2022 CAS Annual Meeting

Airway Management

(Abstracts and Case Report/Series)

Contents

A Virtual Airway Evaluation – As Good as the Real Thing?

Authors:

Zhao, Yixing Mars[1]; Macaskill, James[1]; McKay, William[2]; Hedlin, Peter[2]; Barbour-Tuck, Erin[2]; Walker, Mary Ellen[2]; Gamble, Jonathan[2]

[1] *College of Medicine, University of Saskatchewan, Saskatoon, Canada*
[2] *Department of Anesthesiology, Perioperative Medicine and Pain Management, College of Medicine, University of Saskatchewan, Saskatoon, Canada*

Introduction:

An airway evaluation is a fundamental component of the pre-anesthetic evaluation. The National Audits Project-4 study identified that failure to properly assess the airway and identify potential difficulties contributes to poor patient outcomes during operative care.[1]

The COVID-19 pandemic prompted a dramatic increase in virtual care. Pre-pandemic studies suggest that virtual pre-anesthetic assessments have high patient satisfaction, similar surgical cancellation rates, and lower costs compared to in-person assessments.[2] However, it is unknown if a Virtual Airway Evaluation (VAE) is a reliable alternative to the traditional in-person assessment, or if reliability is affected by the experience of the airway assessor.

Given the recent interest in and potential benefits of virtual care, we aimed to evaluate the reliability of a VAE, performed by assessors with different levels of experience.

Methods:

We conducted a prospective observational study exploring the inter-rater agreement of in-person airway assessments performed by consultant anesthesiologists (Expert In-Person) and VAEs performed by one of two consultant anesthesiologists (Expert VAE) and one of two medical students (Novice VAE). The airway evaluation was completed using a comprehensive airway assessment and scoring tool comprised of ten binary components.[3] The medical students had no experience with airway evaluations prior to receiving a workshop taught by consultant anesthesiologists. Evaluators were blinded to each other's findings.

Data collection occurred between June – August 2021 across three hospitals in one urban center. We targeted a convenient sample size of 100 patients. Eligible participants were all patients ≥ 17 years old, booked for a pre-operative anesthetic assessment, and had access to a device capable of using the *Zoom* videoconference software. If needed, a brief pre-assessment tutorial on downloading and using software was given to patients by the medical students.

Our primary outcome was the inter-rater agreement of total airway scores between the Expert In-Person airway evaluations and both the Expert VAE and Novice VAE, assessed using Cohen's Kappa (CK). Secondary outcomes included the inter-rater agreement for each airway evaluation component, assessed using Prevalence-Adjusted-Bias-Adjusted-Kappa (PABAK).

Results:

One hundred out of 111 participants completed all three evaluations; technological challenges precluded one participant from VAE completion; ten participants had incomplete in-person evaluations.

The inter-rater agreement CK coefficients (none, fair, moderate, good, very good: CK = 0-0.20, 0.21-0.40, 0.41-0.60, 0.61-0.80, 0.81-1.00; respectively) of Expert In-Person to Expert VAE and Novice VAE total scores were fair (CK = 0.21, 95% CI: 0.09-0.33) and good (CK = 0.74, 95% CI: 0.64-0.84), respectively (Table 1). Expert In-Person had significantly higher level of inter-rater agreement with Novice VAE than Expert VAE ($p < 0.001$). Most Expert In-person to Expert VAE and all Expert In-person to Novice VAE PABAK inter-rater assessments of individual airway evaluation components were good to very good (Table 1). Moderate agreement was observed between Expert In-person and Expert VAE for thyromental distance (PABAK = 0.56) and obstructed airway (PABAK = 0.48); and fair agreement in Mallampati class (PABAK = 0.38).

Discussion:

Discrepancies in agreement were expected as previous agreement assessments of in-person to in-person airway evaluation components are moderate.[4] The superior agreement of the Novice VAE may be due to higher Novice VAE evaluator videoconference technological familiarity and/or evaluators offering more participant direction and guidance than Expert VAE evaluators.[5]

The fair agreement between the Expert In-person and Expert VAE, and good agreement between Expert In-Person and Novice VAE of total airway scores, suggest that VAEs can be reliable; however, further studies are warranted to inform ways to improve Expert VAE performance and the sensitivity of VAE for predicting difficult airways.

References:

1. Cook TM, Woodall N, Frerk C; Fourth National Audit Project. Major complications of airway management in the UK: results of the Fourth National Audit Project of the Royal College of Anaesthetists and the Difficult Airway Society. Part 1: anaesthesia. Br J Anaesth. 2011 May;106(5): 617-31.
2. Zhang K, Rashid-Kolvear M, Waseem R, Englesakis M, Chung F. Virtual preoperative assessment in surgical patients: A systematic review and meta-analysis. J Clin Anesth. 2021 Dec; 75:110540.
3. Reed MJ, Dunn MJ, McKeown DW. Can an airway assessment score predict difficulty at intubation in the emergency department? Emerg Med J. 2005 Feb;22(2):99-102.
4. Karkouti K, Rose DK, Ferris LE, Wigglesworth DF, Meisami-Fard T, Lee H. Inter-observer reliability of ten tests used for predicting difficult tracheal intubation. Can J Anaesth. 1996 Jun;43(6):554-9.
5. Lopez AM, Lam K, Thota R. Barriers and Facilitators to Telemedicine: Can You Hear Me Now? Am Soc Clin Oncol Educ Book. 2021 Mar;41:25-36.

Table 1. Inter-rater Agreement of Expert In-Person to Expert Virtual Airway Evaluations and Expert In-Person to Novice Virtual Airway Evaluations

Airway Assessment	Expert In-Person – Expert Virtual (CK/PABAK [95% CI])	Expert In-Person – Novice Virtual (CK/PABAK [95% CI])
Complete	0.21 (0.09-0.33)*	0.74 (0.64-0.84)*
Facial Trauma	0.94 (0.85-1.03)**	1.00 (1.00-1.00)**
Large Incisors	0.88 (0.75-1.01)**	0.96 (0.88-1.03)**
Beard/Facial Hair	0.90 (0.78-1.02)**	0.94 (0.85-1.03)**
Mouth opening < 3 finger breadths	0.82 (0.67-0.97)**	1.00 (1.00-1.00)**
Thyroid-mental < 5 finger breadths	0.56 (0.37-0.75)**	0.86 (0.72-1.00)**
Hyoid-mental < 3 finger breadths	0.62 (0.43-0.81)**	0.88 (0.75-1.01**
Thyroid-hyoid < 2 finger breadths	0.64 (0.45-0.83)**	0.86 (0.72-1.00)**
Mallampati Class ≥ 3	0.38 (0.19-0.57)**	0.80 (0.64-0.96)**
Obstructed airway	0.48 (0.28-0.68)**	0.60 (0.41-0.79)**
Poor neck mobility	0.64 (0.45-0.83)**	0.90 (0.78-1.02)**

**Cohen's Kappa Statistic*

***Prevalence-Adjusted-Bias-Adjusted-Kappa Statistic*

Airway Management During in Hospital Cardiac Arrest by a Consultant Led Airway Management Team During the COVID-19 Pandemic: A Prospective and Retrospective Quality Assurance Project

Authors:

Boersma, D.[1]; Brine, M[2]; Casas, C.[1]; Forristal, C.[2]; Giffin, D.[2]; Turksta, T.[1]; Noppens, R.[1]

[1] *Department of Anesthesia and Perioperative Medicine, Western University, London, Canada*
[2] *Department of Medicine, Division of Emergency Medicine, Western University, London, Canada*

Introduction:

In-hospital cardiac arrests (IHCA) remain inevitable events. During the COVID-19 pandemic, our institution implemented a consultant-led airway management team (AMT; anesthesiology and emergency medicine) deployed to all IHCA. A quality assurance (QA) audit of adherence to the ILCOR guidelines was performed at our institution prior to and after the implementation of the AMT with a focus on airway interventions[1]. The ILCOR recommendations include: that intubation be performed by skilled staff; the intubation success rate for two attempts be ≥ 95%; that waveform capnography be used to confirm endotracheal tube (ETT) placement; and during the COVID-19 Pandemic, that video laryngoscopy be considered to maximize distance between the operator and the patient's oropharynx[2]. Better understanding of airway management during IHCA provides a basis for quality improvement initiatives to improve patient care and resuscitation team safety.

Methods:

Ethics approval was waived by REB on the basis of this being a QA project. This is a before and after study looking at adherence to ILCOR guidelines for airway management in IHCA prior to and following the implementation of an AMT at our institution. Data collection was based on the ILCOR guideline on reporting IHCA[1]. A retrospective chart review of IHCA activations was carried out between January-July 2019; prior to the pandemic's start. The team responding to IHCA consisted of on-call resident staff (internal medicine, cardiology, ICU) and respiratory therapists, with no specifical assignment for airway management. Prospective data with the AMT available was collected between April-October 2021 using an online data entry tool. Airway-specific information included: airway interventions, number of intubation attempts, device used for intubation, the role of the person who provided definitive airway management and method of confirmation of successful ETT placement.

Results:

Prospective analysis included 52 calls for IHCA. 14 patients required intubation. Success rate within two attempts occurred in 12/14 patients, and an unknown number of attempts occurred in 2/14 (non-AMT member intubations). Video laryngoscopy was used in 11/14 cases (McGrath 8/14, Glidescope 3/14) and direct laryngoscopy in 3/14. Confirmation of ETT placement was performed with waveform capnography (10/14), CO_2 colourimetry (3/14) and direct visualization (1/14). ETTs were placed by the AMT (12/14), respiratory therapist (1/14) and another consultant (1/14). The retrospective analysis identified 30 charts with IHCA. Endotracheal intubation was documented for 13 patients. These charts had no documentation regarding who intubated (0/13), method of confirmation of ETT placement (0/13), number of attempts (0/13) or device used to intubate (0/13).

Discussion:

Understanding how airways are managed during IHCAs allows to develop better patient and rescuer safety protocols for intubation and aerosolizing procedures. This audit highlighted the need for better documentation of IHCAs. Regarding adherence to ILCOR guidelines, a two-attempt intubation success rate of 100% was achieved when AMT members intubated. However, confirmation of ETT placement by waveform capnography, and video laryngoscopy use was not achieved for all intubations. These metrics were previously unknown and provide a basis for quality improvement initiatives such as encouraging the use of waveform capnography and video laryngoscopy, and creating a formal template for documenting IHCAs.

References:

1. Nolan, J., Berg, R., Lars, A., et al. (2019) Cardiac Arrest and Cardiopulmonary Resuscitation Outcome Reports: Update of the Utstein Resuscitation Registry Template for In-Hospital Cardiac Arrest. *Circulation* 140: e746-e757.
2. Wyckoof M., Singletary E.M., Soar J. et al. (2021) International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. *Resuscitation*, International Liaison Committee on Resuscitation (ILCOR) Summary Statement, 169:229-311

Prevention of Cautery Induced Airway Fire Using Saline Filled Endotracheal Tube Cuffs: A Study in a Trachea Airway Fire Model

Authors:

Oswald, Tyler[1]; Bysice, Andrew[2]; Laxague, Francisco[2]; Graham, Elise[2]; Fung, Kevin[2]; Noppens, Rudy[1]

[1] *Department of Anaesthesia and Perioperative Medicine, Western University, London, Ontario, Canada*
[2] *Department of Otolaryngology – Head and Neck Surgery, Western University, London, Ontario, Canada*

Introduction:

Airway fires are a considered a 'never-event' in the operating room. Fires in the airway can cause devastating complications, even death. Unfortunately, airway fires still occur and are estimated to happen approximately 200-400 times per year in the United States. Perioperative strategies have been recommended to decrease the likelihood of airway fires. One recommendation is to have saline contained in the endotracheal tube cuff. However, evidence in a biological model is limited. We examined the reliability of this intervention to decrease the probability of an airway fire using monopolar cautery in a pig trachea model.

Methods:

Pig tracheas were intubated with a 7.5 polyvinyl endotracheal tube (ETT). Six air filled cuff ETT and 6 saline filled cuff ETT were tested. Cut function was used to enter the trachea just where the ETT cuff was located to allow the cuff to rupture. Time was measured from starting coagulation and then stopped when flame was produced. Thirty seconds was the cut off for no fire. The type of flame was quantified whether there was no flame (1), intermittent flame (2) or sustained flame (3). Intermittent flame was defined as burst of fire that self-extinguished. Sustained flame was defined as a fire that did not self-extinguish. FiO2 was set at 100% and monopolar cautery was set at 40W in all cases. REB approval was not needed due to being a tissue model.

Results:

In 6 trials with air in the cuff, the average time to ignition was 12 seconds. Subsequently, in 6 trials with saline filled cuffs, the time to ignition was 22.8 seconds. The type of flame for air in the cuff was quantified as 2.5 while saline in the cuff was quantified as 1.8. We found a strong association between the cuff with air and a time less than 15 seconds to ignition, $p=0.061$. On the other hand, we found no association between the presence of air or saline water in the cuff and the generation of fire and the type of flame, $p=0.288$. However, we observed that all the specimens in the cuff with air developed a flame (100%). In contrast, we demonstrated that 66% of the specimens in the saline water group developed a flame.

Discussion:

While saline-filled endotracheal cuffs have been recommended for airway surgery, to our knowledge, no tissue model has tested its utility. While we could not demonstrate a statistically significant difference between having air or saline water in the cuff and the time to ignition and the type of fire, we observed a strong association between the presence of air in the cuff and a time less than 15 seconds to ignition. This model suggests that while saline can increase the time that is needed to start an airway fire, saline can not prevent ignition.

References:

1. Sosis, Mitchel B. PhD, MD; Dillon, Francis X. MD Saline-Filled Cuffs Help Prevent Laser-Induced Polyvinylchloride Endotracheal Tube Fires, *Anesthesia & Analgesia*: February 1991 - Volume 72 - Issue 2 - p 187-189.
2. Roy S, Smith LP. Surgical Fires in Laser Laryngeal Surgery: Are We Safe Enough? *Otolaryngology–Head and Neck Surgery*. 2015;152(1):67-72.
3. Updated by the Committee on Standards and Practice Parameters, Jeffrey L. Apfelbaum, Chicago, Illinois; The original document was developed by the American Society of Anesthesiologists Task Force on Operating Room Fires:, Robert A. Caplan, Steven J. Barker, Richard T. Connis, Charles Cowles, Jan Ehrenwerth, David G. Nickinovich, Donna Pritchard, David W. Roberson, The original document was developed by the American Society of Anesthesiologists Task Force on Operating Room Fires:, Robert A. Caplan, Steven J. Barker, Richard T. Connis, Charles Cowles, Albert L. de Richemond, Jan Ehrenwerth, David G. Nickinovich, Donna Pritchard, David W. Roberson, Gerald L. Wolf; Practice Advisory for the Prevention and Management of Operating Room Fires: An Updated Report by the American Society of Anesthesiologists Task Force on Operating Room Fires. *Anesthesiology* 2013; 118:271–290.

Smart Phone Assisted Retrograde Illumination Versus Conventional Laryngoscope Illumination for Orotracheal Intubation: A Prospective Comparative Trial

Authors:

Sahay, Nishant[1], Bhadani, Umesh Kumar[2] Shadab, Madiha [3] Singh, Ravi Kumar [3]

[1] *Additional Professor, Department of Anaesthesiology, All India Institute of Medical Sciences, Patna, India*
[2] *Professor and Head, Department of Anaesthesiology and Dean, All India Institute of Medical Sciences, Patna, India*
[3] *Senior Resident, Department of Anaesthesiology, All India Institute of Medical Sciences, Patna, India*

Introduction:

Equipment failure during laryngoscopy is a common problem.[1] A failure of the laryngoscope light is an inconvenience at most times, however in an out of hospital setting, or even in some intensive care or emergency units, where conditions are not always under direct control, such failures could be catastrophic. Most of the doctors and paramedics carry a smart phone these days. There are applications in these smart phones which can have a light source and serve as a torch. This study evaluates whether ease of intubation with retrograde illumination using a such a mobile phone torch light is comparable to the conventional laryngoscope light source. The secondary objectives of the study were to compare the quality of glottic exposure during laryngoscopy and total time taken to intubate the patient.

Methods:

This was a prospective randomized controlled study conducted after ethical committee approval and registry of trial. A total of 203 patients were enrolled for this single center study.
Patients were randomly allocated into two groups -
In one group, a normally functioning conventional laryngoscope was used. In the other, batteries of the conventional laryngoscope were reversed to simulate light failure. In these cases, the torch application from a standard mobile phone was used as a light source. Source of light from mobile phone was initially placed on the skin at the level of the thyroid and direct laryngoscopy performed using the laryngoscope with reversed batteries. Operator was free to adjust the mobile phone light location on the neck as per his/her convenience. Once an optimal illumination was obtained the position of the mobile was held by an assistant and the operator proceeded to intubate the patient. In the second group, laryngoscopy was performed in the usual manner using a conventional laryngoscope with a functioning light source. Glottic exposure quality was assessed using the POGO score. Ease of intubation was assessed using the Intubation Difficulty score and total time to intubate was noted using an electronic stop.

Results:

All statistical analyses were performed using software Stata version 10. Shapiro-Wilk normal test was carried out for normality testing and Student's t-test for difference of means was applied for continuous variables having normal distribution. Mann-Whitney Wilcoxon test was applied for f variables having non-normal distribution. No baseline variable was found to be statistically different ($p>0.05$). No difference in the intubation difficulty with either method was noted. It took significantly longer to intubate when retrograde-illumination was used [45.96 sec (SD- 29.61, SEM-3.08) versus 33.26 sec (SD– 11.92, SEM-1.23) $p = 0.001$]. Glottic exposure quality remained similar with Mean POGO score 89.07 (SD-19.85, SEM-2.07) versus 85.308

(SD- 20.24, SEM- 2.08), p=0.202. The duration of laryngoscopy between two groups was found to be comparable when POGO scores were above 60. A significant negative correlation was observed between POGO score and duration of laryngoscopy both in test (Correlation coefficient = -0.698, p=0.001) and control group (Correlation coefficient r = - 0.631, p=0.001).

Discussion:

Retrograde illumination may be a viable option when conventional laryngoscope light fails. It may take longer to intubate patients when using mobile torch light as a light source however the glottic exposure quality and intubation difficulty are similar in both. This finding may be important when training of students or paramedics is contemplated. This is because light failure during intubation is a common problem in an out of the hospital setting and in third world countries when maintenance of equipment may be compromised. It can also be lifesaving in emergency and intensive care settings when time is precious.

References:

1. Philadelphia: Wolters Kluwer Health/Lippincott Williams & Wilkins. p. 25. ISBN 0-7817-6262-6. (2007)

Time to Single Lung Isolation in Massive Pulmonary Hemorrhage Simulation Using a Novel Bronchial Blocker and Traditional Techniques

Authors:

Nielsen, Emma[1,2]; Golding, Halle[2,3]; Golam, Aanisah[2,3]; Zheng, Alex[4]; Görges, Matthias[3,4]; Poznikoff, Andrew[2,3]; Purdy, F Robert[2,3,4]

[1] *Faculty of Medicine, University of British Columbia, Vancouver, Canada*
[2] *Department of Pediatric Anesthesia, BC Children's Hospital, Vancouver, Canada*
[3] *Department of Anesthesiology, Pharmacology & Therapeutics, University of British Columbia, Vancouver, Canada*
[4] *Research Institute, BC Children's Hospital, Vancouver, Canada*

Introduction:

Massive pulmonary hemorrhage (MPH) is an airway emergency with considerable heterogeneity in definition, etiology, and management. Initial approach to MPH involves advanced cardiac life support and airway stabilization with isolation and ventilation of the non-bleeding lung.1 The low frequency, high acuity, and often poor outcome of MPH1 limits direct methodological comparisons in patients. Common methods have limitations; double-lumen (DL) and intraluminal (IL) bronchial blockades require significant technical expertise, while endobronchial (EB) endotracheal intubation, although fast, does not tamponade bleeding. 1 Recently, a novel method of bronchial blockade was developed, whereby a bronchial blocker rigidly attaches to the extraluminal surface of an endotracheal tube; this approach was as fast or faster than five previously described methods of extraluminal bronchial blocker placement in an infant model.2 Therefore, this project aimed to compare the performance of a novel method (NOV) of single lung isolation with three existing methods using a simulation of MPH.

Methods:

Twenty pediatric anesthesiologists consented to participate in this simulation study, which took place in a hospital operating room. Participants were instructed to complete left-sided single lung isolation using four different techniques and were limited to 10 minutes for each device. Devices were used in a pre-randomized stratified order. First, participants reviewed method cards describing each of the four techniques: DL, IL, EB, NOV, and familiarized themselves with the manikin. Briefly, the simulation utilizes a carbon fiber manikin (AirSim Advance Bronchi X, TruCorp, Northern Island) in which artificial blood is pumped into the base of the left bronchial tree to simulate the MPH. The primary outcome was the speed (time) of each trial, whereby time to intubation and subsequent time to device placement were respectively denoted by bilateral and unilateral inflation of balloon lungs on the manikin. Time data was log transformed to control for lack of normality. Three independent mixed effects models were created: time (total time, time to intubation, time to placement) was the outcome, lung isolation method was the fixed-effect variable (with NOV as the reference category), and participant was the random-effect variable. Statistical significance was assessed at alpha=0.05.

Results:

Participants had an average (±SD) of 13.89 (±8.02) years of clinical practice, including fellowship. Analysis included 19 participants' data; one participant was excluded due to a technical error. For methods EB, DL and IL, one trial was excluded from each due to equipment failure, leaving 73 trials for analysis. The average total time to completion (±SD) for each method is as follows, EB:128.9s (±46.5), DL:223.2s (±142.1), IL:240.8s (±147.4), and NOV:215.2s (±134.4). Time comparisons between methods are reported as a percent difference

from the NOV reference. For total time, EB was significantly faster than NOV, by 35% (p=0.007), while IL and DL were not significantly different. Both EB and IL were significantly faster than NOV for time to intubation, by 25% (p=0.002) and 29% (p=0.0002), respectively. Finally, EB was the only method significantly faster than NOV for time to placement, being 36% quicker (p=0.023).

Discussion:

This study established that in a simulation of MPH, pediatric anesthesiologists achieved the fastest time to single lung isolation with the EB method. Although EB allows for rapid establishment of the airway, patients will require further immediate intervention as it does not address the source of bleeding and provide tamponade,[1] as opposed to the other three methods: DL, IL, and NOV. Interestingly, NOV was not significantly different than DL or IL methods, despite participants having considerably more experience with the latter two methods. Future work should replicate this project in resident learners and provide hands-on training for each method.

References:

1. J Thorac Dis 2017; 9 (Suppl 10): S1069-86
2. Anesth Analg. 2020;130(5S): 104-5