Mechanical Ventilation in Mass Casualty Scenarios. Augmenting Staff: Project XTREME

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Summary

Disaster preparedness typically includes plans that address the need for surge capacity to manage mass-casualty events. A major concern of disaster preparedness in respiratory therapy focuses on responding to a sudden increase in the volume of patients who require mechanical ventilation. Plans for such disasters must include contingencies to address surge capacity in ventilator inventories and the respiratory therapy staff who will manage the ventilators. Tactics to address these situations include efforts to lower demand by transferring patients to other institutions as well as efforts to augment staffing levels. Staff can be augmented by mobilization of deployable teams of volunteers from outside the region and through exploitation of local resources. The latter includes strategies to recruit local respiratory therapists who are currently in either non-clinical or non-hospital-based positions and policies that optimize existing respiratory therapy resources within an institution by canceling elective surgeries, altering shift structure, and postponing vacations. An alternative approach would employ non-respiratory-therapy staff to assist in the management of patients with respiratory failure. Project XTREME (Cross-Training Respiratory Extenders for Medical Emergencies) is a cross-training program developed to facilitate training of non-respiratory-therapy health professionals to assist in the management of patients who require mechanical ventilation. It includes an interactive digital video disc as well as a competency validation laboratory and is designed to be performed at the time of an emergency. Pilot testing of the program suggests it is effective. *Key words: disaster, mass casualty, respiratory therapist, mechanical ventilation, ventilator, cross-training*. [Respir Care 2008;53(2):176–188.

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Introduction

"Surge capacity" in medicine refers to a health care system's ability to rapidly expand beyond normal services to meet increased demand for personnel, equipment, supplies, facilities, and services.[1] Increased demand can result from changes in the volume of cases, the rate at which cases present, or the complexity of cases. Hospitals respond to these issues almost daily. Of special concern, however, is addressing surge capacity in preparation for mass casualty disasters resulting from either naturally occurring or terrorist-driven events. The anthrax outbreak in the fall of 2001 heightened awareness regarding the potential consequences of a bioterrorism attack with an agent that targets the respiratory system.[2,3] The severe acute respiratory syndrome (SARS) epidemic of 2003, as well as apprehension regarding pandemic avian influenza, has similarly raised concern about national preparedness for naturally occurring epidemics that might result in a surge of patients with respiratory needs.[4] Depending on their nature and magnitude, these events could result in a surge of patients with substantial respiratory care needs, many of whom would require mechanical ventilation.

The TOPOFF (Top Officials) 2 exercise revealed that hospitals typically do not have sufficient numbers of trained health care professionals on staff to meet the increased demand associated with the surge of patients that may occur early in a disaster.[5] The Rocky Mountain Regional Care Model for Bioterrorist Events study included a survey of current health care resources within Federal Region VIII, as defined by the Federal Emergency Management Agency (FEMA), as part of an effort to develop a regional model for bioterrorism preparedness. Conclusions regarding respiratory therapy staffing projections in this model indicated that in some parts of the region there is an undersupply in the number of respiratory therapists (RTs) required to meet normal demand and that increasing capacity to meet the emergency preparedness benchmark goal of staffing an additional 500 beds per one million population would result in a shortage of RTs in all of the states in the region, save one.[6] Other studies documented that the baseline respiratory therapy manpower shortage is national in scope and will probably persist for at minimum 5–7 years.[7]

There has been considerable interest regarding mechanisms to improve surge capacity for ventilators. The American Association for Respiratory Care has issued guidelines regarding mechanisms to immediately increase ventilator numbers as well as guidelines regarding the minimum features that cached ventilators should have.[8] Several states have begun to explore purchasing and stockpiling supplies of ventilators to be maintained in reserve for emergency distribution during disasters.[9] The federal government has established, as part of the Strategic National Stockpile, a cache of 4,000 mechanical ventilators that are warehoused in various locations in the United States. These ventilators can be delivered as part of Push Packages throughout the nation within 24–36 hours of a decision to deploy them.[10,11] Additional expansion of the number of ventilators in this stockpile is being considered. Ventilators delivered as part of a federal or local response to disaster will be of little or no benefit without adequate staffing by personnel familiar with both their operation and the basic principles of respiratory care. Although the historical experience during the Toronto SARS epidemic indicated that health-care-worker absenteeism during the epidemic was low, subsequent surveys of health care workers' willingness to work during various types of natural and man-made disasters suggest future absenteeism may exceed 50% in disasters that are contagious in nature.[12-17] The potential for staff absenteeism combined with both the pre-existing respiratory therapy manpower shortage and the possibility that some RTs will become incapacitated if they themselves become ill, suggests that a disaster of substantial magnitude or duration could be associated with a decline in respiratory therapy staffing levels at the very time that expansion in personnel is required. The purpose of this paper is to review mechanisms to expand personnel surge capacity as they relate to the supply of RTs. In particular, the cross-training program referred to as Project XTREME (Cross-Training Respiratory Extenders for Medical Emergencies) will be reviewed.

Approaches to Managing Demands in Capacity

There are 2 potential mechanisms to manage increased demand for staffing and equipment resources. One approach is to lower demand on the institution. The other approach involves efforts to increase supply. The initial response of most institutions will be to attempt both a modest reduction in demand as well as simple efforts to increase personnel through reassignment of current staff. Demand can be reduced through (1) early discharge of currently hospitalized patients, (2) transfer of patients to facilities designed to provide care for less seriously ill patients, (3) diverting patients to other facilities, and (4) canceling elective medical and surgical procedures. The efficacy of these approaches would be limited in part because some of them are currently impractical to accomplish. A region-wide disaster would tax the resources of all the health care facilities in the region. It is unlikely that neighboring facilities would have capacity to accept patients in transfer if they were already experiencing their own influx of patients. These institutions may also hesitate to accept patients in transfer until they are able to ascertain that their local area was not involved in the event. These considerations would become even more probable if the disaster were national in scope.

An additional problem with plans to transfer patients is the absence of any established mechanisms to facilitate transfer of large numbers of critically ill patients.[18] The United States Air Force Critical Care Air Transport Teams provide both ground critical care and transport of high-risk, severely injured patients during military conflicts. This program has been recommended as a model for evacuation of critically ill patients in the civilian sector.[19] The military has served in this capacity in the past; for example, forces of the 433rd Aeromedical Evacuation Squadron, based at Lackland Air Force Base, Texas, helped evacuate hospitalized and nursing home patients from Beaumont, Texas, during hurricane Rita. However, it is unclear what the capacity of the military is to transport civilian patients who are critically ill. These services have never attempted to transport large numbers of civilians in an emergency and have limited to no experience transporting critically ill civilian patients. In addition, it is highly probable that the etiology of a surge of patients who require mechanical ventilation would be infectious and possibly contagious in nature. Transfers of large numbers of such patients would be impractical because of concerns related to containing the spread of infection; indeed, the military airplanes needed to facilitate transport would probably not be made available for use if the subjects to be transported were contagious.[20]

For these reasons, efforts to reduce demand will probably be of limited and at most short-term benefit. The increase in capacity with such approaches would be modest. Best-case scenarios suggest that such maneuvers, when coupled with reallocation of existing staff (see below), might increase intensive care unit (ICU) capacity by only 50%.[21] This will be insufficient to meet the needs imposed by a disaster, which might require an increase in critical care capacity of up to 500%. For this reason, the Working Group on Emergency Mass Critical Care organized by the University of Pittsburgh Medical Center and Society of Critical Care Medicine specifically recommended that hospitals not depend solely on transferring or diverting patients to other hospitals as a way to reduce demand in the aftermath of a bioterrorist attack.[21]

The other approach to respond to increased demand is to increase staffing capacity. Staff augmentation can be attempted in 2 ways. One strategy is to rely on deployable teams of health care professionals from outside the affected region who are organized by state and federal agencies or professional societies. The other approach incorporates efforts to increase capacity by reallocating staff already employed by the hospital or present in the community. The latter efforts include approaches based on reassigning staff to perform tasks that are not part of their routine responsibilities.

Augmenting Staff by Relying on Outside RTs

National Disaster Medical System

The National Disaster Medical System is a federally coordinated system administered by the Department of Health and Human Services as part of the National Response Plan. The National Disaster Medical System augments the national medical response capability and includes teams of health care professionals (Disaster Medical Assistance Teams) that can be deployed during an emergency. In 2005 the Department of Health and Human Services initiated a program to recruit 200 RTs as part of the National Disaster Medical System.[22] Therapists who volunteer for this program become federal employees and are compensated when deployed, but must be willing to commit to a minimum of 2 weeks of service (if necessary) when called. They are specifically trained in use of the ventilators stored in the Strategic National Stockpile. The intention of the program is to develop a corps of RTs knowledgeable in that equipment, who could be deployed to a region during an emergency. When fully developed this program may be successful in supplementing local staff in limited emergencies; however, implementation has been limited by difficulty with recruitment. This was partly due to concerns regarding whether the RTs' jobs would be protected while they were deployed. Administrative changes to the program were made in 2007 to address this issue.[23] However, as of June 2006 only 35 RTs had completed the training.

United States Public Health Service

The mission of the Commissioned Corps of the United States Public Health Service is protecting, promoting, and advancing the health and safety of the nation. United States Public Health Service resources include emergency response teams trained and equipped to respond to public health crises and national emergencies, such as natural disasters, disease outbreaks, or terrorist attacks. Some of these teams are multidisciplinary medical response units managed by the Office of the Surgeon General. Although the Commissioned Corps includes over 6,000 commissioned officers drawn from more than 11 health care professions, it has not historically included respiratory therapy among its professions. However, effective September 1, 2007, Bachelor-trained respiratory therapists became eligible to become commissioned officers in the Therapist Category of the U.S. Public Health Service.[24] Most of the officers in the Commissioned Corps are physicians and nurses. Although some of these personnel may have critical care experience, the purpose of the emergency medical response teams has not traditionally been to expand

in-patient critical care capacity or provide specialty service such as mechanical ventilation.

Military Resources

The military has several deployable medical corps that could provide assistance in an emergency.[25] Both the United States Army and the Air Force operate such services. The capability of these forces to augment local resources is unknown. The Air Force program, called the Expeditionary Medical Support System, has experience in providing hospital support, including critical care services, in civilian emergencies.[26] However, its capacity to treat large numbers of critically ill patients in the civilian sector, deploy a large force rapidly in that setting, provide critical care to large numbers of contagious patients, and deliver support services specifically for large numbers of mechanically ventilated patients is not known to civilian authorities.

The United States Army Medical Command also has an emergency management program that can deploy teams and resources under the National Response Plan to augment civilian resources. Special Medical Augmentation Response Teams are composed of Army officers, warrant officers, and enlisted soldiers. They are capable of deploying year-round, within 12 hours, in support of emergency incidents at the request of civil or federal authorities. However, as with the Air Force program, the capacity of these services to provide substantial critical care and respiratory care to the civilian sector is not known to civilian authorities. In addition, given their primary mission and limited resources, competing priorities may limit their ability to augment the civilian sector, especially during times of active military conflict.[18]

Emergency System for Advance Registration of Volunteer Health Professionals

Other efforts to develop external sources of personnel that could be relied upon in a local emergency include development of registries of health care personnel who are willing to volunteer their assistance in an emergency. The Emergency System for Advance Registration of Volunteer Health Professionals (ESAR-VHP) was authorized by Congress in 2002.[27,28] The Health Resources and Services Administration (HRSA) was initially delegated the responsibility for this program, although each state is responsible for developing its own registry. HRSA's role was to assist the states and territories in establishing a standardized registration system. This assistance included development and implementation of technical and policy guidelines, funding to support development of each state's system, and technical assistance. The state-based systems include verifiable, up-to-date information regarding the volunteer's identity, licensing, credentialing, accreditation, and privileges in hospitals or other medical facilities. The goal is to improve the capability to quickly identify and better utilize health professional volunteers in emergencies. In addition, these systems will ultimately enable the sharing of preregistered and credentialed health care professionals between states and nationally. Each state's ESAR-VHP system will be built to standards that will allow quick and easy exchange of health professionals with other states, thereby maximizing the size of the population able to receive services during a time of a declared emergency.

Administration of the ESAR-VHP program was transferred from HRSA to the Assistant Secretary for Preparedness and Response in 2006. The Assistant Secretary for Preparedness and Response has made development of ESAR-VHP a top priority, with funding available to assist states in the development of their programs. Recipients of funding are expected to have fully operational programs by August 8, 2008.

Several factors, however, currently limit the effectiveness of this program. First, the program is being rolled out in 3 phases. Pilot testing of the guidelines began in the spring of 2005 but was limited to only 10 states (Illinois, Massachusetts, Minnesota, Missouri, Texas, Connecticut, Washington, Ohio, West Virginia, and the District of Columbia). However, other states are independently developing databases and adapting them for their ESAR-VHP system. Second, the current ESAR-VHP guidelines (version 2) only include standards for physicians, registered nurses, and behavioral health professionals. The latter include marriage and family therapists, medical and public health social workers, mental health and substance abuse social workers, psychologists, and mental health counselors. Guidelines that include standards for RTs were not scheduled to be released until the summer of 2007.

Subsequent versions of the guidelines will include additional occupations. Ultimately, the guidelines will include emergency credentialing standards for approximately 65 health and health-related occupations.

Third, development of the ESAR-VHP program has not progressed as originally expected, although progress is being made in establishing the foundations for these systems. The HRSA ESAR-VHP program coordinators were contacted in 2006 to determine if any of the state systems could participate in a registrant e-mail survey designed to test the functionality of the registry. None of the ESAR-VHP systems had been developed to a functional status that would allow them to participate in the survey.[29] ESAR-VHP programs will eventually be a resource for identifying most of the health professional groups needed for a disaster or emergency response. However, at this time they have not been developed to that level.

Medical Reserve Corps

The Medical Reserve Corps is another potential source from which volunteers may be drawn. The Medical Reserve Corps program was started by the Department of Health and Human Services in 2002. The mission of the Medical Reserve Corps program is to establish teams of local volunteer medical and public health professionals who can contribute their skills and expertise throughout the year and during times of special community need. It is a specialized component of Citizen Corps, a national network of volunteers dedicated to ensuring hometown security. Citizen Corps, along with AmeriCorps, Senior Corps, and the Peace Corps are part of the USA Freedom Corps, a program that promotes volunteerism and service nationwide. The Medical Reserve Corps National Program Office oversees activities of 10 Medical Reserve Corps Regional Coordinators. These coordinators collaborate with national, state, and local level emergency preparedness and response personnel, including medical and health care personnel.[30]

Medical Reserve Corps units are community-based and function locally to organize and utilize volunteers who want to donate their time and expertise to prepare for and respond to emergencies. They also serve to promote healthy living throughout the year. Medical Reserve Corps volunteers supplement existing emergency and public health resources.[31] They include medical and public health professionals such as physicians, nurses, pharmacists, dentists, veterinarians, and epidemiologists. Many community members, such as interpreters, chaplains, office workers, and legal advisors, fill key support positions. Medical Reserve Corps units in any state or region can be identified at the Web site http://www.medicalreservecorps.gov/findMRC.asp.

Several factors currently limit the reliability of Medical Reserve Corps units with regard to augmenting respiratory care services for critically ill patients. First, Medical Reserve Corps units are in different stages of development. Some units are just becoming organized while others are already functional and have responded to disasters such as hurricanes and floods. Second, there are substantial differences in structure, size, and composition among the units. As of October 2007 there were over 716 Medical Reserve Corps units, with over 147,073 registrants distributed over the 10 regions of the United States. They range in size from zero to more than 6,300 registrants.[29] Third, RTs may not be volunteering in sufficient numbers to have an important impact. There are few data regarding the specific numbers of RTs who have volunteered, and this number probably differs greatly among the units. Most participants are physicians and nurses, but efforts are being made to increase participation by other health care professionals, including RTs. However, as these units are community-based and serve within their own communities, new recruits may merely consist of the very staff that are already being over-taxed and need augmentation. Fourth, although their mission is generally described to include supplementing existing emergency and public health resources in a disaster, some units have restricted their role to specific tasks such as distributing antibiotics and vaccinations to the public during bioterrorist or naturally occurring epidemics.[29] Medical Reserve Corps units do not specifically exist to supplement critical care services. However, the role and structure of Medical Reserve Corps units continue to evolve as new needs are recognized.

Other Limitations

Other factors may also limit the efficacy of deployable forces of RTs to augment local resources. Depending on the nature of the emergency, there may be problems that limit the ability of volunteers and registrants to travel. Disruption in the national transportation system, such as occurred after the attacks on September 11, 2001, when all airlines were grounded, may prevent or at minimum delay their arrival to an area in need. If the disaster is national in scope, increased local demand for service in home communities may be a higher priority than service elsewhere. In addition, well-intentioned volunteers may opt not to leave home and families at a time of national emergency, for fear of endangering family members. This is a particular concern when the disaster is due to contagion.[32,33] For all of the reasons described above, local communities would be ill served to prepare their disaster planning based solely on the concept of the arrival of additional support from outside their community. Indeed, the Working Group on Emergency Mass Critical Care has suggested that local communities may need to rely solely on local resources for at least 1–2 days, and perhaps for as long as 10 days, following a mass-casualty event.[21]

Augmenting Staff by Exploiting Local Resources

The initial response of most health care institutions to staffing shortages related to a mass casualty disaster will be to augment staff by reallocating current personnel within their pre-emergency scope of practice. Initial steps will include canceling elective surgical procedures to redeploy operating room staff with respiratory therapy credentials to the ICU and reassigning RTs from non-ICU settings to the ICU. The latter will include those currently without clinical responsibilities, such as administrators and RTs who work primarily in pulmonary function laboratories, as well as general ward RTs. Other actions to increase supply will include increasing the durations of shifts and canceling vacations.[34] In addition, non-respiratory-therapy ICU staff, such as the primary critical care nurse, may be asked

to perform patient care responsibilities that are traditionally assigned to the RT. These responses will have limited benefits. Critical care nurses will also probably be in short supply if there is a surge of patients who require mechanical ventilation because of the general increase in the number of critically ill patients. They will already be overextended and not able to assume the normal responsibilities of other hospital personnel. The utility of extending shift duration and canceling scheduled time off is limited by the risk of staff burnout and fatigue. If the disaster is infectious or contagious in nature and infection-control measures mandate use of special personal protective equipment, shift duration may need to be shortened because of the additional emotional and physical burdens of patient care in that setting and to limit the risk of contamination of staff due to fatigue-induced failures in infection-control protocols.

If the steps taken above prove to be ineffective in meeting the increased demand for staff, hospitals will probably have to employ "2-tiered" models for critical care staffing. This approach, which was initially endorsed by the Working Group on Emergency Mass Critical Care with regard to staffing shortages for intensivists and critical care nurses, incorporates non-critical-care personnel to assist in the care of critically ill patients.[21] The non-critical-care personnel assume the more general aspects of patient care and function under the direct supervision of the intensivist and critical care nurse. It is likely that hospitals will also have to use a similar approach to meet staffing needs for RTs. The issue that limits this approach to supplementing respiratory care services is that most RTs employed in a hospital are already engaged in active clinical practice. Many hospitals are currently understaffed for respiratory therapy and few RTs are employed in purely administrative positions. This leaves a very small pool within the hospital from which to recruit a second tier of respiratory care providers. One approach to this problem is to cross-train other health care professionals to serve as "respiratory care extenders." Respiratory care extenders would assist RTs in the management of patients on mechanical ventilators. This approach requires a method to quickly cross-train and establish the competence of the extenders.

Project XTREME

Project XTREME refers to a cross-training model developed to train health care professionals to meet the respiratory care needs of a surge of mechanically ventilated patients resulting from a mass casualty event. The model was developed by a team of respiratory care specialists at the University of Colorado Health Sciences Center and Denver Health Medical Center. The project was funded by the Agency for Healthcare Research and Quality under contract 290-00-0014-10, "Model for Health Professionals' Cross-Training for Mass-Casualty Respiratory Needs." The specific directives of the project are listed in Table 1. A complete discussion of all of these objectives is beyond this review, which will focus only on the methodology and content of the cross-training program. Additional information regarding the other directives can be found in the project's final report.[29] The primary development team received guidance and progress review from an External Advisory Committee that included representatives from the United States Department of Health and Human Services, National Institute of Health, American Association of Community Colleges, Office of Domestic Preparedness, American Association for Respiratory Care, Colorado State University, Strategic National Stockpile, the Joint Commission (formerly the Joint Commission for Accreditation of Healthcare Organizations), and the Society of Critical Care Medicine.

Table 1. Directives for Project XTREME

Review issues related to cross-training.
Develop core competencies for mechanical ventilation.
Develop core curriculum, including quantifiable performance indicators.
Identify competency testing models.
Legal/regulatory review of barriers that might limit use of cross-trained health care providers.
Identify health care professionals that might be cross-trained.
Review how this model could be integrated with the Emergency System for Advance Registration of Volunteer Health Professionals program.

XTREME = Cross-Training Respiratory Extenders for Medical Emergencies

The goal of the training program is not to prepare the respiratory care extenders to be RTs, but to teach them the more basic respiratory care skills in order to enable them to assist a supervising RT in the management of patients who require mechanical ventilation. In this model, the extenders work under the close supervision of an RT, assisting in the care of patients who suffer from respiratory failure but are clinically stable. Examples of such patients might include hemodynamically stable patients with acute lung injury on moderately high levels of supplemental oxygen and positive end-expiratory pressure but with stable gas-exchange abnormalities, and patients who are clinically stable but ventilator-dependent from an exacerbation of chronic obstructive pulmonary disease. Off-loading some of the respiratory care responsibilities of these patients from the RT would increase the availability of RTs to assist in the management of patients with unstable respiratory failure. This approach is a variation of the 2-tiered staffing approach recommended by the Working Group on Emergency Mass Critical Care.

It is important to emphasize that respiratory care extenders would not be independently managing mechani-

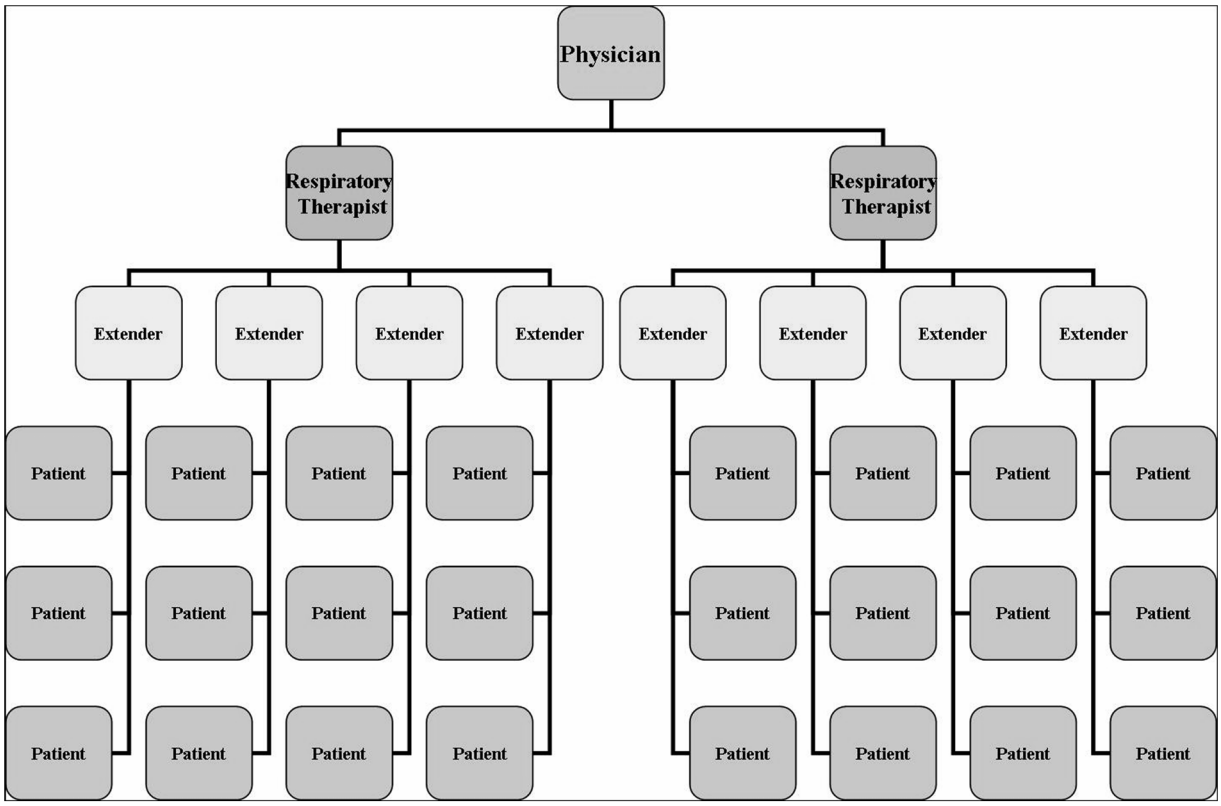

Fig. 1. In the reporting structure recommended in the Project XTREME (Cross-Training Respiratory Extenders for Medical Emergencies) final report, each respiratory care extender is responsible for 3 patients and each respiratory therapist supervises 4 respiratory care extenders.

cally ventilated patients, but would be working under the supervision of an RT. The reporting structure recommended by the Project XTREME authors is depicted in Figure 1. In this model, one extender is involved in the care of 3 mechanically ventilated patients and one RT supervises 4 extenders. The optimal level of responsibility (numbers of patients per extender and extenders per RT) was not validated as part of Project XTREME. The authors based their recommendation on the reporting structure utilized at Denver Health when training respiratory therapy students. The optimal level of responsibility might vary across institutions, depending on factors such as the skill of each extender and the supervisory experience of the RTs.

Project XTREME is intended as "just-in-time" training—a phrase to indicate that the training would occur during the initial phase of a developing disaster. This approach recognizes that the most likely scenarios resulting in a very large surge of mechanically ventilated patients (the kind in which the training program would be needed) will probably be infectious in nature. Such disasters are likely to develop in an exponential fashion, with initially a few ill patients presenting, followed by progressively increasing numbers as the disaster grows. With appropriate vigilance, such a disaster will be identified early, allowing time to pursue the training of staff. However, the training staff will have only a limited amount of time to perform the training. Project XTREME was developed with the goal that training be completed in 90 min, with an additional 90 min available to validate the competency of trainees. The number of skills that can be taught in this period of time is limited; the responsibilities of the respiratory care extenders are similarly narrow. The intended skills the extenders are expected to master are listed in Table 2; those skills that remain beyond the extenders' training are described in Table 3.

There are 2 components to the training program. The first component is an interactive digital video disc (DVD) that shows demonstrations of the skills being taught, accompanied by oral descriptions of the skills. The video includes interactive knowledge validation in the form of 10–15 questions following each module, which reinforce concepts stressed in that module and allow the trainee to review the portion of the module relevant to the question. This feature allows the trainee to receive immediate feedback regarding knowledge acquisition as well as the opportunity to review portions of the training that the questions identify as areas of weakness. The DVD may be viewed as frequently as the trainee feels is necessary to master the material. The second component of the training is a "dry lab" validation of the clinical competencies cov-

Table 2. Responsibilities and Skills Respiratory Care Extenders Should Have Following Project XTREME Training

Airway cuff maintenance
Artificial airway care
In-house patient transport
Manual ventilation via endotracheal or tracheostomy tube
Mechanical ventilator setup
Mechanical ventilator setting adjustment
Observe standard precautions and other infection-control guidelines
Oral care
Pulse oximetry
Routine suctioning
Secure artificial airway
Ventilator circuit change
Ventilator monitoring and patient system check

XTREME = Cross-Training Respiratory Extenders for Medical Emergencies

Table 3. Responsibilities and Skills That Project XTREME Respiratory Care Extenders Would Not Be Able to Perform Without Additional Training

Arterial blood gas analysis and interpretation
Administration of medication
Arterial line catheterization
Arterial puncture (for blood sampling)
Assist bronchoscopy
Bedside spirometry
Clinical assessment of patients
Chest physiotherapy
Deliver high-frequency ventilation
Endotracheal intubation or re-intubation
Hyperinflation therapy
Inter-facility patient transport
Specialty gas administration
Ventilator troubleshooting and problem analysis*

* Beyond recognizing when alarm parameters are being exceeded and manually ventilating patients pending assessment by the respiratory therapist.
XTREME = Cross-Training Respiratory Extenders for Medical Emergencies

ered in the video. This includes 5 stations monitored by an RT, at which the trainee must physically demonstrate the learned skills on a simulator and answer questions relevant to those competencies. An evaluation tool to score and document the competence of the trainee at each station was developed by the authors (Appendix). This tool is a modification of the scoring system endorsed by the American Association for Respiratory Care.[35] Trainees must satisfactorily complete both the training DVD and pass the dry lab competency assessment to successfully complete the training program.

The training DVD is organized into 6 modules, including infection control, terms and definitions, manual ventilation, mechanical ventilation, airway maintenance, and airway suctioning. The curriculum covered in the DVD is summarized in Table 4. The curriculum was developed specific to the 2 ventilators currently cached in the Strategic National Stockpile, specifically the Impact Uni-Vent Eagle and the Puritan Bennett LP10.

Table 4. Training Curricula Covered in Each Module of Project XTREME

Infection Control
Standard precautions (eg, gowns, gloves, and masks)
Isolation techniques (contact, airborne, droplet)
Hand hygiene
Terms and Definitions
Manual ventilation
Glossary of terms
Normal ranges
Mechanical ventilation
Glossary of terms
Normal ranges
Manual Ventilation
Equipment assembly
Equipment function
Oxygen settings
Technique
Monitoring
Assessment of adequacy of ventilation
Mechanical Ventilation
Introduction to mechanical ventilation
Hazards of mechanical ventilation
Assembly and testing of ventilators
Ventilator setting adjustment
Alarm limit settings
Assessment of adequacy of ventilation
Monitoring
Troubleshooting
Airway Maintenance
Assessment of tracheal tube placement
Securing endotracheal tube
Cuff-inflation technique
Minimum occluding volume
Minimal leak technique
Airway Suctioning
Indications for need
Hazards
Equipment
Complications
Procedure technique
Expected outcomes

XTREME = Cross-Training Respiratory Extenders for Medical Emergencies

Several groups of health care professionals underwent Project XTREME training as a means of evaluating the effectiveness of the training program. Test subjects included second-year respiratory therapy students, general internists, non-critical-care nurses, physician assistants,

Table 5. Five Trainee Qualities Essential to Successful Cross-Training

Voluntary participation (self-selection)
Possession of baseline knowledge or competencies
Possession of analytical assessment skills and a large skill base
Experience working within a care team framework
Having time during a mass casualty event to perform the newly acquired cross-trained duties/competencies

Table 6. Minimum Knowledge Base and Competencies Required to Successfully Complete Cross-Training as a Project XTREME Respiratory Care Extender

Medical terminology
Basic mathematics
Written and oral communication
Social/behavioral sciences
Basic computer science
Critical thinking skills
Human anatomy and physiology
Cardiopulmonary anatomy and physiology
Cardiopulmonary pathophysiology
Basic chemistry
Basic physics
Basic microbiology

XTREME = Cross-Training Respiratory Extenders for Medical Emergencies

nurse practitioners, veterinarians, and physical therapists. Most of the non-critical-care nurses were in administrative positions and no longer in active clinical practice. These health care professionals were selected because they had the pre-existing knowledge base and the minimum competencies that a literature review suggested were necessary to successfully complete cross-training in respiratory care (Tables 5 and 6).[36-40] The program was modified from its intended use to accommodate the evaluation process. Because of space and equipment constraints, the DVD was projected onto a large screen and all of the trainees in a training session viewed it together. Answers to the interactive questions were collected at the end of each module on a data-collection form and subsequently scored. These alterations to the training program unfortunately prevented the trainees from receiving the immediate feedback provided by the interactive questions and from re-examining those portions of the DVD in which their knowledge base remained deficient after the initial viewing. These features are considered to be essential to the training program. Despite these limitations, all of the groups evaluated successfully completed the training, as based on their cognitive scores to the questions and performance scores during the dry lab competency testing.[29]

These results suggest that the Project XTREME training program is effective; however, several concerns remain. Are the results of the pilot testing reproducible in other clinical settings, such as nonacademic or rural hospitals? Can the results be reproduced by staff less familiar with its content than the staff that developed it? Does competency determined in a dry lab exercise with simulators equate to competency at the bedside? What is the optimal number of patients per extender and extenders per RT? Are there other health care disciplines that could be cross-trained? How long do respiratory care extenders remain competent if the learned skills are not immediately applied? These issues were not addressed in the original Project XTREME report and warrant further research to improve the program.

Another important concern is the potential existence of legal or regulatory barriers that could prevent cross-trained personnel from applying the skills they have learned.[41] Project XTREME included a legal review that suggested that in declared emergencies, important exceptions to licensing, immunity, and civil liability standards may be enacted through governmental executive orders that would permit non-respiratory-therapy health care workers to assist with respiratory care. Forty-eight states regulate respiratory care services; the statutes of 43 of these states include exemptions to licensing requirements under special circumstances. Many of these include performance of respiratory care services in the case of an emergency and when providing respiratory care services is included within the health care professional's normal scope of practice. However, the definition of what warrants an emergency and what constitutes scope of practice varies among the statutes, making global conclusions regarding this issue difficult. In addition, no court-adjudicated legal precedents address this issue. For these reasons disaster planners considering implementation of a program such as Project XTREME should review the statutes relevant to their states.

Finally, although Project XTREME was envisioned to be used as just-in-time training, the authors also encouraged disaster planners to incorporate it as part of their readiness training plans. In this scenario, potential extenders from within and outside of a health care institution are proactively identified as part of disaster preparedness and go through the training program in a readiness mode. Pre-trained extenders would be required to repeat training on a regular basis, much as many health care professionals are required to renew basic life support skills. Lists of pre-trained extenders would be maintained and reviewed periodically by the institution; new extenders would be recruited to replace personnel who have left the institution or are no longer able to assist in a disaster. Pre-trained extenders would still be required to complete just-in-time training at the time of a disaster to sharpen their skills and ensure that they remain competent.

Summary

Mass casualty events, especially those that are infectious in nature, may result in a surge of patients who require mechanical ventilation. Depending on the magnitude of the event, such a disaster will result in substantial shortages of respiratory care equipment and personnel that may limit the medical community's ability to respond to the disaster. Ventilators and other equipment are currently being stockpiled by the federal and some state governments, with the goal to deliver these stockpiles to affected areas within 24–48 hours of a declared emergency. Supplemental equipment will be of limited benefit, however, without additional personnel to manage patients.

Several options exist to increase staffing resources in such an event. These include both reliance on RTs from outside the area who would be deployed to the region and efforts to enhance supply by exploiting local resources. Programs to develop deployable corps of RTs and registries of volunteer RTs remain in early stages of development and suffer from poor recruitment. Other deployable resources, such as the United States Public Health Service and military medical commands, either do not include substantial numbers of RTs, have limited experience in working in the private sector, or may have other priorities, depending on the nature of the emergency. It is unlikely that personnel resources from outside the region would be available if the disaster were national in scope. These issues limit the effectiveness and reliability of this approach to staff augmentation.

Exploitation of local resources includes recruiting local RTs who are currently in either nonclinical or non-hospital-based positions (such as those employed in the durable medical equipment industry), and reallocating pre-existing respiratory therapy resources within the institution by canceling elective surgeries, altering shift structure, and postponing vacations. These responses will probably be of limited benefit because of concerns related to staff exhaustion and pre-existing staff shortages. An additional approach involves cross-training other health care personnel to assist RTs in managing patients who require mechanical ventilation. Project XTREME is a cross-training program developed to facilitate training of non-respiratory-care health professionals to accomplish this goal. It includes an interactive DVD as well as a competency validation lab, and is designed to be performed at the time of an emergency. Although results of pilot testing suggest this training program is effective, it has not been field tested during an actual emergency.

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Appendix

QUALITY OF PERFORMANCE KEY
5 = Outstanding Performance: No prompting required. Demonstrates mastery of the procedure. No errors noted.
4 = Good: Slight prompting required. No important errors noted.
3 = Fair: Minor errors noted. Some prompting or intervention required. Deficiencies specified below.
2 = Poor: Important errors noted. Much prompting required. Deficiencies specified below.
1 = Unacceptable: Unable to perform procedure without intervention by the evaluator. Deficiencies specified below.

INFECTION CONTROL: Follows standard precautions and provides care to the patient requiring transmission-based precautions
PERFORMANCE CRITERIA

KNOWLEDGE:
__ 1. Identifies the indications for transmission-based precautions and identifies the requirements for the categories of transmission-based precautions.
__ 2. Correlates patient's pathophysiology with signs and symptoms and identifies potential risk for complications.

SKILL:
__ 1. Ensures that the appropriate infection control precautions are taken in the clinical setting.
__ 2. Demonstrates proper technique for entering and leaving an isolation room.
__ 3. Demonstrate use of negative pressure rooms.
__ 4. Demonstrates correct hand-washing.
__ 5. Completes all relevant documentation.

ASSESSMENT: ☐ Meets performance criteria ☐ Does not meet performance criteria
Performance Deficiencies (Check Those That Apply): ☐ Excessive time needed to complete procedure. ☐ Broke aseptic or sterile technique
☐ Important inaccuracy noted ☐ Technique may be harmful to patient ☐ Incorrect procedure/sequence ☐ Incorrect equipment assembly/use
☐ Unable to correctly answer questions about rationale and/or theory related to the procedure ☐ Other: _____
COMMENTS: _____

MANUAL VENTILATION: Provides adequate ventilation in a safe and clinically appropriate manner
PERFORMANCE CRITERIA

KNOWLEDGE:
__ 1. Identifies the indications for manual ventilation and identifies the hazards associated with over- and under-ventilation.
__ 2. Correlates patient's pathophysiology with signs and symptoms and identifies potential risk for complications.

SKILL:
__ 1. Washes hands and adheres to standard precautions.
__ 2. Properly identifies appropriate size resuscitation device.
__ 3. Properly assembles necessary equipment.
__ 4. Test function prior to patient application.
__ 5. Adjust oxygen flow and pressure relief valve.
__ 6. Assure secure artificial airway in place.
__ 7. Properly connects resuscitation bag to airway.
__ 8. Manually bags with appropriate frequency and pressure.
__ 9. Monitors appropriate signs of ventilation including visualization of chest excursion.

ASSESSMENT: ☐ Meets performance criteria ☐ Does not meet performance criteria
Performance Deficiencies (Check Those That Apply): ☐ Excessive time needed to complete procedure. ☐ Broke aseptic or sterile technique
☐ Important inaccuracy noted ☐ Technique may be harmful to patient ☐ Incorrect procedure/sequence ☐ Incorrect equipment assembly/use
☐ Unable to correctly answer questions about rationale and/or theory related to the procedure ☐ Other: _____
COMMENTS: _____

MECHANICAL VENTILATION (Impact Uni-Vent Eagle): Safely institutes and continues mechanical ventilation according to prescribed settings
PERFORMANCE CRITERIA

KNOWLEDGE:
__ 1. Understands indications for mechanical ventilation.
__ 2. Understands hazards of mechanical ventilation.

SKILL:
__ 1. Properly assembles mechanical ventilator.
__ 2. Ensures safe preliminary settings before instituting mechanical ventilation.
__ 3. Properly connects circuitry to artificial airway.
__ 4. Correctly adjusts prescribed settings.
__ 5. Re-adjusts related controls.
__ 6. Adjusts ventilator alarms when appropriate.
__ 7. Ensures adequate delivery of mechanical ventilation.
__ 8. Monitors patient response to ventilation.

ASSESSMENT: ☐ Meets performance criteria ☐ Does not meet performance criteria
Performance Deficiencies (Check Those That Apply): ☐ Excessive time needed to complete procedure. ☐ Broke aseptic or sterile technique
☐ Important inaccuracy noted ☐ Technique may be harmful to patient ☐ Incorrect procedure/sequence ☐ Incorrect equipment assembly/use
☐ Unable to correctly answer questions about rationale and/or theory related to the procedure ☐ Other: _____
COMMENTS: _____

(Continued)

(Continued from previous page)

MECHANICAL VENTILATION (Puritan Bennett LP10): Safely institutes and continues mechanical ventilation according to prescribed settings
PERFORMANCE CRITERIA

KNOWLEDGE:
__ 1. Understands indications for mechanical ventilation.
__ 2. Understands hazards of mechanical ventilation.

SKILL:
__ 1. Properly assembles mechanical ventilator.
__ 2. Ensures safe preliminary settings before instituting mechanical ventilation.
__ 3. Properly connects circuitry to artificial airway.
__ 4. Correctly adjusts prescribed settings.
__ 5. Re-adjusts related controls.
__ 6. Adjusts ventilator alarms when appropriate.
__ 7. Ensures adequate delivery of mechanical ventilation.
__ 8. Monitors patient response to ventilation.

ASSESSMENT: □ Meets performance criteria □ Does not meet performance criteria
Performance Deficiencies (Check Those That Apply): □ Excessive time needed to complete procedure. □ Broke aseptic or sterile technique
□ Important inaccuracy noted □ Technique may be harmful to patient □ Incorrect procedure/sequence □ Incorrect equipment assembly/use
□ Unable to correctly answer questions about rationale and/or theory related to the procedure □ Other: _____
COMMENTS: _____

AIRWAY MAINTANENCE: Properly assesses placement and maintains proper function artificial airway
PERFORMANCE CRITERIA

KNOWLEDGE:
__ 1. Identifies the indications for artificial airways.
__ 2. Understands hazards and complications of artificial airways.

SKILL:
__ 1. Washes hands and adheres to standard precautions.
__ 2. Ensures stability of artificial airway.
__ 3. Assess appropriate placement of artificial airway with available mechanism.
__ 4. Re-secures artificial airway according to institutional guidelines when necessary.
__ 5. Maintains and assesses appropriate cuff volume of artificial airway.

ASSESSMENT: □ Meets performance criteria □ Does not meet performance criteria
Performance Deficiencies (Check Those That Apply): □ Excessive time needed to complete procedure. □ Broke aseptic or sterile technique
□ Important inaccuracy noted □ Technique may be harmful to patient □ Incorrect procedure/sequence □ Incorrect equipment assembly/use
□ Unable to correctly answer questions about rationale and/or theory related to the procedure □ Other: _____
COMMENTS: _____

AIRWAY SUCTIONING: Appropriately identifies need and safely performs airway suctioning
PERFORMANCE CRITERIA

KNOWLEDGE:
__ 1. Describes hazards of airway suctioning.
__ 2. Identifies necessary resources.
__ 3. Describes appropriate desired outcomes of procedure.

SKILL:
__ 1. Assesses need for airway suctioning.
__ 2. Implements appropriate preparation.
__ 3. Assembles appropriate equipment.
__ 4. Utilizes appropriate technique.
__ 5. Properly identifies outcomes and assesses ongoing need.

ASSESSMENT: □ Meets performance criteria □ Does not meet performance criteria
Performance Deficiencies (Check Those That Apply): □ Excessive time needed to complete procedure. □ Broke aseptic or sterile technique
□ Important inaccuracy noted □ Technique may be harmful to patient □ Incorrect procedure/sequence □ Incorrect equipment assembly/use
□ Unable to correctly answer questions about rationale and/or theory related to the procedure □ Other: _____
COMMENTS: _____

Discussion

Nelson: Have you looked at finding and contacting RTs who have left the profession? Such names might be found from a state's department of regulatory agencies.

Hanley: In developing the Project XTREME training DVD we didn't look specifically at other potential trainee groups. ESAR-VHP, the registry of volunteer health care providers, will be the source for finding volunteer trainees. RTs who work for DME [durable medical equipment] companies or have left the health care profession are certainly some of the people we want to try to contact for Project XTREME.

Sandrock: At UC [University of California] Davis we have a large veterinary school and we approached veterinarians and veterinary students. We have a few veterinarians who know how to use a ventilator well, but our state health care surge representative declined to support using veterinarians for disaster response. Our county health officer is still looking at the possibility of veterinarians.

Hanley: There were clearly 2 camps among the veterinarians: those who said they should help because it's a disaster situation and people would be dying, and those who point to the substantial medical and legal risk.

Rubinson: Disaster education started with a litany of disasters threats, and we all got taught about a multitude of chemical, biological, and radiological risks. It looks like Project XTREME is moving towards a universal application of clinical competency, which is more likely to be useful in a disaster. Is there a change underway in disaster training courses, away from teaching about the disease/condition and toward teaching clinical skills to respond to various disasters?

Hanley: Yes. We promoted our training program as just-in-time training; that is, you start training people once the disaster has begun. Of course that's a short-sighted approach.

If I were the director of respiratory therapy at a hospital, I would study the Project XTREME DVD and decide whether it is applicable to where I practice and how would I use it. Then I'd create and maintain a list of people from inside and outside my institution who I think could help me in a disaster, and have them take the Project XTREME training, with a strong focus on what to do during and after an event. Much of the disaster training to date has focused on what emergency medical system and first responders do in the first 6 to 12 hours.

Now we should start training people to deal with the consequences of disasters during the first days after the disaster. This readiness training would include giving the trainees experience at the bedside with an RT right next to them, performing manual ventilation, suctioning, and other extender duties. Then I would have them do the dry lab, and periodically retrain them.

You have to keep your list up to date, because staff that you thought were going to depend upon may leave your institution. It's not adequate to just get a copy of the Project XTREME DVD and put it on your book shelf. You need to be proactive and combine readiness training with just-in-time training.

O'Laughlin: With regard to veterinarians and their scope of practice, I think it would be short-sighted to not include them as potential extenders. Obviously, they can't act as physicians, but they certainly could be extenders. A disaster will cause scope-of-practice issues across the entire gamut of health care. Various professionals may have to assist in care that is beyond their scope of practice, which must be authorized by the state under emergency powers. Any time we approach any legislative body, we should keep this in mind. Do veterinarians or veterinary hospitals or research labs have ventilators that could be used for disaster surge capacity?

Branson: My experience is that veterinary centers have old ICU ventilators. I don't know that anybody makes a ventilator just for animals.

Sandrock: All our old ventilators go to our veterinary hospital.