

This first national Guideline summarizes the knowledge that is available now and provides a framework for future improvement. Anaesthesia and surgery departments should ensure that the pocket version features in every induction of new junior staff. Clinicians at the local level may also decide to use the NICE Guideline for wider purposes than supporting individual doctors' preoperative testing decisions. The Guideline can form the basis of local guidance on preoperative testing, which may need updating, green boxes representing minimum testing and red boxes representing over-testing. Clinicians may wish to clarify the local level view on amber tests. The Guideline could be used to develop audits aiming at identifying pockets of residual extreme over- or under-testing, at local or national level. Other guidance from the NHS Modernisation Agency¹⁴ on how the preoperative process should be organized and how testing fits in, is at www.modern.nhs.uk/theatreprogramme.

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Editorial II

Who is at increased risk of pulmonary aspiration?

Since the danger of pulmonary aspiration was recognized in the 1930s in obstetric anaesthesia,¹ and Mendelson established its aetiology in 1946,² efforts have been made to reduce its incidence: fasting before anaesthesia, prophylactic medication (such as antacids or H₂ antagonists), rapid-sequence induction of anaesthesia with application of cricoid pressure, and the use of a cuffed tracheal tube.

The laryngeal mask airway has gained a firm place in anaesthetic practice since it was made available to clinicians

in 1988. The frequency of tracheal intubation has been decreasing, because of routine use of the laryngeal mask airway and several other supraglottic airways (such as the Laryngeal Tube or Airway Management Device). Nevertheless, there has been ongoing concern that avoidance of the use of a cuffed tracheal tube might increase the incidence of pulmonary aspiration.³ Some consider that spontaneous breathing should be maintained when the laryngeal mask is used, because intermittent positive pressure ventilation may

cause aspiration of regurgitated material, by insufflating gas into the stomach.³ Despite this concern, the estimated incidence of pulmonary aspiration during use of the laryngeal mask is 0.02%,⁴ which is no greater than the incidence of aspiration which occurs in anaesthetized patients as a whole (0.01–0.06%).^{5 6}

In this issue, Professor Brimacombe and his colleagues⁷ report three cases of pulmonary aspiration during use of the laryngeal mask airway: one died and another had brain damage. They state that this is the first report of a death from aspiration during use of the laryngeal mask. It could be interpreted from this report that pulmonary aspiration is not a great concern, considering that the reported incidence is low and that there have been no other reports of death since the introduction of the laryngeal mask into clinical practice more than 15 yr ago. But is this a reasonable interpretation? The answer is most likely to be 'no'. What we should not overlook is that no reports of death does not mean that there have been no deaths. It is conceivable that anaesthetists may be reluctant to report such cases, because they fear they may be blamed that inappropriate use of the laryngeal mask airway caused death. Legal authorities may also forbid such a report until the case is closed. In addition, the editors of medical journals may not be keen to publish the report, judging that the case was malpractice and nothing can be learnt from it.

Brimacombe and colleagues estimated that total deaths from aspiration during use of the laryngeal mask airway would be around 1500 worldwide so far (that is roughly 100 deaths per year), given that the device has been used 150 million times, the incidence of pulmonary aspiration is 0.02%, and mortality occurs in 5% of these cases.⁷ Sidaras and Hunter³ also estimated in an earlier editorial that there would be about 16 deaths each year in the UK. These figures might be overestimates, because the mortality rate of 5% was derived from all anaesthetized patients including those with full stomachs,⁶ in whom the laryngeal mask is unlikely to be used. Nevertheless, there may have been a considerable number of unreported deaths. If so, should we not be doing something about it?

Predisposing factors

How can we reduce the incidence of pulmonary aspiration during anaesthesia? To know this, we first have to determine which patients are likely to aspirate. Brimacombe and colleagues⁷ reviewed reports of pulmonary aspiration during use of the laryngeal mask airway. Of 20 patients reported, 19 patients were considered to be at increased risk of aspiration, and only one patient was at a low risk. There have also been reports of aspiration during use of the intubating laryngeal mask or the ProSeal airway.^{7–9} It is apparent from these reports that the incidence of aspiration can be reduced by adhering to the guidelines that laryngeal mask airways (classic, intubating, or ProSeal) and other supraglottic airways should not be used in anaesthetized patients who are at

increased risk of pulmonary aspiration. Which patients should be regarded as at increased risk? There are four major factors that will theoretically predispose patients to risk: patient factors, operation factors, anaesthesia factors, and device factors.

Patient factors

Patients will be at risk if the stomach is not empty, such as those undergoing emergency surgery. Several diseases and symptoms, such as diabetes mellitus, increased intracranial pressure, hiatus hernia, gastrointestinal obstruction, recurrent regurgitation, and dyspeptic symptoms are known to delay gastric emptying, and these patients may be at risk. Gastric emptying may also be delayed in patients who have previously undergone upper gastrointestinal surgery, in those recently injured or receiving opioids, and in women in labour. Morbidly obese patients may be at risk, because the intra-abdominal pressure is higher and the incidence of hiatus hernia is greater than in non-obese patients.^{10 11}

Even if the patient is fasted, the stomach is often not totally empty. On average about 25 ml of acidic gastric juice remains in the stomach, but this can be as much as 200 ml.¹² Traditionally, the patient has been said to be at risk when the volume of gastric acid is greater than 25 ml (or 0.4 ml kg⁻¹) and the pH less than 2.5,¹³ but if these cut-off values are applied, roughly 50% of fasted patients can be regarded as at increased risk of aspiration. Even if the stomach is empty, vomitus may come from the small intestine.

Operation factors

Even if patients have no predisposing factors, they may become at risk of pulmonary aspiration from a surgical procedure. Patients who are undergoing upper abdominal surgery should be considered at risk, as surgical manipulation may push gastric contents back up to the mouth. Lithotomy or the head-down position may encourage residual gastric contents to regurgitate. Patients who are undergoing laparoscopic surgery are at a higher risk of aspiration, because of the increase in intra-abdominal pressure and the head-down position. Patients undergoing laparoscopic cholecystectomy will be at an even higher risk, because secretion of gastric acid is increased and because these patients may regurgitate or vomit bile-stained fluid.¹⁴ In fact, there have been several reports of pulmonary aspiration in patients undergoing laparoscopic cholecystectomy.⁷

Anaesthesia factors

If general anaesthesia is not sufficiently deep, airway reflexes (such as coughing, hiccoughs, or laryngospasm), or gastrointestinal motor responses (such as gagging or recurrent swallowing) may be evoked. These reflexes may be associated with distension of the stomach, regurgitation and vomiting, increasing the risk of pulmonary aspiration.^{6 15} Anaesthesia

seems to be maintained at a lighter depth during use of a supraglottic airway than during tracheal intubation, because the presence of a supraglottic airway itself does not usually induce such reflexes.¹⁶ However, light anaesthesia may not prevent responses to surgical stimuli or to changing the patient's position.

During intermittent positive pressure ventilation, anaesthetic gas may be insufflated into the stomach and may increase the risk of regurgitation, particularly when high pulmonary inflation pressures are required or when the laryngeal mask is not inserted sufficiently deep into the oesophageal inlet. The incidence of regurgitation may be increased as surgery gets longer. One study showed that regurgitation of carmine red, which had been swallowed 1 h before induction of anaesthesia was higher in patients who underwent surgery for longer than 2 h.¹⁷ When ventilation is controlled through the laryngeal mask, the degree of gastric distension and thus the risk of aspiration will, in theory, increase over time.

During emergence from anaesthesia, both gastrointestinal motor and airway reflexes return. It is not logical to remove an airway before the patient spontaneously regains consciousness, because its removal may evoke gagging and pulmonary aspiration.⁶

Device factors

The presence of a laryngeal mask airway (and perhaps any other supraglottic airway which is inserted in the oesophageal inlet) decreases the lower oesophageal sphincter tone, and thus may, in theory, increase the risk of regurgitation and aspiration.¹⁸ As the incidence of gastric insufflation is greater for the classic laryngeal mask than other supraglottic airways or a tracheal tube, the patient receiving a classic laryngeal mask is at a higher risk of regurgitation and aspiration. If the tip of a supraglottic airway is incorrectly placed in the laryngeal inlet, airway reflexes with aspiration will be more likely to occur.

Variability in the material aspirated

Another important factor we should take into consideration is the nature and amount of material aspirated. Aspiration of gastric acid damages lung tissue, and the extent of the damage increases proportionally as acidity and volume increase. Bile damages the lungs more severely than gastric acid.^{14 19} Greater precaution is required if there is a risk of aspiration of bile. Aspiration of food particles may obstruct the airway and severely damage lung tissue, and is associated with a higher incidence of mortality compared with aspiration of gastric acid.

Do we really know who are at risk?

It seems simple to decide whether or not a supraglottic airway is indicated, by weighing its advantages over tracheal

intubation against the risk of pulmonary aspiration. But in reality, we may often face a difficult decision, mainly because there are so many uncertainties in estimating the risk of aspiration.

We often do not know whether the predisposing factors described above really do increase the incidence of aspiration. Should all obese patients, all patients in the lithotomy position, or all those undergoing laparoscopic surgery (particularly gynaecological surgery) be regarded as at high risk? How long can the airway be safely managed without increasing the risk of aspiration with a supraglottic airway? Is the incidence of aspiration truly higher during controlled ventilation through the laryngeal mask than during spontaneous breathing through it? There have been several reports of the use of the laryngeal mask and controlled ventilation without aspiration during laparoscopic cholecystectomy,^{20 21} and during operations lasting several hours,²² but the number of patients reported so far is too small to conclude that the incidence of pulmonary aspiration does not increase in these circumstances.

We do not know how high the risk of aspiration is for fasted patients. The traditional cut-off value of residual gastric volume greater than 25 ml and pH less than 2.5 is not based on evidence and is unreasonable. Determining more accurate cut-off values may now be more clinically relevant, because the laryngeal mask may encourage regurgitation by decreasing the lower oesophageal sphincter tone. The reported incidence of regurgitation during use of the laryngeal mask in patients without predisposing factors varies considerably from 0 to 80% (into the oesophagus), and from 0 to 28% (into the oropharynx).²³ We know almost nothing about the reasons for these marked differences in the incidence between studies, and thus we know little about how to reduce it. Neither do we know whether the ProSeal laryngeal mask, which in theory reduces pulmonary aspiration, truly reduces the incidence and, if any, the degree of aspiration with this device.

We do not even know the incidence of pulmonary aspiration during tracheal intubation in patients without predisposing factors. It is therefore impossible to estimate whether the incidence of aspiration during use of the laryngeal mask is as low as the incidence during tracheal intubation in patients without predisposing factors.

What we should do?

In view of the uncertainties about the risk of pulmonary aspiration, it is inevitable that there are disagreements among anaesthetists on the use of supraglottic airways. If the patient aspirated in a circumstance, which some anaesthetists believe was a high risk for aspiration, there is a danger of the case being regarded as malpractice. In this era of evidence-based medicine, the primary importance is to keep carrying out reliable research to reduce these uncertainties.

Vomiting or laryngospasm will not occur when the patient is adequately anaesthetized, and thus aspiration after vomiting or with laryngospasm is no fault of the laryngeal mask, but rather of the anaesthetists who use it.²⁴ In the past, these complications were less likely to occur, because neuromuscular blocking agents were frequently given and the trachea intubated routinely. Nowadays, neuromuscular blocking agents are given less frequently and the trachea is not intubated routinely. We should therefore always be vigilant to adjust the depth of anaesthesia so that it is sufficiently deep to prevent airway or gastrointestinal motor reflexes.

Brimacombe and colleagues' report⁷ indicates that pulmonary aspiration can occur if we have failed to detect predisposing factors at a preoperative visit, and we use a supraglottic airway. Certainly, more systematic preoperative checking and more careful selection of patients are necessary before a supraglottic airway is used in preference to a tracheal tube.²⁴ We also should not forget that, even if we avoid a supraglottic airway and intubate the trachea with a cuffed tube in patients with predisposing factors, aspiration can occur:¹⁷ a cuffed tracheal tube may not effectively prevent leakage of fluid into the lower airway. In fact, the incidence of pulmonary aspiration of gastric contents can be high in critically ill patients who require mechanical ventilation.²⁵

Pulmonary aspiration is the key factor that will determine the future of supraglottic airways, as the death toll from aspiration will continue to increase. We are standing at the test of time: it is still not too late to make further efforts to reduce the risk of pulmonary aspiration.

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