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SHORT COMMUNICATION

National survey to assess the content and availability of difficult-airway carts in critical-care units in the United States

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Abstract We have surveyed the availability of equipment, content of difficult-airway carts (DAC), and training in the use of such equipment in intensive-care units (ICU). We devised a set of proposals regarding what constitutes the ideal DAC. We surveyed 300 ICU in the United States. The survey was conducted to inquire about the presence and content of a DAC. Only 70% of respondents had a DAC in their unit. 82% of units surveyed checked the contents of the cart daily. 80% of directors were aware of its location. 80% of units had an attached list of contents and 51% had an attached algorithm for management of a difficult airway. LMA was present in 80% followed by 35 and 30% for Combitube and pre-assembled needle cricothyroidotomy set. Under non-invasive airway devices, video laryngoscope with 48% was ahead of fibreoptic bronchoscope (38%) and lighted stylet (15%). 80% of units had a CO_2-detection device immediately available. Limited data are available on the impact of DAC in airway management in the ICU. It is strongly recommended that a DAC be present. What constitutes the ideal contents of a DAC is open to questions. We hope discussion will lead to consensus of what should or should not be included on the cart.

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Inability to intubate and ventilate patients with respiratory failure is associated with significant morbidity and mortality. A patient is considered to have a difficult airway if an anesthesiologist or other health-care provider experienced in airway management is unable to ventilate the patient's lungs using bag-mask ventilation and/or is unable to intubate the trachea using direct laryngoscopy. Treatment algorithms for difficult-airway management (DAM) developed by the American Society of Anesthesiologists (ASA) assume the availability of equipment and expertise in a "cannot intubate, cannot ventilate" situation [1]. The role of the difficult-airway cart (DAC) in airway management in the intensive-care department has not been evaluated. Rapid access to difficult-airway equipment is essential for provision of safe airway management.

There is extensive literature describing the use of various types of advanced airway equipment [2–4], the use of simulators to teach DAM skills [5], allocation of staff and prevention strategy for management of difficult airways [6], and identification of the need to educate residents in advanced airway techniques [7–10]. However, limited data are available for evaluation of DAC in intensive-care units (ICU) [11–14].

The primary objective of our survey was to determine the availability of DAC and equipment in the ICU.

Following an internal review of DAC at VA Medical Center, an affiliate of the University of Buffalo, a tertiary referral center for cardiac, thoracic, and otolaryngology surgery, we devised a set of proposals regarding what constitutes an ideal DAC (Table 1).

The survey was developed using dichotomous questions. It was first piloted among our own ICU and Anesthesiology staff. If the unit director was not an anesthesiologist, the survey was mailed to the anesthesia director. The responsibility for management of difficult airways in the ICU in academic institutions falls within the practice domain of anesthesiology departments.

In September 2009, 300 surveys were mailed to surgical and medical ICU directors or anesthesia directors with more than 5 years experience in academic institutions in the United States. ICU with <12 beds were excluded. Physicians who did not respond to the initial survey were sent a repeat mailing or fax. If they failed to respond to both mailing and fax, they were contacted by telephone. This survey asked the physicians about training in the use of emergency airway carts and the specific devices they had used for intubations. Alternative devices for emergency airway carts were categorized into those for intubations (i.e., actual placement of the tracheal tube) and those for ventilation. The alternative intubation and ventilation devices selected are specifically listed in the ASA Difficult Airway Algorithm [1].

The survey included a list of equipment desirable in DAM situations, categorized into those falling under basic aids to DAM, alternative ventilation equipment, non-invasive airway devices, invasive airway devices, and intubation-confirming devices, all grouped in a questionnaire. The presence or absence of 16 items was to be answered yes or no. Nine other questions inquired about the presence of any other (DAM) related issues and about training programs for DAC in the ICU (Table 1). The number and percentage availability of this equipment in ICU settings were determined separately in the responding surveys.

We obtained information from 180 of 300 ICU. Only 70% of units surveyed had a DAC in their unit, 69% did not have a consultant responsible for the DAC, 80% of units surveyed checked the contents of the cart either daily or after use in most cases. Eighty percent of staff were aware of its location. Approximately 60% of the units surveyed said that they were not trained in the use of the equipment. Eighty percent of units had an attached list of contents and 51% had an attached algorithm for management of a difficult airway. As expected, there was variability in the availability of equipment on the cart; in some cases this was true of standard equipment. Table 1 summarizes the percentage availability of equipment. Among basic aids to intubation, the presence of curved Macintosh blade, straight adult blade, and tracheal tube stylet were universal.

In the alternative ventilation equipment category LMA was present in 80% followed by 35 and 30% for Combitube and pre-assembled needle cricothyroidotomy set.

Table 1 DAM equipment categorized as basic aids to DAM, alternative ventilation equipment, non-invasive airway devices, invasive airway devices, or intubation-confirming devices

	PAAD (%)
Basic aid in DAM	
Curve blade	100
Straight blade	100
Tracheal tube stylet	100
Gum elastic bougie	50
Oral/nasal airway	90
Alternate ventilation device	
LMA	80
Combitube	35
Pre assembled cricothyroidotomy set	30
Jet ventilation	10
Non-invasive airway device	
Fiberoptic bronchoscope	38
Lighted stylet	15
Video laryngoscope	48
Invasive airway device	
Percutaneous cricothyroidotomy set	38
Percutaneous tracheostomy set	33
Retrograde intubation kit	15
Intubation confirming device	
$ETCO_2$ measurement device	80
Ready DA cart	70
DAC and DAM related questions (positive answer)	
Check content of cart daily	82
Consultant responsible for airway	31
Aware of location of DAC	80
Training in use of DAC	60
DAM algorithm present	51
Airway related complication	30
Airway related death	15
DA evaluated by expert	50
DA extubation with continuous access	16

Nine other questions inquired about the presence of any other DAM-related issues and about training programs for DAC in the ICU

LMA laryngeal mask airway, *DA* difficult airway, *DAC* difficult-airway cart, *DAM* difficult-airway management, *PAAD* percentage availability of airway devices

Under non-invasive airway devices the video laryngoscope (VL) with 48% was ahead of the fibreoptic bronchoscope (FOB) 38% and lighted stylet 15%. Among invasive airway devices the percutaneous cricothyroidotomy kit and the percutaneous tracheostomy kit at 38 and 33%, respectively, were nearly similar, and preferred to the retrograde intubation kit (15%). Jet ventilation was used only in 10% of cases.

In the ICU, diverse patient characteristics, disease processes, and practice environments all can conspire to make

urgent airway management one of the most anxiety-provoking and challenging responsibilities. Airway emergencies generally arise with little or no warning [14].

The risk of difficult intubations is high, ranging between 8 and 22% [15, 16]. Therefore, it is not surprising that the few studies on endotracheal intubations in the critically ill reveal risks of complication as high as 54% [15]. Severe life-threatening complications are reported to be as high as 28% [16]. Schwartz et al. [15] observed esophageal intubations in 8%, aspiration in 4%, and mortality within 30 min of intubations in 3%.

Equipment availability and familiarity are important features of difficult airway programs. It has been documented that a comprehensive airway program resulted in a decrease in the need for an emergency surgical airway procedure [17].

It is recommended to have at least one portable storage unit that contains specialized equipment for the difficult airway [1]. Most general operating room (OR) suites have a variety of airway-management equipment both for anesthesiologists and surgeons. A DAC is readily available in the same area.

The availability of a DAC may have an even greater impact in areas outside a general OR suite. Non-operative areas and critical care departments may not otherwise have immediate access to equipment for airway management. A survey of obstetric units in Germany revealed that most units had laryngoscopes and LMAs but were less likely to have a flexible bronchoscope or the means to deliver transtracheal ventilation [12]. Surveys of emergency departments in the UK showed that they were more likely to have a surgical airway device as an alternative to laryngoscopy than a flexible bronchoscope or LMA [13, 18].

In our study the universal presence of curved blades and stylets or the presence of straight blades is no credit. They are mere basic necessities. Of greater concern is the 50% absence of GEB, which are easy to acquire, very effective, and inexpensive. Gradual turning of attention by ICUs towards alternative ventilation devices is discernible. LMA at 80% is the only other equipment, apart from curved blades and stylets, to have identical presence in routine and emergency DAM setting in ICUs. The presence of LMA and Combitubes in our survey compares favorably with that in UK hospitals [19].

The FOB, introduced for DAM around 1996–1997, at 38%, and video laryngoscopy (VL), at 48%, occupy places above the lighted stylet. This is because even in difficult situations FOB and VL enable viewing of the anatomy and the pathology like no other currently available equipment does. Besides, for passage of LMA an interincisor gap of a minimum of 1.5 cm will be necessary. Measurement of $ETCO_2$ for assessment of successful tracheal intubation is now easy with multipara monitors. Consistent efforts are necessary to achieve 100% use of $ETCO_2$ measurement. The 70% presence of portable DAC needs to be augmented to 100%, as has often been stressed.

Other alternative airway devices are not uniformly available and 20 and 60% of directors were not familiar with their location and its use, respectively, in the ICU. The survey suggested significant variability in the use of airway devices for management of difficult airways. It also suggested that intubations in the ICU are not always performed by individuals with airway training.

The anesthesiology–critical care medicine core curriculum lists the use of airway adjusts for ventilation and oxygenation as recommended skills. Our data suggest that exposure to and availability of these and other, alternative, devices varies substantially among directors. Multi-center, large-scale studies will be required to define the role of alternative devices and the need for these on airway carts when laryngoscopy fails.

From this survey we obtained an approximate general overview of current emergency airway equipment. The fact that DAC is present in some ICU still does not guarantee that the cart is readily available for use. It also does not mean that all equipment is correctly stocked. Currently there is no guideline for the presence and content of this cart in critical-care units.

A difficult-airway cart should be present in all intensive care areas. Equipment and training with reference to DAC varies. What constitutes the ideal contents of a DAC is open to question. We hope more discussion will lead to consensus of what should be or should not be included on the cart. We must ensure that all providers receive formal training in the management of the difficult airway.

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