Flexible bronchoscopy

Flexible bronchoscopy is an essential diagnostic and therapeutic procedure in the ICU. The majority of procedures are performed in intubated patients receiving mechanical ventilation.

ICU indications

- Direct visualization of the upper airway in difficult endotracheal intubation.
- Direct endotracheal visualization and guidance during percutaneous tracheostomy.
- Inspection of the distal portion of an endotracheal or tracheostomy tube to assess patency and position.
- Inspection of the distal trachea and proximal bronchial tree for mucosal pathology/extrinsic compression.
- Removal of material obstructing one or more major bronchi.
- Performing sampling of distal airways for microbiological and/or cytological specimens.
- Guiding the placement of an endobronchial blocking/isolation catheter.

Equipment preparation and aftercare

Prior to use, the bronchoscope should be thoroughly cleaned and disinfected. Cross-infection between patients is a serious hazard. If stored, this should be in a dedicated clean environment. The scope should be handled aseptically and transported in an appropriate enclosed container. All the remaining equipment should be clean or sterile single use. Essential equipment:

- Light source
- Camera/videoscope stack (optional)

- Cleaning brush and / or solution for working channel
- A packet of sterile gauze
- A sterile 1 litre jug.
- A 500ml bag of 0.9% sodium chloride
- A 20ml syringe
- Sputum traps
- Dedicated suction
- A bronchoscopy catheter mount

The scope should be checked for clear vision and a functioning suction system immediately prior to use. The outside of the scope should be wiped with saline-soaked gauze. Avoid water-based gel lubricants as these can dry out and become sticky rather that lubricate. In situations where there is problematic sticking of the scope to the inside of an endotracheal or tracheostomy tube, use sterile liquid paraffin.

The bronchoscopist and any assistants should wear full protective clothing including gowns, gloves and face/eye cover. Appropriate and sensible precautions should be made regarding the potential aerosolization of infected material.

At the end of the procedure, the suction channel of the scope should be immediately brushed and / or rinsed. The outside of the scope should be cleaned. The scope should then be sent for full decontamination. Any other reusable equipment should be cleaned and stored appropriately.

Patient preparation

Whenever practical, inform the patient regarding the proposed procedure and gain their consent. Depending upon the indication, likely duration and clinical condition of the patient, an appropriate plan regarding topical anaesthesia, sedation and neuromuscular blockade should be made. At a minimum, continuous ECG and SpO_2

monitoring together with intermittent, automated non-invasive blood pressure should be used. The FiO_2 should be increased to ≥70% (or as high as possible). If ventilated, a pressure control mode is preferable although a strictly pressure-limited volume control mode can be used. Hypoventilation is an inevitable occurrence during the procedure. In patients in whom even transient hypercapnia needs to be avoided, a series of timed, short bronchoscopies can usually be safely performed. In such circumstances, continuous end-tidal capnography is essential. Alternatively, consider using HFV.

Procedure

Before starting, ensure all necessary equipment is available and working, the patient is comfortable and the bronchoscopist is ergonomically positioned. Consider slowly injecting 3–5ml of sterile saline into the endotracheal/tracheostomy tube to lubricate the passage of the scope. At least one assistant must be present to watch the patient, the ventilator and the monitoring, in addition to being able to assist the bronchoscopist. When performing a bronchoscopy via the mouth / through an oral endotracheal tube, it is recommended to insert a bite guard to protect the scope.

First navigate the endotracheal/tracheostomy tube and ascertain whether the tube is encrusted with secretions. If so, this may both inhibit the procedure and present the patient with unwanted additional resistance. It may be possible to clean the tube effectively using the scope; however, electively changing the tube is usually preferable.

Next, consider whether the tube opens centrally within the trachea and is a sufficient distance from the main carina. If this is not so, reposition the tube under bronchoscopic guidance and make note of the optimal position using the visible reference markers on the tube. Always consider whether moving the patient will

adversely affect the position of the distal end of the tube, and leave a detailed description in the patient's notes.

Then go on to examine the distal trachea, in particular, looking for mucosal trauma caused by the distal tip of the tube and blind suction catheter insertion. Continue by inspecting the remainder of the accessible bronchial tree in a logical order. It should be possible to visualize the first 2–5 divisions of each lobar bronchus.

For visible secretions, try to sample/remove without causing trauma to the mucosa and without using saline lavage. If required, collect a specimen for microbiological examination. Difficult to clear secretions can often be removed piecemeal. Large pieces can often be held against the tip of the scope by application of continuous suction. The scope, together with the offending mass, can then be removed *en masse*, by slowly withdrawing the scope whilst maintaining suction. Obstructing aggregations of inspissated secretions, blood clots or mucosal sloughing may require prolonged or multiple procedures. The use of biopsy forceps and cytology brushes may be useful but require skill and patience. Should flexible bronchoscopy fail, consider using a rigid scope. Nebulized hypertonic (3-7%) saline, unfractionated heparin (10 000–25 000IU 4–12 hourly), 4.2% sodium bicarbonate and dornase alfa have all been described as useful adjuncts, but none has been proven to have superior efficacy over the others in ventilated patients. There is also no evidence to suggest a superior efficacy for direct instillation vs nebulization.

For visible mucosal bleeding, haemostasis will usually occur spontaneously. Haemostasis can be augmented by topical vasoconstriction using adrenaline (epinephrine). Gently instil/irrigate with a 1 in 10 000 (0.1mg/ml) solution. Topical antifibrinolytics, such as neat tranexamic acid (100mg/ml) can also be useful.

If the bleeding is distal to the main carina and unstoppable and/or distal to the limit of visualization, temporary isolation and tamponade can be achieved by wedging the tip of the bronchoscope into the origin of the identified bronchus. The efficacy of instilling vasoconstrictors and/or antifibrinolytics is uncertain. The value of prolonged continuous suction is also debatable. If this fails to achieve haemostasis, then a balloon-tipped bronchial isolation catheter can be inserted parallel to the bronchoscope, which can then be used to guide catheter placement. This can be a difficult procedure due to the aerosolization of blood within the airway masking any vision. Be careful not to dislodge the blocking catheter when withdrawing the scope. Consider paralysing the patient and applying a high level of PEEP. If practical, turn the patient bleeding side down. As a further adjunct, connect and instil oxygen through the bronchoscope suction channel at a high flow rate. Definitive treatment for persistent haemorrhage is either selective bronchial angiography and embolisation or surgery.

Specimens

Whenever possible, send undiluted secretions for microbiological investigation. To obtain a specimen from a region of interest beyond visualization, first locate the nearest lobar, segmental or subsegmental division, then gently wedge the tip of the bronchoscope into it. Before any sampling, ensure that the suction channel is clear of any proximal secretions, which might contaminate the specimen. This may require the scope to be fully withdrawn, the channel cleaned with a brush and rinsed with clean saline, and the scope reinserted and positioned. Next, apply the specimen trap as close to the bronchoscope as possible. Slowly instil 20–60ml of 0.9% sterile saline, wait for a few seconds, then apply continuous suction. If the airway completely collapses, ask an assistant gently to turn the strength of the suction down until some fluid is drawn

into the specimen trap. When no further fluid flows, slowly withdraw the scope whilst maintaining continuous suction. Make a note of the volume instilled and the volume of the specimen. Examine the specimen for adequacy, looking for the presence of mucoid or infected airway secretions. It is worth discussing the optimal handling of specimens with the labs receiving them, in particular if qualitative or semi-quantative microscopy are required or specific pathogens are suspected. If a good quality, large volume specimen is obtained, this can often be divided in the laboratory for both microbiological and cytological examination if required. This prevents repeated saline lavage and scope trauma, both of which are injurious

Blind brush specimens may be useful in both cytological and microbiological testing. Brush and biopsy specimens of visible lesions can also be taken. In patients receiving positive pressure ventilation, transbronchial biopsy and transbronchial needle aspiration specimens carry a significant risk of pneumothorax and pneumomediastinum and are best avoided.

Protected lavage and brush catheters are available, but are of questionable value. There is conflicting evidence regarding the value of bronchoscopic specimens over and above those obtained by blind endotracheal suctioning, most especially in the diagnosis of ventilator-associated pneumonia.

Complications

The following complications can occur and should be prepared for:

- Displacement of the endotracheal/tracheostomy tube out of the trachea.
- Obstruction of the endotracheal/tracheostomy tube.
- Obstruction of the trachea or major bronchus
- Hypoxia/derecruitment/increasing ventilatory requirements post-procedure
- Hypercapnia/underventilation

- Coughing
- Bronchospasm
- Haemorrhage
- Pneumothorax
- Pneumomediastinum
- Sepsis secondary to translocation (bacteraemia) (see Yigla *et al*., 1999)
- Hypo- or hypertension/cardiac arrhythmias

Further reading

Du Rand IA, Blaikley J, Booton R, et al. British Thoracic Society guideline for diagnostic flexible bronchoscopy in adults: accredited by NICE. *Thorax* 2013; 68 Suppl 1: i1-i44

CME question

A 67 year old patient with moderated COPD is admitted to your unit with an acute infective exacerbation. Initial chest x-ray shows dense collapse consolidation of the right upper lobe with mediastinal shift to the right. The patient is drowsy but easily rousable and co-operative; haemodynamically stable; has a respiratory rate of 30 breaths per minute and an arterial blood gas of pH 7.23, $PaCO_2$ 8.2kPa and PaO_2 7.4kPa (on face mask oxygen with an FiO_2 0.28).

With regard to performing a flexible bronchoscopy in this case:

a. There is a clear indication

b. The patient should be intubated for the procedure

c. Blind distal right upper lobe brushings should be obtained

d. Consent should be obtained from the patient

e. The FiO_2 should be increased to ≥ 0.70

Answer: FFFTT

a. The clinical scenario might be consistent with proximal obstruction to the right upper lobe or merely lobar pneumonia. A flexible bronchoscopy should clarify the diagnosis and in addition, should establish the cause of any proximal obstruction (e.g. sputum plug, endobronchial lesion or extrinsic compression). It may facilitate definitive diagnostic sampling and relief of the obstruction. However, if the most likely diagnosis (on the basis of history, examination and investigations) is lobar pneumonia then in the short term, the risk-benefit equation would favor postponing the procedure until the patient's condition has improved but the clinical and radiological features remain unchanged.

b. The procedure can be safely performed using high flow oxygen therapy, via mask ventilation or via an endotracheal tube. The optimal choice will depend upon patient factors, available equipment and clinical expertise.

c. Blind distal brushings are unlikely to improve the diagnostic yield (beyond a well performed bronchoalveolar lavage) and significant increase the risk of causing injury to the right upper lobe with a consequent pneumothorax.

d. Whenever feasible, consent should be obtained from the patient.

e. The FiO_2 should be increased to mitigate against the acute (+/- chronic) hypoxemia, which may deteriorate further during the procedure. The advantage of maintaining some nitrogen in the gas mixture is that it may split open ventilation units with long time constants thus preventing absorption atelectasis. Active titration of FiO_2 during the procedure to maintain an SpO_2 of 88-95% is advisable.