbutamol, with or without an anticholinergic, such as ipratropium bromide, should be given approximately 15 min before the commencement of the bronchoscopy.

### Sedative drugs

Sedative drugs provide amnesia and anxiolysis, as well as preventing coughing. Because no single drug possesses all of these properties, a combination is used. In general, benzodiazepines provide amnesia and anxiolysis, while opioid drugs possess analgesic and antitussive properties. Benzodiazepine and opioid drugs act in a synergistic fashion, but their combined use also increases the risk of cardiovascular and respiratory side-effects.

Where possible within a class of drugs, it is desirable to use agents with a shorter duration of action, such as the benzodiazepine midazolam instead of diazepam, and the opioids fentanyl and alfentanil instead of morphine and pethidine. Doses should be individualized for each patient and titrated with respect to sedative effect (grade C).<sup>24</sup> Dose-response relationships are not necessarily linear and judicious incremental dosing should occur in order to avoid undesirable and unexpected decreases in conscious state.

### Sedative antagonist drugs

When intravenous sedation is employed, specific antagonists to benzodiazepines, such as flumazenil, and to opioids, such as naloxone, must be readily available. It is important to recognize that the duration of action of these agents is less than that of the drugs they antagonize. Thus it is possible for re-sedation to occur once their effect has ceased.<sup>24</sup> Use of either agent at the end of a case to allow for increased sedation during the procedure is not recommended. Flumazenil and naloxone may precipitate withdrawal reactions in patients who are taking benzodiazepines or opioids, respectively.<sup>24</sup>

### Local anaesthetic drugs

The application of topical local anaesthetic to the airways is effective in inducing airway anaesthesia (grade C).<sup>25</sup> Recent studies have shown local anaesthetic agents to have antimicrobial properties, although not all bacteria are susceptible.<sup>26,27</sup> Their use may therefore result in false-negative results of microbiological tests carried out on bronchoscopic specimens (grade C).

Lignocaine, an amide local anaesthetic agent, is the drug of choice because of its relatively quick onset of action, short duration of action and decreased toxicity compared with other agents. It may be administered by nebulization, via a spray to the nasal cavity,

nasopharynx and oropharynx, or via injection through the bronchoscope in a 'spray as you go' technique to the larynx and tracheobronchial tree.<sup>25,28,29</sup> If the nasal route is used for bronchoscopy, lignocaine can be applied as a gel formulation, which can be used to lubricate the bronchoscope in its passage through the nasal cavity.<sup>25</sup> Lignocaine in the nasal and nasopharyngeal spray can be combined with a vasoconstrictor such as phenylephrine. Phenylephrine can provide as efficacious a nasal vasoconstriction as the vasoconstricting local anaesthetic agent, cocaine, without the increased toxicity of cocaine. Transcricoid injection, bilateral lingual and superior laryngeal nerve blocks using lignocaine are no longer recommended.<sup>28</sup>

Absorption of local anaesthetic from respiratory mucosa can be rapid but varies from patient to patient. Plasma levels cannot therefore be predicted with confidence from the dose given to an individual patient.<sup>29,30</sup> In order to avoid toxicity, the administration of topical anaesthesia must be carefully monitored.<sup>30</sup> For lignocaine, neurotoxicity may begin to occur at plasma concentrations of 5–6 g/L. The total recommended dose without adrenaline is 4–5 mg/kg.<sup>31</sup> Up to this concentration topical lignocaine generally is safe, hypersensitivity reactions rare, clinically significant bronchoconstriction does not occur and toxic plasma levels are not reached.<sup>25</sup> A total topically administered dose of greater than 512 mg has been shown to have the potential of causing toxic serum concentrations.<sup>32</sup> It is recommended that when administering topical lignocaine the total dose be calculated cumulatively to avoid giving potentially toxic doses. The total dose should be recorded as part of the written report, together with all other drugs administered.

### Preparation

The patient should be fasted for at least 4 h for liquids and 6 h for solids before the commencement of the procedure. This is to minimize the occurrence of aspiration of gastric content both during and after the bronchoscopy. Before the procedure commences, it is essential that reliable intravenous access be established.

### Supplemental oxygen

Transient hypoxia is almost universal during bronchoscopy.<sup>24</sup> It may be a result of a variety of factors including respiratory depression from the sedative medication, the application of local anaesthetic, partial airway mechanical obstruction by the

bronchoscope itself, and ventilation-perfusion inequalities; it is aggravated by bronchoscopic procedures, such as bronchial washings, bronchial brushings, bronchoalveolar lavage and bronchial or transbronchial biopsies. To avoid the hypoxaemia induced by bronchoscopy it is sensible to administer supplemental oxygen before, throughout and following the procedure.

### MONITORING

All patients should have heart rate, respiratory rate, blood pressure and temperature measured and recorded before the commencement of the procedure. Non-invasive continuous monitoring with pulse oximetry, sphygmomanometry and electrocardiography is strongly advised in all patients and are obligatory for those with significant cardiovascular or respiratory disease; particularly those with cardiac or respiratory failure.<sup>24</sup>

### Medical practitioner acting as an anaesthetist

If intravenous sedation is to be used, the presence of a second medical practitioner is often helpful to monitor the patient. This may not be feasible on every occasion, but it allows the bronchoscopist the freedom to concentrate solely on the task at hand. The presence of another medical practitioner is mandatory when undertaking bronchoscopy in the seriously ill and those with severe impairment of cardiopulmonary function. Any assistant should have a knowledge of the patient and any comorbidities likely to alter the dispositions of the drugs to be given, as well as a sound knowledge of administered drug actions and interactions. In addition to administration of the sedative drugs, the assisting practitioner should be present to anticipate, detect and manage problems as they arise, including the provision of resuscitation.

### Written record

A written record of procedural findings, particular problems encountered and specimens collected should be made at the completion of the procedure. The report should include all drug doses and the times given. It is important to record an estimate of the dose of topical local anaesthetic delivered.<sup>30</sup>

### Recovery

On completion of the procedure, patients should be observed closely in a designated recovery area that is adequately staffed and equipped. Percutaneous

oxygen saturation, heart and respiratory rate and blood pressure should be monitored. Because topical lignocaine has a duration of airway anaesthesia of approximately 40 min, patients should remain nil orally for at least 1 h or until pharyngeal sensation has been restored.<sup>25</sup> A medical practitioner should be readily available at all times to attend to the patient, particularly if the patient is obtunded or has respiratory depression. Following a transbronchial biopsy a routine chest X-ray is not considered mandatory because any significant pneumothorax will be clinically obvious.<sup>33</sup>

### Discharge

The patient should be discharged only after a period of recovery and observation and then only on the authority of a medical practitioner associated with the procedure. Patients should be discharged in the company of a responsible adult, such as a family member or friend. Both the patient and the escort should be given verbal and written instructions that the patient should not drive, operate machinery, drink alcohol, make important decisions or sign legal documents for 24 h after the procedure. They should be advised that some haemoptysis (particularly if biopsies have been taken), transient fever, nausea and vomiting may occur in the 12 h following bronchoscopy. Significant symptoms, such as dyspnoea, chest pain or large haemoptysis should be reported and medical advice obtained. Medical contact details should be given to both patient and escort.

## INFECTION CONTROL

Infection control in bronchoscopy may be divided into two main issues: first, the transmission of infection from subject to staff and second, ensuring adequate disinfection of equipment. Standard infection control precautions should be taken with all patients, regardless of age, gender, health status or lack of known risk factors.

### Staff

To prevent skin exposure, gloves should be worn for all patient contact and for handling equipment. Masks and eyewear should be worn to protect mucous membranes against splashes and droplets, which may be generated during the procedure. Masks are particularly important where airborne infection (e.g. tuberculosis) may be present, and particulate masks capable of filtering 1 µm particles are recommended. Plastic aprons are recommended to protect

clothing and uniforms from body fluids and should be changed between cases.

Hand washing should be carried out before each patient contact and on removal of gloves. Skin exposed to any body fluid should be washed immediately. Care should be exercised when using sharp instruments. Used hypodermic needles should not be manipulated or resheathed, but disposed in puncture-resistant containers. Staff should be offered a vaccination against hepatitis B and tuberculosis, and regular checks on immune status should be undertaken.

### Instruments

The literature contains a number of reports of contamination of specimens<sup>34,35</sup> and transmission of infection<sup>36,37</sup> as a result of inadequate cleaning of bronchoscopes and accessories. To protect against transmission of microorganisms it is essential that adequate cleaning and disinfection methods are in place and adhered to.<sup>38,39</sup> Cleaning and disinfection should be carried out by trained staff in a dedicated room using well-ventilated automated systems, preferably inside a fume cupboard, to protect staff against unnecessary exposure to toxic fumes. Cleaning instructions provided by the manufacturer of endoscopes, manufacturer of chemical germicides and manufacturer of automated endoscope cleaners should be closely followed. The compatibility between endoscopes and automated cleaning systems should be confirmed, as there have been reports of contamination where these procedures have not been followed (grade C).<sup>40</sup>

Thorough manual cleaning with water and a detergent or proteolytic enzyme cleaner should be undertaken immediately after the procedure so secretions do not dry and harden. All surfaces, internal and external, should be cleaned and thoroughly rinsed to remove all debris and detergent before disinfection. Glutaraldehyde is the most common disinfectant used and automated systems are recommended to minimize staff exposure. Glutaraldehyde is a recognized cause of nausea, headache contact dermatitis, rhinitis and asthma, and adequate measures to protect staff against these problems should be in place.<sup>41,42</sup> Immersion in 2% glutaraldehyde at 20°C for 20 min at the beginning and end of each list, as well as in-between patients, will destroy bacteria and viruses, provided there has been adequate manual cleaning of equipment before immersion (grade C). Immersion times of at least 60 min have been recommended if

there is a risk of HIV, hepatitis C, prion or mycobacterial contamination of the bronchoscope because these organisms are more resistant to glutaraldehyde; however, this has not been demonstrated to be completely effective.<sup>43-45</sup> Preventing the transmission of infective agents has only been shown to occur by meticulous mechanical cleaning of bronchoscopes and accessories by trained staff before immersion in glutaraldehyde. The role of adequate mechanical cleaning cannot be over emphasized. Alternative chemical disinfectants, particularly peracetic acid, have been shown to be effective and safe alternatives to glutaraldehyde (grade C).<sup>46</sup> Use of these agents does not remove the necessity for precleaning of instruments and equipment.<sup>47</sup>

The spongiform encephalopathies cause a specific difficulty in preventing disease transmission. While cases of iatrogenic or occupationally acquired Creutzfeldt-Jakob Disease (CJD) have been reported, this has been following exposure to high-risk tissues.<sup>48,49</sup> No occupationally acquired CJD has occurred from low-risk tissues, such as faeces, saliva or tears. The prion proteins responsible for transmitting the disease are highly resistant to inactivation by usual physical and chemical processes. As a result a conservative approach to endoscopy is recommended, involving:

- Use of alternative diagnostic or therapeutic approaches in patients with known or suspected CJD.
- Referral to a large centre where specific endoscopes are reserved for patients with CJD if endoscopic procedures are unavoidable.
- Discard of all accessories used in patients with known or suspected CJD.

Hospital tap water may be contaminated by a variety of microorganisms, thus the quality of water used in the cleaning process should be examined on a regular basis. Sterile water should be used for all rinsing procedures.<sup>38</sup> The instrument should be rinsed thoroughly after disinfection, and if it is to be reused immediately all rinsing water should be purged from channels and exterior surfaces dried with a lint-free cloth. At the end of each list the external surfaces of the bronchoscope should be wiped and all channels flushed with 70% isopropyl alcohol.

Cleaning and disinfection of ancillary equipment is as important as that of the endoscope. Manual cleaning of accessories is a prerequisite to disinfection. Whenever possible, disposable or autoclavable accessories should be used to reduce staff exposure to disinfectants (grade C).

Regular microbiological surveillance of bronchoscopes, the water supply and automated disinfection machines should be undertaken. Reusable glutaraldehyde systems have the potential for the dilution of the glutaraldehyde with rinsing water, and the concentration should be checked.

## TRAINING AND COMPETENCY

There is no clear evidence from the literature to indicate how many procedures are necessary to acquire or maintain the skills necessary to perform fibre-optic bronchoscopy independently. The time to acquire these skills will vary from person to person. In general, the greater the number carried out under supervision the higher the skill level expected to be achieved. Thus, maximizing the number of procedures carried out during training is to be encouraged. Training should be carried out under the direct supervision of an experienced bronchoscopist. The minimum number of procedures recommended during training is:

- 200 for flexible fibre-optic bronchoscopies.
- 50 for endobronchial biopsies.
- 20 for transbronchial biopsies.

In order for trained bronchoscopists to maintain competency, it is mandatory that they continue to be actively involved in performing flexible fibre-optic bronchoscopy and the associated procedures. Ideally, 50 procedures should be carried out annually to maintain competency, but 12 procedures per year is the minimum standard required to maintain necessary skills. For bronchoscopists involved in teaching trainees, 20 procedures per year should be the minimum standard. However, there is no published evidence of the minimum number required to maintain competency as a bronchoscopist. In addition, it is strongly recommended that a record of all procedures is maintained and that regular audit of outcomes is undertaken.

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