

**Actionable Patient Safety Solution (APSS) #8B:
UNPLANNED EXTUBATION**

Executive Summary Checklist

Unplanned extubation, both in the field and in the hospital, is a common and costly problem, resulting in significant morbidity and mortality.

- Assemble a core multidisciplinary airway safety leadership team
 - VP of Quality / Safety
 - Physician, nursing, and respiratory care team leaders across all hospital units to ensure recognition of the problem and support development of systems that will eliminate unplanned extubation and its associated complications, especially preventable deaths.
- Determine baseline rate of unplanned extubation (See Metrics Section below).
- Determine baseline rate of complications (oral mucosa and facial skin pressure injuries, pneumonia, vocal cord injury, hypoxemia, brain injury, death) caused by unplanned extubation.
- Perform a root cause analysis (RCA) for all incidences of unplanned extubation.
 - Utilize a multidisciplinary team including physicians, nurses and respiratory therapists to evaluate the root cause of every unplanned extubation, determine a plan to eliminate the root cause, implement the plan and track results.
- Implement the core unplanned extubation dataset as defined in the Metrics Section of this APSS.
 - Every (endotracheally) intubated, mechanically ventilated patient should have the entire PSMF Core Dataset for extubation recorded in the patient's medical chart.
 - Evaluate your hospital's Electronic Health Record (EHR) to determine if the entire core dataset is included in the EHR.
 - If included, educate all providers of airway management how to properly track UE.
 - If not included, contact the EHR company and request they add the dataset; Develop a system for temporarily tracking the dataset until the EHR Company institutes the dataset.
- Develop a Quality Management Process to promote and ensure continuous improvement with an initial goal of eliminating preventable deaths from unplanned extubation and ultimately eliminating all incidences of unplanned extubation.
 - Require tracking and reporting of all incidences of unplanned extubation and complications of unplanned extubation (hypoxemia, pneumonia, vocal cord injury, brain injury and death).
- Provide periodic education for all airway management providers.
 - Educate providers regarding the importance of prevention of unplanned extubation and the need for accurate data tracking.
 - Include unplanned extubation as part of every presentation of management of the difficult airway patient.
- Implement Clinical Best Practices for Preventing Unplanned Extubation.
 - Standardize tracheal tube restraint devices, utilizing the most proven methods / devices.
 - Implement systems for alerting clinicians to patients with a known difficult airway.
 - Formalize systems for appropriate sedation and patient restraint to decrease the risk of unplanned self-extubation.

The Performance Gap

Unplanned Extubation (UE) is the unintentional removal of a patient's breathing tube, either by self-removal (Self Extubation) or accidental removal due to an external force (Accidental Extubation) causing the tube to become dislodged.

Unplanned extubation, both in the field and in the hospital, is a common and costly problem. Unplanned extubation occurs in approximately 7% (range: 0.5% - 35.8%) of patients undergoing mechanical ventilation in the Intensive Care Unit (da Silva et al., 2012), results in over 12,000 deaths (de Groot et al., 2011), increases the incidence of pneumonia from 14% to 28% , increases the average ICU length of stay from 9 to 22 days, and the complications of unplanned extubation result in over \$4 Billion in unnecessary healthcare costs (Dasta et al., 2005; Needham and Pronovost, 2005).

Although the incidence of unplanned extubation is likely higher in EMS settings due to the difficulties of transporting critically ill patients in a chaotic environment, unplanned extubation is not tracked in most EMS systems. Similarly, most hospitals do not track unplanned extubation. If we are going to get an accurate measure of the commonness and costliness of unplanned extubation, both in the hospital and in the field, we must develop widespread systems to accurately track all incidences.

Closing the performance gap will require hospitals and healthcare systems to commit to action in the form of specific leadership, practice, and technology plans, examples of which are delineated below for utilization or reference. This is provided to assist hospitals in prioritizing their efforts at designing and implementing evidence-based bundles for reduction of unplanned extubation.

Leadership Plan

- The core multidisciplinary team should consist of the following:
 - VP of Quality / Safety
 - Physician, nursing, and respiratory care team leaders from ED, OR/PACU, and ICU
- Hospital governance, senior administrative leadership, safety / risk management leadership and clinical leadership must work collaboratively and:
 - champion efforts, raising awareness regarding the seriousness (commonness and costliness) of unplanned extubation
 - demonstrate commitment and support by shaping a vision of the future, clearly defining goals, and supporting staff as they work through improvement initiatives, measuring results, and communicating progress towards those goals.
 - commit to defining performance gaps within the organization (system-wide, hospital-wide and by department)
 - support a comprehensive approach to standardized data tracking, quality management and process improvement efforts, and implementation of practice and technology plans necessary to eliminate unplanned extubation.

Practice Plan

- Use current evidence-based guidelines and known best practices during airway management of the intubated, mechanically ventilated patient to eliminate incidences of unplanned extubation.
- Implement systems for alerting clinicians to patients with a known difficult airway.
- Position the endotracheal tube with the tip of the tube within the optimal tip position range (2-6 cm above the carina). Proper initial positioning of the endotracheal tube decreases the risk of unplanned extubation should movement of the tube occur.
- Once appropriately positioned, maintain that position with a tube stabilizer that eliminates clinically significant (> 2 cm) total movement of the tube.
- Restrain the patient utilizing a combination of physical restraint and chemical restraint (sedation).

- Institute a continuous sedation protocol with daily interruption of sedatives. Avoid intermittent or no sedation protocols (Chao *et al.*, 2017).
- Use Continuous Waveform Capnography in ALL intubated patients to ensure rapid recognition of a mal-positioned tube.
- The initial evaluation of any cardiopulmonary arrest in an intubated patient should be to determine if the endotracheal tube is correctly positioned and the patient is being adequately ventilated. Waveform capnography along with clinical evaluation must be used to make this determination. If the evaluation suggests the tracheal tube might be mal-positioned, the tube should be immediately repositioned, unplanned extubation should be considered as the cause of the arrest and a root cause analysis of the extubation performed.
- Develop a Quality Management Process to promote and ensure continuous improvement with an initial goal of eliminating preventable deaths from unplanned extubation and ultimately eliminating all incidences of unplanned extubation.
- Require tracking and reporting of all incidences of unplanned extubation and complications of unplanned extubation (hypoxemia, pneumonia, vocal cord injury, brain injury and death).
- Develop a quality management process to:
 - review all incidences of unplanned extubation
 - determine root causes
 - inadequate stabilization of the endotracheal tube
 - inadequate sedation (chemical restraint)
 - inadequate physical restraint
 - plan and implement changes to the system based upon findings from reviews
 - track UE to determine if the implemented processes effect improvement
- Airway management in the field (EMS / Military) should incorporate the same prevention, tracking, and quality management concepts as described above for medical facilities. However, there are a few concepts that apply specifically to out of hospital management of unplanned extubation.
- All incidences of unplanned extubation in the field must be reported to the receiving facility during hand-off communications.
 - The incidence of pneumonia doubles in mechanically ventilated patients who experience an unplanned extubation. To prevent pneumonia in a known unplanned extubation in the field, the EMS airway provider must communicate the incident to the critical care physician and the critical care physician must consider antibiotic therapy.

Technology Plan

Suggested technologies are limited to those proven to show benefit or are the only known technologies with a particular capability. As other technology options may exist, please send information on any additional technologies, along with appropriate evidence, to info@patientsafetymovement.org.

- Standardize tracheal tube restraint devices
 - The current methods and devices for stabilizing endotracheal tubes include adhesive tape, cotton twill ties and multiple commercial devices. The current literature does not clearly identify any device or technique currently on the market that is superior at preventing movement against externally applied forces. However, numerous devices on the market are clearly inferior in their ability to restrain the tube against extubation forces. Therefore, when choosing an endotracheal tube stabilizer, the device's ability to restrain against applied force should be the primary consideration. Other considerations, such as ease of use or ability to prevent skin breakdown should be secondary considerations.
 - A review article, published in 2012 in *Anesthesia and Analgesia* (da Silva, Reis, Aguiar and Fonseca, 2012), which evaluated more than 50 studies published worldwide, demonstrated an average rate of unplanned extubation of 7.3% (range = 0.5% - 35.8%). This high rate of unplanned extubation suggests that current stabilization techniques and devices are inadequate and therefore further research into developing better stabilization systems should be supported to achieve zero preventable deaths by 2020.

- Optimal endotracheal tube stabilizers should:
 - be secure
 - be fast and easy to apply.
 - provide easy access to the mouth for routine oral care.
 - be repositionable and not exert any major pressure points to the skin or oral mucosa that would cause ischemic tissue injury.
- The stabilizer should, at minimum, prevent clinically significant movement (> 2 cm) that could result in an unplanned extubation; Optimally, it should prevent any movement of the endotracheal tube relative to the stabilizer. Even small incremental movements can result in unplanned extubation.
- Mandate the use of Waveform Capnography in ALL intubated patients to ensure rapid recognition of a mal-positioned tracheal tube.
- This important technology has become the standard of care for intubated patients in the UK and parts of Europe. United States Intensive Care Units, Emergency Departments and Emergency Medical Services are beginning to adopt this technology, but significant gaps exist. Continuous Waveform Capnography should become a mandated safety practice for all intubated patients. Systems for in hospital and transport use are manufactured by Masimo, Medtronic (Oridion/Covidien), Nonin, Philips (Respironics) and Welch Allyn.

Metrics

Topic:

Unplanned Extubation in Mechanically Ventilated Patients

Rate of unplanned extubation for patients undergoing mechanical ventilation via endotracheal tube

Outcome Measure Formula

Numerator: Number of incidences of unplanned extubation in patients mechanically ventilated via an endotracheal tube

Denominator: Total number of mechanical ventilation days

*Rate of unplanned extubation is expressed in terms of: Number of unplanned extubation incidences per 100 mechanical ventilation days

Metric Recommendations

Direct Impact: All patients undergoing mechanical ventilation via endotracheal tube

Lives Spared Harm:

*Lives Spared Harm = Unplanned Extubation Rate_{baseline} - Unplanned Extubation_{measurement}) X Vent Days*_{baseline}*

** Vent Days is the Outcome Measure Formula Denominator: (Total Number of Mechanical Ventilation Days)*

Data Collection:

Tracking Sheet for Unplanned Extubations

Data is best collected through electronic capture of data fields from electronic patient care reports. This requires having an Electronic Health Record System that includes the following PSMF Core Data Set for UE.

- Does the patient have a history of Difficult Airway?
- Was a pre-intubation assessment predictive of a Difficult Airway?
- Date of Extubation
- Time of Extubation
- Extubation Type (Planned or Unplanned)
- Unplanned Extubation Cause (Self-Extubation or Accidental Extubation)
- Was patient restrained at time of extubation?
- Was patient sedated at time of extubation?
- Facility Sedation Policy Type (Continuous with daily interruptions, Intermittent, No sedation)
- Was reintubation required?
- Was reintubation successful?
- Outcome/Complications of UE (oral mucosa and facial skin pressure injuries, pneumonia, vocal cord injury, hypoxemia, brain injury, death)

Extubation may occur as a planned or unplanned event. A planned extubation occurs when a physician orders the removal of the endotracheal tube. An unplanned extubation is defined as removal of a patient's endotracheal tube without a physician's order. Unplanned extubation may occur either due to patient self extubation or accidental extubation by an external force.

This standardized core dataset should be incorporated (by legislative mandate if necessary) by all major Electronic Health Record companies to facilitate hospitals' ability to track Unplanned Extubation:

- Many hospitals' Electronic Health Records currently do not have the PSMF Core Data Set for UE and any information on unplanned extubation is difficult to retrieve from narratives and notes. Any hospital whose EHR does include the PSMF Core Dataset should contact their EHR company and request adoption of the PSMF Core Dataset for UE.
- Risk factors for unplanned extubation should be measured including patient sedation and patient restraint.
- Rate of complications and mortality related to incidences of unplanned extubation are important to determine the extent of adverse effects of unplanned extubation:
 - rate of pneumonia in mechanically ventilated patients with an incident of unplanned extubation compared to rate of pneumonia in mechanically ventilated patients without an incident of unplanned extubation
 - rate of severe brain injury in mechanically ventilated patients with an incident of unplanned extubation compared to the rate of brain injury in mechanically ventilated patients without an incident of unplanned extubation
 - mortality rate in mechanically ventilated patients with an incident of unplanned extubation compared to the rate of mortality in mechanically ventilated patients without an incident of unplanned extubation

Mortality (will be calculated by the Patient Safety Movement Foundation): The PSMF, when available, will use the mortality rates associated with Hospital Acquired Conditions targeted in the Partnership for Patient's (PfP) grant funded Hospital Engagement Networks (HEN). The program targeted 10 hospital-acquired conditions to reduce medical harm and costs of care. "At the outset of the Partnership for Patients initiative, HHS agencies contributed their expertise to developing a measurement strategy by which to track national progress in patient safety—both in general and specifically related to the preventable HACs being addressed by the PfP. In conjunction with CMS's overall leadership of the PfP, AHRQ has helped coordinate development and use of the national measurement strategy. The results using this national measurement strategy have been referred to as the "AHRQ National Scorecard," which provides summary data on the national HAC rate (Agency for Healthcare Research and Quality, 2015). Adverse events related to unplanned extubation was not included in the AHRQ National Scorecard document. 53% of patients experiencing unplanned extubation do not require reintubation and those patients have a low mortality rate (3%). 47% of patients experiencing unplanned extubation require reintubation and those patients have a high mortality rate (37%). The overall mortality rate for all incidences of unplanned extubation is 18% (de Groot 2012)



Workgroup

Co-Chairs:

*Arthur Kanowitz (Securisyn)

Members:

Jim Augustine (Patient Safety Movement Foundation)
Steven Barker (Patient Safety Movement Foundation; Masimo)
Jestin Carlson (Allegheny Health Network)
Richard Cooper (Rogers Communications)
Lorraine Foley (Society for Airway Management)
Drew Fuller (Emergency Medicine Associates)
Kate Garrett (Ciel Medical)
Victor Gazette (Virginia Hospital Center)
David Hughes (Do It Hughes)
Hans Huitink (VU University Medical Center)
Thomas Kallstrom (American Association for Respiratory Care)
Ariana Longley (Patient Safety Movement Foundation)
Jacob Lopez (Patient Safety Movement Foundation)
Ariel MacTavish (Medtronic)
Rhea May (Medtronic)
Kellie Quinn (Independent)
Kenneth Rothfield (Saint Vincent's HealthCare)
Stacey Schoenenberger (St. Vincent's HealthCare)
Michael Taylor (Fairview Hospital)
Dianne Vass (Museum of Pop Culture)

References

- da Silva, P. S. L., Reis, M. E., Aguiar, V. E. and Fonseca, M. C. M. (2012). Unplanned Extubation in the Neonatal ICU: A Systematic Review Critical Appraisal, and Evidence-Based Recommendations. *Respiratory Care*, 58(7), 1237–1245. doi:10.4187/respcare.02164
- de Groot, R. I., Dekkers, O. M., Herold, I. H. F., de Jonge, E. and Arbous, S. M. (2011). Risk factors and outcome after unplanned extubations on the ICU a case-control study. *Critical Care*, 15(1), R19. doi:10.1186/cc9964
- Dasta, J. F., McLaughlin, T. P., Mody, S. H. and Piech, C. T. (2005). Daily cost of an intensive care unit day: The contribution of mechanical ventilation. *Critical Care Medicine*, 33(6), 1266–1271. doi:10.1097/01.ccm.0000164543.14619.00
- Needham, D. M. and Pronovost, P. J. (2005). The importance of understanding the costs of critical care and mechanical ventilation. *Critical Care Medicine*, 33(6), 1434–1435. doi:10.1097/01.ccm.0000166360.82336.75
- Chao, C.-M., Lai, C.-C., Chan, K.-S., Cheng, K.-C., Ho, C.-H., Chen, C.-M. and Chou, W. (2017). Multidisciplinary interventions and continuous quality improvement to reduce unplanned extubation in adult intensive care units. *Medicine*, 96(27), e6877. doi:10.1097/md.00000000000006877
- Agency for Healthcare Research and Quality. (2015). Efforts to improve patient safety result in 1.3 million fewer patient harms. Retrieved from <http://www.ahrq.gov/professionals/quality-patient-safety/pfp/interimhacrate2013.html>