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Multidisciplinary airway response teams: Concept, structure, & implementation

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Airway management challenges encompass the anticipated (eg, airway pathology, history of difficult intubation, bleeding) and the unanticipated. Challenging airway situations also occur in patients with existing in situ tracheostomy tubes and laryngectomy stomas or in intubated patients around the time of planned or unplanned extubation. Preparedness to handle difficult airway scenarios requires a structured approach to patient assessment, identification, and planning. Preparedness also necessitates an organized, disseminated, and predefined process to deliver appropriate resources efficiently to the bedside in an emergency at any time of day. Specialized equipment, multidisciplinary expertise, clinical algorithms, effective communication, and teamwork are critical components of an effective response system. A structured multidisciplinary airway rapid response team that includes both an anesthesiologist and a surgeon is one model to effect such as system.

Overview

The inability to oxygenate for an extended period of time is an airway expert's greatest fear. The literature demonstrates that medical legal risk exposure is high for clinicians involved in failed intubation and emergency surgical airway scenarios.[1,2] The anesthesia, otolaryngology, and emergency medicine literature is replete with bedside tools and innovative measurements to predict difficult intubation. All have met with limited success. Novel technologies to manage complex intubations such as videolaryngoscopes and single-use bronchoscopes have become commonplace in many settings.[3] Despite these efforts, the failed airway is still a frustratingly common clinical occurrence in both operative and nonoperative emergency settings. In fact, the evolution of techniques such as transoral robotic surgery (TORS),[4] advanced targeted radiation therapies,[5,6] tracheal stenting procedures,[7] and complex cervical spine surgery[8] has led to an ever expanding population at risk for airway management challenges. A comprehensive difficult airway program can improve care and reduce the risk of surgical airways.[9] The concept of an interdisciplinary emergency airway team developed as an approach to rapidly assemble specialized equipment and diverse clinical expertise to the bedside for complex airway management internal and external to the procedure suite for primary securing of the airway when difficulty was encountered with standard approaches.[10,11] Implementation of the emergency airway team is complicated by many challenges

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related to staffing, notification, equipment readiness, communication, and teamwork.

Difficult Airway Identification and Systems

Traditional approaches to assessment of the airway for prediction of difficulty are discussed in detail by Milner in this volume. Most bedside airway evaluations demonstrate poor positive predictive value.[12] The incidence of difficult and failed intubation has been reported by a variety of clinical studies and data that predates, and may not be applicable to, present circumstances. The widespread use of the laryngeal mask airway (LMA) since the 1990s and the near ubiquitous availability of a very diverse range of videolaryngoscopes has certainly had an impact on airway safety. At the same time, a growing number of patients have received advanced therapies for head and neck cancers (radiation, TORS), tracheal disease (stents, cryotherapy), and cervical spine pathology (ACDF, fusion). These subsets of patients may pose the highest risk of failed intubation even with advanced techniques. Inability to expose the glottic opening may not be the source of intubation difficulty (eg, stents, stenosis, difficult tube passage).[13] Difficult airway algorithms and guidelines have been developed and refined to structure the approach to the difficult airway.[14,15] These algorithms invariably lead to invasive approaches to airway access (ie, needle or scalpel cricothyrotomy) and tracheostomy for definitive airway access after failure of other strategies.[16] In the aforementioned patients, invasive approaches are unlikely to be anatomically straightforward. Both the expanding global obesity epidemic and widespread use of chronic anticoagulation has further impaired emergency surgical airway access. In the most recent review of anesthesiology closed legal claims resulting from "can't oxygenate, can't ventilate situations," difficult emergency surgical airway access was noted in 29% cases, many involving death.[2]

Although intubation is typically the focus of failed airway prevention strategies, acute airway dislodgement, bleeding, or obstruction of an existing in-situ surgical airway (ie, tracheostomy or laryngectomy) is similarly complex. These patients present unique challenges, require different expertise and equipment to manage emergencies, and will benefit from a multidisciplinary airway response team. A review published by the authors (and consistent with current data in our institution) revealed that >25% of surgical airway team activations may involve a patient in an in situ airway (endotracheal tube, tracheostomy tube, laryngectomy tube/stoma).[17]

Airway emergencies are more likely to be encountered outside of the operating room and this further complicates management.[18,2] Contributing factors include emergency conditions, patient co-morbidities, lack of physiologic reserve, positioning related challenges, clinician expertise, equipment availability, and familiarity of the nursing and support staff with airway techniques. The risk of a failed airway catastrophe in a given clinical setting will be a complex function of patient population, hospital procedural case mix, inpatient clinical acuity, clinician subspecialty expertise, resource allocation for emergency preparedness, and interdisciplinary teamwork. Experience suggests that a multidisciplinary airway rapid response team can mitigate these risks.

Multidisciplinary Airway Rapid Response Team (MARRT)

The multidisciplinary airway rapid response team (a.k.a. difficult airway response team, surgical airway response team,) aims to assemble all of the necessary resources to assess and rescue a challenging airway emergency in the shortest time possible. These teams have been deployed in an increasingly number of high acuity inpatient settings over the past 10-15 years.

The structure of MARRT will vary by setting and resources and the mere existence of the team and structured activation protocol may have benefits. A key feature that distinguishes MARRT from the typical emergency airway processes is that activation and resource deployment is not ad-hoc. An ad-hoc system in which a list of on-call surgeons is contacted until one is found and then equipment and other needed resources are gathered is associated with delays that will compromise outcome. MARRT includes a defined team, a defined set of resources including advanced airway equipment, established criteria for activation, and a clear activation process. At a minimum, the team requires clinicians with experience using advanced airway tools (video laryngoscope, LMA, fiber optic bronchoscope), the skillset to perform a scalpel cricothyrotomy or tracheotomy, and the ability to assess and triage an in-situ tracheostomy.[19] In virtually all settings the team will include an anesthesiology expert and at least one additional subspecialty clinician drawn from head and neck surgery, pulmonary medicine, emergency medicine, oral and maxillofacial surgery, cardiothoracic/thoracic surgery, or general surgery. In hospitals without 24/7 in-house specialist coverage it will be necessary to provide additional training to team members in scalpel cricothyrotomy as well as assessment and rescue of the in-situ tracheostomy.[20] While nonspecialist physicians may receive focused surgical airway training in residency or fellowship these clinicians frequently have little if any opportunity for practice or ongoing training since the frequency of actual events will be low in most centers. Ideally, this is accomplished through a combination of simulation and hands-on live clinical experience in the operating room.[21] The most effective technical approach to invasive emergency airway access is beyond the scope of this discussion but guidelines based on small outcomes studies have shifted away from needle techniques and jet ventilation toward open scalpel or scalpel-bougie techniques [22,23] Ideally, training should also be provided in Crisis Resource Management or TeamSTEPPS and algorithms and communication methods rehearsed during in-situ simulated emergencies. With this approach the whole

Table 1 Multidisciplinary airway response team – activation criteria.

Activate immediately if respiratory compromise and a history of
• Tracheostomy, or other in-situ surgical airway
• History of failed or difficult intubation
• Known severe tracheal stenosis
• Significant bleeding from the mouth or nose
• Recent Surgery on neck / mouth / throat
• Inability to open mouth
• Severe swelling to neck/mouth/tongue
• Significant acromegaly
Activate after Initial airway attempts if:
• Inability to ventilate by mask or LMA
• Failure to intubate on 1 attempt with inability to ventilate with mask or LMA
• Increasing difficulty ventilating while making repeated attempts at intubation
• Failure to oxygenate despite ventilation by mask or LMA
Activate for emergent multidisciplinary airway planning in patients with complex /difficult airway history if:
• Worsening respiratory status with high potential for intubation
• Intubated with concern regarding ventilation, tube integrity, or other airway related parameters
ü Any bedside care clinician requests it

Table 2 Multidisciplinary airway response team – potential actions.

Intubation
• Primary intubation attempts **at the bedside**
• Stabilize at bedside – primary intubation attempts **in the operating room**
Surgical Airway
• Primary surgical airway **at bedside** with no further intubation attempts
• Primary surgical airway **in the OR** with no further intubation attempts
In-situ tracheostomy
• Airway assessment to confirm adequacy and position
• Airway assessment followed by tube change at the bedside
• Airway assessment followed by tube change or revision in the OR
No Intervention
• Multidisciplinary assessment and airway planning discussion with no airway intervention
• **Clearly defined criteria should be established for advancing from Plan A to B to C
• **Clear roles to implement each plan should be assigned in advance whenever possible
• **Plans should be reviewed with all team members prior to start and concerns vetted
• ü Anesthesia requests it

team that can identify latent safety issues or process related deficiencies, and can build team resilience and flatten hierarchy.[24] Loss of situational awareness is a major contributor to harm and is more likely to be preserved in high-functioning teams.[25] In addition to airway experts an effective MARRT should also include sufficient nursing and support staff to implement the necessary airway plan, which may include moving the patient to an operative suite or intensive care unit if activated initially outside the OR.

It is imperative that the MARRT should not be viewed exclusively as a team that performs surgical airways when intubation fails. Rather MARRT is a multidisciplinary, highly resourced tactical force that may be deployed broadly to assess a critical airway and develop a plan prior to clinical deterioration, engage in immediate interdisciplinary planning in a metastable airway emergency with options, rapidly assess and triage tracheostomy patients and total laryngectomy patients with airway compromise, and gain invasive airway access in the setting of failed intubation. Response activation criteria (Table 1) should extend beyond post-hoc activation in the setting of cannot-intubation/cannot ventilate. MARRT should be activated for any urgent/emergent intubation for a patient with a history of a difficult intubation or other predictors of difficulty including known or suspected airway pathology, edema, or bleeding, radiation with no recent intubation history, trismus, and recent surgery in the neck or airway. MARRT should also be activated for patients with an in situ tracheostomy or laryngectomy stoma who experience acute respiratory distress. We suggest that airway emergencies in tracheostomized patients are more common than assumed and most commonly involve bleeding, dislodgment, or obstruction due to mucous plugging.[17] Obese patients with a standard tracheostomy tube may be more susceptible to dislodgement.

Activation at any time should be encouraged by staff at all levels (nursing, respiratory therapist, family, physicians, technicians) who should be educated on the system and empowered to activate the MARRT at any point during, or in anticipation of, an airway emergency. This flattening of hierarchy is crucial to the effectiveness of an emergency system.[26] MARRT may also play a critical interdisciplinary planning and crisis prevention role.

When MARRT assembles the options for action include: (1) immediate intervention (intubation, ventilation, surgical airway), (2) stabilization for transport from a non-operative setting to the operating room for further airway assessment/management, and (3) no immediate intervention and a multidisciplinary assessment and formal planning to define potential future airway interventions should the patient's condition worsen (Table 2). The appropriate choice is often determined by a "pause" in action to have a structured conversation with input from all members of the care team. This is particularly true in metastable conditions where "pressure to act" due to anxiety among non-airway experts on the ward could precipitate acute clinical deterioration and a true surgical airway emergency. For example, a bedside tracheostomy change due to air-leak in a coagulopathic patient with tracheal stenosis who is clinically stable. What may be a straightforward procedure in an operating room with perioperative nursing, support

staff, lighting, and good positioning may be treacherous in a ward bed or ICU in the middle of the night.

The importance of a structured assessment and rescue of the in situ surgical airway by subspecialty experts cannot be understated. Published experience demonstrates that the knowledge and experience of nonspecialist clinical staff to manage acute airway emergencies is limited.[27] At the authors' institutions respiratory distress requiring anesthesia or a code in a patient with an in situ surgical airway requires activation of MARRT. To help organize the response a tracheostomy card and emergency algorithm program derived from the UK National Tracheostomy Safety Project and Global Tracheostomy Collaborative have been implemented.[28] The cards for chronic, open, and percutaneous tracheostomy, and one for laryngectomy, include key information relative to placement on the front. The back of the card highlights key steps for first responders and lists potential interventions for expert responders to reduce the errors of omission. This program is supplemented by twice weekly tracheostomy rounds by a team of experts on selected in-patients that includes bedside education on the program.

Airway emergencies will occur throughout the facility including remote areas such as the PET or MRI scanner, the proton beam center, basement corridors, and dialysis. A reliable system will train providers in all of these areas regarding when and how to call MARRT and will facilitate equipment availability at every emergency. There must be a defined process for advanced airway equipment to be brought to the bedside during MARRT activation. Options include difficult airway trolleys,[29] portable airway equipment bags, and placement of equipment on code/resuscitation carts in units and may vary according to local setting and geographic footprint. At the author's institution single-use tracheostomy sets are available on all code-carts, an emergency airway topical medications kit is stocked in the code-drug boxes, a single-use fiberoptic scope and screen is brought to the bedside by respiratory therapy, anesthesiology first responders bring an airway bag that includes a handheld videolaryngoscope and other airway exchange supplies, and a percutaneous tracheostomy set with a Blue Rhino dilator is immediately available in all units that care for these patients. A difficult airway trolley is located in the operating rooms and the intensive care units. The equipment deployed must be familiar to the end-user. For example, an emergency videolaryngoscope that differs from the type used for routine airways in the operating room may present more of an obstacle than a benefit in time-pressured circumstances. In some high acuity settings that perform complex head and neck surgery and interventional pulmonary procedures, immediate access to a rigid bronchoscope and surgical laryngoscopes (eg, Dedo or anterior commissure) may also be advantageous. The role of ultrasound to facilitate landmarks for surgical airway access is developing and may also be considered.[30]

In the experience of the authors, one of the most challenging aspects of MARRT relates to human factors, nontechnical skills, and teamwork.[31,32] Members of the MARRT may not be familiar with one another and arriving MARRT clinicians will be largely unrecognizable to the activating primary clinical care personnel. Key elements of the teamwork include leadership designation, clear, closed-loop communication toward a shared mental model, and maintenance of situational awareness relating to the team, the patient, and the environment.[24] One difficulty is the presence of multiple airway experts with unique but complementary skill sets. Who "leads" the scenario is a critical element to clarify. Consistent with TeamSTEPPS principles this leader functions as the integrator of communication, the primary role assigner, the choreographer and monitor but need not and should and not be the primary clinician tasked with performance of an airway procedure. The lead "do-er" is not the same as the situation leader. Who manages what aspects of airway procedures can be protocolized whereas situational leadership will be defined uniquely with the group assembled at the bedside and must be clearly verbalized. In all but the direst of circumstances the situation leader should undertake an airway huddle (can be 30 seconds) during which primary and backup plans are clearly discussed, the trigger for transition from primary to backup plan defined, roles assigned, necessary equipment reviewed, and concerns from all staff addressed. The situation in which an excellent plan B is never implemented due to loss of situational awareness of the deteriorating conditions and fixation on achieving plan A is well described and represents a failure of teamwork. It is crucial to recognize that many involved with the response will not have expertise or experience with respect to the advanced airway procedures, equipment, and discussion. The overall concept of psychological safety in team interventions is of growing importance.[33] When time allows, responding to challenges or concerns by team members with appropriate acknowledgement and discussion can foster cohesiveness and efficacy. Team members, especially the primary clinical teams, may feel overwhelmed and anxious about the possibility of airway loss or patient distress with what appear to be uncomfortable patient experiences (eg, awake fiberoptic intubation). Similarly, at the end of the event before the team disbands, clear documentation of the decision making process, and interventions, and plans to manage ongoing or anticipated airway issues should be documented, ideally in a structured timeline, for the primary teams to reference.

Implementation, Training, Surveillance

Implementation of MARRT requires coordination among many departments, institutional investment of resources in equipment and staffing, policy revision, education of staff, surveillance of utilization, skill and teamwork training, and continuous event review for improvement. Ideally this is coordinated by a multidisciplinary airway safety committee with participation from all key stakeholder groups. The airway safety committee should

work closely with the clinical emergencies committee as those responders will be critical to MARRT activation in some settings. A well-designed MARRT that is not activated due to lack of primary staff familiarity with the system may as well not exist. Initial implementation of the MARRT system will require unit-based education for care teams as well as responders. This can be done through unit-based in-services, dissemination of flyers, emergency airway posters, required online educational programs, review after more routine emergency intubations, and periodic multidisciplinary and group educational forums. We have found interprofessional, case-based airway safety grand rounds to be an excellent, high-impact approach to continuing education, review of data and protocol revision, and in-depth discussion of system weaknesses and opportunities for improvement. After implementation a system should be developed to track activations and to periodically review utilization, surgical airways, and overall utilization. Safety event reports related to emergency airways should also flow through the committee to provide a complete picture and develop action items for improvement. At the authors' institution this routine surveillance piece was implemented some years after the initial team. After detailed case review the high rate of in situ tracheostomy emergencies come to light. We also learned about challenges with deployment of fiberoptic scopes at airway emergencies through the incident reporting system. Subsequently a single-use, battery-operated fiberoptic scope was deployed for all MARRT teams. Similarly, we learned of several MARRT activations after both planned and unplanned extubation of high-risk patients. From this we developed and implemented a high risk extubation screening, identification, and planning protocol for all intubated patients in the intensive care units across the health system. In conjunction with our clinical effectiveness and quality improvement teams we also have a reporting dashboard that allows us to track MARRT activations with time of day and unit location, surgical airways performed, and MARRT involving in-situ airways.

Challenges to an effective MARRT?

Staff turnover can lead to unfamiliarity with the activation criteria (or even existence of the MARRT). Regular live simulations, flyers, and airway rounds can serve as a reminder. Some centers in the UK have experimented with social media options to reinforce training.[34] Deployment of specialized equipment may be logistically complex (what, who, where, when, and how) and incurs costs to purchase and maintain. Increasing availability of single use products (video laryngoscope, bronchoscopes, and surgical tracheostomy kits) has reduced some of the barriers with regard to equipment, but a reliable supply chain must be achieved. Rigorous processes need to be in place for checking supplies on airway trolleys, keeping high tech equipment clean, in working condition, properly positioned, and delivered in a timely fashion. Staff also needs to maintain proficiency with new devices and a budget must be allocated for supplies and replacement. Round-the-clock staffing with a clinician proficient in the surgical airway is perhaps the biggest resource challenge, especially for smaller institutions. Depending on the setting a broad range of clinicians could potentially fill the void with supplemental training and on-call back-up. These include specialists in emergency medicine, critical care, otorhinolaryngology, oral and maxillofacial surgery, cardiothoracic surgery, general surgery, and anesthesiology.

Summary/Conclusions

Difficult airway situations cannot be prevented and they extend beyond primary intubation to triage and management of in situ endotracheal tubes, tracheostomies, and laryngectomy stoma. As such a multidisciplinary team with expertise in the airway including surgical skills to assess and perform surgical airways is an important component of a comprehensive difficult airway system. Early and appropriate activation, availability of advanced airway equipment, and effective teamwork are critical element of the success of MAART.

Disclosure

The authors report no proprietary or commercial interest in any product mentioned or concept discussed in this article.

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