How to use this guide
This guide gives actions and resources for creating and sustaining safe practices for unplanned extubation (UE). In it, you’ll find:

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APSS #8B: Unplanned extubation (UE)

Executive summary checklist

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) that causes the tube to become dislodged. UE, both in the field and in the hospital, is a common and costly problem. It results in significant morbidity and mortality. Although much of the information in this document relates to adult and pediatric patients, this document currently addresses adult patients only. A specific APSS addressing the pediatric and neonatal population is under development.

Use this checklist to help you prioritize your actions and measure your organization’s progress in your UE prevention.

Create an action plan to prevent UE

☐ Form a core multidisciplinary airway safety leadership team, including:
  ☐ 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 UE and its associated complications, especially preventable deaths
  ☐ Neonatal, Pediatric, and Anesthesiology representation (expertise) is vital
☐ Create a leadership plan where top level leadership regularly review a dashboard of occurrences of UEs, the complications that occur due to UE, and the cost of these occurrences in morbidity, mortality and healthcare dollars

Engage staff and ensure best patient care

☐ Provide periodic education for all airway management providers:
  ☐ Educate providers regarding the importance of prevention of UE and the need for accurate data tracking
  ☐ Include UE as part of every presentation of management of the difficult airway patient
☐ Implement Clinical Best Practices for Preventing UE:
  ☐ Standardize tracheal tube restraint devices, using the most proven methods and devices
  ☐ Formalize systems for appropriate sedation and patient restraint to decrease the risk of unplanned self-extubation
  ☐ Create systems for alerting clinicians to patients with a known difficult airway
☐ Use patient stories, in written and video format, to identify gaps and inspire change in your staff

Track UE and use data to find areas for improvement

☐ Determine baseline rate of UE (see Measuring outcomes section)
☐ Determine baseline rate of complications (oral mucosa and facial skin pressure injuries, pneumonia, vocal cord injury, hypoxemia, brain injury, death) caused by UE
☐ Perform an event review for all incidences of UE. Perform a root cause analysis (RCA) for all deaths associated with UE:
☐ Use a multidisciplinary team including physicians, nurses, and respiratory therapists to evaluate the root cause of every UE, determine a plan to eliminate the root cause, implement the plan, and track results.

☐ Institutions should use techniques described in Failure Modes and Effects Analysis or Safety II to create strategies that mitigate the risks of UE.

☐ Implement the core UE dataset as defined in the Measuring outcomes 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 UE and ultimately eliminating all incidents of UE:

☐ Require tracking and reporting of all incidents of UE and complications of UE, including hypoxemia, pneumonia, vocal cord injury, brain injury and death.

☐ Use patient stories – in written and video formats – to identify gaps and inspire change in your staff.
What we know about UE

Unplanned extubation, both in the field and in the hospital, is a common and costly problem. An extensive review of 50 studies revealed that:

- 7.3% (range: 0.5% - 35.8%) of adult endotracheally intubated Intensive Care Unit (ICU) patients have an UE (daSilva, Anesthesia & Analgesia, 2012)
- 1.65 million adult patients are intubated and mechanically ventilated each year in U.S. ICUs according to The Society for Critical Care Medicine’s 2017 statistics
- Extrapolation of the average 7.3% UE rate to intubated patients in U.S. Adult ICUs would suggest that there are over 120,000 UEs yearly, in U.S. adult ICUs alone
- Based on morbidity and mortality data, those 120,000 UEs yearly would result in over 33,000 deaths (DeLassence, et al., 2002)
- UE increases the incidence of pneumonia from 14% to 30% (DeLassence, et al., 2002), which would result in over 36,000 pneumonias
- UE more than doubles the average ICU stay (DeLassence, et al., 2002), increasing 9 days to 18 days (DeLassence, et al., 2002)
- Complications of UEs in adult ICUs results in over $4.9 billion in unnecessary healthcare costs (Dasta et al., 2005; Needham and Provost, 2005).

The need to accurately track UE

Although the incidence of UE is likely higher in emergency medical services (EMS) settings due to the difficulties of transporting critically ill patients in a chaotic environment, UE is not tracked in most EMS systems. Similarly, most hospitals do not track UE. If we are going to get an accurate measure of the frequency and costliness of UE, 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. This APSS gives examples to help hospitals prioritize their efforts at designing and implementing evidence-based bundles for reducing UE.

Leadership plan

Hospital governance, senior administrative leadership, safety and risk management leadership, and clinical leadership must work collaboratively to reduce UE.

Show leadership’s commitment to reduce UE

- Hospital governance and senior administrative leadership must commit to reducing the incidence of UE with a goal of zero preventable deaths
- Raise awareness regarding the seriousness of UE - champion efforts to raise awareness regarding the seriousness (frequency and costliness) of UE
- Determine the facility’s rate of UE through reporting and tracking within a formal Quality Improvement (QI) program, and engage QI/Patient safety to implement steps to reduce the incidence of UE and eliminate preventable deaths:
  - After you know your facility incidence rate, develop an organizational story and use the skill set of storytelling to raise organizational awareness and action to stay
focused on why there is a need for change

- 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

**Create a team to reduce UE**
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
- Neonatal/Pediatric representation (expertise) is crucial - APSSs are currently being developed for pediatric and neonatal patients

**Engage staff and make policy changes to reduce UE**
- 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 UE
- Use patient stories - in written and video formats - to identify gaps and inspire change in your staff:
  - The story of Drew Hughes, told by his father David Hughes, is an example of an unplanned extubation that led to the preventable death of Drew. You can view the story for free here: [https://youtu.be/v8PV4mDWVWc](https://youtu.be/v8PV4mDWVWc)

**Action plan**

**Create protocols to reduce UE**
- Use current evidence-based guidelines and known best practices during airway management of the intubated patient to eliminate incidents of UE
- 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 (for adults this is 2-6 cm above the carina). Proper initial positioning of the endotracheal tube decreases the risk of UE if the tube moves.
- Once appropriately positioned, maintain that position with a tube stabilizer that eliminates clinically significant (>2 cm) total movement of the tube
- Restrain the patient using 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 malpositioned tube:
  - The initial clinical evaluation of any cardiopulmonary arrest in an intubated patient should include determination that the endotracheal tube is correctly positioned and the patient is being adequately ventilated via waveform capnography. Waveform capnography along with clinical evaluation must be used to make this determination. Assume that the lack of a capnography waveform is due to a malpositioned
endotracheal tube until proven otherwise. “Flat trace, wrong place.”

- If the evaluation suggests the tracheal tube might be mal-positioned, the tube should be immediately repositioned, UE should be considered as the cause of the arrest and a root cause analysis of the extubation performed

- Communication about sedation interruption/vacation should be an integral part of daily rounds/huddles for all intubated patients and should include all members of the team, including the respiratory therapy team

**Track and analyze your progress**

- UE should be considered through an event review as the cause of any cardiac arrest and if determined to be the cause of death a true root cause analysis should be performed

- Develop a Quality Management Process to promote and ensure continuous improvement with an initial goal of eliminating preventable deaths from UE and ultimately eliminating all incidences of UE. To do this:
  - Review all incidents of UE
  - Determine root causes, which may include:
    - 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 cause improvement

- Require tracking and reporting of all incidents of UE and complications of UE (e.g., hypoxemia, pneumonia, vocal cord injury, brain injury, and death)

**Create best practices for out-of-hospital management of UE**

- Airway management in the field (EMS/military) should incorporate the same prevention, tracking, and quality management concepts as described above for medical facilities

- All patients that are transported with an endotracheal tube in place must receive continuous waveform capnography to ensure early recognition of displacement of the tube. Failure to rapidly recognize and remediate a displaced tube has a very high probability of hypoxemia that can result in severe brain injury and death.

- All incidents of UE in the field must be reported to the receiving facility during hand-off communications

- EMS airway provider must communicate the incident of UE to the receiving facility and the receiving providers should consider antibiotic therapy to reduce the likelihood of pneumonia – the incidence of pneumonia doubles in patients who experience a UE

**Technology plan**

These suggested practices and technologies have shown proven benefit or, in some cases, are the only known technologies for certain tasks. If you know of other options not listed here, please complete the form for the PSMF Technology Vetting Workgroup to consider: patientsafetymovement.org/actionable-solutions/apss-workgroups/technology-vetting/

Test and use airway management devices that improve safety and drive better patient outcomes, including:
### ONC Meaningful Use Certified Electronic Health Record (EHR) System

An effective EHR System should include:
- Computerized Physician Order Entry (CPOE)
- Drug-drug interaction check
- Drug-allergy interaction check
- Clinical Decision Support tools (CDS)
- ETT depth alerts for documentation of placement that is outside the normal range
- An alert if >6 hours since the patient completed and passed a spontaneous breathing trial

### Standardize tracheal tube restraint devices

The current methods and devices for stabilizing endotracheal tubes include:
- Adhesive tape
- Cotton twill ties
- 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, et al, 2012), which evaluated more than 50 studies published worldwide, demonstrated an average rate of UE 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

In adults, the stabilizer should, at minimum, prevent clinically significant movement (>2 cm) that could result in an UE. Optimally, it should prevent any movement of the endotracheal tube relative to the stabilizer. Even small incremental movements can result in UE.

**Waveform Capnography**

Mandate the use of Waveform Capnography in ALL intubated patients to ensure rapid recognition of a malpositioned tracheal tube.

This important technology has become the standard of care for intubated patients in the UK and parts of Europe. North American Intensive Care Units, Emergency Departments, and Emergency Medical Services are beginning to adopt this technology, but significant gaps exist.

*Company has signed some form of the Open Data Pledge. Find more information on the Patient Safety Movement Foundation website: patientsafetymovement.org/partners/open-data-pledges/view-all-open-data-pledges/

**Measuring outcomes**

**Key performance indicators**

- UE in intubated patients
- Rate of UE for patients intubated via endotracheal tube

**Outcome measure formula**

**Numerator:** Number of incidents of UE in patients intubated via an endotracheal tube

**Denominator:** Total number of days intubated

*Rate of unplanned extubation is expressed in terms of: Number of incidents unplanned extubation per 100 intubation days

**Metric recommendations**

**Direct impact:** All patients intubated via endotracheal tube

**Lives spared harm:**

Lives Spared Harm = Unplanned Extubation Rate\textsubscript{baseline} - Unplanned Extubation\textsubscript{measurement} X Days Intubated*\textsubscript{baseline}

* Days Intubated is the Outcome Measure Formula Denominator: (Total Number of Intubated Days)
Data collection
Use a tracking sheet for UEs. Data is best collected through electronic capture of data fields from electronic patient care reports. This requires having an EHR System that includes the following PSMF Core Data Set for UE:

- Does the patient have a history of a difficult airway?
- What method was used to identify the difficult airway patient?
- Was a pre-intubation assessment predictive of a difficult airway?
- Route of intubation (e.g., oral, nasal, or tracheostomy)
- What was the method of tube restraint? (e.g., tape, twill, commercial tube holder); if a commercial tube holder, specify the type
- Date of extubation
- Time of extubation
- Extubation type (planned or unplanned)
- UE cause (self-extubation or accidental extubation)
- Location where the UE occurred (e.g., GI suite)
- Did UE occur while the patient was being transported or moved?
- Was the patient adequately restrained at the time of extubation?
- Was the patient adequately sedated at the time of extubation?
  - Facility sedation policy type (continuous with daily interruptions, intermittent, no sedation)
- Was reintubation required?
- Was reintubation attempted (successful or unsuccessful)?
- Outcome/complications of UE (e.g., pneumonia, vocal cord injury, hypoxemia, brain injury, death)
- Did the UE occur during a sedation interruption or “sedation vacation”?
  - Was the respiratory therapist made aware of the sedation vacation?
  - Did appropriate communication to all members of the team (i.e. between nurse and respiratory therapist) occur related to the initiation of the sedation interruption or “sedation vacation”?
- Was the patient on spontaneous breathing trials?
  - If so, was there a delay in extubation due to a delay in the physician ordering the extubation?
- What team members were present when the UE occurred?
- Encourage the addition of an “other” field in the EHR to collect information to learn about new or specific trends identified by staff

Extubation may occur as a planned or unplanned event:

- A **planned extubation** occurs when a physician orders the removal of the endotracheal tube and the extubation proceeds in a controlled manner
- A **UE** is defined as removal of a patient’s endotracheal tube without a physician’s order and the extubation occurs in an uncontrolled manner. UE may occur from either 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 EHR 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 UE 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 UE should be measured including patient sedation and patient restraint
• Rate of complications and mortality related to incidents of UE are important to determine the extent of adverse effects of UE:
  o Rate of pneumonia in intubated patients with an incident of UE compared to rate of pneumonia in intubated patients without an incident of unplanned extubation
  o Rate of severe brain injury in intubated patients with an incident of unplanned extubation compared to the rate of brain injury in intubated patients without an incident of UE
  o Mortality rate in intubated patients with an incident of UE compared to the rate of mortality in intubated patients without an incident of UE

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 Patients’ (PfP) grant funded Hospital Improvement Innovation Networks (HIIN). 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 UE was not included in the AHRQ National Scorecard document. 61% of patients experiencing UE do not require reintubation and those patients have a low mortality rate (5%) (Gao, et al., 2016). 39% of patients experiencing UE require reintubation and those patients have a high mortality rate (37%) (Gao, et al., 2016). The overall mortality rate for all incidents of UE is 28% (deLassence et al., 2002) and accounts for over 33,000 deaths annually, in the U.S.

Conflicts of interest disclosure
The Patient Safety Movement Foundation partners with as many stakeholders as possible to focus on how to address patient safety challenges. The recommendations in the APSS are developed by workgroups that may include patient safety experts, healthcare technology professionals, hospital leaders, patient advocates, and medical technology industry volunteers. Some of the APSSs recommend technologies offered by companies involved in the Patient Safety Movement Foundation. The workgroups have concluded, based on available evidence, that these technologies work to address APSS patient safety issues. Workgroup members are required to disclose any potential conflicts of interest.
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