

Airway Management During a Mass Casualty Event

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Introduction

Influence of the Disaster Scenario on Airway Management

Airway Management in the Presence of Contagion

Airway Management When There Is Other Risk to the Medical Staff

Airway Management in a Mass-Casualty Event With Minimal Risk to the Medical Staff

Technique of Airway Management

Who Should Manage the Airway?

Summary

Mass casualty respiratory failure will lead to many challenges, not the least of which is safe and secure management of the victims' airways. These patients will be sicker than those typically managed in the operating room and will require more emergency management of their airways. Mass casualty incidents involving biological or chemical agents will pose the additional risk of exposure to pathogen. During the severe acute respiratory syndrome epidemic in Toronto, airway manipulation was clearly identified as the procedure most associated with risk to health care workers. Planning for scenarios such as these will require consideration of personal protection for health care workers to minimize these risks. Understanding the risks involved and the airway techniques required for each possible scenario will be key to planning and preparation. Key words: mass-casualty, respiratory failure, airway, intubation, mechanical ventilation. [Respir Care 2008;53(2): 226–231. © 2008 Daedalus Enterprises]

Introduction

Mass casualty scenarios will lead to substantially increased requirement for mechanical ventilation. Prior to

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Dr Talmor presented a version of this paper at the 40th RESPIRATORY CARE Journal Conference, "Mechanical Ventilation in Mass Casualty Scenarios," held July 16-17, 2007, in Reno, Nevada.

The author reports no conflicts of interest related to the content of this paper.

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initiation of mechanical ventilation, thought will have to be given to the issue of airway control. These scenarios will present unique airway management challenges in several respects. In a typical hospital scenario patients commonly require airway manipulation in the operating room, and less frequently in the intensive care unit or emergency department. Occasionally patients will deteriorate on other hospital floors and require an emergency airway intervention in another location.

In a mass casualty scenario we can expect that many more patients will need airway interventions outside the operating room. These patients will be sicker than those typically managed in the operating room and will require more emergent management. Though the spectrum of diseases that may be encountered is wide, many patients will present with symptoms that mimic sepsis and acute respiratory failure. These patients will present substantial challenges in obtaining and protecting a viable airway.

Another unique aspect of mass casualty incidents that involve biological or chemical agents is the risk of exposure to pathogen. During the severe acute respiratory syndrome (SARS) epidemic in Toronto, airway manipulation was clearly identified as the procedure most associated with risk to health care workers.¹ Planning for these scenarios will require consideration of personal protection for health care workers to minimize these risks. Because of the exposure risks involved, it is recommended that early definitive airway control be obtained, rather than temporizing with mask ventilation.² Standardizing an institution's approach to airway management is a key component in reducing risk to both health care worker and patient.

Influence of the Disaster Scenario on Airway Management

A myriad of disaster scenarios may lead to mass casualties suffering from respiratory failure and requiring establishment of an artificial airway. These range from large numbers of conventionally injured patients from a natural disaster such as an earthquake, fire, or flood, through conventional injuries from explosions, contaminations by noxious substances, and, finally, the specter of mass casualties from emerging infectious disease. The nature of the specific scenario encountered will strongly influence the numbers of patients suffering from respiratory failure and requiring airway protection.^{3,4}

A common theme in disaster planning is to use an "all-hazards approach."⁵ This allows common planning for the many possible scenarios that a community may face. This approach is appropriate for planning the larger elements of a community's response, such as the types and location of emergency services and the need for additional community-wide resources. It is important to remember, however, that the details of the response will differ greatly, based on the specific scenario, and this holds true regarding the need for airway management and subsequent requirements for mechanical ventilation. Use of an all-hazards approach does not replace the need for appropriate planning and preparation for specific scenarios.

It is useful to consider the various possible scenarios where the need for mass casualty ventilation and airway management may occur, in terms of the presence or absence of risk to the physician, respiratory therapist, or emergency medical provider charged with managing the airway. A scheme for assessing this risk is presented in Figure 1. The primary threat is that of contagion transferred from the patients to the staff members involved. This may include a known respiratory pathogen such as tuberculosis, newer threats, such as the SARS virus or H5N1 avian influenza, or newer as yet unidentified pathogens. These threats will require specific steps to ensure the

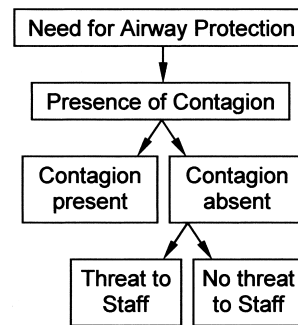


Fig. 1. Approach to the airway management scenario.

staff's safety while managing the airway. These steps are outlined below.

Once the presence of contagion is ruled out, the question must be asked, is there another threat present to the staff's health? The best example of such a threat is the presence of a chemical agent or residual radiation from either a nuclear explosion or other radiation-releasing device. Again, specific measures will be required to ensure the safety and continued functioning of those involved in managing the victim's airway and beginning mechanical ventilation. When there is no contagion present and there is no other threat to staff safety, airway management may proceed using standard precautions, as outlined below.

Airway Management in the Presence of Contagion

The outbreak of highly contagious respiratory disease is likely to lead to substantial demands on hospital resources and in particular to an increased need for mechanical ventilation in patients suffering from acute respiratory failure.^{3,4} Because of the contagious nature of these diseases, there is a high risk of infection of health care workers.⁶ During the 2003 SARS epidemic in Toronto, airway manipulation was identified as a high-risk procedure to the health care workers themselves.⁷⁻⁹ This risk necessitates an organized approach to managing these patients' airways, in order to protect both patients and staff. This approach is outlined in Table 1.²

Early identification of the need to control the airway is crucial. Classification of the patient's airway status as emergency or elective determines the appropriate management options. An emergency situation is one in which a patient with an infectious cause of respiratory failure has undergone a respiratory arrest. An elective situation is one in which the patient is hypoxemic but has not yet deteriorated to the point of frank respiratory failure. An emergency situation may leave no time to move the patient to a negative-pressure isolation room, although every effort should be made to do so. If the patient has already undergone a respiratory arrest, there may also not be time for the treat-

Table 1. Intubation in the Presence of a Contagion

Anticipate need for intubation
Early intubation allows for adequate protection and preparation
Emergency intubation places health care workers at risk
Prepare
Physician, respiratory therapist, and nurse inside isolation room, in personal protective equipment
Parallel team outside room ready to assist
Practice personal protection measures
Rehearse roles and ability to communicate before starting
Modify technique
Topical, nebulized local anesthesia is contraindicated
Use deep sedation, with or without neuromuscular paralysis
Use experienced personnel only
Avoid the need for mask ventilation
Avoid multiple attempts
Inexperience places all team members at risk

ing staff to take the appropriate protective measures to ensure their own safety. An emergency intubation in the context of a highly contagious respiratory disease thus represents a failure of management.

Once the decision is made to control the patient's airway, the airway should be assessed and the appropriate technique chosen. Awake intubation would be contraindicated in this scenario because an awake and coughing patient will considerably increase the risk to the staff. For the same reason, aerosolized anesthetics should not be used because virus may be entrained in the aerosol and pose additional risk. For these reasons, a deeply sedated patient is preferred. Use of neuromuscular blockade should be considered in order to reduce the risk of coughing or bucking, as well as to improve the intubating conditions.

Meticulous preplanning of the equipment, drugs, procedure, and communication required for airway control is needed. The procedure is complicated by the need for full personal protection gear for the participating staff. Functioning in such protective gear severely complicates what may seem to be a relatively routine procedure, and requires practice. This type of preparation is an often overlooked facet of disaster preparedness. All aspects of the procedure should be prepared for and discussed. The goal is to rapidly achieve control of the airway, without coughing, bucking, or periods of mask ventilation. To achieve this, the most skilled airway practitioner should manage the airway. The procedure is carried out in a negative-pressure room, with all operators wearing personal protective equipment and isolated from the rest of the unit by closed doors. An additional parallel team, fully clothed in protective gear, should be ready outside the room in case assistance is required.¹⁰

Airway Management When There Is Other Risk to the Medical Staff

Multiple scenarios may lead to mass casualty respiratory failure that requires control of the victims' airways. These include any kind of chemical exposure or the release of radiation, either intentional or accidental. In both of these cases the risk to the health care worker is not from the patient himself, because the agent is rapidly absorbed into the tissues.¹¹ The risk is from exposure to patients who have not gone through decontamination and may have residual agent or radioactive dust in their clothing or in large accumulations on their bodies. In these scenarios, in addition to the possibility of direct exposure to the offending agent, the patients themselves constitute a potential threat both to the health care workers and to the health care facility itself. Early decontamination outside of the hospital will protect the patients themselves by limiting their exposure to the contaminating agent, as well as protecting the hospital staff and allowing continued functioning of the hospital. Only after this has been adequately ensured should the victims be allowed into the hospital and allowed into contact with unprotected health care workers.

In these scenarios the team managing the airway will probably be operating outside the hospital at a decontamination site, either at the site of exposure or at the entrance to the hospital (Fig. 2). The staff operating in these decontamination areas will require full chemical protection (Fig. 3). This kind of cumbersome protection limits breathing, field of vision, movement, kneeling, holding small objects, and performing delicate tasks such as inserting an intravenous line. Airway management under these conditions may be challenging, even for experienced operators.

In a series of experiments, Flaishon and collaborators examined the success of anesthesiologists, surgeons, and novices in achieving control of the airway with either an endotracheal tube or a laryngeal mask airway (LMA) while wearing a chemical protection suit.^{12,13} They showed that among anesthesiologists the time to endotracheal intubation was lengthened, but not the time to placement of an LMA. For surgeons and novices, initially, time to placement of the LMA was long, but the learning curve was steep, and by the fourth placement was less than 60 seconds. These studies demonstrate the feasibility of achieving airway control under these suboptimal conditions, and have been confirmed by others.¹⁴⁻¹⁶ An algorithm summarizing this approach is presented in Figure 4.

Airway Management in a Mass-Casualty Event With Minimal Risk to the Medical Staff

Events such as natural disasters, fires, and bombings may lead to mass casualties, with a large number who

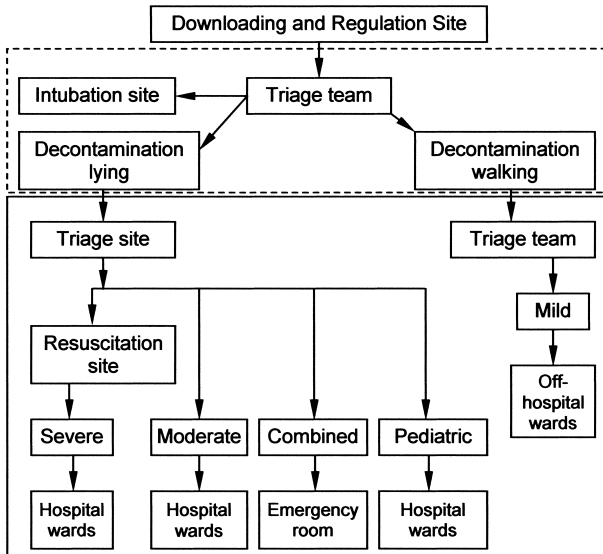


Fig. 2. Out-of-hospital decontamination occurs in the area denoted with the dashed-line box, which is the contaminated area or “hot zone” in which triage and decontamination of patients will take place. Patients in frank respiratory failure will require intubation in this area by an airway management team clothed in the appropriate protective equipment. Once the victims are through decontamination they are admitted to the health care facility and re-triaged. At this point some may have further deteriorated and require intubation. This may be done by unprotected personal because the patients are now considered clean.

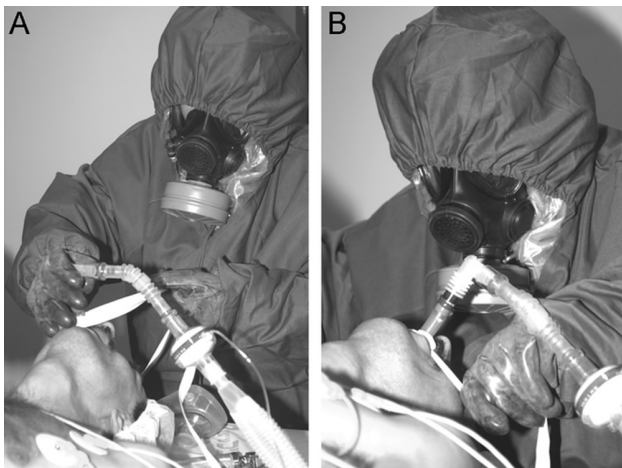


Fig. 3. A physician managing a patient’s airway with an endotracheal tube (A) and with a laryngeal mask airway (B) while wearing antichemical gear. (From Reference 12, with permission.)

require airway protection and subsequent mechanical ventilation. Health care workers will share the risks from these events with the general population, but management of the airway will not pose additional risk, and special measures are not warranted beyond standard precautions. The techniques of gaining control of the airway in these and the preceding scenarios are discussed below.

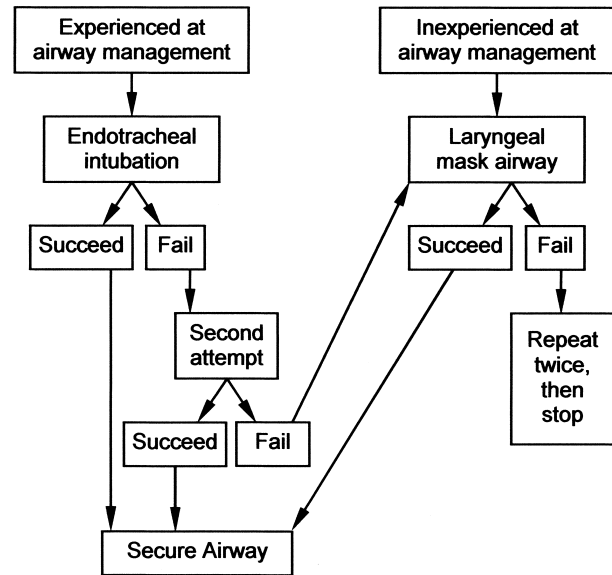


Fig. 4. An approach to airway management in a mass-casualty situation where there is a noncontagious risk to health care workers. (Adapted from Reference 13.)

Technique of Airway Management

Endotracheal intubation has long been the accepted standard of airway management; it provides a secure airway and allows positive-pressure ventilation without air leak. In recent years, alternative methods of securing the airway, such as the LMA and various types of ventilating airways, have been advocated for short-term management of the airway in both the perioperative setting and in situations that require emergency airway management.¹⁷⁻¹⁹ In the intensive care unit, noninvasive ventilation with a tightly fitting face mask has gained favor in various clinical scenarios, including acute respiratory failure.²⁰ Unfortunately, none of these are practical alternatives in a mass casualty scenario.

Exposure risks require that the method of securing the patient’s airway minimize the risk to health care workers. The feasibility of using the LMA in emergency situations has been demonstrated, and in cases where health care workers are required to wear protective garments the LMA may actually shorten the time to obtaining airway control.^{16,21} The LMA, however, provides an effective seal only up to pressures of 20 cm H₂O. That pressure will often be inadequate when ventilating patients with acute respiratory distress syndrome. Additionally, the air leak that may result increases the risk of health care worker exposure. Similar problems limit the use of noninvasive ventilation with a face mask. This is a resource-intensive mode, as it requires considerable patient coaching in order to tolerate the tight-fitting mask and positive-pressure ventilation. Noninvasive ventilation does not provide an impermeable seal, and was associated with increased health

care worker risk of exposure when used to ventilate SARS patients.⁸

Endotracheal intubation will therefore be the safest and most effective way of controlling the airway in a mass casualty scenario. Endotracheal intubation while wearing full chemical protective gear is feasible, although it may take longer. Advance training for the providers expected to manage the airway in a disaster will shorten that time.^{12,14} Alternative methods of airway control should be reserved for the rare case of unexpected difficult intubation where their use may be life-saving.²² These devices should be replaced at the earliest possible time, using fiberoptic bronchoscopy as indicated. Once the airway has been secured, proper placement should be confirmed, both by auscultation and by use of a disposable CO₂ detector.

The equipment required for airway management is available in large amounts in most modern hospitals, and it is difficult to envision a scenario where these stocks would prove inadequate. Typically, this equipment (laryngoscopes, bronchoscopes, and other specialized devices) will be reusable. In the case of an infectious process that leads to mass casualty respiratory failure, attention will need to be paid to appropriate sterilization of these devices between uses. Specific recommendations for each potential pathogen would be promulgated in the event of an outbreak and would need to be followed. An alternative approach would be the use of disposable laryngoscopes. The literature suggests, however, that these devices are inferior to standard laryngoscopes, both in terms of the forces generated in the airway as well as of achieving successful endotracheal intubation.^{23,24} Availability of such devices is also likely to be a serious impediment to such a strategy, because these are not common in day-to-day practice.

Who Should Manage the Airway?

During regular daily hospital operations, anesthesiologists, certified registered nurse anesthetists, and intensive care and emergency medicine physicians undertake airway management. Substantial literature exists that shows that all of these appropriately trained personnel can successfully manage the airway.²⁵⁻²⁷ Rather than training other groups in airway management, planning for a mass casualty event should concentrate on the appropriate use of the already considerable personnel resources available. The exposure risk during airway management dictates that the most experienced provider available perform these procedures.¹ During any mass casualty incident, elective surgery will be cancelled and the majority of trauma casualties will not require emergency surgery. This will free up substantial numbers of anesthesia providers to assist in airway management in the intensive care unit and emergency department. Attempting to train additional, inexperienced providers in an emergency will jeopardize the safety of both the patient and the health care workers themselves.

Summary

Mass casualty respiratory failure will lead to many challenges, not the least of which is safe and secure management of the victims' airways. The challenges will be on multiple levels; among them, the training of providers, the logistics of ensuring adequate personal protective gear for the various scenarios, along with the appropriate airway management devices, as well as the added technical difficulties in securing the airway while encumbered with this ensemble. Forethought and preparation will allow a high level of functioning in a time of need.

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Discussion

O'Laughlin: With regards to the anesthesiologist and intubation in a decontamination area, you mentioned having them geared up and ready for intubation. Has there been strong interest among anesthesiologists for learning the hazmat [hazardous materials] suit donning and doffing process?

Talmor: I think it's like in any other medical specialty. There are those who are interested enough to attend conferences like this, and then there is the majority who may be interested but are caught up in their day-to-day concerns. At our hospital, the emergency physicians have the role of managing the airway outside the hospital in a noncontagious event. They're well qualified in airway management and I would trust them to be out there. They do that with nurses from the emergency room.

Regarding training on personal protection in a contagious event, our anesthesia department has gone through training on how to use a powered air purifying respirator and don a personal protective ensemble. I think we can

do that kind of training once or twice, but that a lot of it is going to be just-in-time training. So when an epidemic disease appears, that will be the time to really focus training efforts.

O'Laughlin: About the intubating LMA; I like them but the cost of stockpiling something like that I think is about \$500 per item for the reusable ones. We've looked at Combitubes as another quick-pass item, but they're not that great either. But for stockpiling, cost is going to be an issue with the intubating LMA, I think.

Talmor: I would suggest that an epidemic is not the time to be learning a new technique, and we should be doing what we know, which is endotracheal intubation. There will be the occasional patient who is very difficult to endotracheally intubate, and intubating may be made more difficult by personal protection gear we'll be wearing. So to have intubating LMAs available would be the second line, per the American Society of Anesthesiologists' Difficult Airway Algorithm,¹ and it's probably safer for the team than an emergency tracheostomy.

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Branson: Regarding noninvasive ventilation, I think it's worth doing in some situations, but there are several reasons we might not want to do it, including that it's not very successful in hypoxemic respiratory failure. If you try to institute it and then wait around in hopes that it's going to work, that could lead to higher mortality and emergency intubations. So I think that in the midst of a febrile respiratory illness I would err on the side of not doing noninvasive ventilation.

Talmor: I agree. I just wanted to present whatever evidence was out there. I think that report from Hong Kong¹ was on patients who weren't very ill. That's why their results were so good.

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