Online Report

Stockpiling Supplies for the Next Influenza Pandemic

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Abstract
Faced with increasing concerns about the likelihood of an influenza pandemic, healthcare systems have been challenged to determine what specific medical supplies that should be procured and stockpiled as a component of preparedness. Despite publication of numerous pandemic planning recommendations, little or no specific guidance about the types of items and quantities of supplies needed has been available. The primary purpose of this report is to detail the approach of 1 healthcare system in building a cache of supplies to be used for patient care during the next influenza pandemic. These concepts may help guide the actions of other healthcare systems.

Introduction and Historical Context

Preparations for the next influenza pandemic have captured a remarkable amount of attention, effort, and fiscal funding since 2004, when the scientific and public health communities became increasingly concerned about the emergence of a novel influenza virus (H5N1) infecting humans in Eurasia (*1*). Many feared the occurrence of an outbreak on the scale of the 1918–19 pandemic, during which one third of the world's population became infected and as many as 100 million persons died (*2*)

Numerous guidance documents call for stockpiling certain supplies that might be needed to care for influenza patients during a pandemic (*3–6*). Just-in-time supply chains and standard operating procedures may be insufficient to meet demand as the number of cases increase (*3–6*). Healthcare systems have been challenged to determine the medical supplies that should be procured. Despite publication of numerous pandemic planning recommendations, little or no guidance has been available about this topic.

In December 2005, the US Department of Veterans Affairs (VA), which has governance over the largest integrated healthcare system in the United States, directed its medical centers to make detailed pandemic influenza preparations. This directive was ushered in by a guidance document (*7*) that broadly defined the goals and expectations of individual VA medical centers and provided a framework for planning and preparedness. Steps taken by medical centers, including decisions about stockpiling items, were determined by leaders at the local level.

To help our healthcare system prepare for a pandemic, a multidisciplinary group of experts drawn from within the VA system were empaneled to help bridge the gap between policy and procedure. Among the most challenging tasks was the development of a prioritized list detailing supplies and the essential quantities that should be stockpiled. This report aims to provide detailed example of 1 healthcare system's approach to building a cache of supplies for the next influenza pandemic and to help identify critical gaps in knowledge that must be addressed for adequate preparedness.

Steps toward Preparedeness

The 1,400 medical facilities in the national VA healthcare system are decentralized into 23 Veterans Integrated Service Networks (VISNs), each representing a specific region of the nation. The concepts described in this report are based on actions taken by staff in VISN 8, which includes southern Georgia, most of Florida, and all of Puerto Rico, and provides healthcare for ≈500,000 veterans. Regional network

offices help integrate the activities of the medical facilities included in each VISN. Local medical center leaders are primarily responsible for the activities at each hospital and its affiliated outpatient clinics.

Step 1: Committee Formation

The VISN 8 leadership appointed a multidisciplinary team to a pandemic influenza planning committee (PIPC) (Table 1) that was tasked to ensure a coordinated and consistent planning and response effort across the VISN. Although the committee had many responsibilities, the focus of this report is limited to the framework developed to estimate supply needs.

The PIPC agreed on a set of basic philosophical principles that guided our pandemic preparation efforts. During a pandemic, the first priority would be to provide the best possible care to patients while maximizing healthcare worker safety. Essential and relatively affordable patient care supplies and medications meant for basic life support (e.g., intravenous fluids, oxygen, and antimicrobial drugs) would be purchased first, and more expensive, technologically advanced life support (e.g., mechanical ventilation) equipment would be purchased when additional funds become available. This approach to balancing utilitarian and deontologic decision making is discussed elsewhere (*8,9*). Vaccines and antiviral drugs would not be relied upon as primary means of intervention because their availability and effectiveness during a pandemic remain uncertain (*4,10*). Although plans to acquire, store, distribute, and administer these countermeasure supplies would be made when possible and necessary, we acknowledge that these plans would not be relied upon as primary countermeasures in most pandemic scenarios.

S Step 2: Agreeing on Assumptions to Key Questions

PIPC members recognized that the uncertainty surrounding a pandemic would require a series of assumptions and that any assumption would include some guesswork. To minimize errors, available historical data and guidance from governmental institutions were used to estimate the effect on our healthcare system.

How Many Persons Should We Expect Would Seek Healthcare at Our Facilities?

Most tools estimate effect on healthcare facilities based on population size, but we were dealing with a subpopulation of veterans that may seek care at the VA facilities or at any other community resource. In addition, VA facilities may open their doors to nonveterans during a pandemic. We decided, arbitrarily, to define our universe of patients as the number of individually enrolled persons who sought care at VA facilities during the previous fiscal year. This figure enabled us to calculate system and facility needs in a standardized fashion.

Once the number of patients was established, we used the US Department of Health and Human Services (DHHS) 1918-scale pandemic model (*11*) (Table 2) and FluSurge version 2.0 software (*12*) (Table 2) to estimate the number of persons who would be expected to seek care, be hospitalized, admitted to an intensive care unit (ICU), or be treated with mechanical ventilation (Table 2). The only modification to the DHHS model was in the proportion of the population likely to contract influenza. The model calls for 40% disease incidence for children, 20% for healthy adults, and a somewhat higher incidence for elderly persons. Therefore, 25% seemed like a reasonable number for the VA, an institution that does not provide healthcare to children. We based calculations on the population likely to request care, not on the physical or personnel capacity of our facilities. It was our assertion that physical capacity would be increased and standards of healthcare would be lowered, as necessary, during a pandemic to permit serving as many people as possible. We acknowledge that alternate sites of care might become available during a pandemic. However, we viewed this possibility as too unpredictable to include in our assumption model.

What Length of Hospital Stay Would Be Required by Our Patients?

Length-of-stay figures were needed to calculate supply needs because resource use is more accurately calculated by patient-days of care instead of number of admissions. We used some of the assumptions made by FluSurge version 2.0 as follows: average length of stay (not in ICU) of 5 days per patient, an additional 10 days for those requiring an ICU stay, and an average time receiving mechanical ventilation of 10 days.

What Personal Protective Equipment Would Be Needed To Care for Patients with Pandemic Influenza?

Among the gaps in knowledge regarding pandemic influenza is the mechanism of human-to-human transmission of influenza (*10*). The Institute of Medicine recommendation (*10*) to consider all transmission routes probable and consequential was accepted. Precautions against standard, contact, droplet, and airborne transmission (*13*) were incorporated into the plan. We assumed that sole use of disposable N95 respirators would be prohibitively expensive or otherwise not possible because of global shortages (*14*). Instead, we decided that staff with prolonged periods of exposure (e.g., physicians, nurses, respiratory technicians, selected housekeepers) would be issued and that just-in-time fit testing, a reusable elastomeric half-face mask with 3 sets of filters, would be used. We estimated that we would need ≈1,000 of these masks and reusable goggles for each 50,000 patients served (on the basis of the size and catchment population of one of our medium-size facilities). Disposable masks would be limited to the beginning of the pandemic and to personnel with infrequent exposure. Using these principles, we calculated the workload, supplies, and medication required to care for typical influenza patients. Accordingly, estimates were produced for the average needs of influenza patients requiring ≥1 types of services, including outpatient, inpatient medical ward, or ICU settings with or without mechanical ventilation.

Step 3: Calculating Supply and Medication Needs

We estimated the per patient–encounter needs by staff category (Table 3) and the number of healthcare worker contacts per patient, per day, for each type of healthcare setting (Table 4). In a similar fashion, supply needs were estimated per patient encounter (for outpatients) or per patient-day of care (for inpatients) (Table 3). The ascertained supply and medication needs were combined in a spreadsheet to estimate the needs of each facility and for our network. Spreadsheet formulas enabled the needs of each facility or healthcare system to be easily modified by using the number of individually enrolled patients (Table 5).

Step 4: Prioritizing Supply Needs

Because limited financial resources were available, the PIPC was asked to establish a prioritization scheme. Although every item on the list was considered important, each was subcategorized into purchase priority A, B, and C; A was the most important (Table 5). To arrive at the category level, the following scheme was used. Category A was personal protective equipment, basic life-support items (intravenous fluids, oxygen), and first-line antimicrobial drugs. Category B was second-line antimicrobial drugs, ventilator supplies, sedatives, nebulizers and β-agonists, home care packs, and morgue packs. Category C was disposable ventilators, proton pump inhibitors, and vasopressors. Antiviral medications and vaccines were not included in this list because it was expected that the VA would acquire and maintain a centralized cache of oseltamivir, and vaccine availability and effectiveness were unknown.

Step 5: Compromising

The calculated cost of purchasing all essential items for a population of 500,000 amounted to ≈$11 million. Despite efforts to prioritize the items into 3 categories, the calculated cost of category A items far exceeded the amount of funds available. The PIPC debated the best approach and recommended that the available funds be used to purchase a percentage of category A items and that future funds would be used to purchase additional category A items and decreasing percentages of category B and category C items. For example, the funds available at that time were sufficient to purchase 12.5% of category A items. Upon the availability of future funding, perhaps an additional 7.5% of category A items would be purchased along with 5% of category B items and 2.5% of category C items.

Step 6: Ordering Items

Purchasing items in large quantity through a prenegotiated agreement enabled a discount off retail prices. However, despite this contract, back-order delays occurred (and would be expected to occur during a pandemic) for several key items. One supplier of personal protective equipment indicated that shipment would be delayed by 6–9 months, affirming predictions of shortages of personal protective equipment. This

experience underscored making purchases well in advance of the date when the items were expected to be used for patient care.

Step 7: Storing Items

Storage of supplies proved to be among the most resource-intensive components of cache-building. Although initial wishes were to store a cache on the campus of each medical center, the space necessary was too large for most VA institutions to accommodate. After extensive discussion and careful analysis of options, a decision was made to store pandemic supplies in a 10,000–square foot, temperature-controlled, leased warehouse. Quoted costs for space ranged from $10 to $14 per square foot per year ($100,000–$140,000 per year for 10,000 square feet). The recommended location was near an airport to ensure efficient transport of supplies either by tractor trailer or by air cargo. A back-up emergency generator was included to maintain air-conditioning in the event of a power failure.

Many items purchased for the cache had expiration dates. Although most items had multiple-year shelf lives, some shelf lives were as short as 1 year. The variability of manufacturer-ascribed expiration dates and other reasons for supply rotation led to the recognition that the cache would become a dynamic component of medical system supplies. Items would need to be inspected regularly and rotated through the storage facility on a regular basis. To meet this need, a human resource commitment of 1 full-time employee equivalent would be necessary for logistics management of the inventory. Duties of this person would include inspecting the inventory, assisting with incoming and outgoing deliveries, rotating items into the routinely used supplies of the medical system to ensure use before expiration, and prodding physical security for the inventory. This person would also be charged with developing and maintaining a plan for transportation and deployment of the inventory in the event of a pandemic. In addition, each medical facility would also be required to provide an employee to help manage the inventory and who would report to the cache in the event of a pandemic.

Discussion and Recommendations

Despite the numerous uncertainties posed by pandemic influenza, the types and quantities of essential items that should be stockpiled can be estimated by using a reasoned approach. What is offered in this report is a method to calculate the components of a stockpile by using assumptions that are drawn from previous pandemics. This method enables modification of figures, making them scalable and adaptable to any size population. By following the logic of the proposed calculations, it should be possible to modify the assumptions and other figures as needed for almost any community or healthcare system.

Perhaps the most important limitation with this method is a reliance on assumptions. No one knows what the next pandemic will bring. We believe that it is better to plan for a more severe event that will leave the system overprepared than to risk being underprepared. However, this approach may be viewed by some as unnecessary or too expensive. A stratified purchase plan, in which a fraction of essential items is purchased periodically, is recommended on the basis of availability of funds. Some may favor purchase of all items in 1 category before moving to the next category.

The formation and management of a pandemic supply cache would require considerable human and financial resources. The level of commitment may be viewed by some healthcare systems as too costly, especially in an era of economic instability and healthcare system instability likely requiring major reform. Some of the more resource-intensive components of the proposed approach, such as the storage of items in a staffed central facility, were facilitated by the large size of our healthcare system and available resources. Achieving a similar product in the private sector, where healthcare systems are typically much smaller than those in the federally managed VA, might require a partnership among multiple healthcare systems in a region.

One of the most common and widely held misconceptions we encountered was the notion that a healthcare system could be stressed to the breaking point, such that a large surge of patients could eventually render a hospital unable to function. It is our view that in reality, healthcare systems are designed to operate in a graded fashion. Although it is theoretically conceivable that a catastrophe could cause hospitals to cease functioning, it is much more likely that they will continue functioning, even under the most ominous circumstances (*15–17*). What will change is the standard of care that is delivered; many patients may have access to less resources than would normally be available (*18,19*). Stockpiling supplies should help prepare

for a downgraded level of care that becomes inevitable as resources are increasingly stretched. A key message taken from our experiences was that supplies need to be ordered far in advance of a pandemic to avoid major problems with back orders and supply shortfalls.

The estimated cost of purchasing all supplies and medications needed to provide healthcare to a population of 500,000 during a wave of an influenza pandemic, including negotiated and contracted prices, was ≈$11 million, or approximately half that amount if one only considers purchasing priority A items. This amount is considerably higher than the amount estimated elsewhere (*20*). This difference may stem from the way we calculated our needs: we did not assume that we could reach a full capacity. Instead, we attempted to estimate the population that is likely to seek care and assumed that under the dire circumstances of a severe pandemic facilities would decrease standards of care, open alternate sites of care, and creatively care for those patients who came for treatment. We also did not assume that we would have a shortage of personnel to care for these patients. Through altered standards of care; emergency privileging and cross-training of healthcare workers, volunteers, and other persons willing and able to care for our patients, a temporary and substantially changed workforce would be expected to emerge.

Numerous gaps in knowledge were encountered. The mechanisms of human-to-human transmission of seasonal and pandemic influenza are poorly understood. Numerous articles have discussed the types of respiratory protection that should be considered and stockpiled (*6,10*) for healthcare workers. However, there has never been a definitive, prospective clinical trial that shows whether respirators are superior to surgical masks. Translational research funding to answer these questions should become a priority.

This report is an attempt to describe the challenges our healthcare system faced when preparing for an influenza pandemic. By no means are all the answers, or even the questions, reported here. Additional work is needed to further identify important questions and appropriate solutions. We hope these concepts will help guide the decisions of other healthcare systems as they work through this challenging task.

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