Actionable Patient Safety Solutions (APSS):

Unplanned Extubation

How to use this guide

This guide gives actions and resources for creating and sustaining safe practices to avoid unplanned extubation. In it, you'll find:

SMART MANAGEMENT CONSULTANCY

Patient Safety MOVEMENT

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 in the US 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 harm and death UEs. These organizations have focused on projects that included **implementing an UE prevention "bundle"**, with the additional effects of increasing patient satisfaction, improving clinician engagement, and growing the financial bottom line.

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 APSS 8D.

This document is revised annually and is always available free of charge on our website. Hospitals who make a formal commitment to improve UE and share their successes on the PSMF website have access to an additional level of consulting services.

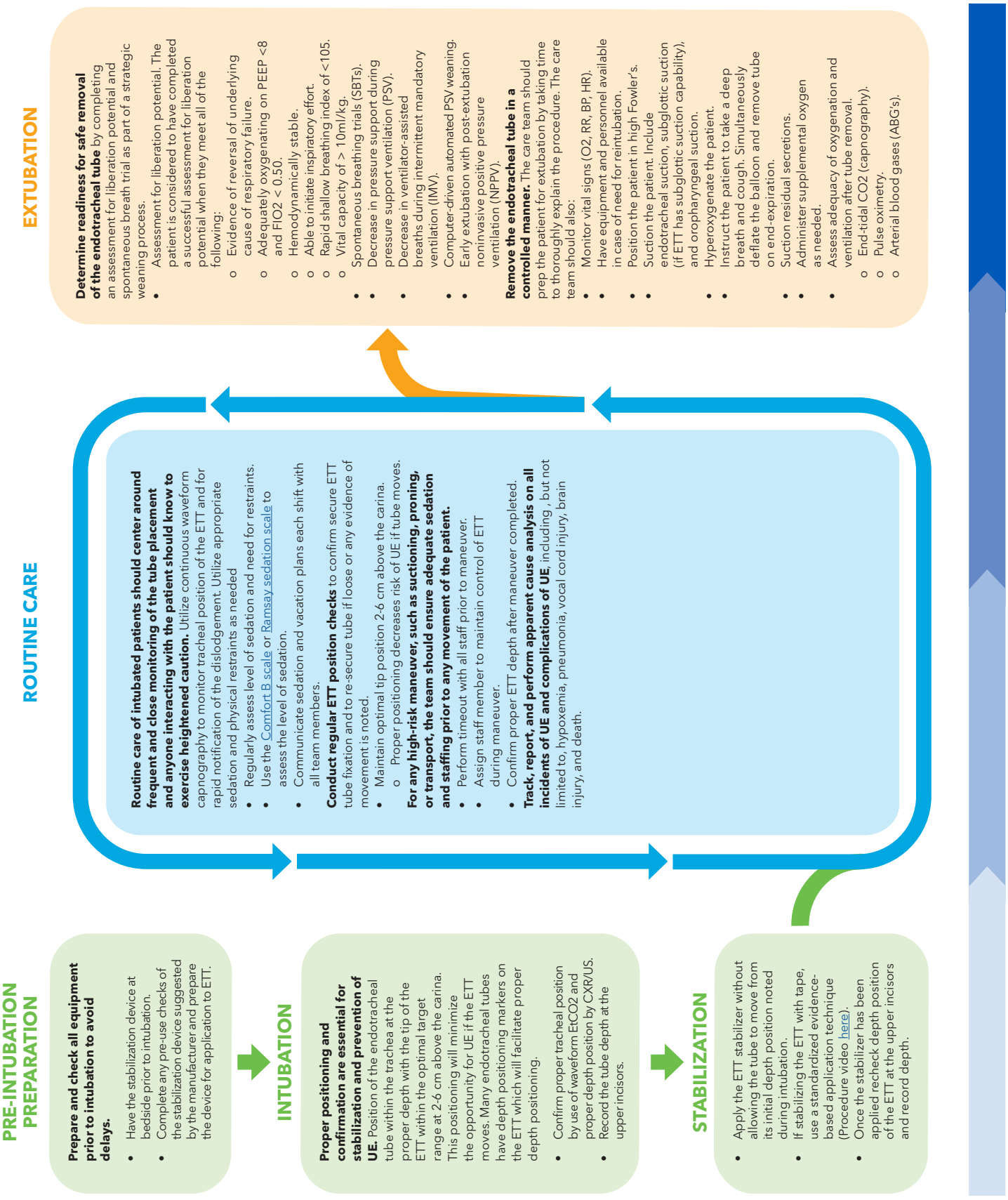
Leadership Checklist

On a monthly basis, or more frequently if a problem exists, the executive team should review all UE trends. Use this checklist as a guide to determine whether current evidence-based guidelines are being followed in your organization:

- ☐ Measure and report UE incidence monthly. Note trends in areas with high incidence and prevalence (i.e. ICU). Routinely reassess outcomes.
- ☐ If not already in place, initiate a performance improvement project around unplanned extubation.
- ☐ Ensure frontline involvement in UE improvement activities. Maintain their engagement and remove barriers to progress.
- ☐ If a PI plan is put in place, 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 accountable for providing the standard of care and 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 Infographic

This clinical workflow deals specifically with efforts to minimize the incidence of unplanned extubation and associated complications in adults. The overall clinical workflow related to adult airway management can be found in APSS #8A and neonatal/pediatric airway management in APSS #8C. Clinical workflow related to neonatal and pediatric unplanned extubation can be found in APSS #8D.



Performance Improvement Plan

Follow this checklist if the leadership team has determined that a performance improvement project is necessary:

☐ **Gather the right project team.** Be 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 oversight 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 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
• Wound care (pressure injury prevention) specialists	• Admitting and registration staff
• EMS	• Quality and safety specialists

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 are 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.

UE PROCESSES THAT SHOULD BE REGULARLY ASSESSED
• Standardized ET Tube securement
• All high-risk situations, including:
o Any manipulation of the ETT
o Patient repositioning or movement
o Transport of the patient
o Any bedside procedure
o 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	• Inconsistent education of new protocols
• Little organizational focus on UE prevention	• Poor circumstances in emergency environments
• Lack of standardization in hospital and in emergency service teams	• Complex work environment with many distractions
• Lack of leadership oversight	• New or visiting staff members
• Inconsistent use of a sedation scoring system	• Inadequate staffing during high risk maneuvers, such as proning or transport
• Variable tube securement practices	• Emergent patient needs
• Lack of restraint use standards	• Lack of adequate supplies
• Lack of a 'time-out' to discuss extubation risk prevention	• Environmental organization
• Inconsistent communication of UE prevention updates	

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 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.

Read this paper **from the Institute for Healthcare Improvement to understand how small local steps can integrate into larger, system changes**

UE COMPARATIVE OUTCOMES	
• Incidence of self-extubation, accidental extubation, and device malfunction	• Rate of re-intubation
• Patient combativeness or sedation reports	• Rate of 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 and to identify areas for intervention, every extubation should be properly classified as a planned extubation or unplanned extubation.

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

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. 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. UE is any extubation that occurs outside the pre-planned process.

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.

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 UE.

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

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 ballon 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**	**Unintentional**	**Controlled**
Unplanned Extubation	**Presumed Internal Dislodgement**	**No**	**Intentional**	**Controlled**

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).

60% of unplanned extubations 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 during COVID-19

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 PPE 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 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-19 infection in clinicians involved in tracheal intubation of suspected or confirmed positive COVID-19 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):

- Appropriate stabilization against external movement
- Movement and flexibility to ensure proper oral care
- Adhesives that do not harm the skin
- Ease of placement, use, and routine care
- Minimal skin pressure
- Ease of suctioning
- 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).

While the ABCDEF bundle is a ready to use, effective strategy, any bundle adopted by a hospital should include the protocols as seen in the clinical workflow.

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.

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.

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 hospital project improvement teams 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

Education for Patients and Family Members

The resources below include the information that should be conveyed to the patient and family member by someone on the care team and patient education material to raise awareness of UE before, during, and after the hospital stay.

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

Measuring Outcomes

Key performance indicators

- 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 $_{baseline}$ – Unplanned Extubation $_{measurement}$) X Days Intubated* $_{baseline}$

* 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 EMR 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 EMR to collect information to learn about new or specific trends identified by staff

This standardized core dataset should be incorporated (by legislative mandate if necessary) by all major EMR companies to facilitate hospitals' ability to track UE:

- Many hospitals' Electronic Medical 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 EMR does include the PSMF Core Dataset should contact their EMR 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:

- 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
- 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
- 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 were not included in the AHRQ National Scorecard document.

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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References

Apfelbaum, J., Hagberg, C., Caplan, R., & Blitt, C. (2013). Practice Guidelines for Management of the Difficult Airway: An Updated Report by the American Society of 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.

Airway Safety & Failure to Rescue (FTR). (2004). Retrieved May 25, 2020, from https://patientcarelink.org/airway-safety-failure-to-rescue-ftr/

Beverly, Brovman, Malapero, Lekowski & Urman. (2016). Unplanned reintubation following cardiac surgery: incidence, timing, risk factors, and outcomes. *J Cardiothorac Vasc Anesth*. https://doi.org/10.1053/j.jvca.2016.05.033

Berkow, L. (2019). *Unplanned or Accidental in the Perioperative Environment.* Retrieved 2019, from Bhatti, N., & Mohyuddin, A. (2010). *Cost Analysis of Intubation-Related Tracheal Injury Using a National Database.* doi:10.1016/j.otohns.2009.11.004

Bhatti, N., & Mohyuddin, A. (2010). *Cost Analysis of Intubation-Related Tracheal Injury Using a National Database.* doi:10.1016/j.otohns.2009.11.004

Boulain, T. (1997). *Unplanned Extubations in the Adult Intensive Care Unit A Prospective Multicenter Study.* doi:https://doi.org/10.1164/ajrccm.157.4.9702083

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.0000000000006877.

Cost Analysis of Intubation-Related Tracheal Injury Using a National Database. (2010). doi:10.1016/j.otohns.2009.11.004

D., & Alberti C., A. (2002). *Impact of Unplanned Extubation and Reintubation after Weaning on Nosocomial Pneumonia Risk in the Intensive Care Unit: A Prospective Multicenter Study.* doi:10.1097/00000542-200207000-00021

Da Silva & Fonseca. (2012). Unplanned Endotracheal Extubations in the Intensive Care Unit. *Anesth Analg.*

Da Silva, P. S. L., Reis, M. E., Aguiar, V. E. and Fonseca, M. C. M. (2013). 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.

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.

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.

De Lassence, A., Alberti, C., Azoulay, E., Le Miere, E., Cheval, C., Vincent, F., . . . Timsit, J. F. (2002). Impact of Unplanned Extubation and Reintubation after Weaning on Nosocomial Pneumonia Risk in the Intensive Care Unit: A Prospective Multicenter Study. Impact of Unplanned Extubation and Reintubation after Weaning on Nosocomial Pneumonia Risk in the Intensive Care Unit: A Prospective Multicenter Study, 97(1), 148-156.

El-Boghdadly, K., Wong, D., Owen, R., Neuman, M., Pocock, S., Carlisle, J., . . . Ahmad, I. (2020). Risks to healthcare workers following tracheal intubation of patients with COVID-19: A prospective international multicentre cohort study. *Anaesthesia.* doi:10.1111/anae.15170

Institute for Healthcare Improvement. (2020). IHI Summit on Primary Care . Retrieved from http://www.ihi.org/education/Conferences/Summit/Pages/default.aspx?utm_source=IHI_Homepage&utm_medium=Education_Navigation&utm_campaign=2019_Summit

IHI: 5 Steps for Creating Value Through Process Mapping and Observation. (2015). Retrieved May 25, 2020, from http://www.ihi.org/communities/blogs/5-steps-for-creating-value-through-process-mapping-and-observation

IHI: A Framework for Spread: From Local Improvements to System-Wide Change. (2006). Retrieved from http://www.ihi.org/resources/Pages/IHIWhitePapers/AFrameworkforSpreadWhitePaper.aspx

Kwon, E. and Choi K. (2017). Case-control Study on Risk Factors of Unplanned Extubation Based on Patient Safety Model in Critically Ill Patients with Mechanical Ventilation. *Asian Nursing Research*, 11(1). doi:https://doi.org/10.1016/j.anr.2017.03.004

Marra, A., Ely, W., Pandharipande, P., & Patel, M. (2017). *The ABCDEF Bundle in Critical Care.* doi:10.1016/j.ccc.2016.12.005

Marchelos, M., & Stewart, G. (n.d.). (2013). *An Innovative Approach to Reducing Unplanned Extubations in the Pediatric ICU,* 41(12). doi:doi: 10.1097/01.ccm.0000439795.58309.0e

Massoud M.R., Nielsen G.A., Nolan K., Schall M.W., Sevin C. (2006). *A Framework for Spread: From Local Improvements to System-Wide Change.* IHI Innovation Series white paper. Cambridge, MA: Institute for Healthcare Improvement.

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.

Patient Safety Essentials Toolkit: IHI. (2019). Retrieved from http://www.ihi.org/resources/Pages/Tools/Patient-Safety-Essentials-Toolkit.aspx

PERT Consortium Webinar: COVID-19 and Pulmonary Embolism: Perspectives from China and the United States (2020). www.pertconsortium.org

Society of Critical Care Medicine: ICU Liberation Bundle (A-F). (2020). Retrieved from https://www.sccm.org/ICULiberation/ABCDEF-Bundles

The ABCDEF Bundle in Critical Care. (2017). doi: 10.1016/j.ccc.2016.12.005

Unplanned Extubation. (2018). Retrieved from https://www.airwaysafetymovement.org/unplanned-extubation

Appendices

Appendix 1: 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.