

## Technical Report

# The use of an endotracheal ventilation catheter in the management of difficult extubations

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**Purpose:** To describe the clinical experience with a new device, designed to maintain airway access following tracheal extubation.

**Features:** The endotracheal ventilation catheter (ETVC) is a semi-rigid polyurethane catheter with a distal hole and side-holes. A proximal connector permits attachment to a high pressure gas source for jet ventilation. Such a device can be introduced through an existing endotracheal tube, prior to its removal, and then used as stylet to facilitate reintubation. In 202 consecutive patients, the main use was to maintain airway access for up to 72 hr. It was well tolerated and associated with a high probability of successful reintubation even when the glottis cannot be visualised.

**Conclusion:** The ETVC is a safe and effective means of maintaining airway access after tracheal extubation, even when the glottis cannot be visualized.

**Objectif:** Décrire l'expérience acquise avec un nouveau dispositif destiné à maintenir un accès aux voies aériennes après l'extubation de la trachée.

**Caractéristiques:** Le cathéter endotrachéal de ventilation (CETV) est constitué d'un cathéter semi-rigide de polyuréthane avec une ouverture distale et deux ouvertures latérales. Un raccord proximal permet de le brancher sur une source de gaz à haute pression pour la ventilation par jet. Ce dispositif peut être introduit au travers d'un tube endotrachéal déjà inséré, avant son retrait, et être l'utilisé par la suite comme un mandrin pour faciliter la réintubation. Chez 202 patients, on l'a surtout utilisé pour maintenir un accès aux voies aériennes pendant 72 heures ou moins. Le cathéter a été bien toléré et a permis un pourcentage élevé de réintubation quand la glotte ne pouvait être visualisée.

**Conclusion:** Le CETV est efficace et permet de maintenir l'accès aux voies aériennes en toute sécurité après l'extubation, même lorsque la glotte ne peut être visualisée.

### Keywords:

AIRWAY: management;

EQUIPMENT: tubes, endotracheal;

VENTILATION: jet.

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Postoperative and intensive care patients occasionally require tracheal reintubation. Emergent reintubation may be complicated by hypoxia, hypercapnia, secretions or blood, haemodynamic instability, agitation or limited access. This may be challenging to the practitioner and life-threatening for the patient. Unfortunately, there is limited literature identifying those patients more likely to require reintubation.<sup>1</sup> The American Society of Anesthesiologists Task Force for the Management of the Difficult Airway recently published practice guidelines, recommending that each anaesthetist have a preformulated strategy for extubating the difficult airway.<sup>2</sup> Since it is difficult to predict which patients are likely to require reintubation, such a strategy should reliably facilitate reintubation, even when the glottis cannot be visualized. This should be possible with minimal risk, discomfort or expense. If warranted by the clinical situa-

tion, the operator should be able to provide oxygenation and/or ventilation during the reintubation effort.

This report describes a device designed to achieve these objectives. The clinical indications and complications encountered in the first 202 consecutive uses are discussed.

#### Methods:

A semi-rigid polyurethane catheter was fashioned after Bedger and Chang's "jet stylet."<sup>3</sup> Preliminary use as an emergency tracheal tube exchange catheter prompted further refinements and the eventual manufacture by CardioMed Supplies, Inc. (Gormley, Ontario). Known as an "endotracheal ventilation catheter" (ETVC),\* it is constructed of polyurethane, with a length of 65 cm, a distal end-hole and several side-holes (Figure). It has a radiopaque stripe and distance markings along its entire length. The outer (OD) and inner (ID) diameters are approximately 4 and 3 mm respectively. Unlike Bedger's jet stylet, a secure Luer-lock connector rather than a removable 15-mm adaptor is provided. This proximal connector permits attachment to a high pressure circuit for jet ventilation, capnography or oxygen insufflation.

Use of the ETVC was approved by the institutional ethics committee and written, informed consent was obtained for its use in elective orthognathic surgery when postoperative mouth-opening was expected to be restricted. The requirement for consent was waived for emergency use.

Tracheal extubation was performed as follows: the trachea and oropharynx were suctioned and the ETVC was introduced through the existing endotracheal tube (ETT), aligning the distance markings of the two devices. The proximal connector on the ETVC was removed, the tracheal cuff was deflated and the ETT was withdrawn over the ETVC, ensuring that the latter remained at the desired depth. The catheter was secured to the face or nose using waterproof tape. It was left *in situ* until there was no longer concern about a potential requirement for reintubation.

If a tracheal tube exchange or reintubation was required, a new ETT was loaded and oxygen tubing was attached to the ETVC to permit insufflation at 2-6 litres per minute as required. If jet ventilation was required, general anaesthesia with muscle relaxation was provided and a hand-held jet injector was attached to the proximal Luer-lock connector. The lungs were ventilated at 15-50 pounds per square inch (psig) so as to achieve adequate chest expansion. Passage of the ETT was gen-

\*The author receives limited royalties from the sale of the ETVC.

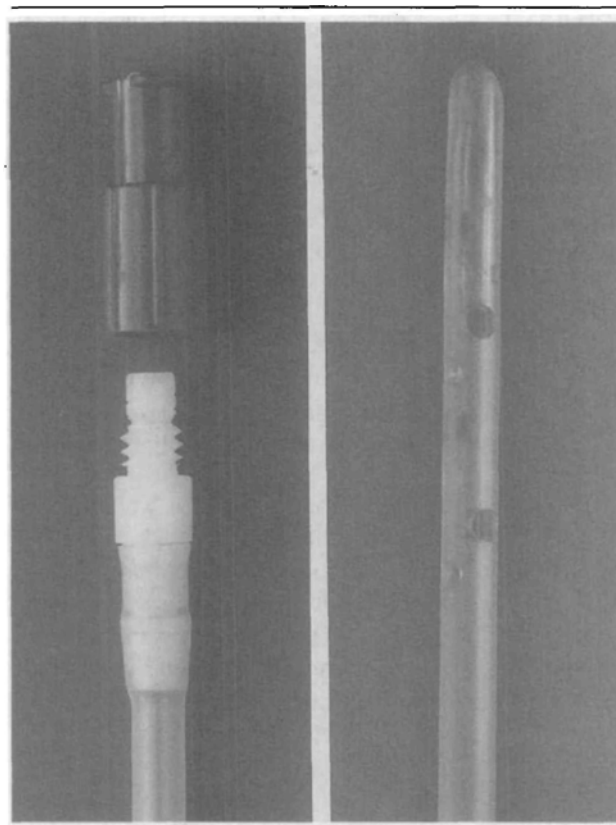


FIGURE The right panel is a close up of the distal end of the ETVC (CardioMed Supplies, Inc.). Eight helically arranged side-holes and an end hole are present. The left panel shows the proximal end. A conical male connector is welded into the catheter and a removable luer-lock jet adaptor can be threaded onto the catheter. This can be attached to a jet injector, oxygen tubing for insufflation or a capnograph for respiratory monitoring. (Reproduced with permission from Cooper RM, Cohen DR Can J Anaesth 1994, 41, 1196.)

erally performed without the assistance of laryngoscopy. In some patients, a jaw thrust or elevation of the tongue was performed. If advancement of the ETT arrested near the vocal cords, rotation of the tube usually facilitated tracheal placement.

During an initial two-year period, patient selection and catheter use was restricted to the author. When a commercial product had become available, patient selection and application was at the discretion of the attending or PACU anaesthetist. In the ICU, medical, surgical or anaesthesia residents and staff selected patients and used the ETVC. Efficacy and complications were assessed by the user, and a form was completed and returned to the author. Requests for additional information were made within two days, whenever possible.

#### Results:

Between January 1991 and November 1993, the catheter

was used in 202 patients (115 males, 87 females, mean age 50.3 years).

The most common indication was to maintain airway access ( $n = 120$ ). Many of these patients had difficult airways, requiring multiple attempts, various techniques or fiberoptic intubation. Also included were patients who had undergone maxillary or mandibular osteotomies with or without intermaxillary fixation, temporomandibular joint repairs, airway burns, prolonged intubation with or without an air leak upon cuff deflation, severe rheumatoid arthritis, cervical spinal fusion, thymectomy for myasthenia gravis, paratracheal lymphoma or hematoma, carotid endarterectomy with a bleeding diathesis and oral malignancy with swelling.

The catheter was well tolerated by nearly all patients, without need for additional analgesia, local anaesthesia or sedation. Coughing or poor tolerance often indicated too distal placement resulting in carinal stimulation. Among the first 202 patients, only five complained of discomfort. This was managed by catheter removal or the instillation of lidocaine. When well tolerated, removal generally coincided with readiness for PACU discharge or when reintubation seemed very unlikely. During this time, the ETVC was used for oxygen insufflation, capnography or to maintain tracheal access. In three patients, the catheter remained in place for 48–72 hours. All patients were able to breathe, cough and talk with the ETVC *in situ*. The ETVC was dislodged by five of 202 patients, as a result of inadequate fixation, vigorous coughing or “tonguing-out.”

Tube exchange and reintubation were attempted in 22 of the initial 202 patients, successfully in 20. Failure may have been related to excessive pliability of a prototype catheter ( $n = 1$ ) and operator inexperience ( $n = 1$ ).

The ETVC was used for to provide jet ventilation for 45 of these patients, including 30 patients undergoing tracheostomy, tracheal biopsy or resection and panendoscopy. All of these patients were anaesthetized, paralyzed and their lungs ventilated by jet injection. Barotrauma occurred in five patients (11%).

### Conclusions

Although respiratory complications are the most costly of anaesthesia complications, both to their victims and the profession,<sup>4</sup> extubation has been largely ignored in the literature. The need to reintubate a wide variety of postoperative patients is in the order of 0.1%<sup>5–7</sup> but may be orders of magnitude higher for selected populations such as panendoscopy<sup>5</sup> or critical care patients.<sup>8,9</sup> Generally such patients can be reintubated with relative ease. However, those whose airways may be less accessible, encroached upon, or who had been difficult during

a controlled induction offer special challenges. The American Society of Anesthesiologists Task Force on the Management of the Difficult Airway has recommended consideration of placement of a stylet prior to extubating the difficult airway, to facilitate reintubation and allow ventilation.<sup>2</sup>

Extubation strategies include simple removal, use of a bronchoscope, nasogastric tube, gum elastic bougie, or the use of a commercial device designed to facilitate tube exchange or reintubation. From Cook Critical (Bloomington, IL) the following products are available: Cook Airway Exchange Catheter™, Metro™ Endotracheal Tube Replacement Obturator, and the Patil Two-Part Intubation Catheter™. As well, the Tracheal Tube Exchanger™ and the JETTX™ are available from Sheridan Catheter Corporation (Argyle, NY). The features of these devices has been discussed elsewhere.<sup>1</sup> None has been evaluated in the literature. The ETVC (CardioMed Supplies Inc., Gormley, ON) was designed to provide a lumen for insufflation, ventilation or capnography, a removable Luer-lock adapter for secure attachment to an injector system and multiple distal side-ports to stabilize the catheter during high pressure jet ventilation.

The majority of patients in whom the device was used did not require reintubation. The high degree of patient tolerance and relatively low cost (currently \$19 Cdn) permit use in patients with difficult airway access, even when reintubation seems unlikely. Apart from poor tolerance or dislodgment, no complications were associated with its use when jet ventilation was not required. Its utility as a reintubation device remains to be determined. Although it was successful in 20 of 22 attempts (91%), a larger experience base is essential before a high degree of confidence can be felt. The plastic's pliability is a compromise between the risk of trauma and the need for rigidity. Additional experience acquired beyond the first 202 patients suggests a higher degree of success, with approximately the same degree of difficulty as is encountered in the passage of an endotracheal tube over a fiberoptic bronchoscope.

The high occurrence of barotrauma (5/45) relates to patient selection and operator errors. Catheter placement, the lowest acceptable driving pressure, an unobstructed upper airway and the appropriate inspiratory : expiratory ratio to minimize gas trapping are essential.<sup>10</sup>

In summary, the ETVC provides a safe and effective means of maintaining airway access following tracheal extubation. Oxygen insufflation, jet ventilation, and intratracheal capnography can be achieved. It may facilitate reintubation, even when the glottis cannot be visualized, although the reliability of this technique awaits a larger experience.

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