Endotracheal Tube Clogging Resulting in Pulseless Electrical Activity Cardiac Arrest: Revisiting the Importance of Confirming Tube Positioning—A Case Report, Review of Literature, and Optimizing Patient Safety

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Abstract

Introduction: Endotracheal intubation while lifesaving, presents itself with a constellation of immediate and delayed complications. The following illustrates a case report of a cardiac arrest secondary to an endotracheal tube (ETT) clot due to ETT malposition in a patient with otherwise normal airways on bronchoscopy, previously undocumented in the literature.

Case Report: A 79 year-old male with multiple co-morbidities, s/p Whipple presented with a complicated post-operative ICU course and later developed pulseless electrical activity cardiac arrest on post-operative day #20. Upon further investigation, it was found that the cardiac arrest most likely stemmed from a completely occluded endotracheal tube due to a previously undetected tube malposition despite a normal immediate post-intubation physical exam and end-tidal CO2 monitoring. Emergent bronchoscopy after CPR and return of spontaneous circulation showed a completely occluded ETT with substantial clot burden within the tube lumen without any evidence of any other airway abnormalities. The ETT was carefully exchanged over direct laryngoscopy and the patient was stabilized. A literature review was performed on the immediate and delayed complications of endotracheal intubation. We propose the implementation of an intubation bundle protocol for quality improvement and patient safety in all ICU or out-of-operating room intubations.

Conclusion: This case report re-emphasizes the importance of verifying ETT positioning after endotracheal intubation to reduce morbidity,mortality, and to improve patient outcomes. We believe that an intubation bundle protocol is paramount in all ICU and out-of-operating room intubations to minimize adverse reactions and improve patient safety.

Key Words: Endotracheal intubation, airway complications, code blue, pulseless electrical activity, cardiac arrest, bronchoscopy, quality improvement

Introduction

Endotracheal intubation, while lifesaving, can impose various immediate and delayed complications. Immediate complications include, but are not limited to, impaired oxygenation and ventilation, hemodynamic instability, sore throat, hoarseness of voice, bleeding and soft tissue trauma of the oropharynx and larynx, esophageal intubation, aspiration pneumonitis and pneumonia, mainstem intubation, tracheal tears, just to name a few. Prolonged endotracheal intubation can cause many of the above problems. In addition, complications such as tracheal stenosis, laryngeal edema, mucosal ulceration, abscess, and necrosis, barotrauma, pneumothorax, pneumomediastinum, subcutaneous emphysema, fistula formation, mucus plugging, etc [1,2,3]. This case report demonstrates a substantial blood clot burden in the endotracheal tube (ETT) with otherwise normal airways at the time of bronchoscopy, which resulted in an inability to ventilate and oxygenate. It reemphasizes the importance of ensuring proper endotracheal tube positioning in order to minimize complications.

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Case Report

79 year-old male with a past medical history of chronic pancreatitis, severe three-vessel coronary artery disease, congestive heart failure with ejection fraction of 40-45% as well as diastolic dysfunction, s/p Whipple procedure for double duct sign on abdominal CT scan for presumed malignancy.

Patient's ICU course was complicated by perioperative NSTEMI on post-operative day (POD)#1, E. coli and C.

Figure 1: Bronchoscopy: Clot in Endotracheal Tube

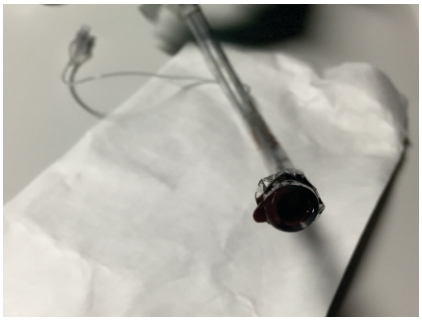

Figure 2: Completely Occluded Endotracheal Tube

Figure 3: Extent of Clot in Endotracheal Tubed

diff septic shock on POD#8, and septic cardiomyopathy on POD#10, severe acute respiratory distress syndrome, hypercarbic respiratory failure secondary to abdominal distension/ascites, and acute kidney injury requiring dialysis on POD#18.

Patient remained critically ill but stable on POD#20 when the bedside nursing staff noted patient to be desaturating on the SpO2 monitor to a nadir of 69%. The respiratory therapist was immediately called for suctioning and noted some blood-tinged tracheal secretions coming from the size 8.0 endotracheal tube. At this time, inspired oxygen concentration was increased to 1.0. The respiratory therapist first tried more aggressive suctioning, meeting severe resistance in the ETT. Next, the breathing circuit was disconnected from the ventilator and the respiratory therapist began to hand-ventilate. The airway resistance was extremely high and the patient was unable to be oxygenated and ventilated. The ICU team was called stat to the bedside. Subsequently, the patient became cyanotic. The heart rate dropped to the 20s and the arterial line blood pressure plummeted to 50/30s. Pulseless electrical activity (PEA) arrest ensued, a code blue was called and CPR started. After approximately twenty seconds, the patient regained his blood pressure and pulse, and his SpO2 recovered to 91%. No medications were administered. The resistance of the airway improved and allowed gas exchange. An emergent bronchoscopy was performed [Figure 1]. Initially, it was difficult to pass the bronchoscope through clogged endotracheal tube. With aggressive repeated attempts, the bronchoscope finally made its way through the clot. The carina only showed some minor suction trauma and inflammation. On further examination, the airways did not show any abnormalities. No mucus plugs or purulent secretions were seen, and no bleeding was noted. The ETT was removed under direct laryngoscopy and replaced with a new 8.0 ETT. The clogged endotracheal tube is shown in Figure 2 and 3.

Further investigation of a portable chest radiograph from the previous evening is shown in Figure 4. On examining lines and tubes in the chest X-ray, the most prominent finding is that the ETT is positioned too close to the carina. The end of the ETT most likely caused intermittent direct irritation to the carina, creating mucus and blood buildup within the lumen. Over the course of the evening, the buildup caused the ETT to slowly clog off, resulting in impaired oxygenation and ventilation, ultimately leading to the PEA arrest and CPR of the patient.

In a closer review of the events that transpired in the previous day and overnight, the patient was intubated on emergency basis the previous evening (confirmed with bilateral breath sounds, absent gastric sounds, and positive end-tidal CO2) and was hurried down to radiology for a CT angiography of the abdomen for possible gastrointestinal bleeding. The chest radiograph that was supposed to be immediately performed after the intubation was delayed for 6 hours in the evening and was not reviewed immediately. Of note, the Palo Alto VA hospital does not have radiology preliminary reads overnight, and the ICU house staff was presumably busy with other critically ill patients, and probably forgot to follow up in a timely manner due to the delay of the chest radiograph.

Discussion

In a review of literature, the incidence of malposition and complications of endotracheal tubes, nasogastric and drainage tubes, indwelling catheters, intravascular lines, or other devices range from 3% to 14% [4]. Immediate post-procedural chest radiograph is recommended to detect proper placement or procedure-related complications. In another study, it was found that 27% of newly placed catheters or tubes were positioned improperly[5]. There have been many case reports of blood clots causing endotracheal tube and tracheobronchial obstruction, but most appear to be related to patients with underlying hemoptysis, underlying hemothorax, or lung infections (i.e. tuberculosis, hospital acquired pneumonia, etc.) [6,7,8,9,10]. Our patient did not have significant evidence of concurrent lung infection, hemoptysis or hemothorax at the time of the pulseless arrest. The most likely cause of the blood and mucus clogging was the placement position of the endotracheal tube.

Proper placement of the endotracheal tube is determined by location of its tip relative to the carina, and should be approximately 5 cm +/- 2 cm above the carina in the neutral position, keeping in mind that flexion, extension, and rotation of the head may

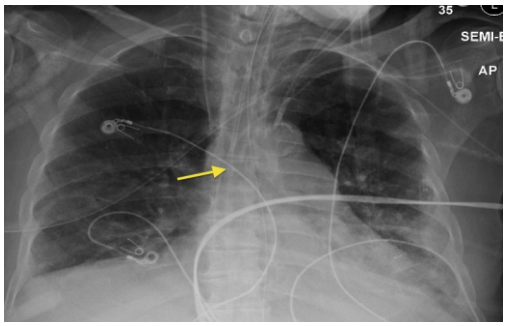

Figure 4: Endotracheal Tube Positioning too close to Carina on Chest Radiograph.

Intubation Bundle

I. Purpose
A. To provide guidelines for routine intubations in the ICU and out-of-operating room environment for adults
B. To prevent severe hypoxemia, severe hypercapnia, and cardiovascular collapse during elective and emergent intubation in ICU and out-of-operating room environments.
C. To prevent complications in post-intubated patients.
II. Procedure
A. Pre-intubation: At least one physician, one respiratory therapist, and two nurses must be present at the time of intubation.

1. Nursing Actions
a. Have 500 ml isotonic crystalloid on a working fluid bolus intravenous line ready for delivery
b. Prepare patient for long-term sedation
c. Have intubation medications drawn up and labeled, have vasopressor medications ready based on physician orders and requests
d. Working suction
e. Non invasive blood pressure cycle at 1 min (or working arterial line), pulse ox working with audible sound, working EKG, End tidal CO2 monitor
f. Ensure IV used for intubation is on opposite side of BP cuff
g. Ensure pulse ox and IV on same side.
h. Creates space at head of the bed for intubation
I. Saline flush syringes available.

2. Respiratory Care Actions
a. Assist physician in gathering tools for intubation
I. Endotracheal tubes 6, 7, 8
ii. LMA sizes 3-5 ready
iii. Mac 3 or Mac 4 blades, Miller 2 or Miller 3 blades
iv. +/- bougie or other rescue device
b. Pre-oxygenates patient at FiO2 1.0 for three minutes
I. In the case of acute respiratory failure this will be accomplished using non-invasive positive pressure ventilation.
NIPPV settings: Pressure support 5 – 15 cm H2O to achieve tidal volumes 6-8 ml/kg of patient's ideal body weight. FiO2 1.0 with PEEP = 5cmH2O.

3. Physician Actions
a. Assure appropriate orders placed in electronic medical record
I. Medications for pre- and post-intubation
ii. Mechanical ventilation orders
iii. Post-intubation chest X-ray orders
iv. Sedation orders
b. Assures appropriate tools for intubation are available
c. Works with pharmacy to ensure phenylephrine, epinephrine and/or vasopressin at standby.

4. Pharmacy Actions
a. Prepares vasopressors for intubation: phenylephrine 100 mcg/ml, epinephrine 10 mcg/ml and/or vasopressin 1 unit/ml
b. Delivers intubation medications and vasopressors to nursing staff
c. Prepares sedation agent for post-intubation
B. Intubation
1. Nursing Action
a. Rapid sequence induction:
b. Fentanyl/Versed if appropriate. Check with physician.
c. Hypnotic agent: Propofol 0.5-1.5 mg/kg, Etomidate 0.1 – 0.3 mg/kg, or ketamine 1.5–2.5 mg/kg TDW, check with physician
d. Paralysis: Rocuronium 1.2 mg/kg IDW as first line. Caution if difficult airway. Second line: Succinylcholine 1–1.5 mg/kg TBW may be used if patient has been working actively with physical therapy, been getting out of bed, less than 14 days bed bound in the ICU. Please caution if allergy (i.e. malignant hyperthermia), hyperkalemia > 5.5, severe acidosis, acute or chronic neuromuscular disease, burn patient for more than 48 h and spinal cord trauma, etc.

2. Respiratory Care Action
a. Prepares ventilator for operation
b. Assists physician with intubation as needed
c. Have airway devices close by in case physician needs additional supplies.

3. Physician Action
a. Directs nursing administration of medication
b. Performs intubation
c. Directs whether they need cricoid pressure during intubation
C. Post-Intubation.
1. Nursing Action
a. Delivers vasopressor medications if hypotension as directed by physician
b. Infusion of vasopressors if hypotensive
c. Connect end tidal CO2 to monitor
d. Initiate long-term sedation.

2. Respiratory Care Action
a. Immediate confirmation of endotracheal tube placement.
I. Capnography placed in-line
ii. Breath sounds, bowel sounds, ensure not main-stemmed
iii. Follow up on CXR and page intubating physician or team to confirm placement of tube
b. Initiate mechanical ventilation
I. Tidal Volume: 6 – 8 ml/kg IBW
ii. Respiratory rate: to meet ventilatory demand of patient
iii. Minimal FiO2 as necessary
iv. Plateau pressure ≤ 30 cm H2O
c. Draw initial arterial blood gas 30 minutes post-intubation
I. Verbal Read Back to physician
ii. Document critical results in electronic medical record.

3. Physician Action
a. Read post-intubation radiography and follow up with respiratory therapist and nursing staff regarding tube depth.
b. Adjust medications, sedation, ventilator as needed.
c. Ensure arterial blood gas appropriate for patient with nursing and RT.

displace the tip. In the present case report, due to the urgent nature of the CT angiography for the gastrointestinal bleed, the patient, after intubation, was immediately taken to radiology for possible life-saving interventions (i.e. possible interventional radiology embolization). The post-intubation chest radiograph, which should have been immediately performed after the intubation, was delayed due to the emergent nature of the CT angiography study. After the patient returned from the scan, the post-procedural chest radiograph was performed sometime in the overnight hours where ICU staffing and radiology staffing was minimal. Consequently, the depth of the endotracheal tube in close proximity of the carina was not immediately corrected. The irritation of the tube with the carina due to alterations in flexion and extension of the head positioning overnight is likely to have caused significant secretion and blood buildup in the distal portion of the tube. By the time the patient had become hypoxic the next day, the mucus and blood buildup had already solidified, rendering ventilation and oxygenation by ventilator and by hand virtually impossible. This case report re-emphasizes the importance of checking endotracheal tube positioning after an intubation by chest radiograph to ensure proper placement. Severe morbidity and mortality as well as patient mishaps can be significantly decreased with continuous vigilance.

We propose an intubation bundle protocol be implemented to ensure patient safety as a quality improvement measure in minimizing complications in all out-of-operating room intubations (ICU, ward, other locations). The presence of an intubation bundle has shown to decrease complications [11]. We have developed a sample intubation bundle protocol, which is listed under the supplementary file: Intubation Bundle Protocol.

The intubation protocol does not have to be exactly identical at different institutions, but should tailor to the hospital's needs, resources, and staffing availability. The bundle essentially serves to provide guidelines in the pre-intubation, intubation, and post-intubation time periods to maximize patient safety and to decrease errors as much as possible. The bundle focuses on details involving nursing staff, pharmacists, respiratory therapists, and physicians working together. It also reminds the provider of backup strategies (presence of a laryngeal mask airway, etc.), the focus on patient cardiopulmonary stability during the intubation, as well as post-intubation crucial events (end tidal CO2 monitoring, verifying tube placement with an active follow-up of chest radiograph). The ultimate goal is to provide further patient safety through increased vigilance, multi-disciplinary efforts, and a protocol-driven approach with safety checklists.

Conclusion

This case report demonstrates cardiac arrest in a critically ill patient due to clogging of the endotracheal tube, rendering ventilation and oxygenation impossible. The most likely culprit was incorrect endotracheal tube positioning secondary to a "perfect storm" of complicating events ultimately resulting in a likely preventable adverse event. Luckily, the patient achieved return of spontaneous circulation and stabilized after the code blue. This case reiterates the importance of vigilance in ensuring proper endotracheal tube positioning in the critically ill setting to minimize complications and other sentinel events. We propose an intubation bundle checklist at all hospitals to ensure patient safety and quality improvement.

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