Actionable Patient Safety Solutions™ (APSS™):
Unplanned Extubation

How to use this guide

This APSS provides evidence-based actions and resources for executives, leaders, clinicians, and performance improvement specialists. This document is intended to be used as a guide for healthcare organizations to examine their own workflows, identify practice gaps, and implement improvements. In it, you'll find:

Best Practice Summary: A high level summary of evidence-based, clinical best practices. (page 2)

Executive Summary: Executives should understand the breadth of the problem and its clinical and financial implications. (page 3)

Leadership Checklist: This section is for senior leaders to understand common patient safety problems and their implications related to unplanned extubation. Most preventable medical harm occurs due to system defects rather than individual mistakes. Leaders can use this checklist to assess whether best practices are being followed and whether action is needed in their organization around unplanned extubation. (page 3)

Clinical Workflow: This section includes more specific information about unplanned extubation across the continuum of care. Leaders should include the people doing the work in improving the work. This section outlines what should be happening on the frontline. Clinicians can use this section to inform leaders whether there are gaps and variations in current processes. This is presented as an infographic that can be used for display in a clinical area. (page 4)

Education for Patients and Family Members: This section outlines what frontline healthcare professionals should be teaching patients and family members about unplanned extubation. Clinicians can inform leaders whether there are gaps and variations in the current educational processes. (page 7)

Performance Improvement Plan: If it has been determined that there are gaps in current practice, this section can be used by organizational teams to guide them through an improvement project. (page 7)

What We Know about Unplanned Extubation: This section provides additional detailed information about unplanned extubation. (page 10)

Resources: This section includes helpful links to free resources from other groups working to improve patient safety. (page 14)

Endnotes: This section includes the conflict of interest statement, workgroup member list, and references. (page 14)

Citation: Patient Safety Movement Foundation. (2022). Unplanned Extubation Actionable Patient Safety Solutions. Retrieved from https://patientsafetymovement.org/community/apss/

Patient Safety
M O V E M E N T

Best Practice Summary

Preparation

- ☐ Check that all equipment is functioning properly to avoid any delays. Have the stabilization device at the bedside prior to any intubation and perform a pre-use check.
- ☐ Intubation
- ☐ Properly position the depth of the endotracheal tube within the trachea with the tip of the ETT within the optimal target ranch at 2 to 6 cm above the carina.
- ☐ Confirm proper tracheal position and record the tube depth at the nare, lips, gums, or teeth, depending on the organizational protocol.
- ☐ Stabilization and Routine Care
- ☐ Once the patient has been intubated, apply the ETT stabilizer without allowing the tube to move from initial depth and recheck depth position of the ETT.
- ☐ Frequently and closely monitor the patient. Anybody interacting with the patient should be educated on exercising heightened caution.
- ☐ Adhere to standardized taping method.
- ☐ Regularly assess the level of sedation and conduct regular ETT position checks to confirm that the ETT is secure. If the ETT becomes loose, re-secure the tube and pay close attention to the patient's secretions.
- ☐ Ensure adequate sedation and staffing prior to high risk movement such as bedside imaging, bedside invasive procedures, and early mobility.
- ☐ Track, report, and perform apparent cause analysis on all incidents of UE and complications of UE.

Extubation

- ☐ Determine readiness for safe removal of ETT.
- ☐ Use spontaneous breath trials to help determine readiness once the patient meets the following criteria:
  - ☐ Evidence of reversal of underlying cause of respiratory failure
  - ☐ Adequately oxygenating on PEEP <8 and FIO2 < 0.50
  - ☐ Hemodynamically stable
  - ☐ Able to initiate inspiratory effort
  - ☐ Rapid shallow breathing index of <105
  - ☐ Vital capacity of > 10ml/kg.
  - ☐ Be prepared with equipment if reintubation is needed.
- ☐ Position the patient in high Fowler's position, and suction the patient as needed.
- ☐ Be sure to instruct the patient to take deep breaths and cough.

Executive Summary

The Problem

Unplanned extubation (UE) is the unintentional removal of a patient's life-sustaining breathing tube which occurs when a patient removes their tube (self extubation) or when the tube is dislodged by an external force (accidental extubation). It can also occur when the endotracheal tube malfunctions (i.e. balloon failure) requiring replacement of the tube (device malfunction). While preventable with stepwise, simple measures, UE is a major cause of harm and death both in the hospital and in the emergency medical service (EMS) sector. Of the 1.65 million intubated ICU patients annually, 121,000 are estimated to experience an unplanned extubation (da Silva & Fonseca, 2012).

The Cost

UE is estimated to cause 36,000 annual ventilator-associated pneumonia cases, to increase ICU costs by $41,000 per UE event, and to double length of stay, ultimately culminating in $4.9 billion in wasted healthcare costs (De Groot et al., 2011; Dasta, McLaughlin, Mody & Piech, 2005). Most importantly, it is associated with 33,000 ICU deaths in the US yearly.

The Solution

Many healthcare organizations have successfully implemented and sustained improvements and reduced death from UEs. This document provides a blueprint that outlines the actionable steps organizations should take to successfully reduce UEs and is targeted toward adult unplanned extubation. Pediatric and neonatal unplanned extubation is addressed in the Pediatric and Neonatal Airway Safety APSS. This document is revised annually and is always available free of charge on our website.

Leadership Checklist

On a regular basis, the executive team should review overall incidence and trends of unplanned extubation . Use this checklist as a guide to determine whether current evidence-based guidelines are being followed in your organization:

- ☐ Develop a high-reliability organization and promote a culture of safety
- ☐ Standardize data collection and reporting processes.
- ☐ Using the operational definition of unplanned extubation, evaluate and classify every extubation as *planned extubation, unplanned/self extubation, unplanned/accidental extubation, or unplanned/device malfunction*.
- ☐ Measure and report UE data monthly or quarterly, noting trends in clinical areas with high incidence and prevalence. Routinely reassess outcomes. Present annually to hospital-wide leadership.
- ☐ All possible UE events should be reviewed by a multidisciplinary review team (RN, RT, MD) using apparent cause analysis and should detail any potential contributing factors and related morbidities.
- ☐ If UE rates indicate room for improvement, initiate a PI (performance improvement) project. If a problem is not identified, routinely reassess to identify gaps, and ensure integrity of the data collected. **The goal is to eliminate all preventable harm to patients**

caused by unplanned extubation.

- ☐ Ensure active frontline involvement in UE improvement activities. Maintain their engagement and remove barriers to progress.
- ☐ Measure the associated process outcomes.
- ☐ Ensure that UE protocols are embedded into clinical workflows, whether electronic or paper.
- ☐ Ensure there are enough staff to effectively manage necessary preventive care.
- ☐ Ensure adequate training and documentation of UE competencies and skills.
- ☐ Eliminate barriers to making rapid changes to documentation templates and order sets.
- ☐ Debrief on a regular basis to solicit team feedback about barriers to sustained compliance. Adjust the plan quickly and nimbly as needed.
- ☐ Hold staff the system accountable for providing the standard of care. and reward Reward success.
- ☐ Ensure that leaders have a simple process to oversee UE improvement work while also considering how it aligns with other initiatives across the organization.

Clinical Workflow

1. PRE-INTUBATION PREPARATION

Prepare and check all equipment prior to intubation to avoid delays.

- Have the stabilization device at bedside prior to intubation.
- Complete any pre-use checks of the stabilization device suggested by the manufacturer and prepare the device for application to ETT.

2. INTUBATION

Proper positioning and confirmation are essential for stabilization and prevention of UE. Position the depth of the endotracheal tube within the trachea at the proper depth with the tip of the ETT within the optimal target range at 2-6 cm above the carina. This positioning will minimize the opportunity for UE if the ETT moves. Many endotracheal tubes have depth positioning markers on the ETT which will facilitate proper depth positioning

- Confirm proper tracheal position by use of waveform $EtCO_2$ and proper depth position by CSR/US
- Record the tube depth at the upper incisors

3. STABILIZATION

- Apply the ETT stabilizer without allowing the tube to move from its initial depth position noted during intubation
- If stabilizing the ETT with tape, use a standardized evidence-based application technique (such as the Lillihei Technique).
- Once the stabilizer has been applied recheck depth position of the ETT at the upper incisors and record depth

4. ROUTINE CARE

Routine care of intubated patients should center around frequent and close monitoring of the tube placement and anyone interacting with the patient should know to exercise heightened caution. Utilize continuous waveform capnography to monitor tracheal position of the ETT and for rapid notification of the dislodgement of unplanned extubation. Utilize appropriate sedation and physical restraints as needed

- Regularly assess level of sedation and need for restraints
- Use the Comfort B scale or Ramsay sedation scale to assess the level of sedation
- Communicate sedation and vacation plans each shift with all team members

Conduct regular ETT position checks to confirm secure ETT tube fixation and to re-secure tube if loose or any evidence of movement is noted.

- Pay attention to the patient's secretions
- Maintain optimal tip position 2-6 cm above the carina
  - o Proper positioning decreases risk of UE if tube moves

For any high-risk maneuver, such as suctioning, proning, or transport, the team should ensure adequate sedation and staffing prior to any movement of the patient.

- Perform timeout with all staff prior to maneuver
- Assign staff member to maintain control of ETT during maneuver
- Confirm proper ETT depth after maneuver completed

Track, report, and perform apparent cause analysis on all incidents of UE and complications of UE, including , but not limited to, hypoxemia, pneumonia, vocal cord injury, brain injury, and death.

5. EXTUBATION

Determine readiness for safe removal of the endotracheal tube by completing an

assessment for liberation potential and spontaneous breath trial as part of a strategic weaning process.

- Assessment for Liberation Potential. The patient is considered to have completed a successful Assessment for Liberation Potential when they meet all of the following:
  - o Evidence of reversal of underlying cause of respiratory failure
  - o Adequately oxygenating on PEEP <8 and FIO2 < 0.50
  - o Hemodynamically stable
  - o Able to initiate inspiratory effort
  - o Rapid shallow breathing index of <105
  - o Vital capacity of > 10ml/kg
- Spontaneous breathing trials (SBTs).
- Decrease in pressure support during pressure support ventilation (PSV)
- Decrease in ventilator-assisted breaths during intermittent mandatory ventilation (IMV)
- Computer-driven automated PSV weaning
- Early extubation with post-extubation noninvasive positive pressure ventilation (NPPV)

Remove the endotracheal tube in a controlled manner. The care team should prep the patient for extubation by taking time to thoroughly explain the procedure. The care team should also:

- Monitor vital signs (O2, RR, BP, HR)
- Have equipment and personnel available in case of need for reintubation
- Position the patient in high Fowler's
- Suction the patient; include endotracheal suction, subglottic suction (if ETT has subglottic suction capability), and oropharyngeal suction
- Hyperoxygenate the patient
- Instruct the patient to take a deep breath and cough; simultaneously deflate the balloon and remove tube on end-expiration
- Suction residual secretions
- Administer supplemental oxygen as needed
- Assess adequacy of oxygenation and ventilation after tube removal
  - o End-tidal CO2 (capnography)
  - o Pulse oximetry
  - o Arterial blood gases (ABG's)

Education for Patients and Family Members

Explain the reasons behind the patient's intubation. The family members should understand the necessity of their loved one's intubation and the circumstances that prompted the intubation. The healthcare team should communicate with the family when, where, and why the patient was intubated.

Define UE, associated complications, and potential causes. After an overview of intubation, the healthcare team should move on to educate the family members about the removal of the tube and the distinction between planned removal and unplanned removal. Ensure family members understand the steps and indications for planned removal, the causes of UE and the complications associated with UE. The family members should understand that they can also unintentionally cause a UE.

Discuss what family members can do to prevent UE. It is very possible that a family member may unintentionally prompt an unplanned extubation by exerting pressure on the patient. By explaining the background and severity associated with an unplanned extubation, family members can both understand how their actions can interfere with treatment and how they can be vigilant during their loved one's stay for any risk factors of unplanned extubation.

Additionally, family members should understand that the patient may remove their tube unintentionally. Ensure family members know who to contact and when if they think there is a possibility of patient removal of their tube.

- 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.
- Society of Critical Care Medicine: Family Engagement and Empowerment

Performance Improvement Plan

Follow this checklist to improve performance and move your organization toward eliminating the harm and death associated with unplanned extubation:

☐ **Gather the right project team.** Bee sure to involve the right people on the team. You'll want two teams: an oversight team that is broad in scope, has 10-15 members, and includes the executive sponsor to validate outcomes, remove barriers, and facilitate spread. The actual project team consists of 5-7 representatives who are most impacted by the process. Whether a discipline should be on the advisory team or the project team depends upon the needs of the organization. Patients and family members should be involved in all improvement projects, as there are many ways they can contribute to safer care.

> **Complete this Lean Improvement Activity:**
> Conduct a SIPOC analysis to understand the current state and scope of the problem. A SIPOC is a lean improvement tool that helps leaders to carefully consider everyone who may be touched by a process, and therefore, should have input on future process design.

RECOMMENDED UNPLANNED EXTUBATION IMPROVEMENT TEAM	
• Nurses	• Clinical educators
• Respiratory therapists	• Information technology
• Physicians (Emergency Medicine, Critical Care, Anesthesiology)	• Patient/family members
	• Admitting and registration staff
• Wound Care (Pressure Injury Prevention) Specialists	
• Emergency Medical Service personnel (e.g., paramedics)	

Table 1: Understanding the necessary disciplines for an unplanned extubation project improvement team

☐ **Understand what is currently happening and why.** Reviewing objective data and trends is a good place to start to understand the current state, and teams should spend a good amount of time analyzing data (and validating the sources), but the most important action here is to go to the point of care and observe. Even if team members work in the area daily, examining existing processes from every angle is generally an eye-opening experience. The team should ask questions of the frontline during the observations that allow them to understand each step in the process and identify the people, supplies, or other resources needed to improve patient outcomes.

Create a process map once the workflows are well understood that illustrates each step and the best practice gaps the team has identified (IHI, 2015). Brainstorm with the advisory team to understand why the gaps exist, using whichever root cause analysis tool your organization is accustomed to (IHI, 2019). Review the map with the advisory team and invite the frontline to validate accuracy.

UNPLANNED EXTUBATION PROCESSES TO CONSIDER ASSESSING
Standardized ET Tube securement
All high-risk situations, including:
• Any manipulation of the ETT
• Patient repositioning or movement
• Transport of the patient
• Any bedside procedure
• Use of a provider responsible for identification and maintenance of ETT position before, during and after any high-risk situation
Sedation and restraint
Hand-off communications, especially communications regarding sedation vacations
Daily maintenance of ETT, including movement during oral care and position checks
Patient and family education

Table 2: Consider assessing these processes to understand where the barriers contributing to unplanned extubation may be in your organization

☐ **Prioritize the gaps to be addressed and develop an action plan.** Consider the cost effectiveness, time, potential outcomes, and realistic possibilities of each gap identified. Determine which are a priority for the organization to focus on. Be sure that the advisory team supports moving forward with the project plan so they can continue to remove barriers. Design an experiment to be trialed in one small area for a short period of time and create an action plan for implementation.

The action plan should include the following:
- Assess the ability of the culture to change and adopt appropriate strategies
- Revise policies and procedures
- Redesign forms and electronic record pages
- Clarify patient and family education sources and content
- Create a plan for changing documentation forms and systems
- Develop the communication plan
- Design the education plan
- Clarify how and when people will be held accountable

TYPICAL GAPS IDENTIFIED IN UNPLANNED EXTUBATION	
• Lack of accountability • Little organizational focus on UE prevention • Lack of standardization in hospital and in emergency service teams • Lack of leadership oversight • Inconsistent use of a sedation scoring system • Variable tube securement practices • Lack of restraint use standards • Lack of a 'time-out' to discuss extubation risk prevention	• Inconsistent communication of UE prevention updates • Inconsistent education of new protocols • Poor circumstances in emergency environments • Complex work environment with many distractions • New or visiting staff members • Inadequate staffing during high risk maneuvers, such as proning or transport • Emergent patient needs • Lack of adequate supplies

Table 3: By identifying the gaps in unplanned extubation prevention compliance, organizations can tailor their project improvement efforts more effectively

☐ **Evaluate outcomes, celebrate wins, and adjust the plan when necessary.** Measure both process and outcome metrics. Outcome metrics include the rates outlined in the leadership checklist. Process metrics will depend upon the workflow you are trying to improve and are generally expressed in terms of compliance with workflow changes. Compare your outcomes against other related metrics your organization is tracking.

Routinely review all metrics and trends with both the advisory and project teams and discuss what is going well and what is not. Identify barriers to completion of action plans, and adjust the plan if necessary. Once you have the desired outcomes in the trial area, consider spreading to other areas (IHI, 2006).

It is important to be nimble and move quickly to keep team momentum going, and so that people can see the results

Read this paper from the Institute for Healthcare Improvement to understand how small local steps

of their labor. At the same time, don't move so quickly that you don't consider the larger, organizational ramifications of a change in your plan. Be sure to have a good understanding of the other, similar improvement projects that are taking place so that your efforts are not duplicated or inefficient.

UNPLANNED EXTUBATION METRICS TO CONSIDER ASSESSING	
• Incidence of self-extubation, accidental extubation, and device malfunction	• Rate of re-intubation
• Patient combativeness or sedation reports	• Rate if UE related aspiration pneumonia
• Rate of compliance with use of pre-extubation Assessment for Liberation Potential and Strategic Ventilator Weaning Processes (Spontaneous Breathing Trial)	• ICU LOS
	• Rate of severe brain injury associated with UE
	• Rate of death associated with UE

Table 4: Consider evaluating related metrics to better understand UE presence and contributing factors

What We Know About Unplanned Extubation (UE)

Operational Definition of All Extubation Types Including Unplanned Extubation (UE)

In order to identify all possible events that should be considered incidents of UE and thereby be able to identify areas for intervention, every extubation should be properly classified as a planned extubation or unplanned extubation. The following operational definition will allow for proper identification of these events.

When a patient requires intubation, whether due to an underlying illness (i.e. respiratory failure), underlying injury (i.e. closed head injury, spinal cord injury) or during general anesthesia for a surgical procedure, it is expected to be temporary. Once the underlying reason for intubation resolves, the patient should be evaluated for readiness for removal of the endotracheal tube. Thus, a planned extubation occurs as part of a process that is "planned" prior to intubation. Anytime an extubation occurs outside of this "pre-planned" process, the extubation is known as an unplanned extubation (UE). All types of extubation, planned or unplanned, have an associated risk of the patient not tolerating the extubation and requiring reintubation to maintain sufficient ventilation (failed extubation).

An Assessment for Liberation Potential (ALP) and a Strategic Weaning Process (SWP) are used to determine risk for a failed extubation. This will help facilitate extubation with the lowest risk of failure (requiring reintubation). Once it is determined that the risk of failure of a planned extubation is minimal, the endotracheal tube is removed intentionally and occurs in a controlled manner, which includes preparation for extubation, patient suctioning, ETT balloon deflation, and controlled removal after balloon deflation. An unplanned extubation is any extubation that occurs outside the pre-planned process.

The normal planning for extubation includes:

- Resolution of the underlying cause for intubation
- Determination of readiness for safe extubation
- Extubation in an intentional and controlled manner.

UE may occur when the patient exerts a force to remove the tube (self-extubation) or by an

external force applied to the tube (accidental extubation), typically during movement of the patient or during a procedure.

Extubation Classification				
Extubation Type		Readiness for safe removal of ETT determined? Assessment for Liberation Potential And Successful Strategic Wean completed?	ETT removal was **intentional**? Airway provider made a conscious decision to remove the ETT	ETT removal was **controlled**? Patient was prepped for extubation and balloon was deflated prior to extubation
Planned Extubation		Yes	Intentional	Controlled
Unplanned Extubation	Self-Extubation	No	Unintentional	Uncontrolled
Unplanned Extubation	Accidental Extubation	No	Unintentional	Uncontrolled
Unplanned Extubation	Device Malfunction	No	Intentional	Controlled
Unplanned Extubation	Presumed Internal Dislodgement	No	Intentional	Controlled

Both self-extubation and accidental extubation may:

- Cause complete removal from the oral cavity
- Cause the tube to remain internal and appear to be in the proper position, but EtC02 indicates it is no longer in the trachea. This is known as internal dislodgement.

A malfunction of the endotracheal tube (obstruction, deflation of balloon, etc.) that causes the tube to be urgently or emergently removed and replaced and is also considered an unplanned extubation.

The above operational definition for classifying extubation is presented in the table below and should be used to classify every extubation:

Clinical and Financial Implications

It has been estimated that 7.3% of ICU patients experience self-extubation or accidental extubation per year. This number increases to 18.2% of intubated patients within the NICU setting (da Silva & Fonseca, 2012; da Silva, Reis, Aguiar & Fonseca, 2013). Extrapolation of the average 7.3% UE rate to the 1.65 million intubated patients in US adult ICUs would suggest that there are over 120,000 UEs annually, ultimately costing $4.9 billion in healthcare costs (De Groot et al., 2011; Dasta, McLaughlin, Mody & Piech, 2005).

UEs account for an estimated 10% of total extubations and 60% require reintubation, a process that can cause severe patient harm (de Groot et al., 2011). As such, one UE correlates with an average increase of $41,000 in ICU costs per event per patient (Unplanned Extubations, 2018).

UE increases the incidence of pneumonia from 14% to 30% (De Lassence et al., 2002). This increased risk for infection is a significant cause for the doubled length of stay in the ICU (De Lassence et al., 2002), increasing 9 days to 18 days (De Lassence et al., 2002).

While UE itself can compromise patient outcome and well-being, the need for reintubation after extubation (both planned and unplanned) can introduce additional risks for patients, including aspiration, arrhythmia, cardiac arrest, and even death (Beverly, Brovman, Malapero, Lekowski & Urman, 2016).

Populations At Risk

Any patient with an endotracheal tube is at risk for UE. Assessment for UE risk should consider presence of delirium, irritability, and method of mechanical ventilation. The following are

circumstances that increase the risk for unplanned extubation (Kwon & Choi, 2017) :

- Inadequate stabilization of breathing tube
- Pain
- Increased level of consciousness or inadequate sedation, especially during transportation or in chaotic environments, like the ED
- Use of benzodiazepines
- Delirium
- Patient restlessness and frustration
- Changes in patient positioning (turning, proning, and transporting)
- Weaning protocols
- Lack of clear policies
- Factors related to nursing, respiratory, and ancillary staff (inexperienced, night shift, inadequate staffing)

Case Study: Implications of UE in COVID

The COVID-19 pandemic places patients at increased risk of UE and places providers at increased risk due to exposure to viral particles aerosolized during the extubation (Berkow & Kanowitz, 2020).

Seriously ill COVID-19 patients with ARDS require repetitive cycles of prone ventilation to improve oxygenation. The process of turning a patient between supine and prone positions ("proning") dramatically increases the risk of UE. A recently released DoD COVID-19 Practice Management Guide recognizes proning maneuvers as the leading risk factor for UE. Mucus plugging due to secretions requiring extubation and re-intubation has also been reported as a complication in patients with COVID-19 (PERT Consortium Webinar: COVID-19 and Pulmonary Embolism: Perspectives from China and the United States, 2020)

Adequate staffing: Optimal provider to patient ratios (<1:2 when caring for critically ill mechanically ventilated patients) are not feasible during COVID-19 surge. Adding to the known shortfall in the availability of mechanical ventilators, fewer critical care trained healthcare providers may be available to manage the increased numbers of intubated COVID-19 patients, thereby increasing the risk of accidental extubation, provider contamination, and both provider and patient morbidity and mortality.

PPE: UE is known to cause aerosolization of viral particles. Forced extubation likely increases the travel distance and spread of these particles. Any healthcare provider responding to a call for emergency resuscitation (i.e., a "Code Blue"), especially one concerning an unplanned extubation, must don full personal protective equipment and should use extreme caution to prevent exposure of themselves and reduce the likelihood of subsequent spread of infection to others. PPE should be donned during all patient care especially procedures at high risk of UE, such as placing in the prone position or patient transport.

Caregivers conducting procedures on ventilated patients, including intubation and re-intubation, are at high risk of contamination due to aerosolized virus from COVID-19 patients. These patients should be managed in **a negative pressure environment**, where possible, and **all caregivers should be wearing full personal protective equipment (PPE)**. This includes a gown, double gloves, N95 facemask (or equivalent), goggles or face-shield or full PAPRS (Powered Air Purifying Respirators). Although the incidence of COVID infection in clinicians involved in tracheal intubation of suspected or confirmed positive COVID patients

is unknown, it can be postulated that this close proximity, as required for intubation, puts the healthcare worker at risk ([El-Boghdadly et al., 2020](#)).

Strategies for Prevention

Optimal ETT Securement

Although a single, superior device has not been verified, an optimal securement method should include ([Berkow, 2019](#)):

1. Appropriate stabilization against external movement
2. Movement and flexibility to ensure proper oral care
3. Adhesives that do not harm the skin
4. Ease of placement, use, and routine care
5. Minimal skin pressure
6. Ease of suctioning
7. Infrequent need for adjustment

Waveform Capnography
One of the most important components involved in prevention of complications when UE occurs is the use of waveform capnography to ensure rapid recognition of a malpositioned tracheal tube. This technology has become the standard of care for intubated patients in the UK and select areas in Europe. Although ICUs in the US are beginning to adopt this technology, there are still notable gaps. See appendix 1 for additional technologies to consider in UE prevention efforts.

Bundles
The ABCDEF bundle is an evidence-based action plan for hospital implementation that incorporates a holistic approach to preventing UEs. The bundle takes into account sedation, length of ventilation, pain level, and alertness and was created to prevent patient deterioration related to acute and chronic illness ([Society of Critical Care Medicine, 2020](#); [Marra, Ely, Pandharipande & Patel, 2017](#)):

A- Assess, Prevent, and Manage Pain

B- Both Spontaneous Awakening Trials and Spontaneous Breathing Trials

C- Choice of Analgesia and Sedation

D- Delirium: Assess, Prevent, and Manage

E- Early Mobility and Exercise

F- Family Engagement

The ABCDEF bundle has been successful in ICUs worldwide. Its implementation has increased daily awakening assessment compliance rates, thereby reducing benzodiazepine dosages by over a third and increasing RASS scores. Additionally, its implementation has been directly related to a 33% reduction in delirium and a 12.4% reduction in length of stay in the ICU ([Unplanned Extubations, 2018](#)).

It is important to remember that although accurate statistics are not available for UEs occurring in emergency medical services in transit to the hospital, any UE project improvement plan must take into account the circumstances and needs of both those in the hospital and those in the field in order to decrease UE overall.

Tracking UEs

The first step for improvement is increasing awareness of the issue. Despite UEs contributing significantly to complications in the hospital, this problem remains underreported.

Although the incidence of UE is likely higher in EMS settings due to the difficulties of transporting critically ill patients in a chaotic environment, UE is not tracked in most EMS systems. In order to get an accurate measure of the frequency and costliness of UE, both in the hospital and in the field, widespread systems to accurately track all incidents must be developed.

Resources
- Society of Critical Care Medicine: Implementing the F Element in the ABCDEF Bundle
- Airway Safety Movement: Unplanned Extubation
- Unplanned Extubations and Falls During Implementation of an ABCDEF Bundle in a Medical ICU
- Ramsay Sedation Scale

For General Improvement:
- CMS: Hospital Improvement Innovation Networks
- IHI: A Framework for the Spread of Innovation
- The Joint Commission: Leaders Facilitating Change Workshop
- IHI: Quality Improvement Essentials Toolkit
- SIPOC Example and Template for Download
- SIPOC Description and Example

Endnotes

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. Workgroup members are required to disclose any potential conflicts of interest.

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Appendices

Appendix A: Technologies

SYSTEM OR PRACTICE	CONSIDERATIONS
ONC Meaningful Use Certified Electronic Health Record (EHR) System	EHR equipped with the following capabilities: • 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 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.

	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 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.