Ability of Regional Hospitals to Meet Projected Avian Flu Pandemic Surge Capacity Requirements

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Abbreviations:
CDC = [US] Centers for Disease Control and Prevention
ED = emergency department
GDAHA = Greater Dayton Area Hospital Association
ICU = intensive care unit
PPE = personal protective equipment
SARS = severe acute respiratory syndrome
WHO = World Health Organization

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Abstract
Introduction: Hospital surge capacity is a crucial part of community disaster preparedness planning, which focuses on the requirements for additional beds, equipment, personnel, and special capabilities. The scope and urgency of these requirements must be balanced with a practical approach addressing cost and space concerns. Renewed concerns for infectious disease threats, particularly from a potential avian flu pandemic perspective, have emphasized the need to be prepared for a prolonged surge that could last six to eight weeks.
Null Hypothesis: The surge capacity that realistically would be generated by the cumulative Greater Dayton Area Hospital Association (GDAHA) plan is sufficient to meet the demands of an avian influenza pandemic as predicted by the [US] Centers for Disease Control and Prevention (CDC) models.
Methods: Using a standardized data form, surge response plans for each hospital in the GDAHA were assessed. The cumulative results were compared to the demand projected for an avian influenza pandemic using the CDC's FluAid and FluSurge models.
Results: The cumulative GDAHA capacity is sufficient to meet the projected demand for bed space, intensive care unit beds, ventilators, morgue space, and initial personal protective equipment (PPE) use. There is a shortage of negative pressure rooms, some basic equipment, and neuraminidase inhibitors. Many facilities lack a complete set of written surge policies, including screening plans to segregate contaminated patients and staff prior to entering the hospital. Few hospitals have agreements with nursing homes or home healthcare agencies to provide care for patients discharged in order to clear surge beds. If some of the assumptions in the CDC's models are changed to match the morbidity and mortality rates reported from the 1918 pandemic, the surge capacity of GDAHA facilities would not meet the projected demand.
Conclusions: The GDAHA hospitals should test their regional distributors' ability to resupply PPE for multiple facilities simultaneously. Facilities should retrofit current air exchange systems to increase the number of potential negative pressure rooms and include such designs in all future construction. Neuraminidase inhibitor supplies should be increased to provide treatment for healthcare workers exposed in the course of their duties. Each hospital should have a complete set of policies to address the special considerations for a prolonged surge. Additional capacity is required to meet the predicted demands of a threat similar to the 1918 pandemic.

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Introduction

Since 2001, communities, their Public Health Departments, and their local medical facilities have developed a heightened concern and an expanded mission for disaster response. In addition to the increased preparation for potential terrorist activities, renewed concerns about infectious disease threats have surfaced in the form of the severe acute respiratory syndrome (SARS) outbreaks and a growing number of avian influenza cases.[1–9] Since this expanded mission puts a strain on resources, an "all-hazards" approach has been adopted to ensure that available resources are utilized effectively.[10,11] This approach applies to all involved organizations and requires a high degree of coordination among all community agencies, including hospitals, as well as local, state, and federal agencies.

The increasing number of documented avian influenza (flu) cases has presented renewed concerns about an avian flu pandemic, which would require a longer surge response than many other threats, such as tornadoes, chemical attacks, or industrial accidents.[11] As of 19 September 2006, the World Health Organization (WHO) Website listed a total of 247 cases of human infections with influenza A (H5N1) reported from 10 countries and resulting in 144 deaths.[6] The influenza virus is constantly undergoing point mutations resulting in changes in its antigenic profile, a process that is referred to as *antigenic drift*. With sufficient antigenic drift, a substantial proportion of the world's population becomes susceptible and a pandemic can result.[13] However, severe pandemics usually are a result of antigenic shift that occurs when a virus with a new antigenic profile jumps species, and thus, has few antigens that are recognized by the human immune system. In either case, the new antigenic profile of the virus bears little resemblance to any antigenic pattern previously experienced by the population.[14] Although human volunteers successfully have been infected with avian influenza viruses under experimental conditions, there are impediments to natural infection of humans by avian viruses due to one or more gene segments.[15] In the past decade, a number of instances of human infections with avian influenza have been documented involving the H7N7,[7] H9N2,[16] and H5N1[17] strains. To date, there has not been any confirmed human-to-human transmission of H5N1.

The collective surge plans and resources available to provide care in the event of an avian flu pandemic to the residents of the eight counties in South-Central Ohio, served by the Greater Dayton Area Hospital Association (GDAHA) hospitals, were evaluated. The null hypothesis predicted that there is no difference between the surge capacity that would be generated with execution of the cumulative GDAHA hospital plans and the demands of the most likely scenario projected for an avian flu pandemic using the [US] Centers for Disease Control and Prevention (CDC) FluAid[18] and FluSurge[19] models.

Methods

This project was approved by the Wright State University Institutional Review Board and the GDAHA Director of Corporate Financial and Emergency Medical Systems. The designated disaster preparedness representative for each GDAHA hospital, was interviewed. An Access (2003 Microsoft Corporation, Redmond, WA) database was used to record the results. In advance of the interview, the subjects were provided with copies of Excel (2003 Microsoft Corporation, Redmond, WA) spreadsheets that listed the data elements required and a definition for each element. The database tables were composed of elements recommended as part of a hospital's prolonged surge response based on a review of the literature addressing surge capacity, avian flu, and SARS. The SARS literature was included, since it represents a viral respiratory infection with a mechanism of transmission similar to influenza, which has caused large-scale outbreaks. Avian flu infections have been limited to individual cases and small clusters. The evaluated elements were divided into six groups: (1) surge beds; (2) surge staff; (3) surge personal protective equipment (PPE); (4) surge pharmaceuticals; (5) surge equipment/supplies; and (6) surge policies. A separate datasheet was created for each group.

The responses from each of the hospitals were collated to determine the total number of surge beds that would be available if all hospitals activated the surge portion of their disaster plans. In addition, the various aspects of the surge plans were evaluated for the presence or absence of elements that might either support or compromise their ability to achieve the anticipated response. The surge in demand generated by an avian flu pandemic was calculated using two models provided by the CDC. The FluAid[18] program was populated with interview information obtained from the GDAHA hospitals and with population data from the US Census Bureau homepage[20] in order to calculate the predicted gross attack rates, outpatient visits, and deaths. The total number of intensive care unit (ICU) beds, non-ICU beds, and ventilators required were calculated using the CDC's FluSurge tool.[19] The collective number of surge beds and other surge resources forecasted by the disaster plans were compared to the predicted demand for each of the items calculated by the FluSurge and FluAid models. The underlying assumptions used to create the CDC models included the following:

1. Average length of non-ICU hospital stay for influenza-related illness is five days;
2. Average length of ICU stay for influenza-related illness is 10 days;
3. Average length of ventilator usage for influenza-related illness is 10 days;
4. Average proportion of admitted influenza patients that will need ICU care is 15%;
5. Average proportion of admitted influenza patients that will need ventilators is 7.5%;
6. Average proportion of people dying from influenza assumed to be hospitalized prior to death is 70%; and
7. Daily percentage increase in cases arriving compared to previous day is 3%.

Descriptive statistics were reported for each variable as total numbers or as a percent of identified capacity.

Results

The data from all of the GDAHA facilities were collated to provide a cumulative surge capacity for the region. Results for each of the six categories of resources were reported.

Surge Spaces

The combined number of operating beds in normal times for the GDAHA facilities was 3,192. The maximum combined surge capacity was 1,143 beds, which consisted of 566 new in-patient beds created within the facilities, 177 beds in designated facilities outside of the current hospital buildings, and 400 beds created by early discharges and

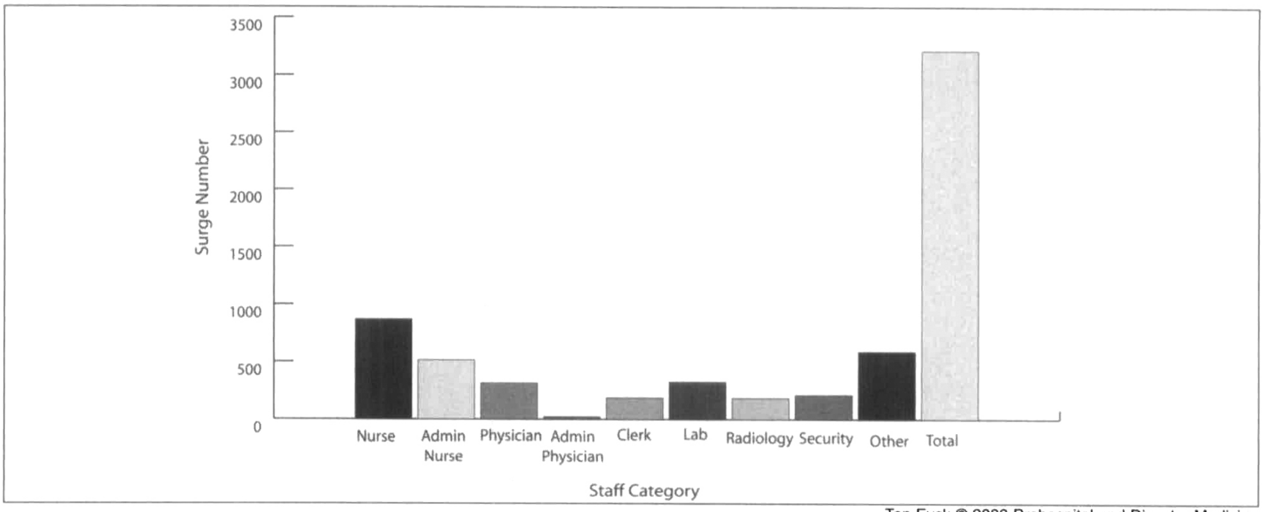

Figure 1—Cumulative estimates of full-time equivalent surge staff GDAHA facilities

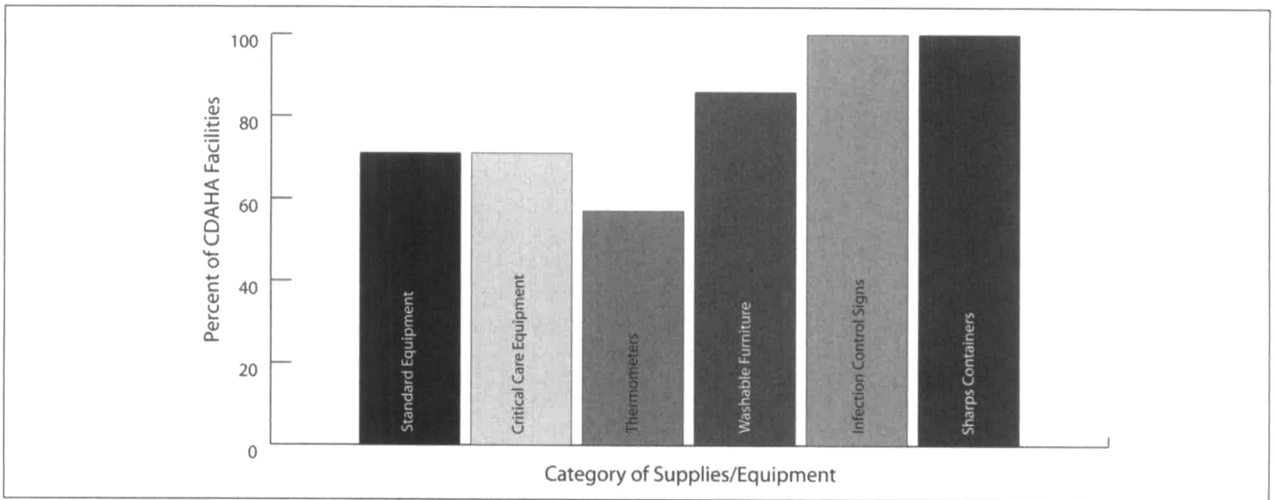

Figure 2—Percent of GDAHA facilities with various categories of supplies/equipment needed to meet surge demands

freezing elective admissions. The 743 new beds represent a 23% increase over the baseline. The projected time to achieve 50% of facility surge capacity ranged from one hour to 24 hours with a average of 8.5 hours, a median of 3.5 hours, and a standard deviation of 8.5 hours. The projected time to reach 100% surge capacity ranged from two to 72 hours with a mean value of 26.6 hours, a median of 19.5 hours, and a standard deviation of 24.8 hours. Special function beds, which were part of the surge total, included 361 additional negative pressure beds and 244 additional ICU beds. Although the feasibility of achieving each element of individual facility surge plans was not assessed, some special considerations for expediting availability of existing beds were assessed in the survey. Twenty-one percent of the hospitals had a discharge holding area to stage patients awaiting services, such as transportation home or outpatient medications following discharge. Only 14% had agreements with home healthcare agencies and 36% had agreements with nursing homes to ensure that they also would be able to surge in order to absorb the increased patient load resulting from early hospital discharges.

Surge Staff

The increased staffing needed to provide services during a prolonged surge in demand was the most difficult area to quantify. The total surge in full-time equivalents was 3,213 (Figure 1). This represents a 14.4% increase over total baseline staffing. For certain disciplines, such as respiratory therapists, almost all of the surge capacity was projected to come from longer work hours. In other areas, such as nursing, the increased staffing was planned to come from a combination of longer hours and redeploying nurses from suspended elective services and administrative positions within the hospital. The physician surge numbers are a combination of estimates of increased staffing provided by residents, physician groups affiliated with the hospital, and hospital-based physicians, including hospitalists and emergency physicians.

Surge Equipment and Supplies

Most of the GDAHA facilities had appropriate stores of equipment to operate their surge spaces in both standard wards and intensive care settings (Figure 2) including a cumulative store of 316 surge ventilators to supplement the

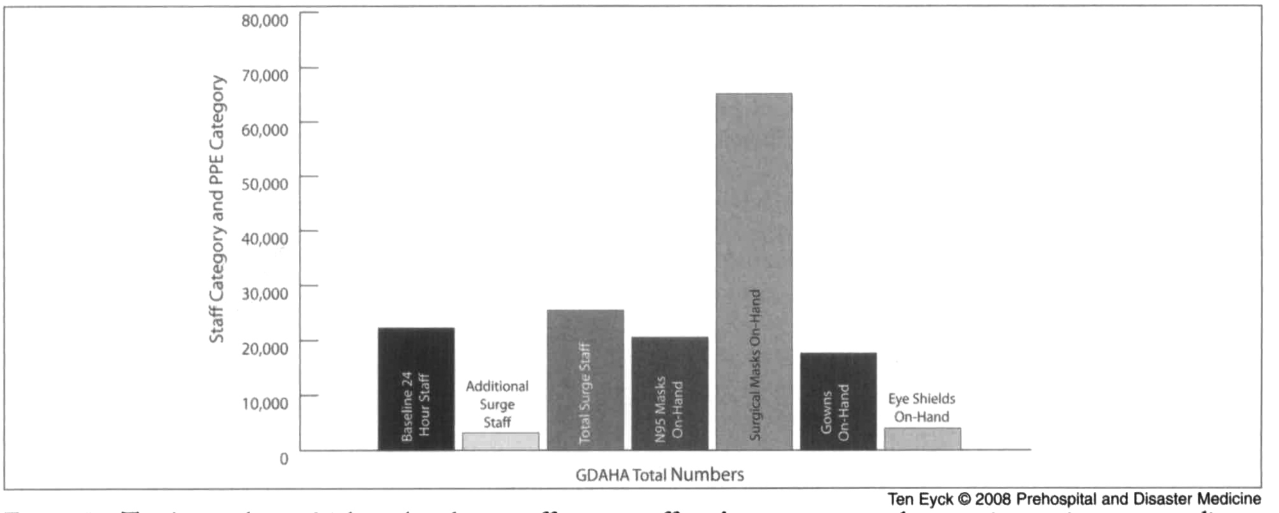

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Figure 3—Total cumulative 24-hour baselines staff, surge staff, and on-site personal protective equipment supplies

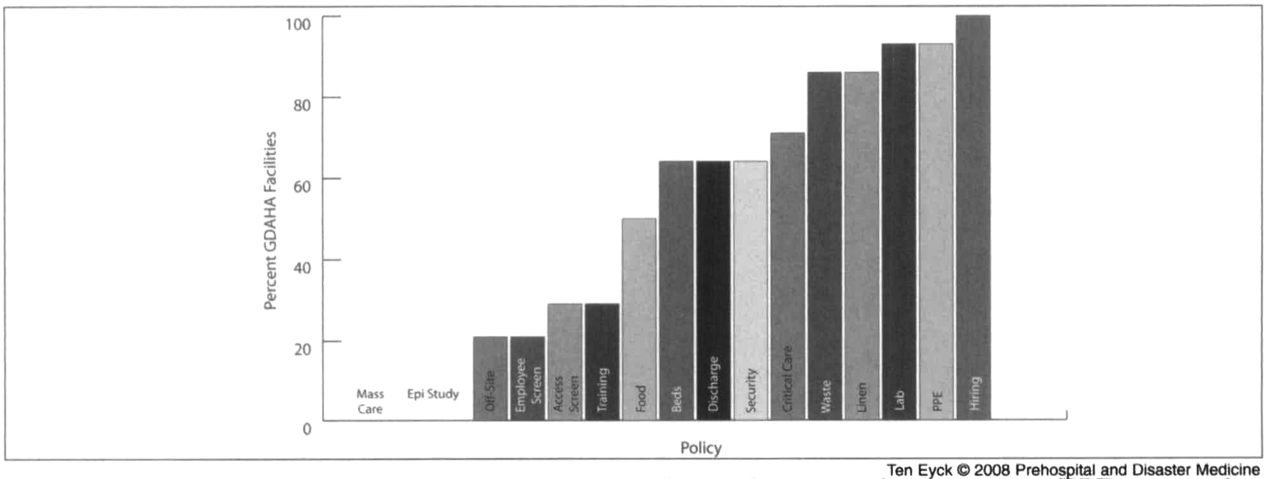

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Figure 4—Percent of GDAHA facilities with policies to guide specific aspects of surge response (PPE = personal protective equipment)

standard ventilators utilized in daily operations. Many of the patient care spaces designated for surge activity were already stocked with beds, linens, pillows, oxygen/suction receptacles, bathroom facilities, and other equipment. In addition, the hospitals had stores of readily available supplies and equipment to set up most of the off-site areas. There were no particular patterns that characterized the areas in which surge equipment shortages exist. In some instances, there was a shortage of additional critical care equipment such as monitors, and in others, there was a lack of dedicated bedside equipment such as sphygmomanometers and stethoscopes. Although there were adequate numbers of thermometers and/or disposable thermometer probe covers for patient care under surge conditions, nearly half of the hospitals did not have sufficient supplies on hand to screen the temperature of everyone entering the hospital in order to segregate potentially infected individuals.

Personal Protective Equipment

The cumulative supply of PPE in the GDAHA facilities was adequate to provide protection for all staff and patients until the facilities could be restocked. Sustained capability was dependent on the distributors' ability to meet contractual delivery times under surge conditions. Figure 3 provides a graph of the PPE stocked within the GDAHA facilities with comparison bars representing the total number of staff, both at baseline and under surge conditions, expected to be working within the facilities during a 24-hour period.

Surge Pharmaceutical Agents

The cumulative supply of antibiotics stocked in the GDAHA facilities exceed the total amount needed to treat even the worst-case scenario for the number of secondary bacterial respiratory infections that could occur following influenza infection. However, the cumulative stock of neuraminidase inhibitors was 677 doses, which would be enough to treat only 67 patients.

Surge Policies

There was wide variation in the availability of formal surge policies among the GDAHA facilities (Figure 4). All of the facilities had a policy that permitted accelerated hiring to meet surge demands. However, in every facility, the policy only applied to emergency credentialing of providers, and there were no provisions to address accelerated hiring pro-

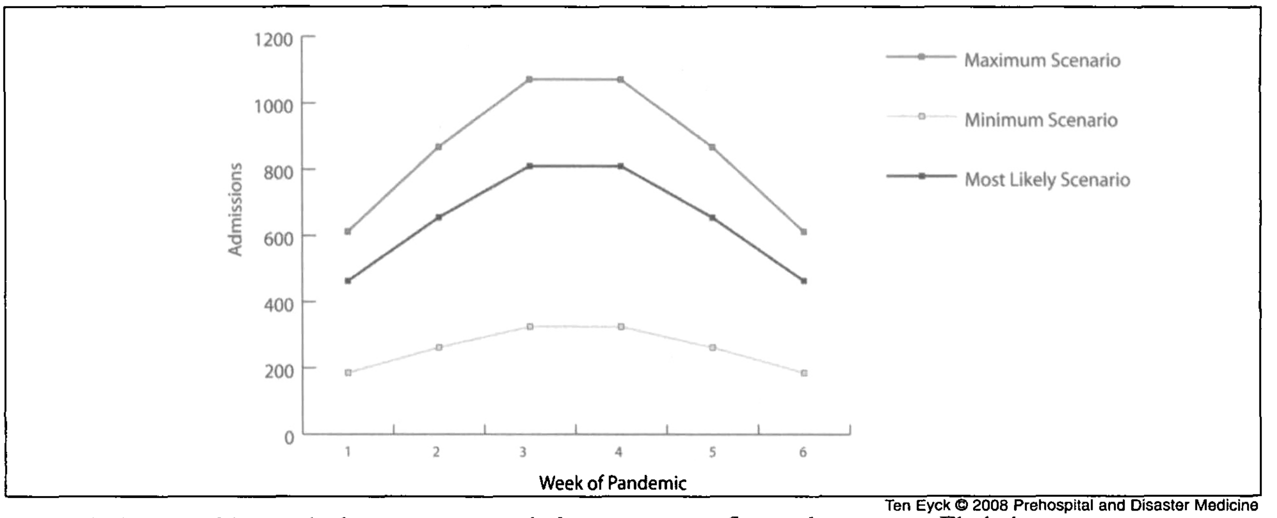

Figure 5—Projected hospital admissions per week during an avian flu pandemic using FluAid assumptions

cedures for nurses and other healthcare personnel. Most of the facilities had policies addressing the use of PPE, and the handling of contaminated laboratory specimens, linen, and waste during surge conditions. Nine (64%) of the facilities had a policy to define the special role of security personnel in a surge environment when access to the hospital, movement within the facility, and other activities would be restricted. Nine (64%) had policies to define the process used to initiate accelerated discharges and the opening of surge beds. Four (24%) of the facilities had a policy to screen employees prior to entering the hospital and during their duty hours in the event of a surge response to an infectious agent. Similarly, 29% of the facilities had a policy addressing plans for just-in-time training on new equipment and procedures that would be required during a surge for an infectious agent. Twenty-one percent of the facilities had a policy addressing the operation of an off-site facility, which represented all of the facilities that had current plans to operate an off-site facility as part of their surge response. Twenty-one percent of the facilities had a policy to address screening all people entering the hospital during a surge response to an infectious agent. Two policies included in the survey were not part of any of the facility plans. One was a mass-care policy to address the process for limiting critical care services in the event that demand greatly exceeded available supplies; one was a policy to conduct ongoing epidemiological studies during the surge in order to provide real-time evaluation of the pattern of disease and the effectiveness of new treatments.

Cumulative Ability to Meet Demand

Based on the demand calculated from the FluAid and FluSurge models, the cumulative resources provided by the GDAHA facilities were not sufficient to meet all of the calculated regional demands generated by an avian flu pandemic. The most likely scenario would generate a peak of 810 admissions per week during a six week period (Figure 5). This level of demand is below the 1,143 surge beds that are projected to be available in the cumulative GDAHA facility plans. Even if the total admissions follow the worst-case scenario in the CDC model, the maximum number of admissions during peak weeks would be 1,071. Since one of the assumptions in the model is that the average non-ICU stay will be five days, the peak number of projected surge beds required was less than the weekly admission total. As illustrated in Figure 6, approximately 54% (616) of the planned surge beds would be needed at the peak of the pandemic for the most likely scenario involving a 25% attack rate. However, the projected requirement would greatly exceed the planned 361 surge beds in negative rooms. The peak ICU bed demand was calculated to be 179, which would be adequately covered by the 244 cumulative surge ICU beds in the GDAHA plans. Using the assumptions employed by the CDC within the models, the peak number of ventilators required for avian flu patients would be 89 in the most likely scenario, which would require only about 28% of the backup portable ventilators available in the GDAHA surge supplies.

The projected number of additional outpatient visits predicted by the FluAid model for an avian flu pandemic in the eight-county region was 147,998 with a range from 69,251 to 296,197. FluAid's most likely scenario projected a total of 770 deaths in the eight counties with a range from 271 to 1,782. The collective expanded morgue capacity, using some refrigerated trucks and a redesign of current morgue space would easily meet this demand.

The FluSurge model predictions were recalculated after substituting the admission rates and death rates reported for the 1918 pandemic.[14] The overall mortality rate in the United States was 0.65%. In addition, the 1918 virus produced pneumonia in 10–20% of the cases. The number of admissions was recalculated using the lower end of this range with the assumption that all pneumonia cases and no other cases would need admission. Changing only these assumptions, the results obtained from the FluSurge Model in Figure 7, predicted that the GDAHA hospitals would fall substantially short of meeting the requirements for total beds, ICU beds, and ventilators. The peak number of admissions per week would increase to 5,819. The ICU bed and ventilator demand would peak during the fourth week at 1,283 and 682 respectively. In addition, the total number of projected deaths would increase to 7,205 with an average mortality rate

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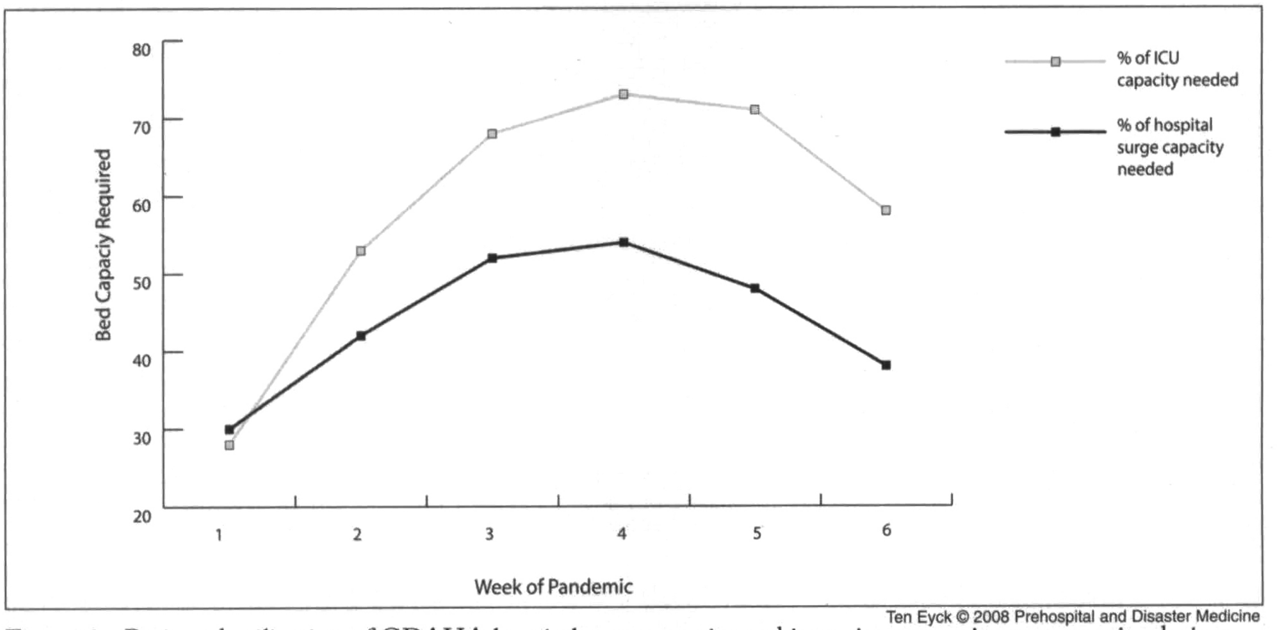

Figure 6—Projected utilization of GDAHA hospital surge capacity and intensive care unit surge capacity during avian flu pandemic using FluSurge assumptions

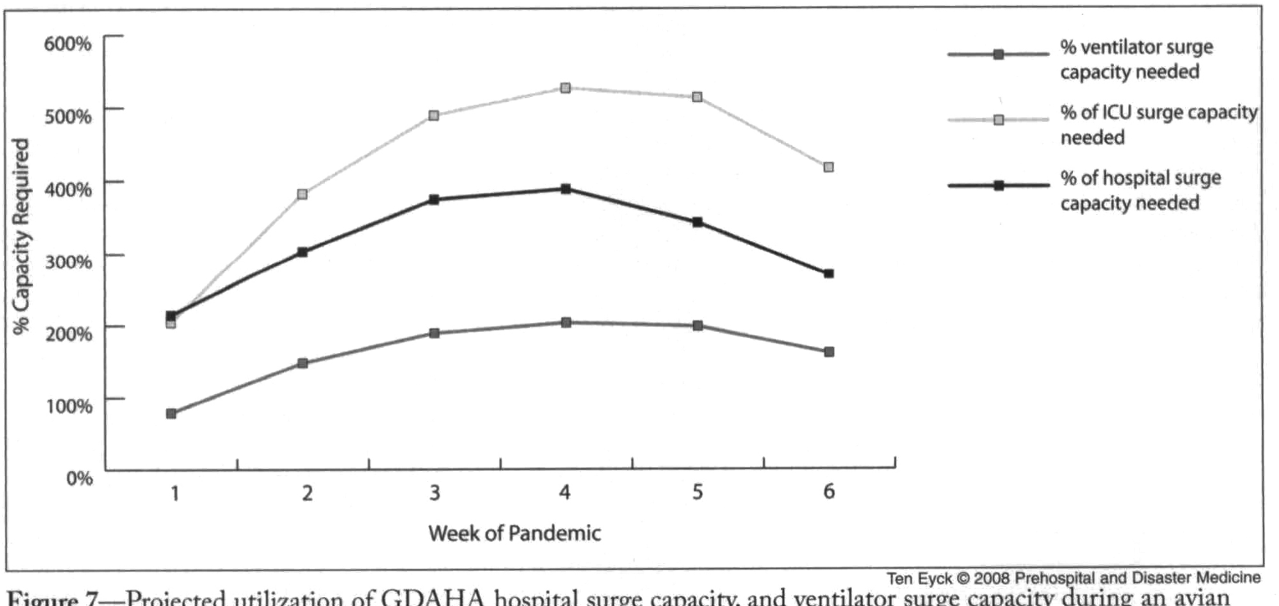

Figure 7—Projected utilization of GDAHA hospital surge capacity, and ventilator surge capacity during an avian flue pandemic using the modified admission rate derived from the 1918 flu pandemic data

of approximately 1,200 patients per week during the six-week period. This rate would overwhelm the cumulative GDAHA morgue capacity of 192 reported in the surge plans.

Discussion

The evaluation of hospital surge capacity is multifaceted. The most obvious component is the expansion in the number of beds, including emergency department beds, ward beds, negative pressure airflow beds, and special unit beds. The planned expansion calls for the creation of new beds and reallocation of existing beds. The latter component is impacted by the availability of a patient discharge holding area, nursing home beds, and home healthcare capacity to provide for the needs of patients discharged to clear acute care beds in the hospital. The early discharge portion of the plan would be less critical in this type of event since the increase in the number of patients would occur over days rather than hours. However, the freezing of elective admissions likely would be limited to a narrower spectrum of conditions for this type of surge, which would last six to eight weeks compared to one lasting only one or two days. Other major considerations in the evaluation of surge capacity include patient care staff, support staff, support services, supplies and equipment, information systems, pharmaceuticals, morgue space and written procedures to deal with the unique threat (e.g., the handling of contaminated bodies as well as lab specimens, and linens from infectious patients). Failure to address any one aspect of

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surge capacity can create a bottleneck that might impede activities in all of the areas. Two final considerations that should be included in surge capacity plans are education and research. Despite ongoing training and exercises, most personnel likely will require some just-in-time training during the implementation of a surge plan for issues ranging from their role in the plan to the proper use of required PPE and new equipment. Plans to conduct real-time epidemiological investigations are required to help define the threat and the success of the medical response, as well as to gather data and evaluate the effectiveness of previously untested treatment modalities for ongoing use during the crisis and for future events.

Based on the demand for surge beds forecasted by the CDC models, the GDAHA facilities will be able to meet and exceed the demands generated by an avian flu pandemic involving the eight counties served by these facilities. There are adequate numbers of ICU surge beds, surge ventilators, and morgue spaces to meet the predicted demand. However, the adequacy of the additional ventilators to provide prolonged ventilation for avian flu patients has not been demonstrated. The user guide for the surge ventilators states: "This policy/protocol is intended for use with patients requiring short-term ventilatory support while being monitored by a clinician trained in the use of mechanical ventilation".[22] These ventilators may be poorly suited for prolonged ventilation of patients that develop an acute respiratory distress syndrome from an avian flu infection. Further research in this area is needed.

The surge in beds in the negative pressure rooms required would not be sufficient to meet a part of the projected demand from an avian flu pandemic. Wider use of low-cost facility modifications in existing structures and in new construction are needed to close the gap in negative pressure capabilities at an affordable price.[23,24] Such options have been described in the literature and have been incorporated into some of the GDAHA facilities.

Although there were three influenza pandemics in the 20th century, the pandemic of 1918–1919 was exceptional in two ways:[25] (1) it was responsible for over 20 million deaths worldwide; and (2) it produced a high mortality rate in the 15–45 year old group as opposed to the normal pattern, which mainly impacts the extremes of age. The increased mortality has been attributed to the increased virulence of the 1918 influenza virus and its propensity for causing pneumonia. The GDAHA cumulative capacity would not meet the demands of a pandemic similar to the 1918 influenza pandemic. An expanded, off-site surge capacity is needed for ward beds, ICU beds, and morgue space in order to be prepared for this contingency. A portable, 1,000-bed regional Acute Care Center for South Central Ohio, recently funded with a Homeland Security grant through the Ohio Department of Health, will provide a potential mechanism to meet these demands.

The GDAHA surge plans for staffing are based on what can be generated as opposed to an analysis of the anticipated increased staff required to respond to a particular scenario. The overall projected surge capacity in staff was 14.4% above baseline compared to a 23% increase in beds. This discrepancy may be sustainable for short periods, but cannot be expected to be sustainable over a 6–8 week surge. The source of the physician surge response was not clearly defined in most cases. Based on historical responses and the demonstrated commitment of the medical professionals in the eight county region, a better than adequate response was anticipated by the representative from each of the GDAHA facilities. The experience in the United States consistently has involved an overwhelming response by medical professionals to disasters such as the Oklahoma City bombing[26] and the destruction of the World Trade Center towers in New York. After the terrorist attack on 11 September 2001, >8,000 physicians offered to respond to New York.[27,28] However, in the face of an increase of up to 296,000 outpatient visits during a pandemic in the GDAHA region, many physicians and other healthcare workers might be overwhelmed and not be able to support hospital efforts as well as they have in past scenarios. Federal resources may be able to supplement the peak staffing requirements. Although the term *pandemic* implies a global event, not all of the countries or regions within a single county should be impacted at the same time.[29] Consequently, as the pandemic progresses, it is conceivable that resources such as Disaster Medical Assistance Teams and the Medical Reserve Corps from areas with low attack rates could be deployed to areas with high attack rates.

In planning for surge staffing issues, an equally important concern is the potential loss of personnel due to illness or as a result of failure to report to work during a disaster. In addition to increasing the number of front-line staff and expanding staff hours, it is essential to minimize staff attrition. During the outbreak of SARS in Taiwan in 2003, healthcare workers constituted 27% of all cases and seven of the 83 deaths.[5] It is essential to protect healthcare workers in a hazardous work environment by addressing good preventive measures including the use of personal protective equipment, vaccinations, and/or prophylaxis. Systems are needed for the rapid evaluation of healthcare worker exposures and close monitoring of staff for signs and symptoms of infection. The WHO interim guidelines on clinical management of humans infected by H5N1[30] recommend that all healthcare workers with direct patient contact check their own temperature twice a day and report any fever (>38°C) in order to receive immediate treatment with a neuraminidase inhibitor and to be isolated as appropriate. The guidelines also recommend offering post-exposure prophylaxis with a neuraminidase inhibitor to any healthcare worker exposed to droplets from an infected patient because of inadequate PPE or failure of PPE. Finally, the guidelines include a recommendation to keep healthcare workers with other illnesses out of direct patient care activities with avian influenza patients, since these workers will be more prone to illness and to complications if they do become ill. Lau *et al* analyzed SARS attack rates in three groups of healthcare workers in all Hong Kong Hospital Authority hospitals that admitted SARS patients.[3] Healthcare workers, including many workers whose jobs did not involve direct patient contact, accounted for 20.5% of all their SARS cases. Thus, the threat from another res-

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piratory pathogen such as H5N1 poses a significant risk for worker attrition. Worker attrition can be minimized best by having: (1) adequate stores of PPE;[4] (2) proper training in their use; and (3) just-in-time refresher training. Healthcare worker compliance with the proper use of PPE should be monitored and real-time corrections should be made when unsafe practices are noted. This is similar to the culture for decades that has been successfully fostered in operating rooms and isolation rooms.

Staff availability and willingness to work extended hours for a prolonged surge will be influenced by how well their personal and family needs are met. Surge plans should address the issues of providing transportation to the hospital, child care, elder care, pet care, and providing for the acute and chronic medical needs of healthcare workers during extended periods of duty.[31,32] The issue of caring for high-risk patients should be addressed with workers and their representative organizations in advance of a disaster.[33,34]

An avian flu pandemic would require extensive use of PPE within the hospitals. The World Health Organization recommends the use of N95 masks in addition to contact and droplet precautions.[35] The Hong Kong[3,4] and Canadian[2] experiences with SARS generated recommendations for use of masks, gowns, and gloves by hospital staff and masks for patients. Since the demand would build over days to weeks instead of hours, there should be an adequate amount of time to restock. All GDAHA hospitals use vendor-managed inventories with just-in-time delivery to provide needed supplies within a few hours. The hospitals have sufficient stores of PPE on hand to meet the initial need during the ramp-up period of a pandemic despite the anticipated substantial increase in requirement for this equipment. The issue of restocking from local distributors is a potential choke point, since each distributor is contracted to supply multiple facilities. The hospitals must evaluate the distributors' ability to meet this projected surge in demand and take corrective actions to address any identified shortfalls at the supplier and manufacturer levels.

There is a severe shortage of neuraminidase inhibitors. The Department of Health and Human Services has started stockpiling antiviral medications and allocating supplies to states based on population.[36] During fiscal years 2006 and 2007, the federal government purchased 20 million courses with an additional 44 million courses available for purchase by the states at a 25% federal subsidy. The availability of these agents and the process for securing them should be incorporated into hospital disaster plans based on the distribution protocol presented in the Federal Response Stages listed on the Health and Human Services Website.[37] Neuraminidase inhibitors will be distributed at Stage 3 as defined by widespread outbreaks overseas and prior to the first human case in North America. Since distribution plans can be disrupted or changed, efforts should be made to secure a sufficient stock to provide prophylaxis for employees who become exposed in the course of their duties before the federal stockpile is made available. This action should help motivate healthcare workers during a period of extreme stress as well as help minimize staff attrition. The WHO does not recommend treatment with amantadine or rimantadine due to demonstrated resistance to these agents by multiple strains of influenza A virus[38] including H5N1.[35,39]

The majority of facilities do not have formal agreements with nursing homes or home healthcare agencies to address their ability to accommodate the surge in demand for service generated by accelerated discharges from the hospital. Without such plans, some of the expected surge beds might be tied up by patients who cannot be discharged.[40]

Most GDAHA facilities do not have plans to screen people prior to entering the hospital. Following the 2003 SARS outbreak in Taiwan, the National Cheng Kung University Hospital published the results of their experiences.[5] The hospital set up two screening areas, one outside the emergency department and one outside the outpatient clinic entrance. In addition, they set up an emergency department surge area consisting of 12 beds in three temporary shelters. Their experiences during the 83-day period of the outbreak helped delineate the scope of screening efforts required to effectively segregate the actual SARS cases from the masses presenting to the hospital. The daily average number of patients screened was 4,520 at the outpatient clinic entrance and 580 at the emergency department entrance. Of these patients, an average of 35 per day were referred to the SARS Assessment Unit for further evaluation and 19 per day subsequently were isolated in one of the SARS units. All hospitals should develop similar screening plans and secure the needed resources, including access to portable facilities and an increased supply of temperature screening devices. The former potentially can be secured through partnering with regional organizations. Policies for all aspects of surge operations should be included in a surge planning document. Many of the policies will overlap with existing policies for daily operations, such as infection control, and can be cross-referenced to those policies.

This study has several limitations. First, although the projected surge demand was obtained from CDC models for an avian flu pandemic, these models have yet to be tested in an actual pandemic. Second, since the study did not evaluate the capability of each hospital to execute all of the components in its plan, the actual surge capacity presented should be considered a best-case scenario and the actual surge capacity may be lower than predicted by the collective plans. Third, the assumptions used to recalculate the projected hospitalization rates using data from the 1918 pandemic have not been validated. Finally, the study only addressed the response planned by each hospital and not the overall coordination among all the GDAHA hospitals, which is an essential element of population-based care.

Conclusions

Based on risks calculated using the CDC models, the GDAHA facilities are prepared to meet most of the surge demands of an avian flu pandemic. Current plans for negative pressure beds fall short of projected needs. The incorporation of relatively inexpensive modifications in existing structures and all new construction is needed to enhance negative pressure surge capacity. Many facilities do not have surge agreements with home healthcare agencies and nursing homes. The establishment of formal agreements should expedite the availability of the segment of surge beds generated by early discharges. Based on the 1918 flu pandemic data, the current GDAHA surge plans fall short of projected demand. Planned implementation of a regional, off-site, acute care center is expected to supplement facility efforts and to provide a catastrophic safety net. Facility surge plans should detail how this resource will be coordinated with their internal operations.

The surge in the number of available beds is more than 150% of the planned percent surge in staff. Support from regional or federal resources will be required to sustain peak surge levels lasting more than a few days. The number of physicians available for a surge likely will be less than expected due to a corresponding surge in outpatient demands. Surge plans should incorporate rates for staff attrition due to illness that are equal to or greater than those calculated for the overall population. They also should address issues that will impact staff response during a prolonged surge including the availability of childcare, eldercare, pet care, transportation pools, and the provision of services for the acute and chronic medical needs of healthcare workers during surge operations. Discussions regarding the responsibility to care for high-risk patients should be conducted with healthcare workers and their representative organizations as part of the planning of a surge response. Surge staff considerations should include steps to minimize worker attrition. These steps include providing adequate stores of PPE, just-in-time/refresher training for PPE use, and enforcement of PPE rules. Although the GDAHA facilities have sufficient PPE stores to meet the initial needs, all of the facilities are dependent on just-in-time delivery from vendor-managed inventory. The distributors' ability to meet a large, simultaneous surge in demand from all the facilities in the region should be evaluated using disaster drills to identify and correct deficits in the distribution and manufacturing processes.

Most surge spaces are fully equipped, but some equipment is lacking and the portable backup ventilators are not designed for the prolonged ventilation required for the segment of avian flu patients that need ventilatory support. Research is required that demonstrates how portable, backup ventilators will function under these conditions. Additional temperature screening devices will be needed to meet the cumulative demand for hospital entrance screening.

Supplies of antibiotics are adequate, but there is a severe shortage of neuraminidase inhibitors in the region. The short-term goal should focus on procurement of sufficient supplies of neuraminidase inhibitors to treat the healthcare workers exposed in the course of their duty prior to the availability of the federal stockpile in order to sustain the critical workforce.

Surge policies are available to varying degrees throughout the GDAHA facilities. In order to ensure a comprehensive set of readily available policies, a separate surge plan should be established for each facility. Cross references to existing policies should be used to avoid duplication of efforts.

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