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JA SYMPOSIUM

Strategies for difficult airway management—the current state is not ideal

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Any problems with current airway management?

Failure to secure a clear airway can be fatal. Historically, a report (in 1990) of US closed claim analysis related to anesthesia practice during 1975–1984 indicated that adverse outcomes involving the respiratory system had comprised the single largest class of injury, and that the incidence of death or permanent brain damage associated with airway management was strikingly much higher (85 %) than the incidence associated with cardiovascular management (30 %) [1].

Since then, several major efforts have been made to reduce complications associated with airway management [2]. Routine use of a capnograph and a pulse oximeter has certainly reduced the incidence of unrecognized esophageal intubation, disconnection of the breathing system, or kinking of a tracheal tube. Improvement of tracheal tube design and development of new airway devices (e.g. videolaryngoscopes) have reduced the incidence of difficult tracheal intubation [3, 4]. Several major guidelines are now available [5, 6] to solve the "cannot intubate, cannot ventilate" scenario. Because of these efforts, the incidence of serious complications is likely to have decreased [7, 8]. Therefore, one may believe that strategies for airway management have already been established, and we do not need to discuss this further.

But, this may not be so. Please see the following case, reported elsewhere [9].

An obese pregnant woman with placenta previa and preeclampsia required emergency Cesarean section because of massive bleeding after lunch. Awake tracheal intubation was attempted, but the patient refused to open her mouth. General anesthesia was induced as a rapid sequence, and tracheal intubation was accomplished with difficulty. Cesarean section started, but soon after this, inadvertent esophageal intubation was found. The tube was taken out and mask ventilation was attempted, but was difficult. Nevertheless, the baby was successfully taken out and the mother started to breathe. To continue the operation a laryngeal mask airway was inserted. The mother vomited, aspirated, and died.

When we see this case, we should admit that we are not sure what should have been done to this case. In fact even now, complications associated with airway management are still the largest cause of death or permanent brain damage. These indicate that current strategies for airway management are not ideal and further improvements are required.

Current state of airway management

To reappraise current strategies for airway management, it is necessary to understand the incidence, consequences,

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nature, and pattern of serious airway complications during anesthesia. Until recently, these had not been clear, because most reports were of analysis of litigation and retrospective series.

In 2011, a series of large prospective studies was reported on this topic [10, 11]. In these reports, the 4th National Audit Project of the Royal College of Anaesthetists (NAP4) and the Difficult Airway Society examined *prospectively* the occurrence of serious airway complications (resulting in death, brain damage, surgical airway, or unexpected admission to the intensive care unit (ICU)) during anesthesia, in the ICU and emergency departments of *all* National Health Service (NHS) hospitals in the UK, over a one-year period from 2008 to 2009. I recommend you read the full report (more than 200 pages), obtainable at the Royal College of Anaesthetists website (http://www.rcoa.ac.uk/index.asp?PageID=1089), which contains several typical cases and recommendations.

In the one-year period, 133 serious airway complications occurred during anesthesia, with an estimated incidence of one serious airway complication per 22,000 cases (and could be as high as 1 in 5,000 cases).

The commonest factor associated with serious airway complications was difficulty with tracheal intubation, although it was "only" a small cause (13 %) of death or brain damage. The next commonest factor associated with serious airway complications involved tracheal extubation or removal of a supraglottic airway.

Pulmonary aspiration was the commonest cause of death or brain damage, and it occurred during use of a supraglottic airway as frequently as, or more frequently than, during use of a tracheal tube.

Studies have also identified several major trends in problems of current airway management. First, facemask ventilation can be difficult as frequently as tracheal intubation is [12, 13]. Second, serious complications may occur during use of a supraglottic airway in 5–6 % of cases [14, 15]. If such a serious complications occur in 1 of 20 patients, we cannot regard our clinical practice in use of a supraglottic airway as optimum. Third, the incidence of airway complications during emergence from anesthesia and during the postoperative period is higher than the incidence during induction of and during maintenance of anesthesia [12].

What are problems with the current strategies?

To prevent complications associated with airway management during anesthesia, we need to establish the following three steps.

1. Prediction of complications associated with airway management.
2. Appropriate preoperative planning of airway management.
3. Strategies for preventing and solving airway complications.

Prediction of complications associated with airway management

There are several useful methods for prediction of difficult tracheal intubation. These include the view of the oropharynx ("Mallampati score"), the thyromental distance, and the degree of head and neck mobility.

What is important is that failed tracheal intubation itself does not kill the patient, but failed oxygenation or pulmonary aspiration does. Nevertheless, compared with methods for prediction of difficult tracheal intubation, methods for prediction of difficult mask ventilation are relatively lacking. In addition, there are many uncertainties in estimating the risk of aspiration. For example, the traditional cut-off value of residual gastric volume greater than 25 ml and pH less than 2.5 is not evidence-based, but if this cut-off value is applied, as many as 50 % of fasted patients can be regarded as at increased risk of aspiration [16].

Difficult tracheal intubation is frequently associated with difficult ventilation and pulmonary aspiration [10, 11]. To minimize difficult ventilation and pulmonary aspiration, repeated attempts at tracheal intubation should be avoided, and use of either an alternative airway device for tracheal intubation (e.g. videolaryngoscopes, fiberoptic bronchoscope) or a supraglottic airway would be appropriate. These useful devices may also fail for some patients, and thus it is necessary to know when they are more likely to fail. Currently, it is not known whether or not preoperative tests for predicting difficult tracheal intubation with the Macintosh laryngoscope can be used to predict difficult intubation with a videolaryngoscope or with a fiberoptic bronchoscope [4]. In addition, methods for prediction of difficult insertion of a supraglottic airway are limited [17–19]. This insufficient knowledge of methods of prediction also applies to surgical access to the airway, for example cricothyroidotomy. It is, therefore, necessary to establish routine preoperative assessment methods to predict not only difficult intubation but also the risk of aspiration and difficulty in ventilation through a facemask, a supraglottic airway, or a surgical airway.

Appropriate preoperative planning of airway management

When tracheal intubation, ventilation, or both, are predicted to be difficult, or the patient is at increased risk of

pulmonary aspiration, a comprehensive preoperative airway plan is required. Failure of the primary airway technique may lead to hypoxia within a few minutes, necessitating rapid implementation of plans B, C, and D, which is extremely challenging without appropriate planning and preparation. Nevertheless, planning is often based on each anesthesiologist's preference, and there is insufficient evidence to establish a logical order of these plans. For example, for patients with difficult airways, awake tracheal intubation is more frequently selected in Japan than in Britain. It is necessary to establish a consensus for logical planning of methods for airway management.

Strategies for preventing and solving airway complications

Several major areas require more comprehensive strategies to prevent and solve airway complications. For example, little effort has been devoted to reducing complications associated with use of a supraglottic airway. A supraglottic airway may often be placed in a suboptimum position, even when adequate ventilation is achieved: the device may not be inserted deep enough, the tip of the device may be impacting upon the glottis, with the mask twisted around the long axis of the tube or even folding over on itself. A suboptimally positioned device may often cause airway complications; it is, therefore, necessary to establish methods for detection of suboptimum positioning [15, 20].

The incidence of pulmonary aspiration during use of a supraglottic airway should be lower than the incidence during tracheal intubation, because a supraglottic airway is indicated *only* for patients at low risk of aspiration. Nevertheless, several studies have shown that the patient for whom a supraglottic airway was used aspirated as frequently as, or even more frequently than, in the patient whose trachea was being intubated [10, 11]. The number of deaths resulting from pulmonary aspiration during the use of a supraglottic airway is unacceptably high (estimated to be 16 in the UK or 100 worldwide each year [21, 22]). A striking fact is that almost all patients who aspirated during use of a supraglottic airway should have been regarded as at increased risk of aspiration [10, 22]. Therefore, this most frequently occurring life-threatening complication can be reduced simply by avoiding use of a supraglottic airway for patients at increased risk of aspiration [20].

Use of supraglottic and surgical airways are major rescue methods in the "cannot intubate, cannot ventilate" scenario; these methods may, nonetheless, fail [8, 10, 11]. There are several situations in which both insertion of a supraglottic airway and tracheal intubation can be difficult—limited mouth opening, restricted head and neck movement, and cricoid pressure [18]. There may be situations in which both facemask and a supraglottic airway fail [17].

The NAP4 data cast serious doubt on the wisdom of continuing to use needle or cannula cricothyroidotomy. Twelve of 19 cricothyrotomies using a narrow-bore needle and three of seven using a wide-bore needle failed, and had to be rescued by surgical tracheostomy. It is necessary to reappraise whether or not cricothyroidotomy is fundamentally less reliable than a surgical airway.

Similar to the importance of planning airway management during induction of anesthesia, it is necessary to establish safe methods of finishing airway management during emergence from anesthesia [12].

Teaching and training

Even when we have established guidelines for difficult airway management, when difficulty occurs we need to perform appropriate management rapidly and safely. To achieve this, it is necessary to establish a curriculum which includes not only *what* is taught, i.e. the syllabus of airway management (including cognitive, psychomotor, and behavioral areas) but also *how* it is delivered, assessed, maintained, and evaluated. For example, the success and quality of surgical and needle cricothyroidotomies can be poor if performed by inexperienced staff [23]; with training, however, needle cricothyroidotomy may become as effective as surgical cricothyroidotomy [24].

Conclusion

As a result of extensive research and new technology, airway management can be regarded as a safe procedure. Nevertheless, serious complications still occur for a limited number of patients, and improvement of some aspects is still needed. We must, therefore, conduct more research on topics for which knowledge is insufficient, to build firmer strategies for management of difficult airways.

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