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Special Article

The unanticipated difficult airway with recommendations for management

Purpose: To review the current literature and generate recommendations on the role of newer technology in the management of the unanticipated difficult airway.

Methods: A literature search using key words and filters of English language and English abstracted publications from 1990-96 contained in the *Medline, Current Contents* and *Biological Abstracts* databases was carried out. The literature was reviewed and condensed and a series of evidence-based recommendations were evolved.

Conclusions: The unanticipated difficult airway occurs with a low but consistent incidence in anaesthesia practice. Difficult direct laryngoscopy occurs in 1.5 - 8.5% of general anaesthetics and difficult intubation occurs with a similar incidence. Failed inubation occurs in 0.13-0.3% general anaesthetics. Current techniques for predicting difficulty with laryngoscopy and intubation are sensitive, non-specific and have a low positive predictive value. Assessment techniques which utilize multiple characteristics to derive a risk factor tend to be more accurate predictors. Devices such as the laryngeal mask, lighted stylet and rigid fibreoptic laryngoscopes, in the setting of unanticipated difficult airway, are effective in establishing a patent airway, may reduce morbidity and are occasionally lifesaving. Evidence supports their use in this setting as either alternatives to facemask and bag ventilation, when it is inadequate to support oxygenation, or to the direct laryngoscope, when tracheal intubation has failed. Specifically, the laryngeal mask and Combitube™ have proved to be effective in establishing and maintaining a patent airway in "cannot ventilate" situations. The lighted stylet and Bullard (rigid) fibreoptic scope are effective in many instances where the direct laryngoscope has failed to facilitate tracheal intubation. The data also support integration of these devices into strategies to manage difficult airway as the new standard of care. Training programmes should ensure graduate physicians are trained in the use of these alternatives. Continuing medical education courses should allow physicians in practice the opportunity to train with these alternative devices.

Objectif : Passer en revue la documentation courante et fournir des recommandations sur le rôle de la nou velle technologie dans la conduite à tenir lors d'une intubation difficile.

Méthodes : On a procédé à une recherche documentaire selon des mots-clés et des filtres de langue anglaise et des publications de résumés anglais de 1990 à 1996, contenus dans les bases de données de *Medline, Current Contents* et *Biological Abstracts*. La littérature a été revue et résumée et une série de recommandations basées sur les faits ont été élaborées.

Conclusion : Les difficultés d'intubation non prévues surviennent selon une incidence faible, mais constante, dans la pratique de l'anesthésie. Des problèmes de laryngoscopie directe et des difficultés d'intubation ont lieu dans 1,5 – 8,5 % des anesthésies générales. L'échec de l'intubation survient dans 0,13 – 0,3 % des anesthésies générales. Les techniques habituelles de prédiction des difficultés de laryngoscopie et d'intubation sont sensibles, mais non spécifiques et ont une faible valeur prédictive. Des techniques d'évaluation qui utilisent plusieurs caractéristiques pour en déduire un facteur de risque ont généralement de meilleures qualités prédictives. Lors d'une intubation difficile inattendue, des appareils comme le masque laryngé, le stylet lumineux et le laryngoscope fibroscopique rigide sont efficaces dans le rétablissement de la perméabilité des voies aériennes, ils peuvent réduire la morbidité et peuvent parfois sauver des vies. L'expérience encourage leur emploi en remplacement du masque et de la ventilation manuelle quand la ventilation assistée est inappropriée, ou à la place du laryngoscope direct quand l'intubation endotrachéale a été un échec. Le masque laryngé et le Combitube® ont été spécialement efficaces dans le rétablissement et le maintien de la perméabilité des voies aériennes, dans les situations où l'on ne peut ventiler. Le stylet lumineux et le fibroscope rigide Bullard réussissent souvent à faciliter l'intubation endotrachéale quand le laryngoscope direct a échoué. Les données favorisent également l'intégration de ces dispositifs, considérée comme le nouveau standard de soins, dans la démarche à suivre lors de l'intubation difficile. Les programmes de formation devraient garantir que les médecins diplômés soient familiarisés avec l'usage de ces solutions de remplacement. L'éducation médicale continue devrait donner aux praticiens l'occasion d'apprendre à utiliser ces dispositifs.

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THE *"Practice guidelines for management of the difficult airway"* produced by the American Society of Anesthesiologists' Task Force on Management of the Difficult Airway and published in 1990 represented a major advance in the approach to and management of difficulties related to airway interventions.[1] Evidence-based recommendations were derived by consensus of the Task Force members and input from the ASA membership, following an extensive literature search. Since the publication of the guidelines there has been a substantial number of new publications in the field of airway management. As well, there have been both the introduction of new airway devices and a wider dissemination of a number of devices with which there had been limited experience at the time of publication of the guidelines.

It was the opinion of the authors that there was value in reviewing the more recent literature as well as the accumulated experience with the new devices, in order to determine whether previous recommendations might be modified or new recommendations derived. The following text is the product of this review.

Methodology

Canadian anaesthetists with an interest in airway management and education were invited by the lead author to participate in the project. A meeting was held to establish a mandate and set an outline for the project. Draft positions on the various facets of the mandate were generated following completion of a structured search of the literature. Additional meetings were held at which the drafts were reviewed, discussed and revised and consensus reached on the content and the recommendations derived. The final draft document was approved by the members of the authors group.

STRUCTURED LITERATURE SEARCH AND GENERATION OF RECOMMENDATIONS

A structured literature search intended to inform the workings of the project members was carried out. Key words and filters were employed to generate a search of English language and English abstracted publications from 1990-96 contained in the *Medline, Current Contents* and *Biological Abstracts* databases. For literature published prior to 1990, the structured search carried out by the ASA Task Force was obtained from the ASA and utilized. The new search was expanded beyond the scope of original ASA Task Force search to obtain studies relating to the expanded mandate for this project including the paediatric and obstetrical airway, applications of new drugs and technology and educational issues. A large number of titles retrieved were deleted for lack of relevance. The remaining titles were searched and culled. Only titles including original data were included; excluded were titles relating to animal work and titles with no original data (reviews, editorials, comments). The reference lists of relevant articles were searched and project members added references from their own files to complete the search.

This document summarizes the results of the literature review; the recommendations contained represent the consensus opinion of the project membership regarding the materials reviewed. The data supporting the recommendations were assigned a level of evidence ranking according to the levels established by the Canadian Task Force on the Periodic Health Examination.[2] (Table I) Recommendations were graded according to the level of evidence supporting them.[3] (Table II)

1a. The difficult airway - a definition of terms

Anaesthetists agree that management of the difficult airway is a fundamental part of clinical practice. There is not agreement as to how to define the condition, which results in difficulties gathering data on both the incidence and outcome. As well, commentary or rec-

TABLE I Quality of evidence[1]

Level I	Evidence obtained from randomized controlled trial(s)
Level II	Evidence obtained from controlled trials without randomization, cohort or case-control studies, or from observational studies.
Level III	Opinions of respected authorities, based on clinical experience, descriptive studies or reports of expert committees.
N/A	The recommendation is the consensus opinion of the Group; the subject is one that cannot be studied using accepted study designs.

TABLE II Grading system for recommendations[2]

Grade A	The recommendation is based on one or more studies at level I.
Grade B	The best evidence available was at level II.
Grade C	The best evidence available was at level III.
Grade D	The recommendation is based on expert opinion alone.

ommendations regarding the management of the difficult airway is reliant on concise and accepted definitions of terms to give such discussions clarity.

The ASA Task Force defined a ***difficult airway*** as "the clinical situation in which a conventionally trained anesthesiologist experiences difficulty with mask ventilation, difficulty with tracheal intubation, or both."[1] The task force defined ***difficult mask ventilation*** as occurring when: "it is not possible for the unassisted anesthesiologist to maintain the $SPO_2 > 90\%$ using 100% oxygen and positive pressure mask ventilation in a patient whose SPO_2 was >90% before anesthetic intervention; and/or it is not possible for the unassisted anesthesiologist to prevent or reverse signs of inadequate ventilation during positive pressure mask ventilation."[1] Successful laryngoscopy would imply that an adequate view of the glottic structures and laryngeal inlet to allow for tracheal intubation could be achieved using a direct laryngoscope.

Difficult laryngoscopy was defined by the ASA Task Force as occurring when "It is not possible to visualize any portion of the vocal cords with conventional laryngoscopy."[1] This would equate to a grade III or IV laryngoscopy.[4](Table III) The ASA Task Force defined ***difficult endotracheal intubation*** as occurring when "proper insertion of the tracheal tube with conventional laryngoscopy requires more than three attempts or more than 10 minutes."[1]

With respect to the ASA definition for difficult tracheal intubation, an optimal, best attempt at laryngoscopy may be achieved on the first attempt and may reveal a grade IV view which results in a failed intubation. Thus, difficult tracheal intubation may be readily apparent to an experienced practitioner on the first attempt at intubation. Further, if direct laryngoscopy was abandoned immediately after achieving a grade IV view and tracheal intubation was achieved with an alternative technique on the first attempt then, by the ASA definition, that would not be a difficult intubation, although it clearly was. Difficult intubation should not be exclusively defined as either attempts- or time-dependent.

TABLE III Cormack and Lehane Classification of Laryngeal View[4]

Grade	*Structures visible*
I	glottis, including anterior and posterior commissures
II	posterior aspects of glottis (anterior commissure not seen)
III	epiglottis only (glottis cannot be exposed)
IV	hard palate only (epiglottis and glottis cannot be seen)

We utilized the ASA definitions relating to ***difficult airway, difficult mask ventilation*** and ***difficult laryngoscopy.*** However, ***difficult intubation*** was defined: ***when an experienced laryngoscopist, using direct laryngoscopy, requires: 1) more than two attempts with the same blade or; 2) a change in the blade or an adjunct to a direct laryngoscope (ie. bougie) or; 3) use of an alternative device or technique following failed intubation with direct laryngoscopy.***

The increasing use of alternatives to direct laryngoscopy for airway management has a number of implications. If an alternative (ie. lighted stylet) is employed because of concerns about potential difficulties with direct laryngoscopy and is successful, no conclusion may be drawn regarding the ease of intubation with direct laryngoscopy. Thus, a previous, uneventful anaesthetic experience does not necessarily imply that future experiences will be similarly uncomplicated by difficult airway. If an alternative technique is used for tracheal intubation because of concerns about potential difficulties, this should be documented on the anaesthetic record.

1b. The incidence of difficult airway

The incidence of the difficult airway, difficult laryngoscopy and difficult intubation is not well defined. However, a number of conclusions can be drawn from recently published, large series involving prospective, preoperative airway assessments.[5-11](Table IV) First, achieving a poor view (Grade 3/4) during laryngoscopy is common (2-8%). Experiencing difficulty intubating the trachea, although associated with a poor view, is less common, likely by a factor of 5-10. Failure to intubate the trachea is even more uncommon, likely seen one to three times per 1,000 attempts, and again less common than difficult intu-

TABLE IV The incidence of difficult airway - prospective reviews

Population (n)	Difficult/failed ventilation	Grade 3/4 *laryngeal view*	Difficult intubation (≥ *3 attempts)*	Failed *intubation*	Reference
general surgical (18,500)	0.01%		2.5%	0.3%	5
obstetrical (1500)		1.8%	1.8%	0.13%	6
general surgical (3,325)		8.5%	1.9%		7
general surgical (6,477)		1.5%	1.7%		8
general surgical (3,312)			3.8%		9
general surgical (10,507)	0.07% 6.1%				10
general surgical + obstetrical (15,616)	0.025% (requiring tracheostomy)		1.15%	0.28%	11

bation by a factor of 5-10. Finally, being unable to ventilate the lungs with facemask and bag is more uncommon still, now likely occurring 1-3 times per 10,000 attempts.

1c. Preoperative assessment of the airway - prediction of difficult intubation

Mallampati reported a correlation between the visibility of oropharyngeal structures and the degree of difficulty of laryngeal exposure during direct laryngoscopy and concluded that poor visualization could be predicted by a visual assessment of the airway (Table V).[12] Preoperative examination and classification using a three tier grading system was proposed. Samsoon and Young added a further tier, class IV, and observed that among patients in whom laryngoscopy was known to be difficult, class III and class IV assignments predominated.[13]

There have since been proposed further modifications of Mallampati's original schema and alternative strategies to assess the airway.[6,14–20] These have ranged from using simple anatomical descriptors, ranking and summating anatomical factor scores,[10,15–20] (Table VI) using logistic regression to create predictive scales,[6] and the derivation of a performance index.[21] The different strategies share some common characteristics; they have a high sensitivity but low specificity and low positive predictive value with respect to the diagnosis. Additionally, many of the tests have only moderate inter-observer reliability.[22] This may help explain why the tests fail to predict difficult tracheal intubation accurately.

TABLE V Mallampati Classification, Samsoon* modified[12,13]

Class	*Structures visible*
I	soft palate, fauces, pillars and uvula
II	soft palate, fauces and uvula
III	soft palate, base of uvula
IV	hard palate only*

TABLE VI The sensitivities, specificities and positive predictive values of some anatomic risk characteristics of difficult laryngoscopy.

Characteristic	*Sensitivity*	*Specificity*	*Positive predictive value*	*Reference*
sternomental distance				
≤ 12.5 cm	82.4	88.6	26.9	16
≤ 13.5 cm	66.7	71.1	7.6	17
head extension				
< 80	10.4	98.4	29.5	10
≤ 80	10	93	18	18
Mallampati score				
III	44.7	89	21	10
III	64.7	66.1	8.9	16
III or IV	66	65	22	18
III or IV	67.9	52.5	2.2	19
III or IV	56	81	21	20
thyromental distance				
< 6 cm	7	99.2	38.5	10
≤ 6.5 cm	64.7	81.4	15.1	16
≤ 6.5 cm	62	25	16	20
inability to prognath	16.5	95.8	20.6	10
29.4	85	9.1	16	
mouth opening < 4cm	26.3	94.8	25	10

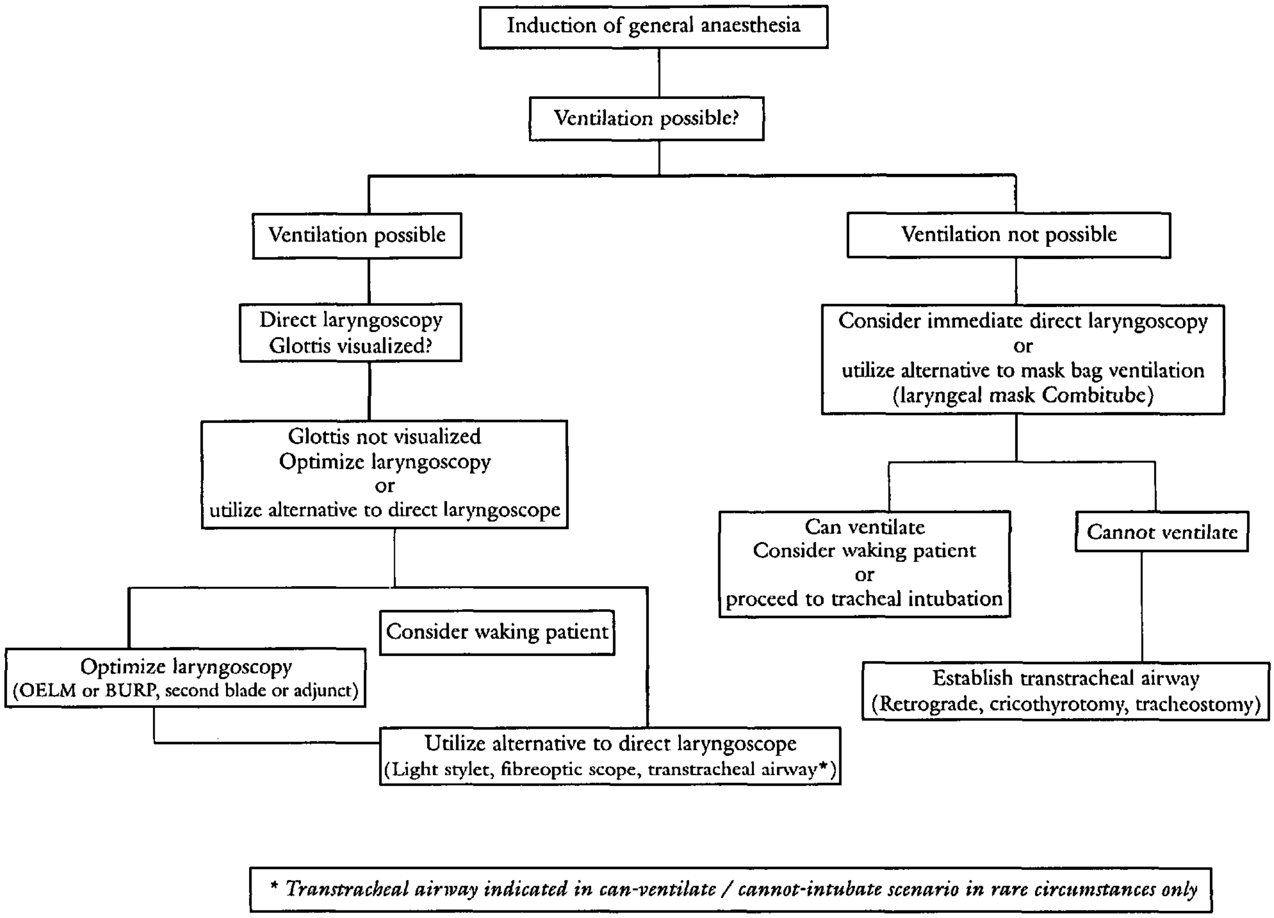

FIGURE Algorithm for the proposed management of the unexpected difficult airway.

Although the majority of strategies implicate airway class as a predictor of difficult intubation, the Mallampati classification used alone is an imprecise mechanism for the preoperative detection of the difficult to intubate patient. The combination of the Mallampati classification with evaluation of other risk criteria improves the specificity and sensitivity of the preoperative assessment.[6,10,15,18,21] For example, a higher likelihood of difficult intubation can be anticipated with Mallampati class IV combined with a receding chin, a short neck or protruding maxillary incisors and, in particular, with a combination of class IV and any two of the above characteristics than with a class IV designation alone.[6] Thus, an assessment strategy which summat es the impact of anatomical findings is most likely to predict problems accurately.

A preoperative airway assessment will reveal many of the patients who ultimately will have a difficult airway and it is recommended on that basis. The most common problem will not be missed diagnosis but, rather, predicting many to be difficult when, in fact, they are not. The low specificity of the tests, when combined with the low incidence of difficult airway, leads to the poor positive predictive value. However, a false positive assessment is a benign consequence of the airway evaluation and should not deter clinicians from performing the assessment, leading to the surprise occurrence of difficulties and possibly resulting in either morbidity or mortality.

Because a preoperative assessment will predict many difficult airways, it is recommended. However, despite careful preoperative evaluation, difficulties will not be predicted in some instances and strategies to manage the unanticipated difficult airway should be pre-formulated and practised.

1d. Management strategies

Difficult or failed mask ventilation

In some patients mask ventilation is difficult, yet tracheal intubation is achieved readily. Thus, an attempt at tracheal intubation is a prudent first intervention when it is realized that ventilation is difficult or impossible. Given that the compelling clinical imperative in this setting is to establish a patent airway and not to effect intubation, attempts at intubation must not be persistent.

All physicians responsible for airway management should be practiced in at least one alternative to mask-bag ventilation. New technology intuitively useful in this setting include the laryngeal mask airway and the Combitube™. Transtracheal techniques should be considered early if alternative trans-oral techniques are either not available or do not achieve ventilation.

Difficult direct laryngoscopy and intubation

Best laryngoscopic view is dependent on optimal positioning of the patient, an experienced practitioner with capable assistance, and a technique designed to ensure that the best view is obtained. For direct laryngoscopy, the patient should be in a sniff position (slight flexion of the neck and extension of the head on the neck), to best align the oral, pharyngeal, and laryngeal axes. If the best laryngoscopic view is grade II-IV, then optimal external laryngeal manipulation (OELM) or backward, upward, rightward laryngeal displacement (BURP manoeuvre) should be used.[23,24] Optimal external laryngeal manipulation is described as pressing posteriorly and cephalad over the thyroid, hyoid and cricoid cartilages in an attempt to improve laryngeal view.[23] The BURP manoeuvre requires the manual displacement of the larynx posteriorly against the cervical vertebrae, superiorly as far as possible and to the right.[24] These manoeuvres can improve the laryngoscopic view by at least one grade and should be the initial response to a poor laryngoscopic view. If optimal positioning, OELM, BURP or blade selection provides an inadequate laryngoscopic view, early consideration should be given either to awakening the patient or choosing an alternative to direct laryngoscopy. Multiple attempts using direct laryngoscopy is associated with morbidity.[5]

If difficulty is encountered during attempts at tracheal intubation, oxygenation must be maintained. The quality of the airway may deteriorate with multiple intubation attempts, leading to the development of progressive difficulty in ventilating the lungs with a facemask; the final result may be an inability to ventilate the lungs.[25]

Adjuncts to direct laryngoscopy

An adjunct to direct laryngoscopy for the unanticipated difficult intubation meriting attention is the gum elastic bougie.[26-8] If the larynx is anterior and either poorly visualized or not visualized, an attempt to pass the bougie may be made. With this technique, under direct laryngoscopy, the epiglottis is elevated with the tip of the bougie which is then passed anteriorly under the epiglottis and into the trachea, typically without visualizing the glottis. The endotracheal tube is then passed over the bougie and into the trachea, the bougie is withdrawn and successful tracheal intubation confirmed. Kidd reported the use of the bougie in 98 patients with simulated and two with genuine grade 3 laryngoscopy.[26] The bougie entered the trachea in 78 patients and the oesophagus in 22. Tracheal clicks were noted in 90% of the tracheal placements and no clicks were noted with the oesophageal placements. Hold-up of the bougie at 24-40 cm occurred in all tracheal placements as the tip made contact with the smaller airways and this was not seen in any of the oesophageal placements. Both signs were advanced as useful indicators of tracheal placement. Although studies comparing it with other airway adjuncts in the difficult airway scenario are lacking, it has been shown to be an effective tool in the simulated difficult airway.[26-8]

A vast number of laryngoscope blades are available, many are subtle variations on earlier designs. Few have undergone a controlled assessment to determine whether they provide improved glottic visualization in patients with difficult laryngoscopy. A new blade recently introduced into anaesthetic practice, the McCoy articulating blade, has undergone such assessments. In 50 patients, in whom difficult laryngoscopic conditions were simulated by neck immobilization in the neutral position, the laryngoscopic views obtained with the McCoy blade were better by at least one grade in most of the patients with a grade II (70% improved) or III (83% improved) compared with the view obtained with the Macintosh blade.[29] However, in the patients with a grade IV view, there was no improvement in view. Similar findings of improvements on grade II and III views were reported by others.[30,31] Laurent has also determined that cricoid pressure does not interfere with use of the McCoy blade and that similar improvements in view can still be expected.[30]

Adjuncts to the direct laryngoscope should be introduced early during management of the unexpected difficult intubation. They may convert a difficult laryngoscopy into a successful tracheal intubation by improving a less than optimal technique to achieve intubation in that particular patient. However, they rarely represent ideal choices for the elective management of the perceived difficult intubation. Repeated attempts at tracheal intubation using adjuncts to the direct laryngoscope are not warranted.

A simple algorithm is proposed to aid in the management of the difficult airway (Figure). It is based on the strategy that encourages the immediate diagnosis of the airway problem (i.e. failed ventilation) and a directed response determined by the clinical scenario. The diagnostic choices are limited to three: 1) difficult or failed mask ventilation; 2) difficult laryngoscopy; and 3) difficult or failed intubation. The choice of the response is determined both by the underlying diagnosis and the physician's chosen alternative for managing condition. The chosen alternative is directed specifically at the underlying problem.

1e. Confirmation of tracheal intubation

There are two methods of ensuring tracheal intubation: 1) determination of the presence and persistence of a level of carbon dioxide in the exhaled gas that is appropriate for the clinical circumstance; and 2) visual inspection of the airway after passage of the tube. Visual inspection to confirm tracheal placement may be done with either an examination of the glottis, usually with a direct laryngoscope, or examination of the subglottic airway using endoscopy. Inspection, palpation and auscultation of the chest, although informative, cannot be relied upon to confirm tracheal placement. Oxygen saturation, measured by pulse oximetry, may be maintained for variable periods after unrecognized oesophageal intubation and so is unreliable.[32]

2. Alternatives to mask-bag ventilation and direct laryngoscopy - application in the unanticipated difficult airway

Alternative techniques and technologies directed towards the management of the difficult airway continue to proliferate. Although their specific roles and efficacy have not been rigorously defined to date, some conclusions may be drawn from the experience thus accumulated:

1) Success with all devices relies more on the operator's experience and skill than on the tools themselves.
2) The success of any technique depends on proper patient selection, meticulous preparation, good technique and regular practice, regardless of the device employed.

2a. The role of the laryngeal mask airway

The laryngeal mask airway (LMA) is a novel airway device which, when blindly inserted into the pharynx forms a low pressure seal around the laryngeal inlet.[33] It typically provides a clear, unobstructed airway, even when used by practitioners with no previous experience.[34] Insertion of the LMA is not more difficult in patients with class III or IV airways or in those patients in whom laryngoscopy reveals grades III or IV views.[35] There are now numerous reports of the LMA being used to facilitate ventilation of the lungs after failed intubation and ventilation.[36–41]

When the lungs can be ventilated with a face mask after failed intubation, the LMA confers little advantage as the airway can be maintained with a face mask until spontaneous ventilation resumes. Once ventilation has resumed, there is again little advantage to be gained by passing an LMA.[42] However, if adequate ventilation cannot be obtained or maintained and tracheal intubation fails, immediate placement of an LMA should be considered. The attempt should be made early in the course of management of failed ventilation as the laryngeal reflexes may still be blunted by the residual effects of the anaesthetic induction and the patient is less likely to react unfavourably to airway manipulation. The stimulation related to passage of an LMA is approximately the same as that for an oropharyngeal airway.[43] Earlier placement should also reduce gastric distension and the attendant risks of regurgitation, especially if persistent and forceful attempts to ventilate a patient with a variably obstructed airway can be avoided.

The LMA has been utilized in patients at risk for regurgitation, whose tracheas could not be intubated but whose lungs could be ventilated with a face mask.[40,44,45] This latter application has generated controversy for two reasons. First, the LMA is more likely to promote gastric regurgitation than is face mask anaesthesia.[46] The postulated mechanism is that the LMA causes reflex relaxation of the lower esophageal sphincter by distension of the hypopharyngeal muscles, similar to the effect of a food bolus. Second, the LMA may prevent escape of regurgitated stomach contents from the pharynx, and hence the use of the lateral head-down position may have no value in a patient who regurgitates with an LMA in situ.

Cricoid pressure and the LMA

There is consensus that application of cricoid pressure is protective, reducing both gastric insufflation and the risk of aspiration in patients at risk even though the quality of evidence to support this impression is weak.[47] The evidence in support of the recommendations for the forces necessarily applied to achieve a protective effect with cricoid pressure is also not strong and lesser applied forces may or may not be protective. Cricoid pressure, even when appropriately applied, may result in airway obstruction, impeding mask-bag ventilation and may interfere with direct laryngoscopy and tracheal intubation.[47] If improperly applied, it is possible that these effects will be augmented although this has not been formally studied.

If cricoid pressure is deemed indicated, whether or not it should be released during insertion of the LMA for failed ventilation is controversial. Cricoid pressure makes the insertion of the LMA more difficult but the presence of the LMA in the airway does not prevent effective application of cricoid pressure.[48–55] Once the LMA is placed, ventilation is more difficult with maintained cricoid pressure. It is also more difficult to pass an endotracheal tube through the LMA and into the trachea, both blindly and assisted by a fibreoptic scope, with cricoid pressure applied.[48,49,56]

The LMA is not an elective alternative to the tracheal tube in patients at risk for regurgitation and aspiration but rather is an alternative to the face mask when it is not possible to ventilate the lungs.[57] An attempt to pass the LMA should be made early, with cricoid pressure maintained and, if unsuccessful, the pressure can be released to allow for insertion. The LMA should already be in the oropharynx before releasing cricoid pressure. Cricoid pressure should be reapplied once the LMA is sited. If it is not possible to ventilate the lungs in this manner, cricoid pressure can be gradually reduced or released as further attempts to ventilate are made. If ventilation remains impossible, the LMA should be removed and the face mask reapplied with cricoid pressure now reduced or released. An attempt to ventilate the lungs with reduced or without cricoid pressure can now be made.

If ventilation is re-established with the LMA, the patient should be allowed to awaken. The option to wake the patient should only be excluded by an urgency to proceed. In this circumstance, general anaesthesia may be provided via the LMA, with cricoid pressure maintained to protect the airway. Other considerations, such as the patient's preoperative reluctance to undergo surgery with regional anaesthesia should not compel the anaesthetist to carry on with general anaesthesia with a controlled but unprotected airway in a patient at risk for aspiration.

The LMA as a conduit to facilitate other airway interventions

If it is possible to ventilate the lungs via the LMA and the decision is made to proceed with general anaesthesia, further steps may be taken to protect the airway if indicated by circumstance or operative requirements. Intubation through the LMA with an uncut, small gauge endotracheal tube (6.0 mm or less for # 4 LMA, 7.0-7.5 for # 5 LMA), both blindly or assisted with a bougie, tube changer or fibreoptic scope have all been described.[48,50,58,59] Attempts to pass an endotracheal tube should not be persistent, given that an adequate airway has already been established with the LMA and may be jeopardized with repeated manipulation.

A number of modified LMA prototypes are being developed and may serve a role in the management of the difficult airway; their evaluation will be possible only when these devices become widely available.

2b. The role of the Combitube™

The Combitube™ is a new emergency airway, which can be used in the oesophageal as well as tracheal positions.[60–2] It is a double lumen tube with distal and proximal cuffs, presently available in sizes 37 Fr (women and young adults) and 41 Fr (adult males). Rumball compared the Combitube™ with a pharyngotracheal lumen airway (PTLA), the LMA and an oral airway, inserted by emergency medical technicians (EMT) for the field management of the airway in 470 victims of cardiopulmonary arrest.[63] Successful insertion and ventilation occurred in 86% of the attempts with the Combitube™ compared with 82% for the PTLA and 73% for the LMA. The Combitube™ was associated with the fewest problems achieving ventilation and was the preferred technique for the majority of the EMTs. This is consistent with the observations of Lefrançois, the medical coordinator of emergency medical services for the Régie régionale de la santé et des services sociaux de la Montérégie (South Shore Montreal).[a] The Combitube™ has been used as the prehospital airway during cardiopulmonary arrest resuscitation in Montérégie's EMS System since 1992. The Combitube™ was successfully placed in 1445 of 1550 (93%) attempts from November, 1992 to October, 1995. In 21 failed placements, failure was attributed to obstructing foreign bodies, tumours of the pharynx or larynx, *in situ* tracheostomy, oesophageal stenosis or severe airway deformations related to suicidal hanging. In 84 cases (5.1%) failed placement occurred without apparent aetiology. In 91.3% of insertions, the lungs were adequately ventilated, as determined by the receiving emergency physicians. Although the success of field airway man-

[a] Presented at the *Emergency Cardiac Care Update*, Montreal, May 1996.

agement with the Combitube™ does not necessarily imply similar successes with its application in difficult airway situations, these experiences do encourage its use and evaluation in this application.

There is a single case report of oesophageal rupture associated with the elective use of the Combitube™.[64] In this instance, two initial attempts at placement were abandoned because increased resistance was felt with tube advancement, the third pass resulted in tube placement. However, ventilation was not possible, the tube was removed and the trachea was intubated with a cuffed tracheal tube. A mid-oesophageal perforation with mediastinal soiling was diagnosed postoperatively necessitating operative repair.

The Combitube™ is an alternative to the LMA in patients at risk of aspiration when intubation has failed and ventilation is difficult. It can be placed quickly and allows for a measure of protection for the airway, reducing the likelihood of aspiration. Cricoid pressure would have to be released transiently to allow for placement of the Combitube™ and the airway would be at risk from aspiration during the brief period before cuff inflation. Once cuff inflation has occurred there is no further need for cricoid pressure.

Although intended to be inserted blindly, intuitively it would seem both reasonable and prudent to insert the Combitube™ under direct laryngoscopic view in the event of failed mask ventilation and failed intubation.

2c. The role of the rigid fibreoptic laryngoscopes

Combining rigid laryngoscopy with fibreoptic intubation is a technique utilized to permit tracheal intubation in obese, paralysed patients or those with an oropharyngeal mass, upper airway oedema, or a posteriorly displaced epiglottis (because of a supraglottic mass or because the epiglottis is large and floppy).[65,66] The epiglottis is exposed using a rigid laryngoscope by one anaesthetist who then guides the tip of the flexible fibreoptic endoscope (FFE) toward the glottis while the other is looking through the FFE. If successful, this facilitates exposure of the vocal cords and advancement of the FFE into the trachea. The logistical issues relating to this technique make it one utilized rarely. A modification of this two-person technique can also be accomplished by a single operator with the use of an indirect, rigid fibreoptic laryngoscope.

The Bullard laryngoscope (BL) is representative of the indirect, rigid fibreoptic laryngoscope and its use has been most widely reviewed.[67–76] Minimal mouth opening is required for insertion of the blade of the BL and there is no need to align the oral, pharyngeal, and laryngeal axes in order to view the larynx with retraction of the epiglottis. The blade portion is designed to match the anatomical airway, negating the need to manipulate the patient's head and neck to visualize the larynx. There is a bifurcated channel incorporated into the laryngoscope. One port is equipped with a Luer-lok® fitting to allow for suction, insufflation of oxygen, or application of local anaesthetics; the other port accepts the dedicated, non-malleable intubating stylet.

The time course for developing proficiency is similar to that with the flexible fibreoptic endoscope.[67,68] Its use has been reported in a variety of circumstances, including in patients with both normal and abnormal airways, cervical spine instability, rapid sequence intubations, and in awake patients.[69–72] Evaluation of the dedicated intubating stylet with the BL demonstrated that fewer attempts and less time were required to intubate the trachea.[73] The time to successful intubation was not affected by the laryngoscopic grade. Intubation failures are uncommon in experienced hands but two particular difficulties have been encountered. The first is the ETT impacting against the right arytenoid cartilage or right aryepiglottic fold with advancement of the tube off of the stylet. A modification of the terminal angle of the stylet has been suggested to reduce the incidence of tube impaction.[74] There is also occasional inability to retract the epiglottis with the BL. Typically, in these patients, the blade is not long enough to reach the tip of the epiglottis. A plastic, disposable blade extender, now commercially available, is a useful adaptation to the BL to reduce the likelihood of this occurrence.

Mendel compared the Bullard with the direct laryngoscope in 20 patients with anatomically abnormal airways, presenting for panendoscopy.[75] Six patients were assessed as having a grade III laryngeal view and six had grade II. Tracheal intubation was possible in all patients in a mean time of 22 ± 6.8 sec with the BL. The tracheas of only 16 patients could be successfully intubated with a Macintosh laryngoscope and intubation took considerably longer (34 ± 18.3 sec). Seven patients had carcinoma and one had a rhabdomyosarcoma. In four of the patients with tumours (50%), the laryngeal view was grade III. None of these tracheas was intubated successfully with the Macintosh laryngoscope yet all intubations with the BL were successful.

Application to the difficult airway

The Bullard laryngoscope is a viable alternative in the difficult airway setting. There are a number of conditions in which an indirect, rigid laryngoscope may be advantageous. These include limitation of mouth opening from any cause as well as congenital or acquired conditions which lead to distortion of the upper airway and an inability to align the airway axes. The rigid structure of the BL allows it to achieve an endoscopic "airspace" to allow for anatomic visualization, a property not characteristic of flexible endoscopes. This may facilitate the manipulation of excess pathological (tumour) or non-pathological tissue (obesity, lingual tonsil) in the airway. There is less head and cervical spine movement required to achieve tracheal intubation with the BL compared with the Miller or Macintosh blades and the laryngeal view obtained is consistently better.[76] The laryngeal view obtained with the BL was better than that achieved with the Miller blade in 25% of patients and better than that obtained with the Macintosh in 39% of patients. This would be an advantage when it was either not possible (cervical spinal ankylosis) or not desirable (cervical spinal injury) to manipulate the cervical spine.

2d. The role of the lighted stylet

The lighted stylet (LS) or lightwand uses the principle of transillumination of the soft tissues of the anterior neck to guide the tip of the ETT into the trachea.[77] The largest published series relating to the use of the LS in patients with difficult intubation is that of Hung *et al.*, using the Trachlight™ LS, describing their experience with 265 patients.[78] There were 206 patients with a history of difficult airway (105) or anticipated difficult airway (101) and 59 were anaesthetized patients, with an unanticipated difficult and failed laryngoscopic intubation. In the first group, tracheal intubation was achieved in all but two, with a mean time-to-intubation of 25.7 ± 20.1 sec (range 4-120 sec). One of the failures was a morbidly obese patient and transillumination was impossible. The second was a patient with longstanding cervical arthritis and a fixed flexion deformity. Both had awake tracheal intubation with a fibreoptic bronchoscope. In the second group, (failed direct laryngoscopic intubation), tracheal intubation was successful in all patients with a mean time-to-intubation of 19.7 ± 13.5 sec (range 5-75 sec). Apart from mucosal bleeding in patients who had multiple unsuccessful direct laryngoscopic attempts, no other complications were noted. This contrasts with the report of Rose, who noted an increased incidence of unanticipated ICU admissions following persistent attempts to intubate the trachea with the direct laryngoscope.[5] It is tempting to infer from this, that an early decision to employ an alternative technique in a difficult intubation due to poor direct laryngoscopic view, may be associated with lower patient morbidity.

Adjunct use of the lighted stylet in other intubating techniques

In a limited number of patients, an LS-guided retrograde intubating technique was an effective technique to intubate the trachea in patients with cervical spine instability.[79] Asai and Latto suggested a role for the LS to facilitate tracheal intubation through the LMA.[80] Even though they demonstrated the ease of tracheal transillumination through an LMA using the Trachlight™ LS with an 80% success rate after one attempt, they did not attempt to place a tube in the trachea.

Application to the difficult airway

The particular advantage of the LS is in its application to those patients with anatomical characteristics that interfere with aligning the axes for obtaining an in-line view during direct laryngoscopy. These include: limited mouth opening from any cause; a hypoplastic mandible; prominent upper incisors; restricted cervical spine movement or spinal immobilization; glossoptosis or glossomegaly; or restricted access to the airway (halo traction, stereotaxic frames). The LS may also be advantageous for patients who are at higher risk for dental trauma during direct laryngoscopy.

Limitations of lighted stylet intubation

Lighted stylet-facilitated intubation is an indirect technique during which there is no visualization of the laryngeal structures. Their elective use should be avoided in patients with known anatomical abnormalities of the upper airway, such as tumours, polyps, or infection (e.g. epiglottitis), trauma to the upper airway, or if a foreign body is suspected in the upper airway. They should be used with caution in instances where the aetiology of acute upper airway compromise is not defined. Finally, they may be less effective in patients in whom transillumination of the anterior neck may not be adequate, such as, those who are grossly obese or patients with limited neck extension.

2e. The role of the flexible fibreoptic endoscope

Tracheal intubation with a flexible fibreoptic endoscope (FFE) is a technique particularly well suited for tracheal intubation in the awake patient although intubation can be done in the unconscious or anaesthetized patient. In Rose's review of 18,500 patients, the FFE was the most commonly utilized alternative to the direct laryngoscope, electively, or in the event of unanticipated difficult intubation.[5] Unfortunately, use of the FFE may be rendered more difficult by induction of general anaesthesia. Loss of consciousness is associated with a loss of tone in the muscles that support the tongue and indirectly support the epiglottis. Posterior movement of the tongue and epiglottis can then obstruct the airway at the level of the pharynx and larynx respectively. The degree of obstruction is influenced by variations in airway anatomy, body habitus, and depth of coma.[81] Additionally, in the unconscious individual, reduction of the calibre of the pharyngeal lumen makes fibreoptic visualization more difficult.[81] Contact of the lens with the mucosa results in complete loss of the visual field and thus the ability to manoeuvre past an epiglottis in contact with the posterior pharyngeal wall is limited.[81] Although the FFE is a useful device in the hands of experienced operators for the management of the difficult airway, its effectiveness is compromised in the unconscious or anaesthetized patient.

2f. The role of the transtracheal airway

A number of transtracheal techniques have been advocated for both the elective and emergency management of a difficult airway. In the emergency setting, the transtracheal airway has been predominantly, but not exclusively, used to provide an avenue for oxygenation in the failed ventilation scenario. Techniques reported include: cricothyroid puncture with a small needle or catheter and subsequent ventilation through the catheter; cricothyroid puncture with a small needle or catheter and subsequent use of the catheter to perform retrograde intubation facilitated with either a catheter or a guidewire and occasionally aided by adjuncts such as a fibreoptic bronchoscope or a lighted stylet; cricothyrotomy with placement of a large diameter prosthesis; and tracheostomy.[79,82–6] All have been reported to be effective in establishing oxygenation and being lifesaving in application.

Complications relating to the small transtracheal catheters, when used directly for ventilation, have generally arisen either due the instability of the catheters with kinking and displacement being commonly cited and due to the high pressure gas sources employed to ventilate the lungs.[87,88] Barotrauma is a commonly cited complication occurring as a result. There are no data comparing the different techniques with respect to their effectiveness or complication profiles; most reports document care provided in either a single instance or on a limited number of occasions. Larger, non-comparative series of patients managed with retrograde techniques are now being reported which cite high (100%) rates of success and low rates of minor complications, typically minor mucosal bleeding at the puncture site.[79] However, these largely relate to elective scenarios and the applicability of these data to the emergency situation with unanticipated failed ventilation is uncertain.

A technique to establish a transtracheal airway should be part of every anaesthetist's clinical repertoire and the equipment necessary to do so should be included in every difficult airway kit. The technique should be considered early in all situations where nonsurgical techniques either have either failed to establish a patent airway, are contraindicated or are not available.

2g. The difficult airway kit

The standard airway kit in every operating room should include a selection of airways, tracheal tubes, direct laryngoscope blades, and stylets as well as an alternative to the facemask should ventilation be difficult. Additionally, a kit should be immediately available in all patient care areas in which airway care is commonly provided or the where there is potential for emergency airway intervention.

As a minimum, a difficult airway kit should contain:

1) a selection of blades for the direct laryngoscope;
2) a malleable bougie;
3) an alternative to the facemask for difficult or failed ventilation;
4) an alternative to the direct laryngoscope for failed intubation; and
5) a transtracheal airway kit.

It is far more important that the kit contain tools with which the physician is familiar and practised than that it contain a larger number of items.

3. Extubation of the difficult airway and tracheal tube exchange

Only a small percentage of patients require tracheal re-intubation following extubation. For most surgical procedures, this number is in the order of 2 per 1,000[89–92] but for some procedures and for critically-ill patients, the necessity for re-intubation may be as high as 25%. If tracheal intubation had initially been difficult, re-intubation may be even more so, due to its emergency nature, hypoxaemia or hypercapnia, haemodynamic instability, agitation and inadequate preparation or assistance. Access to the airway may also be limited by such factors as postoperative intermaxillary or cervical fixation, cervical instability or neck swelling.

An extubation strategy should begin with identifying patients who are likely to tolerate tracheal extubation. This includes a review of the level of consciousness, adequacy of oxygenation, ventilation, probable patency of the airway and the ability to clear secretions. If tracheal intubation had originally been easy, no problems have since developed related to airway access or patency, and the pre-extubation review is satisfactory, there is generally no need for special precautions. These patients represent a low risk of complication from tracheal extubation. Patients who may not tolerate extubation but for whom tracheal access is not problematic represent an intermediate risk. Attention must be paid to the factors that make them at risk for failed extubation and these should be optimized, and they should be carefully monitored until it is certain that they are no longer at risk.

In patients in whom tracheal intubation was initially difficult or who have developed airway problems since the original intubation, a strategy should be in place to ensure continuous access to the airway during extubation, whether it be for tube exchange or a trial of extubation. When there is doubt about airway anatomy or glottic function, consideration should be given to extubating the trachea over a fibreoptic bronchoscope. Bronchoscopic examination best provides information about glottic function and airway anatomy.[93]

If intubation had been difficult, and extubation is for the purpose of tube exchange, consideration should be given to the use of an airway exchange catheter or a similar device which maintains access to the airway as extubation occurs. In this same setting, if a trial of extubation is planned, extubation over a jet stylet should be considered. This device is introduced through the endotracheal tube prior to extubation and left *in situ* until it becomes apparent that the need for reintubation is unlikely.[94–97] During the trial, the stylet may permit capnography or oxygen insufflation. Should tracheal reintubation be required, the jet stylet may be used as a guide over which a new endotracheal tube may be introduced. Even if reintubation over the stylet is unsuccessful, it may be used as a means of administering oxygen by insufflation or providing jet ventilation while alternative methods to effect tracheal intubation are pursued. Such a device should not interfere with spontaneous breathing following removal of the endotracheal tube. It should also be sufficiently well tolerated to permit it being left in place long enough to evaluate the likelihood of reintubation.[96,97]

4. The obstetrical airway - special considerations

Difficult intubation in obstetrical anaesthesia

The incidence of failed intubation in obstetrical anaesthesia is higher than that seen in the general surgical population.[4–11,13,98–102] Lyons and Hawthorne reported the incidence of failed intubation in parturients as 0.33% in 1984 and 0.4% in 1994.[102] There are a number of reasons why failed intubation may be more frequent in obstetrical anaesthesia. Maternal weight gain results in an increased Mallampati score[103] and fluid retention results in airway oedema. General anaesthesia is now too often provided to obstetrical patients in urgent or emergency situations. Hawthorne reported that 91% of the general anaesthetics given to parturients in their institution were provided under emergency conditions.[102] Inadequate time may be available or taken to carry out an airway evaluation or to ensure optimum patient positioning to facilitate laryngoscopy. These factors may be further compounded by both increased physician anxiety when managing the obstetric airway and the reduced skills of anaesthesia assistants in the obstetric setting.[104,105]

Oxygen stores are lower and consumption higher in the parturient and hypoxaemia will become manifest earlier than in the general surgical patient if tracheal intubation is delayed.[106] Because parturients are at risk for aspiration, there may be a greater likelihood of morbidity should airway difficulties be encountered than would be the case with the airway in general surgery.

Morbidly obese parturients and those with preeclampsia constitute particular high-risk groups for anaesthetic intervention. They are more likely to require obstetrical intervention in general and also more likely to require it on an urgent basis.[106,107] The time available for pre-anaesthetic evaluation may be limited and general anaesthesia may be indicated for fetal or maternal welfare. Morbid obesity and preeclampsia may have important impact on the quality of the airway, both typically narrowing it with redundant folds of tissue (obesity) or pharyngeal oedema (preeclampsia). It is a widely-held clinical impression that difficult ventilation and intubation are more common in morbidly obese and preeclamptic parturients although supporting numerical data is not available to corroborate this impression. However, these parturients should be reviewed by an anaesthetist either antenatally (morbid obesity) or at the first opportunity on presentation to the labour suite (pre-eclampsia). An airway assessment should be made and, if there is concern regarding potential airway difficulties, the obstetrical team should be advised that urgent induction of general anaesthesia for obstetrical intervention would be imprudent and perhaps life-threatening.

Airway assessment and care

The parturient's airway should be assessed as part of the anaesthetic evaluation at first contact. Because deterioration in airway status may occur during labour,[108,109] reassessment is indicated if the woman has laboured since the initial assessment. If general anaesthesia is indicated during the care of a parturient, she should be positioned to facilitate laryngoscopy and intubation while maintaining uterine displacement.

Management of failed intubation: no fetal distress
After the first failed attempt at oral intubation with a direct laryngoscope, the lungs should be ventilated with cricoid pressure applied and help should be sought. Before a second attempt at laryngoscopy, a critical review of the situation should be made. Patient positioning, cricoid pressure application and the equipment employed in the first attempt should all be reassessed. After two failed attempts at oral intubation, if it is possible to ventilate the lungs by face mask with cricoid pressure applied, the patient should be woken up.

If it is not possible to ventilate the lungs with cricoid pressure applied, an alternative to the face mask should be immediately implemented as outlined in *section 2.* Two options which should be considered early are: 1) the LMA, size # 3 or # 4; or 2) a Combitube™, size # 37Fr. Manual ventilation should be employed until the patient resumes spontaneous ventilation and awakens. If it is not possible to ventilate the lungs with cricoid pressure, it can be released incrementally until ventilation is achieved. If placement of alternative devices or ventilation through them proves to be impossible, then a transtracheal airway should be established.

Extreme fetal distress or maternal threat and maternal airway difficulty
It may be necessary and it is prudent to proceed to Caesarean section under general anaesthesia in the absence of a tracheal tube, in the setting of extreme fetal distress or grave maternal threat (i.e. haemorrhage) only if a continuously patent airway can be established. This may be achieved with any of the techniques discussed previously. The surgeon should be asked to minimize fundal pressure at time of delivery to reduce the potential for increased gastric pressures, regurgitation and aspiration. This may be achieved with either a vacuum or forceps extraction of the fetus.

Extubation of the difficult maternal airway
Careful consideration must be given as to when extubation should be carried out in parturients with a recognized difficult airway. It is prudent to move the patient, trachea still intubated, to a recovery site where technical and experienced personnel support are available rather than to attempt extubation in the recovery area of the labour and delivery suite. If the potential for increasing airway oedema exists, such as in the preeclamptic patient, and in patients who have received major fluid resuscitation for blood loss, the airway should be carefully assessed before extubation. Additionally, a technique which facilitates reintubation should a trial of extubation fail, should be utilized.

5. The paediatric airway - special considerations

Airway assessment and care
The principles of airway care previously discussed have the same applicability to the paediatric patient as to the adult. However, knowledge of the physiology of children and of the anatomical differences between paediatric and adult airways is essential.[110] Congenital anomalies and infectious problems are seen more frequently in the paediatric population.[111] Some syndromes are characterized by gradual worsening of the quality of the airway. Finally, because a child's airway anatomy can be modified with growth, a previous successful intubation does not guarantee success in the future.

There are a number of imposed limitations regarding airway management in children. The degree of cooperation attainable from a child is variable and awake intervention may not always be an option. Techniques applicable in adult care may not be available because of size and technological limitations.

Loss of patency of a child's airway can rapidly result in hypoxaemia and desaturation due to a high baseline oxygen consumption. Administration of oxygen is critical during airway management in children. In addition, in small children, the use of atropine is recommended to prevent bradycardia associated with airway manipulation. Bradycardia in these patients can lead to severe hypotension because of the frequency-dependant cardiac output.

Role of newer technology in the management of the difficult paediatric airway
The content of a difficult airway kit intended for use in paediatric patients should be determined using the criteria set out in *2g. The difficult airway kit.*

The LMA is available in suitable sizes (# 1, 2, 2.5, 3) for use in the paediatric patient and case reports have documented its use in the management of the difficult airway. In some reports, the LMA was utilized to establish an airway urgently, whereas other reports cite its use to deal electively with a potentially difficult airway, alone or in association with a technique involving another device such as a fibreoptic bronchoscope.[112-17] Although good results have been noted with the use of the LMA in children with normal airway anatomy, the success rate in children with an abnormal airway has not been defined. Successful use in neonates for the purpose of resuscitation has been published.[117]

Lighted stylets are now available for use with endotracheal tubes as small as size #2.[118-20] The tracheas of 83.2% of 125 children were intubated with an LS in the largest paediatric series published.[120] In 40% of the failed attempts, the tracheal tube selected was too large for the child's trachea. Additionally, the intubations were performed by anaesthesia residents with little or no experience with LS intubation. In another series, in children with abnormal airways, tracheal intubation was successfully accomplished in 30 of 31 (97%) patients, with mean times for tracheal intubation, by staff anaesthetists. of 29.3 sec.[118]

The use of flexible fibreoptic endoscopes in children has expanded in recent years with the availability of FFE able to accommodate ET tubes as small as 2.5 mm (ID). There are case reports relating successful intubation of patients with recognized difficult airways or in patients in whom cervical spine movement was contraindicated.[121-3]

Borland and Casselbrandt reported their experience with 93 paediatric patients (range 1 day to 10 years) using the paediatric Bullard laryngoscope.[124] A success rate of 97% was noted in children with both normal (63/93) and abnormal (30/93) airways. Finally, Shulman published their experience using the adult BL in 50 consecutive children, aged 1-10 yr.[125] In four patients, all < 38 months of age, the tracheas could not be intubated with the adult BL yet were easily intubated with direct laryngoscopy. The mean time to intubation (time from last mask ventilation to the re-establishment of ventilation through the ETT) was 38 ± 13 sec.

The initial experiences with the newer technology in paediatric airway care, although limited, is positive and should encourage wider application and evaluation of these techniques.

The transtracheal airway in paediatric care

Retrograde intubation has been used in children either alone or in association with an FFE or a tube exchanger.[127-9] Concerns have been expressed regarding the possibility of trauma to the airway, especially in infants, because of the poorly defined cricothyroid membrane and the proximity of the vocal cords to the puncture site. Audenaert reported no complications in their experience with retrograde-assisted fibreoptic intubation with 20 patients (six less than 12 months of age).[127] A limited experience regarding the use of transtracheal jet ventilation (TTJV) in children has been published in the form of a two patient case report and it is not possible to comment meaningfully on the basis of the reviewed experience.[129]

Establishment of a transtracheal airway in children is a procedure that should be considered an option by experienced personnel, in emergency situations where immediate ventilation is necessary to prevent serious morbidity and mortality.

Extubation of the paediatric airway

Should the decision be taken to extubate the trachea in a child that presented difficulty at intubation, the extubation would ideally take place in a setting with not only experienced laryngoscopists present but also, depending on the situation, a surgeon competent in providing surgical access to the airway. An operating room equipped with a difficult intubation kit is likely the site where the most options to manage a difficult airway successfully would be located.

The airway in neonates - special considerations

Neonates represent a sub-group that deserves special consideration in regard to their particular anatomy and physiology which make them even more demanding to manage in a difficult airway situation. Advanced resuscitation of a newborn requires at least two persons competent in this field but in a difficult airway situation, the presence of a third person is advisable. When bag-mask ventilation, tracheal intubation and the LMA all fail to establish effective ventilation, the possibility of a laryngotracheal anomaly must be suspected. Immediate surgical access may be the only way to save the baby.

6. Documentation of a difficult airway experience

Following a difficult airway experience, a note should be written in the hospital chart detailing the nature of the problem and how it was dealt with. The old chart may not always be available to future caregivers and a note or letter should also be given to the patient again detailing the problem encountered and how it was resolved. (see Appendix 1 for sample letter) The attending surgeon should be informed of the difficulties encountered and a report sent to the primary care/family physician detailing the incident (see Appendix 2 for sample letter). Consideration may also be given to enrolling the patient with an accessible, dependable database, such as Medic-Alert.[130] If the experience in managing the patient's airway was such that, in the future, the physician would be reluctant to induce general anaesthesia and administer muscle relaxants without first securing the airway, then a Medic-Alert bracelet is likely indicated.

7. Airway management training

Theoretically, every anaesthetist should be familiar with and well practised in a variety of the techniques that are available so that when an unanticipated airway problem occurs, it can be managed successfully. However, with the advances in airway management technology, many of the newer airway devices are foreign to most anaesthetists. Rose has reported that alternatives to direct laryngoscopy were used in only 1.9% of 18,558 tracheal intubations in a tertiary care hospital.[5] If awake fibre-optic laryngoscopy was excluded, tracheal intubations were achieved through direct laryngoscopy almost exclusively. Rose further reported that, if Grade III-IV laryngoscopy was noted, 16% of patients experienced three or more laryngoscopies before tracheal intubation was achieved. This suggests that even experienced academic anaesthetists will persevere with standard techniques even if it is not optimal for the task at hand. Perhaps this is because many anaesthesia care providers lack familiarity with alternative techniques.

7a. Teaching airway management

The completion of an approved residency training programme is generally accepted to equate with the possession of the skills and knowledge necessary to deliver all forms of anaesthesia. However, documentation of technical performance during a minimum number of procedures during residency training is not required. Furthermore, the number of attempts at various procedures before a trainee becomes proficient at performing these techniques is not known. Kopacz assessed the training experiences of new trainees with respect to regional anaesthesia and tracheal intubation.[131] Each trainee attempted 86 ± 13 tracheal intubations. Successful tracheal intubation was achieved by the residents without staff assistance in 90.8% of the attempts. Although resident success at tracheal intubation had improved, compared with baseline, after only 20 attempts, a significant improvement was not maintained until after 45 attempts, when success simultaneously reached and was sustained above the 90% level. Although it is acknowledged that residents completing their training will have achieved these levels of experience with direct laryngoscopy, it is improbable that most will have similar levels of experience with the alternative techniques.

Despite recognition that airway management is fundamental to anaesthesia practice and may be life-saving, structured teaching of airway management does not occur in many training programmes.(Hung, personal communication) A core curriculum needs to be defined, either at the national, regional or local level, as the earliest step toward evolving a structured approach to teaching airway management. The most basic curriculum would have as its objectives: 1) providing trainees with a representative sampling of the literature regarding airway management and; 2) ensuring that the trainees, at the time of completion of their training, have the knowledge to ensure a prudent and rational approach to the difficult airway and the technical skills to enable them to execute the approach. Efforts must be made within training programs to ensure that trainees are both given adequate training and opportunity to become practised with alternative techniques.

7b. Continuing medical education

If new technologies are slow to be embedded in academic centres, acceptance in the community setting will not be widespread. With fibreoptic intubation, for example, there has been slow dissemination of the technique within the anaesthesia community; despite the formal establishment of various training programmes and workshops. Reasons offered for the slow acceptance of fibreoptic or, for that matter, of any new airway technology have included the high initial cost and subsequent repair or replacement of equipment, lengthy cleaning and disinfecting routines, and difficulty in learning and mastering the techniques. However, a lack of training and teaching is likely more of a problem than purchasing the equipment.[132] Continuing medical education programmes should be structured to allow physicians the opportunity to train with alternative airway devices. Simulation centres provide an opportunity to develop difficult and failed airway management techniques for initial and continuing education.

9. Recommendations regarding airway management

I A pre-anaesthetic airway evaluation should be carried out on all patients and a conclusion drawn regarding the likelihood of airway difficulties.

Quality of evidence: Level III; Grade C recommendation.

II The anaesthetic management plan should reflect the conclusions drawn from the pre-anaesthetic airway evaluation.

Quality of evidence: Level III; Grade C recommendation.

III All clinical care areas should be equipped with alternatives to facemask-bag ventilation and direct laryngoscopy for tracheal intubation.

Quality of evidence: Level III; Grade C recommendation.

IV Physicians providing airway care to patients should be familiar with and practised in alternative techniques to face mask-bag ventilation.

Quality of evidence: Level III; Grade C recommendation.

V In the event that unanticipated difficulty is encountered with face mask-bag ventilation, an alternative technique to ventilate the lungs should be utilized.

Quality of evidence: Level III; Grade C recommendation.

VI Physicians providing airway care to patients should be familiar with and practised in alter native techniques to direct laryngoscopy.

Quality of evidence: Level II; Grade B recommendation.

VII In the event that unanticipated difficulty is encountered with direct laryngoscopy for tracheal intubation, an alternative technique to intubate the trachea should be considered.

Quality of evidence: Level II; Grade B recommendation.

VIII A strategy should be in place to ensure continuous patency of the airway before extuba tion of a trachea which was previously difficult to intubate.

Quality of evidence: Level III; Grade C recommendation.

IX Patients should be advised when unanticipated airway difficulties were encountered.

Quality of evidence: N/A; Grade D recommendation

X A note should be entered on the patients' record when unanticipated airway difficulties were encountered, detailing the nature of the difficulties and how they were resolved.

Quality of evidence: N/A; Grade D recommendation

XI Training programmes in anaesthesia should develop a curriculum to ensure graduate physicians are skilled in alternative techniques for airway management.

Quality of evidence: N/A; Grade D recommendation

Appendix 1. Patient Sample Letter

THE TORONTO HOSPITAL
Department of Anaesthesia
200 Elizabeth St., Toronto, ON, Canada M5G 2C4
OR. (416) 340-3405 Fax: (416) 340-3698

October 20, 1996
To the patient:
During most general anaesthetics (sleep for surgery) it is necessary to put a breathing tube into the patient's trachea (windpipe). This tube assures oxygen flow to the lungs, heart, brain, and other vital organs.
It is more difficult to place the breathing tube for you than in most other people.
It is very important that you show this form to any anaesthetist taking care of you in the future. Your anaesthetist will be in a much better position to take good care of you if warned of this situation.
You should get and wear a Medic Alert Bracelet stating: "Difficult Tracheal Intubation".
If you have questions at any time regarding this matter, please do not hesitate to contact the Department of Anaesthesia at the Toronto Hospital.

Yours sincerely;

Signature of Physician

Appendix 2. Physician Sample Letter

THE TORONTO HOSPITAL
Department of Anaesthesia
200 Elizabeth St., Toronto, ON, Canada M5G 2C4
OR- (416) 340-3405 Fax: (416) 340-3698

October 20, 1996

To whom it may concern,

Re:________________________

This patient was found to be difficult to intubate by direct laryngoscopy at The Toronto Hospital.
Difficulty was:

☐ Unpredicted
☐ Predicted because:________________

Reasons for difficulty included:
☐ Prominent teeth ☐ Reduced neck mobility
☐ Large tongue ☐ Anterior larynx
☐ Reduced mouth opening
☐ Immobile epiglottis ☐ Other: __________

Bag/Mask ventilation was:
☐ Easy ☐ Difficult ☐ Impossible

The patient's airway was ultimately secured:
☐ Awake ☐ Asleep ☐ Could not be secured
using:
☐ Blade type:______ ☐ Laryngeal mask # ____
☐ Retrograde technique ☐ Stylet/Gum elastic bougie
☐ Light wand ☐ Cricothyrotomy
☐ Fibreoptic bronchoscope ☐ Blind nasal
Tracheostomy
☐ Other: ____________________

My recommendation for future anaesthetics is:
☐ Induction with short-acting agent and alternative techniques readily available
☐ Awake intubation after topical anaesthesia.
☐ Other:____________________
Further comments:

For any further information, please use the address and telephone numbers above.

Yours sincerely;

Signature of Physician

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