Update in
Anaesthesia

Using a facemask during anaesthesia

Nicholas Boyd* and Anna Negus
*Correspondence email: nicholasboyd@doctors.org.uk

Summary

Effective and safe use of the anaesthetic facemask is a core skill of the anaesthetist. It is used less for maintenance of anaesthesia in well-resourced countries, having been largely superseded by the laryngeal mask airway (LMA). In resource poor settings drug and equipment availability have limited use of the LMA and so the choice for airway management in general anaesthesia remains facemask or endotracheal tube. This article outlines the roles of facemasks in anaesthesia and provides advice on overcoming pitfalls in their everyday use.

INTRODUCTION

The facemask has been used since the origins of anaesthesia and it remains an essential and versatile piece of equipment. It offers a simple, non-invasive method for delivering both oxygen and anaesthetic gases and vapours to the patient and it is widely used for both induction and maintenance of general anaesthesia. It is an effective way to ventilate the unconscious patient and therefore also has a major role during resuscitation. Every anaesthetist should be confident in using this piece of equipment.[1]

This article addresses the practical aspects of its use.

Table 1. *Uses of the facemask*

- Pre-oxygenation prior to induction of anaesthesia
- Inhalational induction of anaesthesia
- Bag-mask ventilation (BMV) prior to intubation
- Maintenance of anaesthesia
- BMV during resuscitation
- Non-invasive ventilation for respiratory failure

TYPES OF FACEMASK

The 'facemask' is a general term that includes many different designs, but essentially there are two main types.

The first is an 'open' type, such as the Hudson mask, which is commonly used for delivering supplemental oxygen (Figure 1). It does not require a tight seal against the patient's face and there are often additional holes in the mask to allow expired gases to escape. It cannot therefore be used to ventilate a patient or administer volatile agents safely. In the theatre environment, this type of mask can be used to provide oxygen to a spontaneously ventilating patient during intravenous anaesthesia or sedation and is widely used in recovery areas.

'Closed' facemasks are designed to provide a complete seal around the patient's mouth and nose. This feature allows safe delivery of volatile agents and, if required, for the patient to be ventilated with positive pressure. This type of mask is commonly used during resuscitation and general anaesthesia. Many different designs have been described, all comprising a rim, a body and a connector (Figure 2). The rim is soft and air-filled, allowing a good seal to be formed against the patient's face. Some models have a filling valve to enable the degree of pressure in the rim to be regulated (Figure 2). The body is firmer and may be made of plastic, neoprene or rubber. In some cases a wire stiffener is incorporated to allow the mask to be moulded around the patient's face. The connector is hard plastic or metal and should be of a standard 22mm inner diameter (ID) to allow attachment of connector hosing or a self-inflating bag.

Figure 1. *A 'Hudson' oxygen mask*

Many facemasks are now made of a transparent plastic which have the benefit of allowing visualisation of skin colour, fogging and signs of regurgitation.[2] In addition, many facemasks also have a plastic or metal ring with hooks to allow the attachment of a harness (Figure 2, label D). In many parts of the world use of a facemask with harness has now been superseded by the laryngeal mask airway.

The internal volume of the mask is part of the apparatus dead space. In the adult, this is relatively insignificant but in the neonate it could constitute 30% of their tidal volume.[3] Therefore masks have been developed to minimise this dead space for paediatric use and various designs are in use today (Figure 3).

Nicholas Boyd
Specialist Registrar in Anaesthesia
Derriford Hospital
Plymouth
Devon
UK

Anna Negus
Anaesthetic Fellow
Starship Hospital
Grafton
Auckland
New Zealand

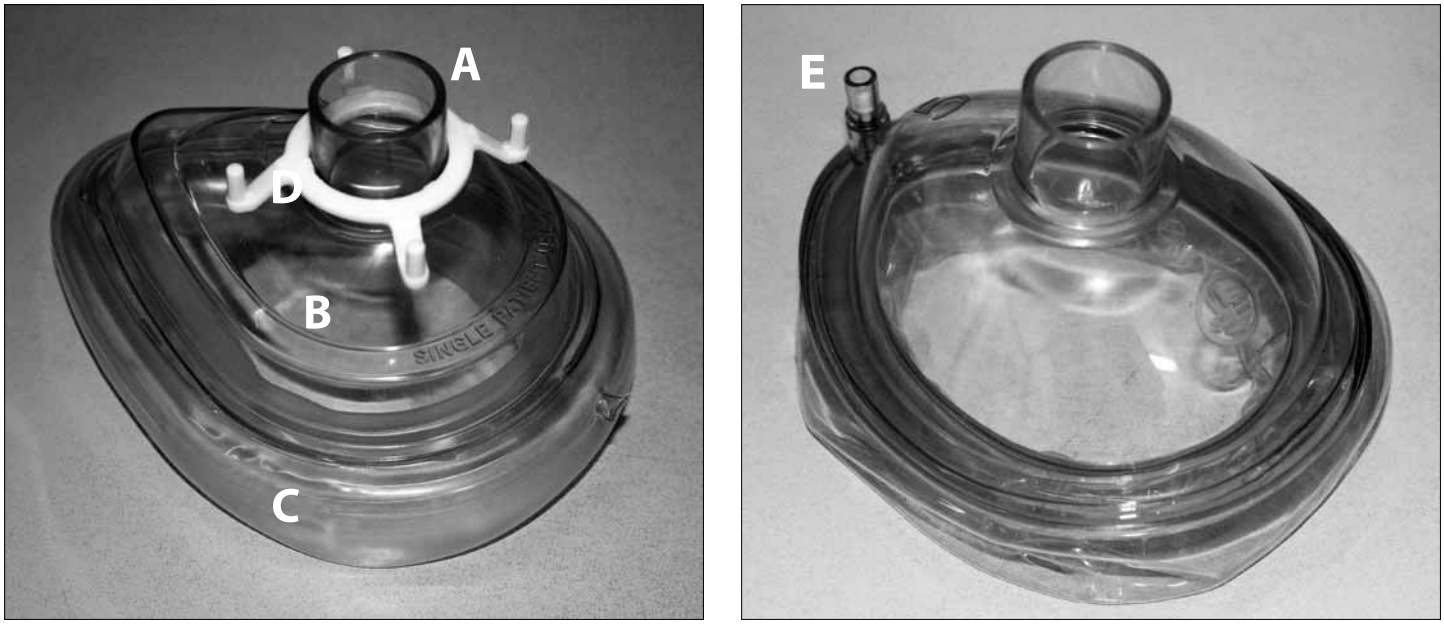

Figure 2. *The parts of an anaesthetic facemask; A - the connector; B - the body; C - the rim; D - hooks for attachment of harness; E - valve for adjusting inflation of rim*

Figure 3. *Some examples of paediatric facemasks*

USES OF THE FACEMASK

The main areas of use for the facemask are listed in Table 1. In addition to holding a facemask correctly for a spontaneously breathing patient, effective bag-mask ventilation (BMV) is an essential skill for the anaesthetist. It is interesting that much attention in airway teaching focuses on tracheal intubation, particularly for patients who are difficult to intubate. However, the severe adverse outcomes that can occur are not due to the inability to place an endotracheal tube but result from a failure to adequately oxygenate the patient. Many guidelines are available for managing these scenarios and central to all the algorithms is adequate oxygenation rather than repeated attempts at intubation.[4] Facemask ventilation remains central to achieving this.

TECHNIQUE FOR USING A FACEMASK

The aim in using an anaesthetic facemask is to ensure a complete seal between the mask and the patient's face whilst exerting the minimum of pressure that may cause soft tissue damage.[1]

First, it is important to choose the correct size for your patient. It should sit over the bridge of the patient's nose with the upper border aligned with the pupils. The sides should seal just lateral to the nasolabial folds with the bottom of the face mask sitting between the lower lip and chin. In the awake patient the mask is held in this position either by hand or by attaching a harness behind the patient's head. Standard sizes are available for adults - a size 3 or 4 will fit most females and size 4 or 5 suits the majority of males.

When the patient is unconscious the airway must be held open whilst maintaining this seal. It is crucial to ensure the airway is patent since gases applied under positive pressure may otherwise insufflate the stomach and increase the risk of aspiration. The most effective method of opening the airway in this setting is to employ a *jaw thrust* technique. This can be achieved by using either a one-handed or two-handed technique.

Jaw thrust

One-handed technique

- Place correct sized mask over the nose and mouth.

- Use your **non-dominant hand** to position the facemask, holding the body of the mask between your thumb and index finger.
- Use your remaining 3 fingers to support the jaw, with your little finger hooked behind the angle of the mandible. Be careful not to place pressure on sub-mandibular soft tissues as this may occlude the airway, especially in paediatric patients
- Lift the mandible **upwards,** towards and into the mask to create an air-tight seal.
- Slight **head extension** may improve airway patency.
- Ventilate the patient with your **dominant hand** by squeezing the bag or using bellows.
- Continually assess the adequacy of the technique by observing bilateral chest movement, listening for air leaks and assessing for signs of inadequate facemask ventilation (Table 2)

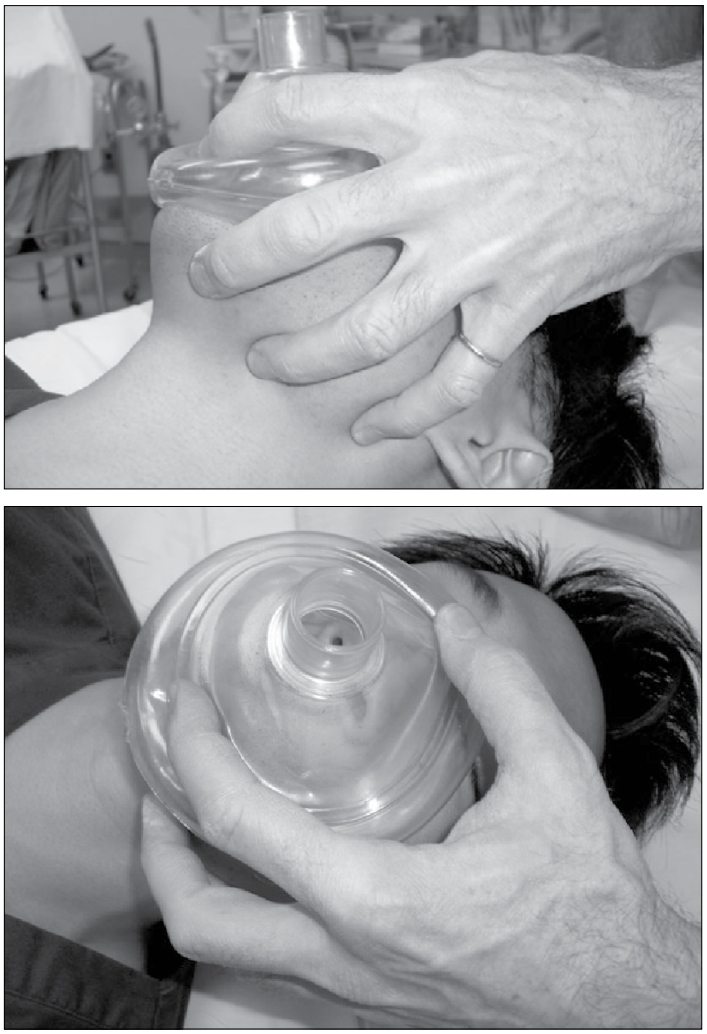

Figure 4. *A one-handed technique for applying jaw thrust whilst holding a face mask*

It is advisable that you can perform this task as effectively with your hands reversed since there may be theatres or anaesthesia rooms in your institution where the room set up is opposite to that with which you are familiar.

The main benefit of using a one-handed technique method is that it enables one person to create an air-tight seal with the facemask, leaving the other hand free to ventilate the patient. However, even for the experienced anaesthetist it is not always possible to obtain a good seal while keeping the airway open. In addition, it is tiring for one person to maintain this hand position for any length of time and it can be particularly difficult for people with small hands to reach behind the angle of the jaw. A two-handed technique should therefore be considered early and must not be seen as a sign of failure.

Table 2. *Signs of inadequate facemask ventilation*

- Poor chest expansion.
- Absent or quiet breath sounds.
- Audible gas leak or inability to generate positive pressure with bag.
- Visible gastric insufflation or audible insufflation with stethoscope.
- Absent or poor end-tidal CO_2 trace (if available).
- Patient cyanosis or, if available, low oxygen saturation (<92%).
- Haemodynamic consequences of hypoxaemia or hypercarbia (tachycardia, hyper- or hypotension). **Note that these are late signs.**

Two-handed technique

As with the one-handed technique, the aim is to ensure a complete seal of the mask to the patient's face and maintain airway patency. There are two main approaches for this technique (Figure 5). The first uses a similar approach to the one-handed technique described above, with the additional hand adopting an identical position on the other side of the mask and face (Figure 5a). Alternatively, the mask can be supported with the thumbs while the index and middle fingers hook behind the angle of the jaw (Figure 5b). Whether a one- or two-handed technique is used, it is important to ensure the airway is opened by lifting the mandible towards the mask, rather than applying downwards pressure onto the mask.

DIFFICULT FACEMASK VENTILATION

Facemask ventilation is not always easy. The overall incidence of difficult facemask ventilation is approximately 5% and the patient factors associated with this are shown in Table 3. It is important to look for these factors at preoperative assessment.

Difficult or inadequate ventilation must be identified early. Signs include reduced chest movement, significant air leak, cyanosis, desaturation or haemodynamic deterioration (Table 2). It is important that the anaesthetist recognises this early and has a clear plan to improve the situation. Common problems and solutions are listed in Table 4 and a few are discussed below in more detail.

Use of an oropharygeal (e.g. Guedel) airway can often significantly improve airway patency and many anaesthetists advocate its use routinely for facemask ventilation in unconscious patients. A nasopharyngeal airway can also be used, even in awake patients

where an oropharyngeal airway would not tolerated. The use of these supraglottic airway adjuncts reduces the incidence of difficult BMV to less that 0.5% and therefore should be considered early whenever there is concern about facemask ventilation.[3]

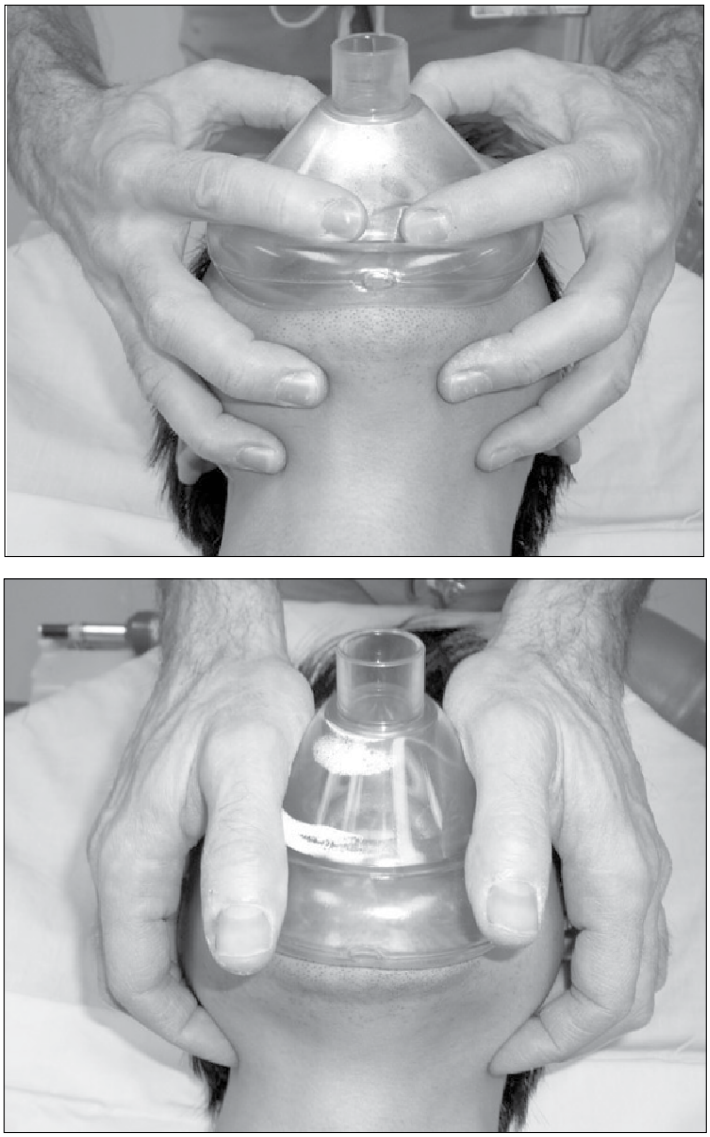

Figure 5. *Two-handed techniques for applying jaw thrust whilst holding a facemask*

Table 3. *Patient factors associated with difficult facemask ventilation*[5]

• Presence of facial hair
• Lack of teeth (edentulous)
• Patients with sunken cheeks
• Obesity (BMI >25)
• History of obstructive sleep apnoea
• Age >55yrs
• History and signs of upper airway obstruction

Older patients tend to have less supportive soft tissues due to a loss of collagen with age and therefore creating an adequate seal around the mask can be difficult. If a one-handed technique is being used, this leak can be particularly marked on contra-lateral cheek. This can be improved by an assistant lifting the skin and soft tissue of this cheek towards the mask rim to create a seal, although opting for a two-handed technique may be more effective. In addition, it is common for this age group to have dentures or a complete absence of teeth (edentulous). If dentures are secure, it is often helpful to leave these in place for face mask ventilation as this helps to support the mouth and prevent the cheeks becoming sunken. However, loose dentures should be removed as they can potentially shift and occlude the airway. For edentulous patients, a recent study has advocated placing the lower pole of the facemask over the lower lip itself, thus reducing the air leak at the cheek.[6]

The presence of facial hair can make it very difficult to create a seal even if there are no other airway problems. A number of techniques have been described to improve the seal. These include applying aqueous gel to the beard underneath the rim of the face mark or using a large occlusive air-tight dressing over the beard with a hole cut for the mouth. However, it may be worth considering a method that would avoid facemask ventilation such as using a laryngeal mask airway or an endotracheal tube.

Finally, if there are preoperative signs and symptoms of upper airway obstruction, face mask ventilation is likely to be difficult and may be impossible. Approach these cases with extreme caution and make a careful anaesthetic plan. A gas induction to maintain spontaneous ventilation before ventilating may be indicated but in severe cases, consider avoiding facemask ventilation altogether by opting for a awake fibreoptic intubation or tracheostomy.

FACEMASK VENTILATION DURING GENERAL ANAESTHESIA

Using a facemask for maintenance of general anaesthesia is common, particularly for short operations or where alternative airway equipment is less available. Many of the techniques described above are relevant in this setting but there are a few additional points to consider.

- Allowing the patient to breath spontaneously has many advantages, especially for longer procedures. Even with a good technique there is likely to be gastric insufflation during positive pressure ventilation which increases the risk of gastric reflux, particularly with pressures over 20cmH_20. The facemask will not protect the airway from aspiration if this occurs. In addition, it reduces the potential for the partial pressure of carbon dioxide ($PaCO_2$) to rise significantly.

- Maintaining the mask seal and keeping the airway open for prolonged periods is tiring. To address this, the facemask can be kept in place by using a harness and an oropharyngeal or nasopharyngeal airway is helpful to maintain airway patency.

- When using breathing circuits that use high pressure gases (such as the Boyle's machine or circle systems) the Adjustable Pressure Limiting valve allows a simple conversion from spontaneous

to positive pressure ventilation. Ensuring the valve is open during spontaneous ventilation will reduce gastric insufflation.

CONCLUSION

The facemask is an essential piece of equipment for anaesthesia and confidence in bag-mask ventilation is a core skill for every anaesthetist. It is important to identify patients who may be difficult to ventilate with a face mask, to recognise early when ventilation is inadequate and to know what steps to take to improve this.

A facemask can be used for maintenance of general anaesthesia and spontaneous ventilation is desirable in this setting. However, it is important to understand the limitations of the technique and in particular that prolonged positive pressure ventilation can lead to gastric insufflation. In addition, the airway remains unprotected from tracheal aspiration. However, the facemask remains a versatile aid to airway management and should be present during every anaesthetic. When used correctly, it can provide an effective and rapid method for patient ventilation and oxygenation.

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Table 4. *Problems and suggested solutions for inadequate facemask ventilation*

Problem	Solutions
Poor mask seal *Indicated by audible leak, poor chest expansion or difficulty generating positive pressure in bag*	• Use two-handed technique and ensure good jaw thrust. • Ask assistant to support soft tissues of cheek around rim of mask. • Consider using an oropharyngeal or nasopharyngeal airway to improve airway patency. • Ensure no leaks in equipment or circuit. • See below for advice on special cases. • If unsuccessful, consider using laryngeal mask airway early.
Partial or complete airway obstruction *Indicated by high airway pressures, poor chest movement, cyanosis or low oxygen saturations*	• Optimize patient head position with slight head extension. • Use two-handed technique and ensure good jaw thrust. • Use an oropharyngeal or nasopharyngeal airway. • Consider possibility of laryngospasm – often giving additional intravenous anaesthetic agent (e.g. propofol) can improve this. • Ensure no occlusion in equipment or circuit – consider reverting to self-inflating bag and mask. • If unsuccessful, consider using laryngeal mask airway early.
SPECIAL CASES	
Presence of facial hair	• Use of aqueous gel or occlusive dressing. • Consider using larygneal mask airway or endotracheal tube early.
Patients with dentures, edentulous patients or sunken cheeks	• Consider leaving dentures in place if secure. • Use oropharyngeal airway and/or nasopharyngeal airway. • Consider placing lower pole of face mask over lower lip itself in edentulous patients. • Ask assistant to support soft tissue of cheeks against mask.
Obese patients	• Pre-oxygenation is essential (with continuous positive pressure if possible) in head up position. • Recognise that facemask ventilation and maintaining adequate oxygenation can be difficult. • When facemask ventilating, keep patient 5-10° head up position, with anaesthetist standing on a platform or step if necessary to achieve this. • Use two-handed technique with oropharyngeal airway. • Endotracheal intubation is often indicated for surgery.

Figure 1. *Anaesthetic Novice Decision Support Algorithm (ANDSA)*