Actionable Patient Safety Solutions (APSS):

Safer Airway Management

How to use this guide

This guide gives actions and resources for creating and sustaining safe practices for safer airway management. In it, you'll find:

SMART MANAGEMENT CONSULTANCY

Patient Safety MOVEMENT

Executive Summary

The Problem

The goals of airway management are uniform, but clinical best practices remain fragmented, lack standardization, and depend heavily on provider specialty and physical locale in the healthcare space. Delays or failure to provide and maintain adequate oxygenation can significantly increase risk of patient mortality and morbidity en route to the hospital, in the hospital, and during surgical procedures.

The Cost

The lack of standardized protocols is directly related to the incidence of failed airway management, which is as high as 1 in 50-100 in ED and ICU settings. Death and brain damage associated with adverse airway events have been reported to be 38-fold (ED) to 58-fold (ICU) higher compared to in the operating room (Cook & MacDougall-Davis, 2012). Even when airway management is ultimately successful in establishing an airway, delays and multiple unsuccessful attempts may cause serious harm (Mort, 2004; Sakles, 2013; Natt et al., 2016).

Placement of a breathing tube and ventilation via mechanical means are often necessary in critically ill patients or as part of anesthesia to maintain adequate oxygenation. Morbidity and mortality can occur when there is a inability to maintain oxygenation and ventilation due to the failure to rapidly obtain a secure airway, failure to recognize a malpositioned breathing tube (esophageal intubation or right mainstem intubation), or failure to maintain a secure airway (unplanned extubation).

The Solution

Many healthcare organizations have successfully implemented and sustained improvements in safer airway management. These organizations have focused on projects that included **implementing a standard process to prevent airway complications, including delayed or failed airway, breathing tube malpositioning (i.e. unrecognized esophageal tube position) and unplanned extubation.**

This document provides a blueprint that outlines the actionable steps your organization should take to successfully and consistently ensure safer airway management and summarizes all available evidence-based practice protocols for you to integrate into your current practice. This document is revised annually and is always available free of charge on our website. Hospitals who make a formal commitment to improve airway management and share their success 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 all airway management trends. Use this checklist as a guide to determine whether current evidence-based guidelines are being followed in your organization:

- ☐ Measure and report adverse events related to airway management incidence monthly. Note trends in areas with high incidence and prevalence. Routinely reassess outcomes.
- ☐ If adverse event rates indicate room for improvement, initiate a PI (performance improvement) project, routinely reassess to identify gaps, and ensure integrity of the data collected.
- ☐ Ensure frontline involvement in airway management 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 airway management protocols are embedded into clinical workflows, whether electronic or paper. Ensure there are enough staff to effectively manage the airway in routine care and emergency settings.
- ☐ Ensure adequate training and documentation of airway management 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 airway management improvement work while also considering how it aligns with other initiatives across the organization.

Clinical Workflow Infographic

ADMISSION

Assess for patient-specific airway complication risk factors. Identify and flag previous history of intubation and assess the patient for potential difficult intubation using the LEMON assessment. A difficult airway should be documented in the EMR and the patient should wear a difficult airway bracelet on their wrist for the entirety of their hospital stay, if applicable.

ROUTINE CARE

When treating a patient with airway associated needs, (Panchal et al., 2019):

- Identify primary plan and emergency backup plan.
- Adhere to proper personal protective equipment protocols, including use of masks (N95/PAPR if potential for aerosol transmission of respiratory illness), goggles/face shield, and gloves.
- Select and use the appropriate equipment for each patient and ensure all equipment is functioning properly. Equipment such as the following should be accounted for:
  - Suction.
  - Laryngoscope handle and blades.
  - Endotracheal tubes and stylet.
    - Short term intubation: Women 7.0-7.5mm ETT; Men 7.5-8.0mm ETT.
    - Long term intubation: Women 7.5-8.0mm ETT; Men 8.0-8.5 ETT.
    - Have a smaller ETT (6.0 or 6.5mm) available in case of swelling and edema of glottic opening.
  - Sterile lubricant and syringe to inflate ETT balloon.
  - ETT introducer (bougie).
  - Oral/nasal airways/rescue airway.
  - End-title CO2 monitor (capnography) and esophageal detector.
  - Other items such as tape, ETT tube holder, and towels or pillows for positioning.
- State the correct dosage of induction agent (if applicable).
- State the correct dosage of neuromuscular blockade (if applicable).
- Position patient optimally (trauma, ramp, sniffing).
- Maintain C-spine precautions during airway management.
- Suction residual airway fluids.

DISCHARGE

If patient is identified as a difficult airway patient, the patient should:

- Be registered as difficult airway in MedicAlert Registry.
- Receive a bracelet to have outside OR.
- Receive a letter from physician who did intubation and send to the patient's primary care provider.

It should be confirmed that the difficult airway is also logged in the EMR.

PREPARATION

All equipment and personnel should be ready and all clinicians should communicate to understand the appropriate actions that should take place if a complication arises.

- Place appropriate monitors.
  - Cardiac monitor.
  - Capnography.
  - Vital signs (BP, pulse ox).
- Position the patient properly.
  - Supine to perform head tilt, chin lift.
  - Sniffing position if not contraindicated. This can be accomplished through pillow placement, manipulation of bed position, or by using a rolled towel.
- Prepare medications.
- Prepare needed equipment and personnel (ex. crash cart, suction, extra personnel).
- Adhere to proper PPE protocols.
- Identify primary and backup plans.

PLACEMENT OF BREATHING TUBE

- Position the patient.
- Gather supplies including laryngoscope, cuffed endotracheal tube, syringe for cuff inflation, monitoring equipment, tape, suction, ventilation bag, face mask, oxygen supply, and medications.
- Conduct preoxygenation.
- Administer medications, muscle relaxants, and/or sedatives.
- Intubate:
  - Apply traction to the long axis of the laryngoscope handle.
  - Insert tube so cuff passes vocal cords.
    - Insert tube so cuff passes the vocal cords and the tip of the ETT is positioned at the proper depth within the trachea, 2-6 cm above the carina.
  - Remove the laryngoscope and inflate the cuff to an appropriate pressure. While typically 20-30 cm H_2O, types and sizes of balloons differ by manufacturer. Therefore, ensure that pressure is high enough to avoid aspiration and low enough to avoid pressure injuries.
  - Attach $ETCO_2$ detector immediately (disposable or inline) then ventilator to confirm proper placement. Listen bilaterally for breath sounds on side of chest to prevent cross sounds from other side.
  - Attach the ventilation bag/machine and ventilate. Watch for chest rises.
  - If no $ETCO_2$ detected, remove ETT and mask ventilate. If positive $ETCO_2$, secure ETT.
  - Secure the tube with tape/ETT stabilization device.
- Confirm correct placement of tube.
  - Breath sounds.
  - End-tidal CO_2 (capnography).
  - If in ED/ICU (outside OR), confirm proper placement with chest X-ray.
  - If in ICU or outside OR, confirm proper placement after with CXR.
- Document depth of tube.
- Adequately secure tube.
  - Use ET tube stabilizer device (follow manufacturer instructions).
  - Understand tape/tie techniques .

EXTUBATION

Upon extubation, the patient should be monitored very closely and clinicians should be ready with equipment and personnel if reintubation is necessary.

- Perform weaning trials such as:
  - 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).
- Monitor vital signs.
- Have equipment and personnel available in case of need for reintubation.
- Position the patient in high Fowler's.
- Suction ET tube and oral cavity.
- Hyperoxygenate the patient.
- Instruct the patient to take a deep breath and cough - simultaneously deflate the cuff and remove tube.
- Suction residual secretions.
- Provide the patient oxygen via a face mask or nasal cannula.
- Assess for adequate oxygenation and ventilation.
  - End-tidal CO_2 (capnography).
  - Pulse oximetry.
  - Arterial blood gases (ABG's).
- Prepare devices for oxygenation and ventilation support (HFNO, CPAP, BiPAP).

Performance Improvement Plan

Follow this checklist when 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 AIRWAY MANAGEMENT IMPROVEMENT TEAM	
• Clinical leaders involved with airway management from the ED, ICU and OR environments, such as nurses and physicians, particularly anesthesia providers • Respiratory therapist • Paramedics and EMS personnel	• Clinical educators • Information technology • Patient/family members • Admitting and registration staff • Quality and safety specialists

Table 1: Understanding the necessary disciplines for an airway management 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.

AIRWAY MANAGEMENT PROCESSES TO CONSIDER ASSESSING	
• Hand hygiene • Training of airway providers on equipment and protocols • Process for identifying and tracking difficult airway patients • Intubation protocols • Timing of intubation	• Process for decision-making upon failed airway • Communication between teams for pending intubation • Communication between EMS and emergency room regarding a difficult airway • Equipment availability • Airway cart availability

Table 2: Consider assessing these processes to understand where the barriers contributing to airway management 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 AIRWAY MANAGEMENT	
• Lack of accountability	• Delay or failure to secure a patient's airway
• Little organizational focus on management	• Delay or failure to recognize a malpositioned endotracheal tube
• Lack of leadership oversight	• Difficult intubation (more than three attempts)
• Inconsistent communication	• Failed intubation (requiring surgical intubation or wake up)
• Inconsistent education of new protocols	• Movement of a previously established breathing tube
• Complex work environment with many distractions	• Aspiration
• New or visiting staff members	• Quality and safety specialists
• Lack of adequate supplies	
• Lack of a standardized approach to failed airway protocols	

Table 3: By identifying the gaps in airway management and compliance, organizations can tailor their project improvement a 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**

AIRWAY MANAGEMENT COMPARATIVE OUTCOMES
• Hand hygiene compliance
• Physician stress
• Transition from EMS to ER
• ICU LOS

Table 4: Consider evaluating related metrics to better understand safer airway management

What We Know About Safer Airway Management

Airway Management

The airway is the pathway through which air flows into your lungs, commencing at the nose or mouth. The airway encompasses the throat, the windpipe, and the lungs (Ponnusamy, 2018). Airway safety refers to proper management, maintenance, and monitoring of the airway tract.

Successful airway management aims to:

- Maintain airway patency
- Provide oxygenation and ventilation
- Protect against aspiration

Successful airway management depends on a thorough, complete assessment of a patient's breathing and adequate assessments of the likely progression of potential airway problems such as deterioration versus improvement of function (Thompson & Salonia, 2011). This also includes identifying patients known to have difficult airways and those with anatomical or physiological indications of a difficult airway.

Populations At Risk

Those at higher risk for airway complications include (Gillen et al., 2015):

- Those undergoing an anesthetic procedure or surgery
- Those undergoing endotracheal intubation (ETI) or any other form of airway management during emergency circumstances
- Those with respiratory failure (such as hypoxia or hypercapnia)
- Those with a reduced level of consciousness or rapid changes in mental status
- Those with injury or trauma to the airway (i.e. larynx) (Avva et al., 2020)
- Those at high risk of aspiration
- Those who smoke, chew tobacco, or have poor nutrition (Siddiqui et al., 2016)
- Small neonates who have vocal cords that are anteriorly placed
- Congenital anomalies of the airway including absent trachea, H type fistula, and tracheal stenosis
- Pregnant women
- Infants and children

Harm and death from any of the following events can be preventable through standardization in airway management across the hospital:

- Unrecognized esophageal intubation.
- Multiple failed attempts to secure the airway.
- Failure to correctly secure the endotracheal tube and subsequent delayed recognition of tube malpositioning.
- Patient aspiration of gastric contents, airway injury (including tracheal perforation), trauma to teeth, hypoxemia, and brain injury.
- Inadvertent tracheal intubation when placing a nasogastric tube (See APSS #15: Nasogastric Tube Placement and Verification).

Suspicion of any sort of respiratory difficulty should be attended to with a safe supply of oxygen until the abnormalities can be identified and adequately treated. Safe administration of oxygen requires proper handling of airway equipment (Thompson & Salonia, 2011).

The following indicate a need for airway management:

- Failure to oxygenate
- Failure to ventilate
- Failure to maintain a patent airway (Mouri, Krishnan & Maani, 2020)

Sequence of Airway Management Steps

The below information outlines the stepwise hierarchy of airway management in terms of severity (Mouri, Krishnan & Maani, 2020).

Basic airway management:

1. Nasal cannula
2. Face mask
3. Non-rebreather mask
4. Non-invasive positive pressure ventilation (High Flow Nasal Oxygenation, BiPAP, nasal CPAP)

Advanced airway management:

5. Endotracheal intubation
    a. Patients may require intubation for certain types of illnesses, such as pneumonia, severe injury, or procedures requiring general anesthesia.
2. Supraglottic airway placement
3. Cricothyrotomy
4. Tracheostomy

Clinical Implications of Unsuccessful Airway Management

Poor adherence to airway safety protocols can lead to death or harm due to:

- Unrecognized esophageal intubation
- Multiple failed attempts to secure the airway
- Failure to correctly secure the endotracheal tube

- Delayed recognition of endotracheal tube malpositioning
- Patient aspiration of gastric contents
- Airway injury
- Trauma to teeth
- Hypoxemia
- Brain injury
- Hypercapnia
- Perforation of or other injury to the trachea

It is estimated that more than 33,000 patients in US ICUs die from airway complications and unplanned extubation (Kanowitz, Berkow & Longley, 2019). Additionally, failed intubations occur in as high as (Crewdson, Lockey, Roislien, Lossius, & Rehn, 2017):

- 38% of patients intubated in the field by non-physicians
- 22% of patients intubated in the field by physicians

The incidence of failed airway management can be as high as 1 in 50-100 in ED and ICU settings. Additionally, the occurrence of death or brain damage related to airway management have been reported to be 38-fold (ED) to 58-fold (ICU) higher outside the operating room compared to inside the operating room (Cook & MacDougall-Davis, 2012). Even when airway management ultimately saves the life of the patient, delays and multiple unsuccessful attempts may cause serious harm (Mort, 2004; Sakles, 2013; Natt et al., 2016).

In a case study of adverse respiratory events, the main problems included inadequate ventilation (38%), substandard care (90%), esophageal intubation (18%), and failure to accurately identify the problem (48%) (Divatia & Bhowmick, 2005**).**

Airway Management in the Emergency Medical Service (EMS) Sector

Failed intubations in the EMS setting have been reported to be as high as 52% (Hubble et al., 2010), while studies show that unrecognized esophageal intubation in prehospital settings is as high as 25% (Katz & Falk, 2001).

Although unplanned extubations are more likely in EMS settings due to the difficulties of transporting critically-ill patients in a chaotic environment, incidents are not tracked in most EMS data systems. Because of underreporting, the true frequency of airway management-related injuries is unknown.

Case Study: Airway Management of Patients with COVID-19

The 2019 Novel Coronavirus (COVID-19) affects the lungs, as well as other organ systems, often resulting in hypoxia, damage to the lung mucosa, and inadequate ventilation and oxygenation that can progress to Acute Respiratory Distress Syndrome (ARDS), requiring management of these patients with an endotracheal tube and mechanical ventilation. The process of placing the endotracheal tube (intubation) places the healthcare provider in close proximity to aerosolized viral particles and puts them at an increased risk of contracting the virus (Caputo, Strayer & Levitan, 2020).

Many COVID-19 patients are asymptomatic for up to 2 weeks and may present for general anesthesia requiring airway management during this asymptomatic period. Therefore, any patient undergoing airway management in the operating room must be suspect for being a COVID carrier and therefore safety and proper PPE must be utilized on every patient requiring airway management (Slessarev et al., 2020).

For those acutely ill patients, early delivery of supplemental oxygen, the use of non-invasive ventilation strategies, and the prone position have been shown to be beneficial and may avoid the need for intubation and mechanical ventilation (Sztrymf et al., 2011).

Due to the highly infectious nature of the virus and the high exposure risk to health care providers during aerosol-generating procedures such as airway management, consider the following (Sullivan et al., 2020):

- Avoid emergent intubation, where the procedure is done prior to providers donning proper PPE (Sullivan et al., 2020).
- Early intervention with aggressive non-invasive strategies and prone positioning may avoid the need for emergent intubation (Sullivan et al., 2020).
- Consider creation of airway teams for intubation of COVID-19 patients to maximize success and minimize provider exposure. Intubation should always be done by the most experienced airway provider (Cook, 2020).
- Always don full PPE including N95 mask or equivalent, face shields, gowns, and gloves before proceeding with airway management (Cook, 2020).
- Utilize a negative pressure room for intubation and extubation, if available (Cook et al., 2020).
- Minimize the number of providers in the room during intubation and extubation (Cook et al., 2020).
- Consider cohorting COVID positive patients in isolation wards (Cook et al., 2020).
- Use videolaryngoscopy as a first line technique for intubation (Cook et al., 2020).
- Use disposable airway equipment when available to reduce contamination risk (El-Boghdadly, 2020).
- In the operating room, provide preoxygenation and avoid bag mask ventilation after induction of anesthesia (El-Boghdadly, 2020).

Careful consideration of the above recommendations is key to maintaining patient and provider safety during the COVID-19 pandemic. A recent study reported that 1 in 10 health care workers performing intubations on COVID positive patients developed symptoms of the virus (El-Boghdadly, 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 unplanned extubation (UE). A recently released DoD COVID-19 Practice Management Guide recognizes proning maneuvers as a leading risk factor for UE. UE is known to cause aerosolization of viral particles. Forced extubation likely increases the travel distance and spread of these particles. Any provider responding to a call for emergency resuscitation ("Code Blue"), especially one concerning UE, 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 used during all patient care, especially procedures at high risk of UE, such as placing in the prone position or patient transport.

Unplanned extubation occurs in over 7% of patients who undergo mechanical ventilation in the ICU and the complications of unplanned extubations result in over $4 billion in healthcare costs (da Silva & Fonseca, 2012).

National and International Standards

Respiratory diseases are the leading cause of death and disability in the world today. Chronic respiratory diseases (CRD), chronic obstructive pulmonary disease (COPD), and asthma have increased in the last ten years worldwide (Forum of Respiratory Societies, 2017). Each year, 4 million people die prematurely globally from respiratory diseases (Forum of Respiratory Societies, 2017). Furthermore, approximately 2 billion individuals are exposed to indoor toxic smoke each year and nearly 1 billion are exposed to tobacco smoke.

The Centers for Medicare and Medicaid Services (CMS) has identified airway safety as a priority area for Round 2 of the Hospital Engagement Networks (HENs) due to the high risk and significant impact of airway-related injuries and deaths.

Anesthesia and Airway Management

Airway management is essential in patients undergoing minor procedures to major surgeries requiring a range of moderate sedation to general anesthesia (Patel & McNarry, 2017). Airway management can range from delivery of oxygen via a nasal cannula to endotracheal intubation. Significant respiratory events can occur at all levels of anesthetic provided. Therefore, safe airway management is important to avoid these complications.

For rapidly deteriorating or emergency patients who require immediate intubation to secure the airway, there is little time available for evaluation and careful consideration of proper airway management protocols. Therefore, these protocols must be easily accessible in times of emergency.

Airway management is particularly important upon administration of moderate sedation to general anesthesia. Those who provide general anesthesia should be licensed and board certified or should be an eligible anesthesia provider (International Standards, 1992).

- Pre-anesthetic care: The patient should be evaluated with a complete medical history for any underlying health conditions. There should also be a physical exam which evaluates the patient's airway, circulation, and respiration (International standards, 1992).
- During all procedures requiring sedation to general anesthesia: standard continuous monitoring is required.
- Post-anesthetic: All vital signs should be monitored continuously during the patient's recovery.
    - All patients receiving an anesthetic that involves loss of protective airway reflexes or loss of consciousness should be monitored post-operatively in a location specifically designed for post-anesthesia recovery (International standards, 1992).

Organizational Causes of Preventable Patient Harm and Death

The goals of airway management are essentially uniform, but clinical best practices are not standardized and depend heavily on provider specialty and physical locale in healthcare settings. Below are examples of organizational gaps in airway management:

- The wide variation of available airway management techniques and tools.
- The wide variation in training and competency of airway techniques and tools.
- Lack of video laryngoscopy and flexible intubation scope equipment in all areas.
- Inconsistent outcome definitions and subsequent underreporting using registries or databases.

See Appendix 3 for recommended actions for stakeholder groups to promote airway safety in a standardized manner.

The Role of Registries for Reporting

While registries collect information about the adverse event, information is also recorded about procedures and subspecialty practice. These databases serve to highlight the outcomes of routine practice but also shed light on gaps and limitations. There are several resources and databases available for evaluating airway management (Cook, 2017):

- Danish Anaesthesia Database
- Medic Alert Database

- National Emergency Airway Registry
- Australia and New Zealand Emergency Department Airway Registry
- The Airway App

Barriers to Successful Airway Management

- Inadequate communication of patients known to have a previous history of difficult airway.
- Delay or failure to secure a patient's airway.
- Delay or failure to recognize a malpositioned breathing tube.
- Difficult intubation (more than three attempts).
- Failed intubation (requiring surgical airway or need to awaken patient).
- Movement of a previously-established endotracheal tube.
- Lack of end tidal CO2 monitor or CO2 detector.
- Aspiration.
- Inappropriate laryngoscope size for the patient.
- Wrong tube size for patient

Additional Barriers to Proper Airway Management in Trauma Settings Before Hospital Arrival

7 to 28% of trauma patients require either endotracheal intubation or a surgical airway (Khan, Sharma, & Kaul, 2011). In addition to the aforementioned barriers to proper airway management across the general hospitalized patient population, the following can add particular challenges when treating victims of trauma:

- Poor conditions (e.g. lighting, weather)
- Poor patient positioning or risk for injury upon movement
- Unfamiliar EMS team personnel
- Oropharyngeal bleeding or facial/tracheal trauma
- Vomiting
- Patient combativeness
- Compromised respiration due to chemical inhalation (Khan, Sharma, & Kaul, 2011)

Priorities for Safer Airway Management

- **Avoid Delayed or Failed Airway Management:** Delay or failure to secure a patient's airway or to recognize a malpositioned endotracheal tube (such as intubation of the esophagus) can result in preventable death or catastrophic injuries. 40% of adverse events resulting in death or brain injury were due to delayed intubation (Cook, 2017).

  Time delays are especially critical in pregnant women, infants, and children because the time to desaturation is markedly decreased due to various anatomical and physiological factors.

  To avoid delays (Higgs et al., 2018):

  1. Call for help immediately
  2. Limit intubation attempts
  3. Promptly recognize failure
  4. Transition quickly to the next step for airway management

While predicting a difficult airway is dynamic and situation specific, the following indicators and tools can be helpful in evaluation:

- Mallampati Classification 3 and 4
- Thyromental distance <6cm
- Mouth opening <4cm
- Thyromental distance: A small distance has been suggested to be associated with difficult intubation
- BMI >40
- Prominent front teeth
- Large tongue
- Decreased range of neck movement

- **Recognize a Malpositioned Endotracheal Tube:** Studies show that unrecognized esophageal intubation in prehospital settings is as high as 25% (Katz & Falk, 2001), and leads to a higher likelihood of death. See Appendix 2 for a comprehensive description of technologies available to assist in confirming successful placement of the airway.
- **Avoid an Unplanned Extubation:** Unplanned extubation happens in over 7% of patients who undergo mechanical ventilation in the ICU. Complications of unplanned extubations result in over $4 billion in healthcare costs (da Silva & Fonseca, 2012).

See APSS 8B: Unplanned Extubation.

Although unplanned extubations are more likely in EMS settings due to the difficulties of transporting critically ill patients in a chaotic environment, incidents are not tracked in most EMS data systems. Similarly, most hospitals do not track unplanned extubations and, therefore, the 7% incidence may be an underestimate.

Best Strategies for Proper Airway Management

- **Failed Airway Pathway Standardization:** A key contributing factor to improper airway management in hospitals

is the lack of a standardized guideline by which every healthcare worker operates in the case of a failing airway. Hospitals should develop universal standards for failing airway situations.

  - Failed Airway Pathway example infographic

- **Decision to Intubate:** While non-invasive ventilation often involves less risk, if patients are unable to maintain a patent airway, endotracheal intubation should be employed. Intubation should be used as judiciously as possible as a last resort. While in some cases, the decision to intubate might be obvious, as in the case of, for example, a patient with a traumatic brain injury, airway management may be unclear in many other scenarios. The inappropriate deliberation to intubate can compromise patient outcomes by allowing a previously controlled situation to escalate into a chaotic situation. Therefore, healthcare professionals require a standardized clinical assessment tool that can be employed quickly and in stressful situations:
  - *Is patency of the airway at risk?*
  - *Is oxygenation or ventilation failing?*
  - *Is the need for intubation anticipated? (Brown, 2019)*

Equipment Considerations

Common tools used in airway management include an endotracheal tube and supraglottic airway device (Ponnusamy, 2018).

A basic overview of equipment within carts would include:

- Adjuncts, including, but not limited to, nasopharyngeal airways, tongue blades, and oral airways
- Basic equipment, including, but not limited to, direct laryngoscopes and video laryngoscopes
- Other airway adjuncts such as first and second generation SGAs and intubating SGAs
- Surgical airway equipment including, but not limited to, kits, trays, scalpels, and hemostats
- Emergency Cricothyrotomy, including scalpel, bougie, ETT
- Flexible bronchoscope or flexible intubation scope, including, but not limited to, video monitors

To see a complete list of recommended equipment to keep in stock, view the Essential Equipment Safer Airway Guide.

Individuals of different ages may have different tracheal dimensions and therefore may have variations in the anatomy of the airway, thereby influencing the equipment necessary (Avva et al., 2020). For example, the dimension of the trachea depends on the age, sex, and the build of the individual. Placement and proper execution of intubation requires thorough observation of the patient and of the airway (Avva et al., 2020).

Resources

- Failed Airway Pathway Infographic
- Emergency Department Intubation Checklist
- Airway Safety Checklist Tool
- Overview of potential complications associated with airway management procedures
- Patient story of Dave Bunoski's unrecognized esophageal placement
- Patient story of Drew Hughes's unplanned extubation
- Difficult/Critical Airway Pathway Infographic
- The Vortex Approach
- Safer Airway: Essential Equipment Safer Airway Guide
- Tasks From Comprehensive Airway Management Process Identified by Expert Panel as Critical for Patient Safety and Outcome
- ASA: Difficult Airway Algorithm
- British Journal of Anaesthesia: Guidelines for the Management of Tracheal Intubation in Critically Ill Adults

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 outline below illustrates all of the information that should be conveyed to the patient and family member by someone on the care team in a consistent and understandable manner.

Explain why airway management is needed. A member of the healthcare team should elaborate on the signs and symptoms indicating the need for airway management and should provide a basic overview of the methods of airway management, including in what circumstances each might be used. If patient has been identified as a difficult airway, discuss the meaning and potential implications associated with the family members.

Indicate what to watch out for. Family members can serve as an extra pair of eyes and ears and can alert medical staff if something might be wrong. Family members should have an understanding of what to look for that may indicate deterioration, such as abnormal vital signs or a change in patient alertness. Additionally, family members should know exactly when to call for help, where to go for help, and with whom they should speak.

Instead of employing a directive conversation style, an active, engaging conversation should take place, leaving capacity for questions and repeat-back strategies. When patients and family members understand the signs and symptoms that could be indicative of a problem, they are able to serve as an extra set of eyes in order to elevate this concern as early as possible.

Describe what can be anticipated. In addition to explaining when to call for help in the case of a potential emergency, healthcare providers should also thoroughly explain the treatment that can be expected when an airway issue is detected or anticipated. By engaging in these conversations before a problem arises, family members can be prepared in the circumstance of necessary treatment and will have an understanding of where to go to find out more information about their loved one's condition.

Explore next steps. Planning for life after the hospital, whether in assisted living, returning home, or another option, should begin as early as possible between the healthcare providers and the patient and family.

- If the patient is a smoker, the healthcare team should encourage smoking cessation and provide additional resources for further information, groups, or strategies for smoking cessation.
  - Try to understand what specific barriers that patient as an individual faces in cessation.
- Have a discussion with the patient and family around end of life care and advanced directives.
  - Make an attempt to thoroughly understand the religious or cultural nuances in any of the patient's or family members' decisions or questions.
- Ensure thorough explanation of necessary post-discharge appointments, therapies, medications, and potential complications.
  - Assess for patient preference in time and location of follow-up appointments, if possible.
- Provide patients and family members resources, including direct contact phone numbers, to the hospital for post-discharge questions.
  - Make sure the resources are in their own language.

Each conversation with a patient and family member should be inclusive and void of bias. Additionally, these conversations should leave ample time for discussion and the facilitator should encourage questions from the patient and family members.

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 1: Hospital-wide Failed Airway Protocol/Pathway (FAP)

	SOLUTION AND KEY FEATURES	LEVEL OF RECOMMENDATION	SAFETY RATIONALE	REFERENCE SOURCE
1	**Failed Airway Protocol/ Pathway (FAP) Alternative term is "Difficult Airway Pathway" (DAP)**	Mandate	FAP should be operational, standardized, and actionable. Creates a team approach.	
A	Choose a simple format (3-4 key steps) that can be known & used by all team members	Mandate	Aligns teams to focus on major vulnerabilities and key actions	NAP4
B	Integrate "awake" non- paralyzed intubation into difficult airway pathway for ED/ICU	Highly recommend	Essential practice not commonly performed in EM	ASA, DAS
C	Include Video Laryngoscopic (VL) intubation for ED/ICU			DAS
D	Standardize throughout hospital	Highly recommend	Validated safety practice	

	SOLUTION AND KEY FEATURES	LEVEL OF RECOMMENDATION	SAFETY RATIONALE	REFERENCE SOURCE
2	**Airway Equipment**			
A	Choose a consolidated Airway Cart (standardized) that includes equipment for basic and difficult airway management. Use for all intubations and airway emergencies in the ED, ICU, OR, Post Anesthesia Care Unit (PACU) and general unit settings.	Mandate	Avoids critical delays, assures equipment availability, and prompt access.	ASA
B	Cart components Organize the cart to support FAP progression of need.	Highly recommend	Reinforces FAP and increases reliability	
1	Oral (mouth) and nasal (nose) airways			
2	Full face masks			
3	Nasal CPAP mask			
4	Video laryngoscope (VL) – in room and ready for all intubations	Mandate	Gives higher 1st pass success and is an essential airway tool	ASA, NAP4
5	Bougie type introducer catheters and stylets	Mandate	Critical adjunct	ASA
6	Supraglottic airway devices (SGAs) – appropriately sized to meet needs of patient population	Mandate		ASA
	a. Laryngeal mask airways (LMAs)	Mandate	Essential Rescue Device	ASA
	– LMAs with intubation capability	Highly recommend	Allows conversion to ETT	ASA
	– LMAs with gastric access capability	Recommend	Lowers aspiration risk	DAS
	b. King airway/ combitube – alternative to LMA or rescue for LMA	Highly recommend	Key rescue device option	
7	Cricothyrotomy kits (simple surgical)	Mandate	High reliability kits	ASA
8	Needle jet ventilation kits/sets – for pediatric patients under age 10 and adults, Use in ED/ICU after failure of VL, DL, SGA and BVM.	Mandate		ASA

9	Continuous Waveform Capnography – maintained on all intubated patients including ED/ ICU/ Transports and with central monitoring enabled	Mandate	Monitoring ventilation effectiveness and continued placement with ETT and SGA. Standard of care in UK/ Europe and U.S. EMS but have significant gaps in U.S. EDs and ICUs.	AHA 2010 AARC (2003), ACEP, NAP4, AAGBI, ICS, EBA
10	Endoscope (flexible bronchoscope or flexible intubating scope) and/or optical stylets – in ED/ ICU at all times	Mandate	Essential for awake intubation, SGA conversion. Video scope preferred.	ASA
11	LED blades/handles for direct laryngoscopy – replace bulb models with single-use models, which may be better	Highly recommend	10x brighter, higher reliability, and better visibility	Anesthesia
12	Devices or systems for securing airway in patient – to avoid unplanned extubation	Highly recommend	High rates of unplanned extubation (UE)	

	SOLUTION AND KEY FEATURES	LEVEL OF RECOMMENDATION	SAFETY RATIONALE	REFERENCE SOURCE
3	**Critical practices** **Use these recommended clinical and safety practices for preparing, performing, and maintaining artificial airways**			
A	Use a Checklist Quality Assurance (QA) tool for hardwiring and assessing critical practices	Mandate	Tool for practical preparation and critical practice assurance and QA monitoring	
B	Use assessment, planning, and team communication for airway management – as appropriate in the various clinical settings	Mandate	Basic clinical and safety practices are known and accepted but often not utilized or hardwired into practice	
C	Use optimized patient positioning – such as ear to sternal notch, head elevated laryngoscopy position (HELP), and ramped position in obese patients (Levitan et al., 2003)	Mandate	Critical but commonly overlooked	ASA
D	Follow apneic oxygenation protocols – such as "no desat" or heated, humidified high-flow nasal oxygen or nasal CPAP	Mandate	Significant potential to prevent or delay desaturation in patients	Ann Emer Med
E	Use 1- and 2-person bag-mask ventilation (BVM) techniques – appropriate seal, jaw thrust, and prn bilateral NPA and OPA	Mandate	Key basic airway skill for all healthcare personnel in all settings. Often not effectively performed.	
F	Use BIPAP/CPAP pre-oxygenation in patients with persistent hypoxia	Highly recommend	Useful with persistent hypoxia in obesity, CHF, other	Ann Emer Med
G	Use delayed sequence intubation with Ketamine – use for agitated patients with hypoxia	Recommend	Important for allowing pre-oxygenation	Ann Emer Med
H	Quickly use SGA if DL/ VL failed			
I	Place SGA during codes (cardiac/ respiratory arrest)	Highly recommend	Assures open airway, prompt easy placement, and avoids resuscitation delay	
J	Quickly use surgical cricothyrotomy if VL/DL, SGA, BVM failed. Only qualified personnel should use this.			
K	Use flexible bronchoscope or flexible intubating scope to convert SGA to ETT	Highly recommend	Blind techniques with only 65% 1st pass success rate	NAP4
L	Use awake fiberoptic intubation (AFOI) or other non-paralyzed intubation techniques. Use for intubations that may be difficult or highly difficult.	Highly recommend	Essential practice that is not commonly performed in EM	ASA , DAS, NAP4
M	Immediately use and maintain Continuous Waveform Capnography – on all intubated patients	Mandate	SEE Equipment above	See references above

N	Optimize sedation and restraint protocols to minimize unplanned extubations (UEs)	Highly recommend	Patients who are under sedation or agitated are at risk for airway loss (UE)	AJCC
O	Formalize system for optimally securing ETT (Tube holders for adults, C- Collar infants in transport)	Highly recommend	UE causes high death rates – reportedly as high as 7%. High risk in pediatric patients	
P	Implement a System for flagging identified difficult airway patients in electronic health records (EHR) system	Highly recommend	Many EHR systems are able to flag difficult airway patients, but flagging is not developed or used	
Q	Use extubation guidelines	Highly recommend		
R	Implement system for tracking and reviewing QA data from intubations or UEs – see Airway Registry	Highly recommend	Safety reporting systems have shown low yield for near- miss events from fear of punishment	
S	Use strategies for avoiding peri-intubation hypotension	Highly recommend	Use IVF, positioning, and medications in high- risk groups	
T	Promote routine recording of airway management when video devices are utilized. Promote use of cognitive aids for routine and failed airway management, such as the Vortex Airway Approach (vortexapproach.org)			

	SOLUTION AND KEY FEATURES	LEVEL OF RECOMMENDATION	SAFETY RATIONALE	REFERENCE SOURCE
4	**Team training**	Mandate		
A	Train all clinical staff on airway safety protocols, equipment, and critical practices – including basic and advanced practices for preparation, performance, and post-intubation management. Make sure all clinicians doing airway management are credentialed.	Mandate		
B	Promote teamwork and clear communication – include a plan for sharing, open communication, and debriefing	Mandate		
C	System for ensuring that practitioners are trained and credentialed in airway management	Mandate		

Appendix 2 : Technologies

Test and use airway management devices that improve safety and drive better patient outcomes, including:

SYSTEM OR PRACTICE
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)
Laryngoscopes Direct laryngoscopy (DL) has been used for decades to perform placement of endotracheal tubes. In 2001, video laryngoscopy (VL) was introduced. Although the literature has little to support that VL improves first pass success, some meta- analyses suggest that VL reduces the incidence of difficult or failed intubation. Therefore, based on VLs ability to reduce failed intubations, it is highly recommended that: • VL equipment be readily available for all intubations • All airway providers responsible for intubation be trained and comfortable with these devices Many providers and hospitals haven't made the transition to VL, either because of the cost of VL equipment or the change in technique required for successful VL. More recently, many video laryngoscopes have developed VL equipment that allows use of a traditional DL technique. This change may help with the transition.

Video Laryngoscopes An effective VL system should: • Be portable and easy to use. • Have clear and reliable airway visualization without fogging. • Permit ETT delivery with minimal operator fine motor skills. • Have a large video screen that allows multiple operators to act as a team. Devices with small video screens may be better when space is limited, such as in helicopters. • Have large image storage capability. • Have low risk for cross-contamination.
Fiberscopes Although video laryngoscopes have reduced the need for fiberoptic intubation, fiberscopes remain the device of choice in certain critical airway conditions, such as angioedema, oropharyngeal neoplasm, head and neck radiation, and congenital deformity. Low cost single-use fiberscopes with reusable video monitoring are now available as an alternative to high-priced reusable fiberscope systems.
Waveform Capnography 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. The use of waveform capnography in the intubated patient is considered standard of care by the American Society of Anesthesiologists (ASA). It should be adopted as standard of care by all organizations whose providers are responsible for airway management. Continuous Waveform Capnography: • Should become a mandated safety practice for all SGA or intubated patients. • Should have the capability to integrate into your facility's monitoring systems.
Endotracheal Tube Stabilizers The current systems for stabilizing endotracheal tubes include adhesive tape, cotton twill ties, and multiple commercial devices. Although the current literature does not clearly identify any particular device or technique that is superior, numerous devices on the market are clearly inferior in their ability to restrain against extubation forces. The most current cited unplanned extubation rate of 7.3% (with a range of studies showing rates as high as 35.8%) suggests that current stabilization techniques and devices are inadequate. Further research into developing a better stabilization system should be supported (da Silva et al., 2012).
Ultrasonography Ultrasonography can be used to confirm correct placement and is widely available, even in the EMS sphere. Additionally, it is useful to predict difficult airways in preparation for anesthesia, evaluate contents of the gastric cavity to assess aspiration risk, and locate cricothyroid membrane before challenging airway management (Kristensen, Teoh, Graumann, & Laursen, 2014).

Appendix 3 : Recommended Actions for Stakeholders

These are recommended actions for stakeholder groups, other than EMS and hospitals, to improve airway safety.

Actions for outpatient procedure centers using moderate or deep sedation

- Ensure staff who administers sedation are trained to monitor and manage airways appropriate to the setting.
- Use proper monitoring equipment and tools, including pulse oximetry and waveform capnography.
- Equip your facility with needed airway management equipment and skills for use, including: oxygen therapy, bag-valve mask ventilation, BLS-level use of supraglottic airway devices.

Actions for professional/healthcare/stakeholder organizations

Seek national collaboration with other professional, safety, and healthcare organizations in an Airway Safety Collaborative with the aim to help the industry:

- Learn more about airway management practices in a broad representation of hospitals and other clinical environments.
- Develop and promote high impact best practices to be implemented in specified clinical units, such as pre-hospital, ED, ICU, medical/surgical floor, procedural areas, and outpatient settings.
- Research system solutions to improve airway safety.
- Develop education programs and materials for trainees and practicing clinicians.

Actions for companies in the airway industry

- Collaborate with current and future safety initiatives to develop or modify products or solutions that best address airway safety threats. To do this:
  - Optimize human factors and device usability.
  - Label products to be clearly and easily identified for size and use (considering human factors in high-stress events).
  - Seek out and respond to clinical and safety requests for modification.
- Establish a mechanism for industry to collaborate on:
  - Rapidly identifying and responding to vulnerabilities.
  - Seeking fast dissemination and adoption of high-reliability components to products or services.
  - Package products for high reliability and easy access.
  - Package essential supplies to work with portable airway cart systems.
- Support:
  - Airway safety research.
  - The development of a national airway safety policy.
  - Unbiased educational forums for airway safety.
- Participate in the Global Airway Safety (GAS) Collaborative.

Actions for accrediting agencies

- Work with professional clinical/safety organizations to establish airway safety process, performance, and measurement standards.
- Highlight and assess airway standards during site visits as a high priority focus.
- Elevate airway safety as a national patient safety goal.

Actions for government (funders/regulators/service providers)

- Work with professional clinical/safety organizations to establish airway safety process, performance, and measurement standards.
- Fund, and encourage others to fund, research for improving airway management safety through the entire spectrum of hospital and healthcare settings.
- Use financial incentives to help drive adoption of established highly reliable airway safety practices.

Actions for safety organizations (global, national, regional, state levels)

- Assist, support, and participate in the development of a Global Airway Safety Collaborative.
- Elevate airway safety as a national safety goal.
- Support and promote the development and implementation of actionable airway safety solutions.
- Network with potential funders to help empower development and research of airway safety solutions.
- Support the development of airway safety training programs and tools.

Actions for the risk management/insurance industry

- Elevate airway safety as a national safety goal.
- Fund and support the development and implementation actionable airway safety solutions.
- Establish financial incentives for groups that demonstrate implementation, tracking, assessments, and training in airway safety practices, tools, and procedures.
- Actions for consumer groups.
- Support and help fund the development of a Global Airway Safety (GAS) Collaborative with the aim to elevate the airway safety standard of care.
- Support and help fund safety organizations and programs that will help protect constituent members with regard to airway safety, including key focus areas in patient groups for older adults, children, and people with obesity.
- Demand specific, demonstrable, and highly reliable airway safety programs from healthcare organizations and institutions.
- Help establish and promote public awareness campaigns for airway safety engagement, practices, and performance.