

## **Certificate in Physician Leadership for Hospital Medicine**

### **Capstone Project Report**

**Joseph P. Mathew, MD**

#### **Project Title:**

Improving the safety of intubation in the Intensive Care Unit

#### **Project Description:**

Airway management in critically ill patients is associated with high risk of complications such as severe hypotension, severe hypoxemia, cardiac arrhythmias, aspiration, brain damage and death.<sup>1</sup> Airway management in the critically ill patient, as compared to that in the operating room, is all the more risky as the patients often have suboptimal physiology (e.g. hypoxemia, hypotension, coma) and there is often no time to prepare. Complications increase with each failed intubation attempt.<sup>2</sup> This project aims to improve the quality and safety of intubations performed in the Medical Intensive Care Unit (MICU) at Mount Sinai St. Luke's and Mount Sinai West.

Mount Sinai St. Luke's and Mount Sinai West are both urban university-based hospitals (500 beds each) with various residencies and fellowships. Intubations in the MICU are mainly performed by Pulmonary and Critical Care Medicine (PCCM) fellows who are considered novice intubators or PCCM attending physicians. Intubations outside the ICU are performed by Anesthesiologists. We conducted a series of interventions based on informal needs assessments done through surveying fellows, program directors, faculty members, and ICU staff members.

Based on feedback from staff, the following areas were identified as areas for potential interventions:

1. Training – primary operators (PCCM fellows) could benefit from airway training to enhance confidence with intubation and overall airway management.
2. Medication access – ICU nursing and physician staff expressed concern that medications for proper induction and neuromuscular blockade (NMB) for endotracheal intubation were not always readily available in the ICU. Orders would have to be placed in the EMR and would often have to come from the pharmacy department leading to delays in intubation in an emergency setting.
3. Medication dosing and ordering – intubation medication orders and dosing was often incorrect as the primary operators did not always know the correct dosing of sedative-hypnotics and neuromuscular blockers which were used for intubation. Sedation post-intubation was not always ordered or available. Additionally there was lack of comfort in using neuromuscular blockers despite literature showing that it improves intubation success and intubation conditions.<sup>3,4</sup>

4. Equipment needed for airway management, although available, was not always readily found as they were stocked in different areas of the ICU.

**Project Objectives:**

1. Provide educational opportunities to staff members involved in endotracheal intubation using both didactic lectures and simulation-based training.
2. Improve access to medications necessary for intubation in the ICU.
3. Create intubation laminated card as quick reference for intubation medication dosing.
4. Create a cart in the ICU where all airway and intubation-related equipment can be found.
5. Implement a checklist-based systematic approach to airway management in the ICU.

**Methodology:**

Several key system-based gaps were identified with regard to the safety and quality of airway management in the ICU. The project was approached both from a system perspective with regard to improving access to intubation medications and equipment, as well as from an educational perspective with regard to narrowing gaps in knowledge and training. Execution of the project involved engaging staff members from various professions including nursing, clinical pharmacy, and physicians and leadership from multiple departments including critical care, pharmacy, simulation, information technology (IT), material management, and printing services.

A Plan-Do-Study-Act (PDSA) cycle was implemented to address the gaps listed above. A series of meetings was conducted with ICU, pharmacy, and nursing leadership as well as ICU faculty and staff members. The meetings also involved PCCM faculty, fellowship leadership and simulation team to discuss educational interventions. Our institution had recently transitioned to EPIC Electronic Medical Record. The IT department was also engaged to help with building order sets for intubation. Materials management and hospital operational leadership was approached with procuring carts to stock airway equipment.

1. Training
  - a. A simulation-based bootcamp was conducted in July 2018 for all incoming PCCM fellows (7 total). Fellows were provided task training in basic airway management including bag-valve-mask (BVM) ventilation, intubation using direct and video laryngoscopy. They were also provided simulation-based training on intubation using a high-fidelity manikin (SimMan 3G, Wappinger Falls, NY).
  - b. Additional simulation-based airway training was provided to fellows with special focus on rapid sequence intubation (RSI) and modified RSI using a high-fidelity manikin. This training composed a didactic lecture reviewing basic concepts of airway management and indications and contraindications for RSI and modified RSI. A checklist-based approach (Figure 1) was taught based on available literature and publication by the Difficult Airway Society. The learners were subsequently given 3 scenarios where they are expected to choose appropriate induction medications including neuromuscular

blockers to intubate the manikin. Learners were debriefed by simulation faculty (Dr. Mathew and Dr. Rose) after each scenario. A pre-course survey was administered prior to each session.

## 2. Medication Access

- a. An inventory of ICU PYXIS machines was performed to identify available intubation medications. Based on input from clinicians, a “Virtual Intubation Kit” was created in PYXIS such that based on verbal or EMR orders, the critical care nurse could type in “intubation” into PYXIS and click off the medications (sedative-hypnotics, NMBs, and phenylephrine) requested for the pertinent patient and then able to obtain them from PYXIS.

## 3. Medication Dosing and Ordering

- a. A laminated ICU Medication card was created in conjunction with clinical pharmacy. Frequently used medications were identified and appropriate dosing was agreed upon (Figure 1). The card contains usual dosing range as well as average doses and maximal doses and general comments about adverse effects. This card was posted in the intubation box as a quick reference and copies were given to ICU staff physicians, PCCM fellows, and critical care nursing staff. These cards were utilized during simulation-based training for PCCM fellows.
- b. An intubation and post-intubation order-set was created in EPIC in conjunction with IT and pharmacy. The order set included commonly used intubation medications with appropriate dosing as well as post-intubation sedatives which are commonly forgotten. Mechanical ventilation settings and post-intubation chest radiograph are also part of this order set.

## 4. Equipment

- a. An airway cart was been identified to streamline where all airway equipment is kept. This was performed after vetting of vendors by ICU stakeholders. The equipment has been ordered after meetings with hospital leadership and material management.

An ICU intubation survey was administered to ICU staff including attending physicians, PCCM fellows, critical care nurses, clinical pharmacists, and respiratory therapists to further assess staff perceptions of above interventions designed to improve the safety of intubation and to assess further needs for improvement.

## Results

### 1. Training

- a. PCCM Fellows Bootcamp  
Very favorable reviews of airway stations and simulation from course
- b. PCCM Fellows RSI and Modified RSI training  
Pre-course survey (n=6) identified that although fellows were generally comfortable with intubation in the ICU there were uncomfortable with RSI and modified RSI, as well as intubating patients with difficult airway. Fellows were also comfortable with usage of

sedatives and hypnotics however not paralytics. Post-course survey results will be available prior to capstone presentation in Jan 2019.

2. Medication Access

- a. Survey results (36 responders: CCRN 15, Fellow 11, Attending 7, pharmacist 2, RT 1)  
All ICU staff members agreed or strongly agreed that the “Virtual intubation kit” has improved access to intubation medications. Few individual comments indicated that they may have missed the inservice on this feature and specific inservice on phenylephrine syringe pushes and paralytics.

3. Medication Dosing and Ordering

- a. Survey results

The majority of staff members strongly agreed that both ICU physicians (83%) and critical care nurses (78%) should have a strong working knowledge of intubation medication dosing.

The majority of staff members strongly agreed (77%) that a post-intubation sedation order set is important for vent synchrony and to prevent self-extubation.

4. Airway equipment

- a. An Storz Davi airway cart was identified and ordered in an effort to have a one-stop shop for all airway related equipment including for intubation and bronchoscopy (Figure 3). In the meanwhile, the ICU intubation box is placed on a standard procedure cart with labeled drawers for all relevant intubation equipment.

5. Teamwork

- a. Pre-intubation checklist

The majority of staff members (68%) strongly agreed or agreed (30.5%) that a pre-intubation checklist is helpful in standardizing the intubation sequence. Individual comments identified that there is variation in practice among the ICU attending physicians.

- b. The overall teamwork of the ICU staff during intubations was rated as excellent (30%), good (50%) or average (19%).

**Next Steps:**

1. Ongoing training for all PCCM fellow in RSI and modified RSI and extend this to entire Mount Sinai Health System.
2. Offer airway training as part of faculty development for critical care physicians in MSHS (similar to previous initiative<sup>5</sup>).
3. Next edition of intubation card with airway checklist on the back of it.
4. Work with nursing and respiratory to provide interprofessional airway training and thereby work on improving teamwork and communication.

Figure 1. Intubation checklist



**intensive care society**  
care when it matters

**Intubation Checklist : critically ill adults – to be done with whole team present.**




**Prepare the patient**

- Reliable IV / IO access**
- Optimise position**
  - Sit-up?
  - Mattress hard
- Airway assessment**
  - Identify cricothyroid membrane
  - Awake intubation option?
- Optimal preoxygenation**
  - 3 mins or ETO<sub>2</sub> > 85%
  - Consider CPAP / NIV
  - Nasal O<sub>2</sub>
- Optimise patient state**
  - Fluid / pressor/ inotrope
  - Aspirate NG tube
  - Delayed sequence induction
- Allergies?**
  - ↑ Potassium risk?  
- avoid suxamethonium

**Prepare the equipment**

- Apply monitors**
  - SpO<sub>2</sub> / waveform ETCO<sub>2</sub> / ECG / BP
- Check equipment**
  - Tracheal tubes x 2  
- cuffs checked
  - Direct laryngoscopes x 2
  - Videolaryngoscope
  - Bougie / stylet
  - Working suction
  - Supraglottic airways
  - Guedel / nasal airways
  - Flexible scope / Aintree
  - FONA set
- Check drugs**
  - Consider ketamine
  - Relaxant
  - Pressor / inotrope
  - Maintenance sedation

**Prepare the team**

- Allocate roles**  
One person may have more than one role.
  - Team Leader
  - 1<sup>st</sup> Intubator
  - 2<sup>nd</sup> Intubator
  - Cricoid force
  - Intubator's assistant
  - Drugs
  - Monitoring patient
  - Runner
  - MILS (if indicated)
  - Who will perform FONA?
- Who do we call for help?**
- Who is noting the time?**

**Prepare for difficulty**

- Can we wake the patient if intubation fails?**
- Verbalise "Airway Plan is:"**
  - Plan A:**  
Drugs & laryngoscopy
  - Plan B/C:**  
Supraglottic airway  
Face-mask  
Fibreoptic intubation via supraglottic airway
  - Plan D:**  
FONA  
Scalpel-bougie-tube
- Does anyone have questions or concerns?**

Figure 2. ICU intubation card

<b>Intubation Medications</b>				
Medication	Usual Dose	Avg Dose	Max Dose	Comment
<b>Etomidate</b>	0.2 mg/kg	15-20 mg	0.4 mg/kg (30 mg)	Give 50% usual dose in hemodynamic instability Associated with adrenal insufficiency
<b>Propofol</b>	1-1.5 mg/kg	70 mg	2.5 mg/kg (200 mg)	Associated with dose-related hypotension Avoid in hypovolemic, hypotensive patients
<b>Ketamine</b>	1 mg/kg	70 mg	2.5 mg/kg (200 mg)	Do not use in head injury, heart disease, or hypertensive patients
<b>Midazolam</b>	0.03-0.1 mg/kg	4 mg	0.1 mg/kg (10 mg)	Active metabolite is renally eliminated
<b>Fentanyl</b>	1 mcg/kg	50-75 mcg	2 mcg/kg (100 mcg)	Adjunct medication for pre-treatment For analgesia if needed for RSI
<b>Succinylcholine (depolarizing)</b>	1.5 mg/kg	100 mg	2.0 mg/kg (200 mg)	Use total BW for dosing (onset within 30 seconds) Do not use if history of malignant hyperthermia or seizures Caution if at risk for hyperkalemia (muscle disorders, burn, etc) Onset: 30-60s Duration: 4-5 min Half-life: <1 min
<b>Rocuronium (non-depolarizing)</b>	1 mg/kg	70 mg	1.2 mg/kg (100 mg)	Use adjusted BW if > 130% IBW (Paralysis within 60 seconds) Onset: 1-2 min Duration: 30 min Half-life: 60 min
<b>Sugammadex</b>			16 mg/kg for immediate reversal	For reversal of NMBA induced by rocuronium or vecuronium Not recommended if severe renal dysfunction or HD
<b>Phenylephrine</b>	100 mcg	100-200 mcg	500 mcg	Monitor for reflex bradycardia, arrhythmias
<b>Ephedrine</b>	5 mg	5 mg	10 mg (50 mg total)	Caution in pts with ventricular arrhythmias, QT prolongation, CAD

Figure 3. Airway cart



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References:

1. Cook TM et al. 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 2: intensive care and emergency departments. *British Journal of Anaesthesia* 2011; 106(5):632–42
2. Mort TC. Emergency tracheal intubation: complications associated with repeated laryngoscopic attempts. *Anesth Analg* 2004;99:607–13
3. Mosier JM, Sackles JC et al. Neuromuscular blockade improves first attempt success for intubation in the intensive care unit. A propensity matched analysis. *Ann Am Thorac Soc* 2015;12:734-741

4. Wilcox SR, Bittner EA, Elmer J et al. Neuromuscular blocking agent administration for emergent tracheal intubation is associated with decreased prevalence of procedure-related complications. *Crit Care Med* 2012;40:1808-1813
5. Mathew J, Rose K et al. Creation and implementation of a multi-institutional simulation-based airway management course for critical care attendings. *AJRCCM* 2017;195:A3286