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Guidelines to Effectively Increase Positive Pressure Ventilator Surge Capacity Pandemic Flu and Mass Casualty Incidents

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Introduction

Following the tragedy of September 11, 2001 and the anthrax mailings of the same year, the U.S. medical community has undertaken steps to deal with a potential event which would result in a large number of patients requiring mechanical ventilation. More recently, the threat from nature, in the form of the Avian Flu (H5N1), has accelerated preparations for a pandemic flu, which might result in thousands of patients requiring mechanical ventilation.

At present, the H5N1 flu remains difficult to transmit from person to person, but mutation of the virus could change this quickly. Reports from Southeast Asia suggest that the virulence of H5N1 results in severe acute respiratory failure (ARF).[1]

In the United States, the common treatment for ARF is supplemental oxygen and mechanical ventilation. Thus we can expect a surge in demand for ventilators if a pandemic of H5N1 were to occur.

Mechanical ventilation typically is implemented and managed by respiratory therapists, in intensive care units, under the direction of a physician. Despite the severity of ARF, most patients survive.[2-8] However, most patients with SEVERE ARF, except when caused by conditions immediately correctable by antidotes, (e.g., naloxone for opiate overdose), are likely to die.

The typical hospital maintains sufficient numbers of ventilators, support equipment, and supplies to meet current demands. At times of peak demand, (i.e., flu season), hospitals frequently are required to supplement their ventilator inventories, by renting additional ventilators. Thus, our hospitals have virtually no reserve ventilators to respond a disaster or pandemic.

The ventilators used in critical care settings, are complex, microprocessor-driven devices. They are designed to support a wide range of medical conditions, acuities, ventilation modes, flows and pressures. The high cost of purchasing and maintaining such critical care ventilators makes stockpiling these devices financially impractical.

Moreover, the extensive training and competency requirements necessary to operate these ventilators safely and effectively, preclude use of support personnel who may be used to assist respiratory therapists if a pandemic or other mass casualty event hits the country.

The following represents the recommendations from the American Association for Respiratory Care to assist with decisions to plan and implement mass casualty response for both pandemics (H5N1) and other mass casualty disasters.

It must also be emphasized that ramping up ventilator capacity, for any mass casualty response, will require concomitant ramping up human resources to assist respiratory therapists and physicians with treatment of casualties/patients requiring mechanical ventilation. This human resource issue is a key factor in ventilator selection, of no less importance that the ventilator itself.

The result then is obvious. In the wake of a pandemic flu with a virulent flu strain like H5N1, patients with survivable illness will die from lack of resources unless more ventilators that have the capabilities to support patients with ARD, are readily available.

US Strategic National Stockpile (SNS)

The U.S. Center for Disease Control and Prevention's Strategic National Stockpile (SNS) program owns and maintains thousands of mechanical ventilators for distribution to states affected by mass casualty events. However, a serious influenza pandemic is likely to overwhelm even the SNS inventory.

The inventory should be expanded to include approximately 1500 ventilators, with the same features and capabilities as those currently used in critical units throughout the country.

This added resource will help meet an anticipated surge in demand of the most clinically versatile ventilators, in order to meet the clinical needs of the severe H5N1 patients, especially those who have co-morbidities.

A reliable triage system is absolutely necessary to assure that only patients who cannot be managed with the more numerous but less complicated ventilators,

receive the ventilatory support necessary to support them throughout the incidence of H5N1.

As such, local planning will be essential.

Critical Points to Consider When Purchasing Ventilators at the Local Level

Human Resources Issues

- Under normal conditions critical care professionals are in short supply.[21, 22] Reducing services to essential non-elective levels will free some personnel and equipment.
- If the need for mechanical ventilation overwhelms the capacity, non-critical care professionals will be enlisted to assist in the care, but only after undergoing some degree of training, by respiratory therapists and other critical care specialists.
- Therefore:
    - Ventilators for these events must be easy to use.
    - Ventilators for these events must have adequate alarms.
    - Minimum alarms would include loss of power source (gas and/or electricity), low pressure, high pressure, and disconnect.
    - Standardized training programs must to be undertaken to first train the trainers, and then facilitate use of additional caregivers.

- The complexity of mechanical ventilation requires that respiratory therapists play the lead role in this educational effort.
- Since all mechanical ventilators are powered by compressed gas (air), and or electricity plans must include pre-identified additional sources for high capacity air compressors (that can power several ventilators simultaneously). These compressors must be able to produce clean and dehumidified air at within a pressure range specified by the ventilator manufacturer. Gasoline-powered generators should also be identified in the plan. Natural disasters may eliminate electricity, or a pandemic may require continuing ventilator use in facilities not designed or configured for the wide array of medical technology devices.

Logistical Support:

- Adequate supplies of ventilator circuits, suction equipment, pulse oximeters must also be available in order to maintain airway clearance, and monitor oxygenation.
- Ventilator circuits (tubing/valves) are used to connect the patient with the ventilator and must be sterilized if reusable, or replaced, as ventilators are switched to different patients over the course of the pandemic.

- Oxygen supply may be limited by events that destroy commercial infrastructure (hurricane) or hospital supplies (flood, earthquake.)
    - Oxygen consumption of ventilators must be limited
    - Ventilators capable of operating from compressed gas **and** a variety of electrical sources are preferred.

- Children will also be victims
    - Ventilators should be capable of ventilating pediatric patients.
- In case of contagious respiratory disease caregivers should use appropriate protections.
    - Non-invasive (mask) ventilation should be avoided
    - Caregivers should wear appropriate protective respirators.
    - Caregivers should minimize exposure time.

- The following capabilities are necessary to treat patients with H5N1 and the resultant acute respiratory failure.
    - Operate across a wide range of patient populations (pediatric to adults)
    - Easy, safe operation.
    - Minimal maintenance.

- Operate for 4-6 hours when electric and gas supplies are unavailable (battery).
- Ventilation of acute respiratory failure will require, at a minimum the ability to control tidal volume, respiratory rate, inspired oxygen concentration, and positive end-expiratory pressure (PEEP).
- Devices used in EMS for transporting patients commonly do not meet these requirements and may not have any value in a pandemic flu or mass casualty event. They are designed for short term use and not to manage patients with ARDS

- Increasing ventilator capacity
  - Stockpiling of ventilators with the characteristics necessary to meet the challenges of acute respiratory distress is recommended
  - Stockpiling ventilator power sources and the previously mentioned supplies and equipment is recommended
  - A system to periodically inventory and test stockpile equipment must be instituted virtually at time of acquisition, if not currently in place.
  - Efficient utilization of current, non- stockpiled ventilators
    - Use of anesthesia ventilators (canceling of elective surgery) for patient care.

- Sharing of ventilators between hospitals, municipalities, and cities.
- Request all hospitals to ascertain existence and condition of obsolete yet functional ventilators that could be used in the vent of a pandemic, or other disaster.

- Establish procedure for appropriate distribution of local stockpiles and rental companies.
- Access to SNS reserves.

Summary

- Ventilator reserves must be versatile enough to meet demands for mass casualty and pandemic ventilator use.
- Planners should consider standardization of ventilators when practical in order to simplify a) training support staff, b), inventory of support resources (circuits, etc), and c) anticipated site of use.
- Ease of training and training programs must be established at time of ventilator purchase.
- Numbers and types of ventilators should reflect the differences in need between disaster response with mass casualties and a pandemic such as H5N1.
- Ultimately we will have just one reserve of ventilators to use in both scenarios. As such the need to add ventilators that have ventilation mode capabilities that support pandemics is paramount, given the excellent response to support disaster mass casualty situations.
- Much of the current reserve can support a pandemic outbreak, but not all.
- At least an additional 1500 ventilators (1000 adult, 500 pediatric) are required to supplement the stockpiles already in place, for pandemic occurrences, that lead to support of patients with Acute Respiratory Failure.
- Respiratory therapists can and are assisting agencies at all levels to assure that ventilator stockpiles are not measured by quantity alone, but also clinical capabilities, as well.

The American Association for Respiratory Care stands willing to assist all emergency preparedness agencies as they provide further consideration to purchase of ventilators. It will also assist in identifying the support, and logistical issues that manifest as part of the this process.

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