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Video Laryngoscopy for Tracheal Intubation

An Evidence-Based Analysis

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Executive Summary

Objective

The objective of this health technology policy assessment was to determine the effectiveness and cost-effectiveness of video-assisted laryngoscopy for tracheal intubation.

The Technology

Video-assisted, rigid laryngoscopes have been recently introduced that allow for the illumination of the airway and the accurate placement of the endotracheal tube.Two such devices are available in Canada: the Bullard® Laryngoscope that relies on fibre optics for illumination and the GlideScope® that uses a video camera and a light source to illuminate the airway. Both are connected to an external monitor so health professionals other than the operator can visualize the insertion of the tube. These devices therefore may be very useful as teaching aids for tracheal intubation.

Review Strategy

The objective of this review was to examine the effectiveness of the most commonly used video-assisted rigid laryngoscopes used in Canada for tracheal intubation. According to the Medical Advisory Secretariat standard search strategy, a literature search for current health technology assessments and peer-reviewed literature from Medline (full citations, in-process and non-indexed citations) and Embase for was conducted for citations from January 1994 to January 2004. Key words used in the search were as follows: Video-assisted; video; emergency; airway management; tracheal intubation and laryngoscopy.

Summary of Findings

Two video-assisted systems are available for use in Canada. The Bullard® video laryngscope has a large body of literature associated with it and has been used for the last 10 years, although most of the studies are small and not well conducted. The literature on the GlideScope® is limited. In general, these devices provide better views of the airway but are much more expensive than conventional direct laryngoscopes. As with most medical procedures, video-assisted laryngoscopy requires training and skill maintenance for successful use.

There seems to be a discrepancy between the seeming advantages of these devices in the management of difficult airway and their availability and uptake outside the operating room. The uptake of these devices by non-anesthetists in Ontario at this time may be limited because:

- Difficult intubation is relatively infrequent outside the operating room
- Many alternative and inexpensive devices are available
- There are no professional supports in place for the training and maintenance of skills for the use of these devices outside anesthesia.

Video laryngoscopy has no obvious utility in preventing airborne viral transmission from patient to provider but may be useful for teaching purposes.

Objective

The objective of this health technology policy assessment was to determine the effectiveness and cost-effectiveness of video-assisted laryngoscopy for tracheal intubation.

In October 2003, the Ontario Technology Advisory Committee requested an evidence-based analysis on the effectiveness and cost-effectiveness of video-assisted laryngoscopy for tracheal intubation. A literature review of this technology was synthesized with health system information so that recommendations for the provision of this technology in Ontario could be made.

Airway management is critical to the care of patients who are undergoing anesthesia during surgery, or who appear in trauma centres for acute myocardial infarction, respiratory distress or removal of foreign bodies. Difficult airway management has been a focus in medical school curriculum and many clinical organizations have addressed this issue in the form of guidelines and clinical statements. (1-11) The American Society of Anesthesiologists define difficult airway as "the clinical situation in which a conventionally trained anesthesiologist experiences difficulty with face mask ventilation of the upper airway, difficulty with tracheal intubation, or both."(2)

Tracheal intubation is the most common procedure for airway management. The American Society of Anesthesiologists (2) defines tracheal intubation as when an experienced practitioner with a rigid laryngoscope experiences:

- Difficulty in visualizing any part of the vocal chords after multiple attempts.
- Tracheal intubation that requires multiple attempts in the presence or absence of tracheal pathology.
- Placement of endotracheal tube fails after multiple attempts.

Various methods and devices are used for tracheal intubation with many associated technological advancements. The direct method of laryngoscopy with a rigid scope is the technique or pattern of practice most commonly reported to achieve tracheal intubation. When there is poor glottic visualization the intubation procedure using the rigid laryngoscope may be long and complicated.

Intubation with video capacity has greatly increased the ease of this procedure, especially in the operating room and in training students. (12-19) Supervisors can assess students more easily by visualizing the procedure on an external monitor and can also evaluate the placement of the tube as the procedure is taking place. They can give students immediate re-direction if the tube is not placed into the trachea correctly.

As in many medical procedures, there is a strong relationship between the volume of tracheal intubation procedures that a provider does and their success rates. It has been noted that for a 90% intubation success rate, a mean of between 47 and 57 attempts are required. (20;21) Anesthetists commonly perform tracheal intubation during surgery as part of their routine function in the operating room. As such, anesthetists are adept at intubation as part of their specialty training. Reported difficult intubation rates in the operating room range from 1.5% to 3.8%. (3) In the emergency room, difficult intubation rates range from 3% to 5.3% (4;9;22) and complications rates may be as high as 50% in providers with little experience. (22) Outside the hospital the reported rate of difficult intubation between 3% to 10%. (4;6) The difference in these rates is based on patient factors, provider experience and differences in the setting where intubation occurs. For example, the operating room setting is typically very controlled where patients are usually anaesthetized. In contrast, the emergency room, intensive care unit and trauma

situations outside the hospital, the environment is more likely to be uncontrolled and patients are more likely to be awake.

There is a huge volume of literature on the management of difficult airway and on tracheal intubation, specifically. This review will describe the most pertinent issues for tracheal intubation and the use of video laryngoscopy in particular. A discussion about the utility of video laryngoscopes and implications for their use in Ontario will follow.

Background

Clinical Need: Target Population and Condition

Airway management is critical for patients who are undergoing anesthesia, who have trauma or have severe respiratory disease. Tracheal intubation is a necessary part of airway management and if difficulties arise, it can be the cause of serious patient morbidity and sometimes, death. More recently, difficult intubation has been implicated in the patient-to-provider transmission of infectious disease in Ontario. Intubation is associated with provider and patient stress because of the difficulties sometimes encountered with the insertion of the tube. Some patients are difficult to intubate because of anatomical variations of the throat and larynx and/or foreign objects or blockages, making visualization of the glottis and airway difficult for the provider. Poor visualization of the airway has been estimated in about 2% to 8% of patients who require intubation, (5) whereas intubation that required a change in blade (mild difficulty) was reported as occurring in 1% to 18% of intubations in the operating room. (5) In the emergency department setting, the incidence of difficult airway is from 1% to 30%. (9)

As Table 1 illustrates, the focus of airway management in the emergency department and in the operating room differs because of the various functions that occur within these 2 settings. (9) In general, tracheal intubation in the operating room is a necessary procedure to guarantee airway protection while a patient is in a controlled, unconscious state. On the other hand, tracheal intubation in an emergency setting is based on patient need, such as potential facial, cervical, and airway injury, cervical immobilization or respiratory failure. Therefore, the patient requirements, the setting, and the physician specialty and experience are important factors in the comparison of operating and emergency airway management.

Most guidelines suggest that providers assess the patient's airway before starting tracheal intubation. (1-11) Tables 2 and 3 outline methods to determine the extent of visualization before tracheal intubation. A potentially difficult airway is defined by grades 3 and 4 in the Cormack-Lehane (23) and class III in the Mallampati system (24).

Guidelines for intubation suggest a pre-planned strategy for difficult intubation and a pre-set cart with the various devices necessary for difficult intubation in a particular setting. (1;2;8) The American Society for Anesthesiologists Guidelines (2) are among the most widely cited. Suggested devices on a difficult airway cart include the following:

- Assortment of rigid laryngoscopes in various sizes and shapes; may include a fibre optic rigid laryngoscope
- Assortment of tracheal tube sizes
- Tracheal tube guides including: light wands, forceps, ventilating tube exchanger, etc.
- Gum elastic bougies

- Flexible fibre optic scope
- Assortment of alternative device such as laryngeal mask or Combitube®
- Retrograde intubation equipment
- Emergency airway access equipment such as cricothyrotomy
- An exhaled CO2 detector

Table 1: Comparison of Airway Management in the emergency department and in the operating room

Aspects of Airway Management	Emergency Medicine	Anesthesiology
Setting	➢ Uncontrolled	➢ Controlled
Patient characteristics	➢ Always urgent or emergent ➢ Frequent cervical spine precautions ➢ Respiratory failure common ➢ Full stomach presumed	➢ Usually elective situation ➢ Infrequent cervical spine precautions ➢ Respiratory failure uncommon ➢ Usually NPO
Provider characteristics	➢ Emergency specialist ➢ GP/emergency specialist ➢ Paramedic	➢ Anaesthesia specialist
Usual preparatory time	➢ Seconds to minutes	➢ Hours to days
Alternatives for failed direct laryngoscopy	➢ Alternative devices (COMBITUBE, LMA) ➢ Fibre optic intuabation	➢ Fibre optic intubation ➢ Video technologies

Adapted from: Orebaugh SL. Difficult airway management in the emergency department. J of Emerg Med 2002; 22(1):31-48.

Table 2: Cormack-Lehane Classification (23)

Grade	Visual structure
1	Complete visualization
2	Visualization of the inferior portion of the glottis
3	Visualization of the epiglottis only
4	Inability to visualize the epiglottis

Source: Cormack RS, Lehane J. Difficult tracheal intubation in obstetrics. Anaesthesia 1984; 39:1105-11.

Table 3: Mallampati Classification (24)

Class	
I	Soft palate, faces, uvula, and pillars visible
II	Soft palate, fauces and uvula visible
III	Soft palate and base of uvula visible

Source: Mallampati SR, Gatt SP, Gugino LD et al. A clinical sign to predict difficult tracheal intubation: a prospective study. Can Anaesth Soc J 1985; 32:429-34.

Existing Intubation devices and techniques

Rigid laryngoscopes are traditionally used for tracheal intubation but when difficulties arise, external manipulation of the larynx, devices such as flexible fibre optic scopes, bougies and stylets or technologies such as light wands, laryngeal masks or Combitubes® may be used to secure the airway. (5;26)
The most frequently used devices for airway management and specifically, tracheal intubation are as follows.

Rigid Laryngoscope

The rigid laryngoscope is the device most commonly used for tracheal intubation. A direct line of vision is necessary for the successful insertion of a rigid laryngoscope. Typically, the operator stands behind the head of a patient who is lying down on their back, with the neck of the patient hyper extended and their nose is in the air. This is called the 'sniffing position'. If the epiglottis can be visualized, the rigid laryngoscope can be inserted under the epiglottis and advanced anteriorly. The provider maintains laryngeal force with one hand and then threads an endotracheal tube over a plastic bougie for intubation. (6) External manipulation of the larynx or depression of the thyroid may be indicated if the glottis cannot be visualized (e.g. anterior larynx). A change in operator positioning may be indicated if the patient is lying supine on the ground.

Rigid laryngoscopes are easy to use for a normal airway, inexpensive (about CDN$100), and easily sterilized. They are most frequently used to teach intubation to medical students. (27)

Standard rigid laryngoscopes have the following limitations:

- Limited view through the mouth of the patient
- View is apparent to only to the operator
- Operator needs both hands to hold the laryngoscope and to pass the endotracheal tube
- Difficulty in teaching the procedure because there is no practical way for the students and the teacher to have the same view

There are various types of rigid blades in various constructions, such as straight and curved blades and these come in various sizes. Once the blade is inserted into the patient's mouth and the larynx is exposed, the practitioner takes the tracheal tube in the right hand and passes it into the mouth, and then through the vocal chords and trachea under direct vision.

Flexible fibreoptic laryngoscope

Flexible fibre optic laryngoscopes are long and narrow and provide excellent well-lit views . This device passes the glottis, then the tracheal tube passes over it for intubation. Visualization past the glottis is often not optimal and fogging may be a problem. The use of these devices in conjunction with conventional rigid laryngoscopes may be effective in difficult airway situations. This device is very expensive, tends to break easily and is difficult to clean quickly. It is, however, recommended as a necessary component of a difficult airway cart. (2)

Other devices

Lighted Optical Stylet: The stylet is inserted into the endotracheal tube and can therefore aid in the view in difficult airways. This device may be used with other adjuncts such as laryngeal mask airways, flexible fibre optic scope, and direct laryngoscope. Unlike fibre optic devices, these stylets can be

cleaned and transported easily. The stylet should be bent at 40º to 60º for optimal outcomes. This device often requires external lights, video cameras and monitors. Fogging may also be a problem. (6)

Video-assisted endotracheal tube (VETT): This device is a standard tracheal tube with the capacity to transmit a video image of the trachea through fibres placed within the tracheal tube itself. The video tracheal tube is inserted into the pharynx under direct vision. Once in place the video capability can guide the operator to confirm the correct placement of the tube. (12)

External laryngeal manipulation with direct laryngoscopy: With the laryngoscope in the left hand, the operator's right hand manipulates the thyroid cartilage back, up, or to the side while observing the effect of the exposure of the larynx. This may improve the laryngeal view and facilitate the ease of laryngoscopy. (13)

Alternatives and adjuncts to tracheal intubation

There are a variety of devices that can be used when direct intubation has failed or is not an option. An alternative to direct intubation for airway management should always be available. Although this review will not focus on these devices, they are part of the ensemble of devices identified as being necessary for difficult intubation.

Combitube®: The Combitube® consists of 2 tubes fused together to form a single lumen that is inserted blindly into the trachea or the esophagus. The first tube has a closed distal end and ventilating side holes located between 2 balloons. When the Combitube® is in the esophagus the tidal volume down tube 1 goes into the lungs. Tube 2 is open-ended and provides a direct route to the stomach when the tube is in the stomach or to the lungs when it is in the trachea. The balloons are inflated in sequence. The tube enters the esophagus because of its shape and stiffness in relation to the pharynx structure. The Combitube® can reduce the risk of aspiration and provide more consistent ventilation. Training and use are relatively easy and skills can be maintained over a long period of time. Further, the operator does not need to be behind the patient's head for insertion. However, esophageal and pharyngeal trauma are possible complications. (26) This device is used frequently in the emergency department and by paramedics in the field. ((29) (personal communication)

Laryngeal mask airway (LMA): The laryngeal mask airway consists of a tube attached to a cuffed mask at the distal end. This device can be effectively used as an alternative to tracheal intubation and its use has been added to some life-saving courses. The operator blindly introduces the mask into the pharynx and advances it until resistance is felt as the tip of the mask reaches the upper esophageal sphincter. The cuff is then inflated and this seals the laryngeal inlet, leaving the distal opening above the glottis clear and secure. It can achieve similar oxygenation and ventilation volumes as tracheal intubation. It is easy to use with minimal training but it cannot overcome problems of gastric aspiration. Its use may protect against blood and other secretions in the upper airway. It slows for easier access to the patient than intubation because it can be inserted from the side or front of patient. (6) Successful insertion rates are reported as being from 64% to 100%, even for persons who were not intensely trained. (26)

Gum elastic bougie: The gum elastic bougie can assist the provider with tracheal tube insertion. It is long and flexible with an angled distal tip and is easier to place than the tracheal tube, even when visualization of the glottis is poor. Once the tracheal rings are felt, the tracheal tube is passed over the bougie and into tracheal position. (26)

Video-assisted larynogscopy

Video-assisted laryngoscopes were designed for intubating patients with known difficult airways.(6;12;15;16;25;34;35) These devices rely on the video transmission of the view from the tip of a rigid laryngoscope. The original designs employed a very thin fibre optic cable leading from the rigid laryngoscope to a video monitor at the patient bedside. Current models include a very tiny video camera mounted on the blade. The video capability provides the operator with visual cues to manoeuvre the laryngoscope and to confirm the position of the endotracheal tube.(12) Head and neck position is not as critical as it is with the use of conventional rigid laryngoscopes so these devices may be useful in trauma situations, although there is no empirical evidence of this. The video assistance also allows for better

teaching and training for medical, nursing, and emergency response trainees. (15) However, as with conventional laryngoscopy and other airway devices, successful use of the device requires skill and multiple uses is usually necessary for proficiency. (21) These devices can also be very expensive and the video monitor and necessary cables may be cumbersome in an emergency or operating room setting.

Choice of device for difficult airway

Table 4 provides a list of factors that could be considered when deciding to acquire or use alternative devices for airway management. Adapted from Smith and DeJoy, (6) this framework is important because it highlights various considerations for most devices used for tracheal intubation and could be consulted when purchasing any new devices or equipment for emergency airway management. However, gathering information on these various factors may be difficult and time consuming for each device considered.

Table 4: Consideration for selection and use of alternative intubation and ventilation devices (6)

Education	**Training**: practice time, availability of training materials (mannequins, simulators etc), supervision
Logistical	**Equipment costs/expenses**: initial costs, repairs, set-up times, mobility of equipment (cart), back up units
Clinical	**Clinical considerations**: Oxygenation and ventilation, minimize potential for complications; confirmation of proper placement; expertise in various situations

From Smith CE, DeJoy SJ. New equipment and techniques for airway management in trauma. Curr Opinion in Anaesthesiology 2001; 14:197-209.

Literature Review on Effectiveness

Objective

To review the effectiveness of the most commonly used video-assisted rigid laryngoscopes used in Canada for tracheal intubation.

Methodology

According to the Medical Advisory Secretariat standard search strategy, a literature search for current health technology assessments and peer-reviewed literature from Medline (full citations, in-process and non-indexed citations) and Embase for was conducted for citations from January 1994 to January 2004. Key words used in the search were as follows: Video-assisted; video; emergency; airway management; tracheal intubation and laryngoscopy.

Guidelines and articles about airway management and emergency airway management were included. Information from the grey literature was also included, where applicable.

Results of Literature Review

No previous health technology assessments pertaining to video-assisted laryngoscopy were found. Forty-three relevant reviews or articles pertaining to the management of difficult airway, particularly in the emergency department were found and used as background material. Six video-assisted rigid laryngoscopes are described in the literature. These are: Bullard®, GlideScope®, Macintosh, Miller, Upshurscope®, and the WuScope®.

Only the Bullard® and GlideScope® are licensed by Health Canada and these will be reviewed below.

Summary of Medical Advisory Secretariat Review

Bullard® laryngoscope

The Bullard® laryngoscope is a rigid blade whereby an ultra thin, fibre optic video endoscopic system is inserted into the working channel of the scope. The construction of the Bullard® has gone through much iteration over the 10 years since it was introduced, and many of the peer-reviewed articles focus on new additions to the scope. The blade is used almost exclusively with either a camera attached to the eyepiece or using direct view to a monitor.

With the video capabilities, the view from the distal blade can be seen from a bedside monitor and the operator can view through a working eyepiece on the scope. Laryngoscopy can be achieved without the added weight and the cumbersome nature of additional camera, light and cables. (14)

The noted advantages of this device are that the patient does not have to be in 'sniffing' position with neck extended and nose up. It therefore may be used when the patient requires cervical spine stabilization. (30) It is very useful for teaching intubation, (15) however the blade has a different shape than other conventional rigid laryngoscopes. As is the case with conventional laryngoscopy and other airway devices, the Bullard® requires training and practice for successful use. It has been associated with longer intubation times than other conventional laryngoscopes. (15;30) A pediatric version is available.

The Bullard® laryngoscope was developed in the early 1990's. The Bullard® was approved by Health Canada in May 2002 (Class II; License 156050), although it has been used in some centres in Ontario since it was developed in the early 1990s (personal communication; January 2004).

Seventy-two articles were found in the peer-review literature. These articles included the following:

- 8 randomized controlled trials or comparison study designs
- 15 case series including 3 with N<5; 2 with pediatric subjects
- 3 review articles
- 3 provider surveys
- 14 language other than English
- 29 letters

Appendix A describes the randomized controlled trials and comparison studies where the Bullard® was compared with various other devices. (31-37) All of these studies were set in the operating room with the anesthesia expert (anesthetist, resident or nurse) as the main operator. The main conclusions of these articles stated that the Bullard® was useful for tracheal intubation and airway management in general, especially for patients where cervical mobilization is not desirable. There was one study that suggested that the Bullard® was not as effective as rigid laryngoscopy. (31) In adult patients with simulated difficult airway, an 88% successful intubation rate was observed. (31)) In another study, successful intubation on a mannequin with a grade III view was about 90%. (35) There was a report that the additional tip of the blade became disengaged in the throat, (38) however this incident was deemed to be isolated. Most of these studies were either small, not randomized adequately and/or were analyzed descriptively. Many of these studies did not differentiate between measuring the technical skills of the operator and the efficiency of the device (Personal communication; January 2004;(39).

GlideScope®

The GlideScope® is a Canadian invention, developed in British Columbia. It is a self-contained intubation tool that provides professionals with an unobstructed view of the airway with a video monitor. This device can be used for grades 1-4 intubations, management of difficult airway, for removal of foreign objects and for teaching purposes. This device has a chip camera on the end of a laryngoscope so that the entire airway can be seen from an external monitor at the patient's bedside. A red and blue light emitting diode provides light and contrast and a fog-resistant high-resolution video chip at a 60º angle are inserted in the small plastic blade (18 mm thickness). The blade shape is similar to a conventional rigid laryngoscope and it is inserted by the direct method. The GlideScope® was approved for distribution in Canada by Health Canada in September 2001 (Class II; License 31781). A pediatric version is currently under development (Personal communication; November 2003).

Two articles on the GlideScope® were found in the peer-reviewed literature. One was a case report, (25) and the other was a letter describing a case series of 15 patients. (40) In the latter citation, the author reported that the GlideScope® successfully increased the ability to visualize the airway, according to the Cormack scale in 14 of 15 patients. The authors did not, however, provide adequate empirical evidence to make any conclusions on the effectiveness of this device compared with other

Comparison of Bullard® and the GlideScope®

There is no direct empirical evidence comparing the ease of getting a laryngeal view using these two devices. Table 5 highlights the characteristics of the Bullard® and GlideScope®, according to manufacturer's specifications and information from the literature review. The angle of the GlideScope® blade is similar to that of a conventional laryngoscope (60 degrees). Because of this characteristic the manufacturer of GlideScope® claims that additional training is not required for successful insertion of the scope. The Bullard® blade is S-shaped and is noted to require training to obtain optimal laryngeal views. The GlideScope® is small and lightweight while the Bullard® is larger. Because there are no fibre optic parts, the GlideScope® is durable and easily cleaned. The Bullard® has an eyepiece so the operation of inserting the tube is different than direct laryngoscopy. The monitor of the Bullard® is larger than the GlideScope® monitor. Both are easily cleaned.

Table 5: Comparison of Bullard® and GlideScope® characteristics according to manufacturer specifications and peer-reviewed and grey literature

Major Characteristic	**Bullard®**	**GlideScope®**
Eyepiece	Yes	No
Pediatric blade available	Yes	No (underway)
Patient position	Neutral	Neutral
Blade angle	S – shaped with removable tip to lift epiglottis	60 degrees (18 mm wide)
Cleaning properties	Fully immersible	Fully immersible as conventional laryngoscope
Training above direct laryngoscopy necessary?	Yes and practice (according to literature)	No (according to manufacturer)
Cost ($Cdn)	Approx. $8,000	Approx. $7,000

Diffusion of airway devices in Canada

In 2002, Jenkins et al (10) surveyed 833 Canadian anesthetists (response rate 49% of 1,702 surveys sent) to get an understanding of the devices available and used for airway management across Canada. Ontario respondents composed 41% of all respondents Canada-wide. Sixty percent of respondents worked in teaching hospitals. Availability of devices in Canada was stratified by region (Western Canada, Ontario, Quebec, Atlantic provinces) and by teaching and community hospitals. Table 6 the devices used in Canada, in teaching and community hospitals in Canada and in Ontario. There was a statistically significant difference in the devices reported by anesthetists in teaching versus community hospitals in Canada. For example, 43% of respondents reported having a rigid fibre optic scope in their hospital in Canada, whereas 51% of respondents in teaching hospitals and 31% of respondents in community hospitals reported having this type of device. In Ontario 48% of respondents reported having a rigid fibre optic scope in their hospital. It should be noted, however, that 60% of respondents worked in teaching hospitals and although this comparison was not reported for Ontario, this was probably not a representative sample because there are only 16 acute care teaching hospitals in Ontario.

This study supported previous conclusions that stated that the best management for difficult airway:

- Rests in the "experience, skill and familiarity of the airway device, rather than the devices themselves" (11)
- The incorporation of a new airway management technique into practice relies on "acquisition of information on a new technique, validation of information, clinically testing the technique, satisfaction with technique and incorporation of the technique into practice". (54)
- Training on advanced techniques and devices, simulation and repeated practice workshops are essential to integrating new techniques into practice.

Expert Opinion

To further understand the utility video-assisted laryngoscopes by specialists in various settings in Ontario, experts in the field were consulted. Table 7 summarizes their perspectives.

Summary of Review

Tracheal intubation and difficult airway management is a potential problem in operating rooms, emergency departments, intensive care units and out in the field. Management of difficult airway has been well researched and many devices have been developed and used to improve the process of attaining a good airway. The direct method of laryngoscopy is the most frequently used technique for tracheal intubation. Guidelines are available for the management of difficult airway. (2) In the hospital setting, a difficult airway cart that contains a variety of devices that can be used when a problem arises is recommended. In the field, paramedics use a variety of alternative devices that reflect the unique challenges that they face.

Video-assisted laryngoscopy is a relatively new method of tracheal intubation in which the airway can be visualized on an external monitor at the patient's bedside during the insertion of the endotracheal tube. Two such laryngoscopes are available in Canada, the Bullard® laryngoscope and the GlideScope®. Although the Bullard® laryngoscope has been used in Ontario for many years, there is currently limited empirical evidence to suggest that patient intubation outcomes using video-assisted devices are better than conventional laryngoscopy. Most of the peer-reviewed literature on video-assisted laryngoscopy is set in the operating room with intubation performed by anaesthetists.

In Ontario, the utility of these devices seems currently limited to the operating room where intubation is done routinely. Video-assisted laryngoscopy requires a monitor and is therefore not practical outside the hospital (they require electrical power, although battery operation is an option in some cases). They are more expensive than rigid laryngoscopes.

Table 6: Perspectives of Ontario specialists about the utility of video laryngoscopy

Specialist	Setting	Perspectives
Anesthetist #1	Urban teaching hospital #1	➢ Video laryngoscopes should be more widely used
Anesthetist #2	Urban teaching hospital #2	➢ Difficult intubation is more common in emergency departments and intensive care units than in the operating rooms ➢ Emergency doctors who don't do a lot of intubations may be anxious about direct laryngoscopy ➢ Video-assisted laryngoscopy could help alleviate anxiety (better visualization, easier intubation) ➢ New technologies should be reviewed and evaluated
Emergency specialist	Urban teaching hospital #3	➢ Received training on a Bullard® a while ago, but haven't used it since then ➢ Patient outcomes depend on the experience of the operator ➢ Decision of what to buy for airway management should be made by the hospital with input of professional practitioners
Emergency specialist	Urban teaching hospital #4	➢ Time taken to learn video laryngoscopy would not be effective because there are too few cases where it would be used ➢ No clear advantage to patient outcomes
Emergency specialist/ educator	Urban teaching hospital #3	➢ Doubtful if there are differences in patient outcomes between video-assisted laryngoscopy and conventional direct laryngoscopy ➢ Emergency departments have many devices that the emergency physicians are trained to use ➢ Video-assisted laryngoscopy is not more effective or cost-effective than devices already in use ➢ May be useful for teaching purposes
Chief of Emergency	Rural community hospital	➢ Most emergency physicians are comfortable with alternative airway devices such as laryngeal mask airway, Combitube® and/or bougie ➢ Video-assisted laryngoscopy takes some practice to learn; skill must be maintained; wouldn't use the device enough to make the time taken to learn worthwhile ➢ Cost for training on video laryngoscopy would be better spent on advanced airway training and a difficult airway cart with devices that a group of physicians prefer
Emergency Services Branch	Ontario Ministry of Health and Long-term Care	➢ 99% of paramedic intubations in Ontario are currently successful

These devices seem to have limited utility in the protection of infectious disease transmission between patient and provider. Although the operator may not need to peer down the patient's throat to visualize the airway, the transmission of infected droplets is still possible. Universal precautions should always be executed when a patient with infectious disease is suspected (e.g. SARS) and pre-specified guidelines for practice should be used. Current guidelines recommend the paralyzation of suspected SARS patients prior to intubation.(5)

The diffusion of video-assisted laryngoscopy seems to be low, especially in anaesthesia departments in community hospitals and in emergency departments overall.(10;17;18) Their utility in Ontario at this time may be limited because difficult intubation is relatively infrequent outside the operating room, many cheap, alternative devices are available, and there are no professional supports in place for the training and maintenance of skills for the use of these devices.

The use of video-assisted laryngoscopes may, however, be of benefit in a teaching situation where novice practitioners can visualize the technique of a supervisor and visa versa.

Appendices

Appendix A: Comparison studies of Bullard® Laryngoscope

	Shulman, Nordin, Connelley 2003 (33)	Shulman, Connelley 2001 (32)	Weiss, Schwarz, Gerber 2000 (35)	Shulman, Connelley 2000 (32)
Study type	RCT – video monitor vs eyepiece	RCT – patients vs themselves	Contemporaneous comparison	Prospective comparison
Operator	Anesthetists and nurses who performed < 3 intubations using Bullard® in past 5 years	1 anesthetist	40 anesthetists	anesthetist
Setting	Operating room	Operating room, tertiary care	Operating room	Operating room
Patient population	459 patients with initial video training vs 579 patients using direct method through eyepiece	50 patients (25 with cricoid pressure; 25 without)	40 anesthetists x 10 attempts with each device	50 pediatric patients (ages 1 to 5) undergoing anesthesia
Comparison	Training – Video using Bullard® (N=16) vs direct laryngoscopy (N=20)	Bullard® vs flexible fibre optic on patients with neck collar	Bullard® vs video optical stylet (VOIS) in tracheal tube using direct laryngoscopy	Adult Bullard® vs Wis-Hipple laryngoscope (WhL)
Outcome measures	Success rate and time to intubation	Success rate and time	Success rate and time to intubation	Laryngeal view, number of intubation attempts, time to intubation, reason for difficult intubation, attempts and time by age and weight of patient
Conclusions	Video feedback allow for individualized learning	Anesthetized patients undergoing inline stabilization are intubated faster and more successfully using Bullard® than flexible fibreoptic bronchoscope even under cricoid pressure	VOIS requires little training and no change of protocol should difficulty arise compared to Bullard®	Adult Bullard® complemented the WhL in pediatric patients

Appendix A continued: Comparison studies of Bullard® Laryngoscope

	MacQuarrie, Hung, Law 1999 (31)	Watts, Gelb, Bach, Pelz 1997 (30)	Hastings, Vigil, Hanna, Yang, Sartoris 1995 (37)	Cooper, Benumof, Ozak 1994 (36)
Study type	RCT	Contemporaneous comparison; patients as own controls	Contemporaneous controls	Comparison
Operator	Anesthetist	1 experienced anesthetist using Bullard (at least 50 procedures)	Anesthetist	2 skilled anesthetists
Setting	Operating room	Operating room	Operating room	Operating room
Patient population	40 patients with rigid cervical collar to simulate difficult airway	24 patients	35 patient lying on board with head in neutral position to simulate immobile spine	60 patients undergoing elective surgery
Comparison	Bullard® plus independently stylletted endotracheal tube (ISETT) vs Bullard® plus new multifunctional intubating stylet (MFIS)	Bullard® vs Macintosh rigid blade with and without inline stabilization	Bullard® vs Macintosh vs Miller blades	Bullard® with ISETT vs Macintosh 3 blade vs Bullard® with intubation forceps vs Bullard® with endotracheal tube and directional tip vs Bullard® with new dedicated intubating stylet
Outcome measures	Time to intubation, failure rate, number of attempts, hemodynamic changes	Mean cervical spine extension, mean time to intubation	Head extension, cervical spine movement, laryngeal view	Time to intubation, number of attempts
Conclusions	Bullard® used with either stylet was effective for patients with simulated difficult airway.	Intubation with Bullard® took longer and was more difficult to manipulate; more training necessary with Bullard but less cervical spine extension.	Bullard® caused less head and cervical extension than rigid blades and yielded better view; may be useful where spine movement is not desirable.	Bullard® may be uniquely useful in trauma patients wth uncleared cervical spines and other patients when head and neck require immobilization

References

(1) An EAST Practice Management Guidelines Workgroup. Guidelines for emergency tracheal intubation immediately following traumatic injury. 1-80. 2002. Youngstown, Ohio, Eastern Association for the Surgery of Trauma.

(2) American Society of Anesthesiologists. Practice Guidelines for Management of the Difficult Airway. Anesthesiology 2003; 98:1269-1277.

(3) Crosby ET, Cooper RM, Douglas MJ, Doyle DJ, Hung OR, Labrecque P et al. The unanticipated difficult airway with recommendations for management. Can J Anaesth 1998; 45(8):757-776.

(4) Clancy M, Nolan J. Airway management in the emergency department. Emerg Med J 2001; 19:2-3.

(5) Cooper A, Joglekar A, Adhikari N. A practical approach to airway management in patients with SARS. CMAJ 2003; 169(8):Online 1-Online 3.

(6) Smith CE, DeJoy SJ. New equipment and techniques for airway management in trauma. Curr Opinion in Anaesthesiology 2001; 14:197-209.

(7) Blanda M, Gall UE. Emergency airway management. Emerg Med Clinics of North America 2003; 21(1):1-80.

(8) Colleges des medecins du Quebec. Demarche en cas de difficultes imprevues a l'intubtion. 2000. Montreal, College des medecins du Quebec.

(9) Orbaugh SL. Difficult airway management in the emergency department. J of Emerg Med 2002; 22(1):31-48.

(10) Jenkins K, Wong DT, Correa R. Management choices for the difficult airway by anesthesiologists in Canada. Canadian Journal of Anaesthesia 2002; Vol. 49(8):-856.

(11) Rosenblatt WH, Wagner PJ, Ovassapian A, Kain ZN. Practice patterns in managing the difficult airway by anesthesiologists in the United States. Anesth Analg 1998; 87:153-157.

(12) Weiss M. Video assisted airway management. Int J of Anesthesiology 1999; 3(1).

(13) Levitan RM, Mickler T, Hollander JE. Improving laryngeal view during intubation: a videographic analysis of external laryngeal manipulation. Academic Emergency Medicine 2001; 8(5):421.

(14) Dullenkopf A, Lamesic G, Gerber A, Weiss M. Video-enhanced visualization of the larynx and intubation with the Bullard laryngoscope--equipment report. Can J Anaesth 2003; 50(5):507-510.

(15) Weiss M, Schwarz U, Dillier CM, Gerber AC. Teaching and supervising tracheal intubation in paediatric patients using videolaryngoscopy. Paediatric Anaesthesia 2001; Vol. 11(3):-348.

(16) Biro P, Weiss M. Comparison of two video assisted techniques for the difficult intubation. Acta Anaesthesiol Scand 2001; 45:761-765.

(17) Hung O. Airway management: the good, the bad and the ugly. Can J Anesth 2002; 49(8):767-771.

(18) Ezri T, Szmuk P, Warters RD, Katz J, Hagberg CA. Difficult airway management practice patterns among anesthesiologists practicing in the United States: have we made any progress? J Clin Anesth 2003; 15(6):418-422.

(19) Levitan RM, Kush S, Hollander JE. Devices for difficult airway management in academic emergency departments: results of a national survey. Ann Emerg Med 1999; 33(6):694-698.

(20) Mulcaster JT, Mills J, Hung OR, MacQuarrie K, Law A, Pytka S et al. Laryngoscopic intubation. Anesthesiology 2003; 98(1):23-27.

(21) Konrad C, Schupfer G, Wieuisbach M, Gerber H. learning manual skills in anesthesiology: is there a recommended number of cases for anesthetic procedures? Anesth Analg 1998; 86:635-639.

(22) Morton T, Brady S, Clancy M. Difficult airway equipment in English emergency departments. Anaesthesia 2000; Vol. 55(5):-488.

(23) Cormack RS, Lehane J. Difficult tracheal intubation in obstetrics. Anesth 1984;39:1105-1111.

(24) Mallampati SR, Gatt SP, Gugino LD et al. A clinical sign to predict difficult tracheal intubation: a prospective study. Can Anaesth Soc J 1985;32:439-434.

(25) Cooper R. Use of new video laryngoscope (GlideScope®) in the management of a difficult airway. Can J Anesth 2003; 50(6):611-613.

(26) Shuster M, Nolan J, Barnes TA. Airway ventilation and management. Emerg Card Care 2002; 20(1):23-34.

(27) Hung WT, Yang MW, Lin CY. Evaluation of learning effectiveness in endotracheal intubation by the use of a laryngoscope in combination with a flexible fiberoptic bronchoscope. Acta Anaesthesiologica Sinica 2001; 39(3):129-133.

(28) Foley LJ, Ochroch EA. Bridges to establish an emergency airway and alternate intubating techniques. Crit Care Clin 2000; 16(3):429-44, vi.

(29) Lefrancois DP, Dufour DG. Use of the esophogeal tracheal combitube by basic emergency medical technicians. Resuscitation 2002; 52(1):77-83.

(30) Watts AD, Gelb AW, Bach DB, Pelz DM. Comparison of the Bullard and Macintosh laryngoscopes for endotracheal intubation of patients with a potential cervical spine injury. Anesthesiology 1997; 87(6):1335-1342.

(31) MacQuarrie K, Hung OR, Law JA. Tracheal intubation using Bullard laryngoscope for patients with a simulated difficult airway. Can J Anaesth 1999; 46(8):760-765.

(32) Shulman B, Connelly NR. The adult Bullard laryngoscope as an alternative to the Wis-Hipple 1(1/2) in paediatric patients. Paediatr Anaesth 2000; 10(1):41-45.

(33) Shulman GB, Nordin NG, Connelly NR. Teaching with a video system improves the training period but not subsequent success of tracheal intubation with the Bullard laryngoscope. Anesthesiology 2003; 98(3):615-620.

(34) Shulman GB, Connelly NR. A comparison of the Bullard laryngoscope versus the flexible fiberoptic bronchoscope during intubation in patients afforded inline stabilization. J Clin Anesth 2001; 13(3):182-185.

(35) Weiss M, Schwarz U, Gerber AC. Difficult airway management: comparison of the Bullard laryngoscope with the video-optical intubation stylet. Can J Anaesth 2000; 47(3):280-284.

(36) Cooper SD, Benumof JL, Ozaki GT. Evaluation of the Bullard laryngoscope using the new intubating stylet: comparison with conventional laryngoscopy. Anesth Analg 1994; 79(5):965-970.

(37) Hastings RH, Vigil AC, Hanna R, Yang BY, Sartoris DJ. Cervical spine movement during laryngoscopy with the Bullard, Macintosh, and Miller laryngoscopes. Anesthesiology 1995; 82(4):859-869.

(38) Habibi A, Bushell E, Jaffe RA, Giffard RG, Brock-Utne JG. Two tips for users of Bullard Intubating Laryngoscope. Anesth Analg 1998; 87(5):1206-1208.

(39) Crosby ET. Modelling the difficult airway - how real is faking it? Can J Anesth 2002; 29:448-452.

(40) Agro F, Barzoi G, Montecchia F. Tracheal intubation using a Macintosh laryngoscope or a GlideScope in 15 patients with cervical spine immobilization. Br J Anaesth 2003; 90(5):705-706.

(41) Slotnick HB. How doctors learn: physicians self-directed learning episodes. Acad Med 1999:83:1343-46.