

EDITORIAL

Survey of Mechanical Ventilators in US Acute Care Hospitals: A Baseline for Critical Care Surge Capacity Planning

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The study by Rubinson et al reported in this issue of *Disaster Medicine and Public Health Preparedness* estimating the number and distribution of mechanical ventilators in the United States has been much anticipated and is important to emergency preparedness.¹ It is surprising to many that this information was not previously known, but, in fact, no attempt to comprehensively count and characterize the ventilators in the United States had ever been attempted. Previous estimates of the total number differed by a factor of 2, from approximately 50 000 to approximately 100 000. The critical importance of this information became apparent following the terrorist attacks of September 11, 2001, and the 2001 anthrax attacks as federal planners began to consider the number of ventilators needed in the Strategic National Stockpile (SNS). Before one can make an informed judgment about how many additional ventilators may be needed in a disaster, an inventory of the existing supply is needed.

This need became even clearer when federal, state, and local planners started preparing for a possible H5N1 influenza pandemic. Available models for pandemic planning such as the Centers for Disease Control and Prevention's FluSurge indicated a huge demand for mechanical ventilation in a severe pandemic. Intuitively, many health care planners knew that this would mean that there would be a shortage of ventilator capacity because few hospitals keep more ventilators on hand than they need day to day; but the anticipated scale of the shortage was hard to judge. An individual hospital can easily count its ventilators, but in a large-scale event, such as a pandemic, in which all of the hospitals in a region are affected, it is the number of ventilators in a region that matters, not just the number in an individual hospital. In many cases, obtaining a count of ventilators in a city or other local region proved difficult because of the highly fragmented and competitive nature of our health care system. Hospitals sometimes are reluctant to share this information with their competitors. Thus, a census of ventilators performed by an outside entity was required.

The study by Rubinson et al demonstrates that the total number of full-feature ventilators falls between the previous estimates. More important, it further breaks down this number by those that are capable of ventilating children. However, this survey, as thorough and well designed as it is, is not completely comprehensive and therefore probably underestimates the true number of ventilators. As the authors note, they did not count rented ventilators, backup ventilators, or anesthesia

machines. Many hospitals rely on rented ventilators or unused older backup ventilators for much of their surge capacity during times of high demand. Furthermore, hospitals that offer surgery, which is nearly all hospitals, have anesthesia machines. These machines provide mechanical ventilation and anesthesia to patients during surgery. In many hospitals, the number of anesthesia machines may approximate the number of traditional ventilators. In addition, outpatient surgical centers may also have anesthesia machines, another source of ventilator capacity not captured by this study. The true number of machines capable of providing mechanical ventilation is undoubtedly larger than this study found.

Whatever the actual number, it is probably still insufficient to meet the demands of a severe influenza pandemic. The authors point out that the federal government is responding to this gap by purchasing additional ventilators for the SNS and supporting research into novel types of ventilators. The total number of ventilators does not, however, fully measure the surge capacity and capability for critical care services.

Rubinson and colleagues note that there is more to critical care surge capacity for adults and children than the presence of mechanical ventilators in hospitals, and that several additional issues need to be considered. Are consumable ancillary resources available and scalable to the potential increased use of surge mechanical ventilators? Without consumable supplies such as circuit tubing, the ventilator is of no value. How many of these ventilators would be unassigned and available in a surge of acute respiratory failure? Would there be sufficient staff trained in the management of acute respiratory failure to effectively use an increased number of available ventilators supplied by the state or region or through the SNS? Without surge capability of trained critical care staff, the situation would be analogous to adding additional operating rooms without adding additional surgeons. In addition, as was seen during the recent H1N1 pandemic, the severe acute respiratory syndrome outbreak, and the anthrax attacks of 2001, and with the several hundred patients infected with H5N1 during that last 6 years, patients sick enough to require mechanical ventilation often require other forms of intensive care that may be in limited supply, such as vasopressors and dialysis. It is not at all clear that providing mechanical ventilation alone without being able to provide these other lifesaving measures would be of value. Lastly, and perhaps most important, by what mechanism and through what operational authority would the supply of ventilators, ancil-

lary equipment, and trained staff be matched to the demands of patient surge in a severe pandemic or other catastrophic health event?

The authors compared the number of ventilators in the United States with the numbers reported from several other similar countries—Canada, New Zealand, and Australia—and found that the number that they determined for the United States is significantly higher than these other countries. Does this mean that those countries have too few ventilators or that the United States has too many? What is the most appropriate way to determine the right number? The answer is not obvious, but it is obvious that it is not possible to have enough for every conceivable scenario. It is not possible or prudent to entirely buy our way out of this problem.

This means that at some point we must do the most good that we can with the limited resources that we have. In large-scale disasters, the problem is likely to be as much a problem of maldistribution as it is a problem of absolute shortage of ventilators in a region. It is essential that we continue to make progress in building coalitions of health care institutions and local response agencies in every community to facilitate optimal sharing of medical resources and distribution of patient load in catastrophic health events. Such coalitions, which are explicitly called for in the guidance from the Department of Health and Human Services' hospital preparedness program and implied in The Joint Commission's emergency management standards, and have already developed in many states and communities,² could also facilitate other essential actions, such as coordination of volunteers and alternate care facilities, needed in large-scale disasters. Another potential function of these coalitions could be coordination of decisions around the implementation of crisis standards of care.

No matter how many ventilators we have or how many more we buy, there may always be situations in which there are not enough at the time and place that they are needed. In these circumstances, it is imperative that there be a coordinated, fair, ethical, and legal mechanism for allocating scarce lifesaving resources.

Dr Rubinson and his collaborators should be congratulated for finally conducting a careful and comprehensive inventory of such an important national resource. However, knowing how many ventilators that we have is only a beginning. We now need to use this baseline information to make rational and informed judgments about further preparedness measures and to accelerate our efforts to make the best possible use of the resources that we have.

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