Influenza Pandemic Preparedness in the Public Health Sector: How to Improve on Existing Pandemic Preparedness Plans of the Medical Community

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Introduction

Influenza, commonly known as the flu, is a contagious zoonotic viral infection caused by the influenza virus (Chang, 2011). Influenza viruses are known for rapid evolution leading to many diverse strains of influenza (Blut, 2009). Each year, several viral strains of influenza circulate through the world as the seasonal flu. Though these strains are generally considered innocuous, the seasonal flu kills 36,000 people in the US alone, and hospitalizes 200,000 (Chang, 2011). However, the larger threat to society is influenza pandemics, which are caused by novel strains of influenza that infect large portions of the population (DHHS, 2005). These viruses have high mortality rates and are easily transmissible, leading to rapid worldwide infection (DHHS, 2005).

Society saw the first influenza pandemic in 1889, though influenza outbreaks have been common throughout most of human history—the first instance we can identify recorded by Hippocrates in the 4th century B.C. (Barry, 2004). The 1889 pandemic, known as the Russian Flu, killed one million people (Cunha, 2004) and might well have spread farther and faster because of the industrialization in many places that led to larger cities and denser populations. In 1918, the largest influenza pandemic, the Spanish Flu, seems to have started in a county in Kansas and quickly spread, killing 70 million individuals in two years (Barry, 2004). In 1957, the Asian Flu killed two million people, and ten years later, the Hong Kong Flu killed an equal number. The second Russian Flu, in 1977, killed one million people.
Today, the medical community responds to pandemics in two ways – prevention and treatment. Initial responses, starting as early as the 4th century B.C., sought only to treat influenza, and treatments were largely evacuation treatments like blood letting, vomiting, and defecating to release foreign elements later known as toxins from the body, a process that usually weakened the patient and hastened death (Barry, 2004). Response changed very little until the Spanish Flu pandemic in 1918, when doctors ascertained that influenza was an airborne pathogen as well as a contact pathogen. Use of masks, isolation, and quarantine introduced new methods of prevention (Capps, 1918). Treatment during the Spanish Flu also progressed, focusing more on bed rest and hygiene rather than the historical treatments of evacuation. In 1945, the medical community created an influenza vaccine, which furthered prevention of influenza pandemics. In 1966, the first antiviral treatment for influenza (Symmetrel) was approved by the Food and Drug Administration, and in 1994, a second antiviral (Flumadine) was also approved. Five years later, in 1999, influenza treatment expanded with the Food and Drug Administration’s approval of two new antiviral drugs (Relenza and Tamiflu).

However, even with the development of prevention and treatment techniques for influenza, it is estimated that an influenza pandemic with similar virulence to the 1918 pandemic would kill 1.9 million Americans and hospitalize close to 10 million (DHHS, 2005). The Swine Flu pandemic in 2009 infected 89 million individuals in the United States, and killed close to 20,000 (Flu, 2010). Given the problem influenza pandemics represent, understanding how society responds to these pandemics is important in formulating better responses to future pandemics. Medical facilities (defined as policies, practices, and procedures carried out by clinical and administrative staff in the light of regulatory context and infrastructure) and independent clinicians play a pivotal role during influenza outbreaks, acting as the bridge from
governments and scientists to the general population, with whom they interact in person. Understanding the medical community’s response to influenza pandemics can illuminate gaps between the general population and other actors in influenza pandemics like government, as well as gaps in the response to and knowledge of influenza pandemics.

**Question**

How do clinicians and medical facilities respond to influenza pandemics in the United States, with a particular focus on Phoenix?

**Methods**

To answer my research question, I made use of a collaborative group project call the Global Classroom Experiment. The Global Classroom Experiment is a class that seeks to answer the question: Are sustainable cities a contradiction in terms? Forty students from both Arizona State University (ASU), in Tempe, Arizona, and Leuphana University (LUL), in Luneburg, Germany, made a three-semester commitment to attempt to answer this question. In the first semester, the wide range of professors who teach the course introduced students to different topics related to sustainability, including retrofitting, complex adaptive systems, and solution oriented thinking.

At the end of this first semester, students submitted topics that they wanted to research for the remaining two semesters, these topics in some way meant to address the larger question of contradiction. The topics were then condensed and students put into six international groups based on these topics.
My interest in sustainability largely involves the consequences of sustainable actions – unforeseen costs, benefits, and reactions – as well as looking at what we are sustaining and why we are sustaining it. With the mindset to look at these topics, I selected health as a general topic for research. Four other students also selected this topic – Rachel Gur-Arie, Kara Karaniuk, and Kenneth Aiello from ASU and Rebecca Chudaska from LUL. Dr. Jane Maienschein and Master’s student Sean Cohmer oversaw our group.

Starting with health and sustainability as our general interest left our group with many options. Through much discussion, we found that each member in the group had a different interest in health and sustainability, some more in the social aspect of this relationship, others more in the regulatory aspect, and others with less clear interests, leaving us with the challenge of incorporating many different aspects into a single project, which required a fairly broad topic. Dr. Jane Maienschein suggested influenza pandemics as a starting point.

Influenza pandemics are recurring problems that threaten the population of the world. They require the mass mobilization of scarce resources as well as coordinated response from different parts of society. Using influenza pandemics as a starting point, we came to the question of whether the world is prepared for the next influenza pandemic. In order to answer this larger question, we each picked a different actor, or responder during a pandemic, to focus our research, looking at that actor’s actions to both prepare and respond to an influenza pandemic. The actors were government, researchers and pharmaceutical companies, medical professionals, and individuals in the form of students. To further narrow the scope of our question, we focused our research in the United States, more specifically Arizona, and Germany because our international group was composed of students from these regions. This method and question allowed each member of our team to carry out an individual research project and then bring them together.
The main method for my individual research project was a literature review of past responses to influenza pandemics, influenza pandemic preparedness plans for medical facilities and clinicians, critiques of past responses and current response plans, as well as literature that addresses the ethical issues involved in the response to a pandemic, including triage procedures, resource allocation, and crowd management. I started with a general review of literature published by national regulatory agencies that play a role in influenza pandemic response – the Centers for Disease Control and Prevention (CDC), the Department of Health and Human Services (DHHS), and the Occupational Safety and Health Administration (OSHA). On each of the agency websites, I searched for influenza pandemic preparedness literature as well as influenza pandemic preparedness planning literature, or literature published to aid other institutions in planning for a pandemic. Though I cannot ensure that this was a comprehensive review, I do feel that I found the majority of the literature relating to influenza pandemic preparedness, as well as any literature specifically addressing medical preparedness, providing me with a national perspective on influenza preparedness.

I also did a general literature review on Google Scholar looking for outside considerations of an influenza pandemic response. I searched specifically for literature addressing an influenza pandemic, not just a pandemic in general, with terms like “triage,” “ethics,” “vaccine allocation,” and “anti-viral use.” I also searched for “response to pandemic Swine Flu” to locate literature addressing the most recent influenza pandemic.

The final aspect of my literature review drilled into the specific response of Phoenix. Phoenix has been identified by the CDC as a city particularly well prepared for an influenza pandemic, hence understanding the specific preparedness plans in Phoenix gives an understanding of the benchmark for preparedness (CDC 2008). I started with a systematic search
of the websites of the largest hospitals in Phoenix – Banner Health, Mayo Clinic, Scottsdale Healthcare, John C. Lincoln, St. Joseph’s, and Phoenix Children’s Hospital. I looked for any literature pertaining to influenza, pandemic preparedness, and influenza pandemics, trying to locate the specific influenza pandemic preparedness plans of each hospital. I also searched for these plans, as well as more general influenza preparedness literature, on the Arizona Department of Health Services (ADHS) website.

It proved difficult to locate any specific preparedness plans using this method, so I then emailed the librarians at each of the hospitals as well as the librarian at the ADHS and the CDC. This turned up only general results. Each librarian, with the exception of the librarian at Scottsdale Healthcare, emailed me back much of the same literature that I had already found during my search of each hospital’s website. The librarian at Scottsdale Healthcare emailed me more general information but upon further inquiry, found Scottsdale Healthcare’s influenza preparedness plans.

I then called the public health and prevention department at each hospital as well as the CDC and ADHS. Automated systems answered the majority of these calls. I was, however, put in to contact with two individuals at ADHS and Mayo Clinic. The individuals I spoke with at ADHS were not able to locate the specific plans of any hospital in Arizona, something they should have on file. The individual at Mayo Clinic did not know what an influenza preparedness plan was and explanation of what I was looking for did not help. It is of note that nearly every person I talked to, through email or phone, did not know what I was talking about or where to find the influenza preparedness plans.

After my group members and I compiled our individual research on the preparedness and response of the different actors, we came together to discuss all aspects of pandemic influenza
preparedness and response. This discussion culminated in a presentation of all our results at the final symposium for the Global Classroom Experiment in Luneburg, Germany. As well, our final thoughts on the overall preparedness and response to influenza pandemics led us to our conclusions for improvements to the response and preparedness.

Results

The results of my research can be divided into two categories: the medical community’s plans before the pandemic and the medical community’s response during the pandemic. A variety of government documents, including the Department of Health and Human Services’ *HHS Pandemic Influenza Plan* and the Occupational Safety and Health Administration’s *Pandemic Influenza Preparedness and Response Guidance for Healthcare Workers and Healthcare Employees*, characterize these responses. The DHHS *Pandemic Influenza Plan* is the product of many contributions and will be the primary source of the following summary. However, many other documents cover similar points, drawing directly from the DHHS document. Unfortunately, specific influenza pandemic preparedness plans for hospitals and other medical facilities were difficult to locate and often not publically available, and neither the ADHS nor the CDC could locate them in their archives. However, both the CDC and the DHSS offer several examples and model plans, representing the majority of medical facility plans for influenza preparedness.

Most preparedness plans divide pandemic response into three sections – the interpandemic period, the pandemic alert period, and the pandemic period – which represents the continuum of influenza response as labeled by the WHO. A visual representation of this cycle can be found in Appendix F. Below, each the response during each period is described.
Interpandemic Period

The interpandemic period refers to the period between influenza pandemics, where the longest and most often occurring period (DHHS, 2009). This period corresponds with the World Health Organization’s Global Pandemic Phases 1 and 2. The WHO’s Global Pandemic Phases are an international signaling method to inform the world how it needs to be prepared with regard to a pandemic. Phases 1 and 2 respectively refer to 1) the time when no novel influenza strains have been detected in humans and any strains detected in animals do not pose significant risk to humans, and 2) no novel influenza strains have been detected in humans, but strains have been detected in animals that may pose a risk to humans (WHO, 2005).

At this time, the major focus of the medical community is planning for the eventuality of a pandemic. According to the Department of Health and Human Services, healthcare facilities’ responsibilities during this time include developing “planning and decision-making structures for responding to pandemic influenza,” written plans that address the different aspects of the response and can be applied to any influenza pandemic, regardless of the strain, as well as participating in drills and exercises meant to prepare them for a pandemic (DHHS, 2009: S3-2). Medical facilities do not put the plans developed during the interpandemic period into action until the pandemic alert and pandemic periods.

Administratively, hospitals put together committees and planning groups to develop these plans. The plans are required to address “disease surveillance, hospital communications, education and training, triage and clinical evaluation, facility access, occupational health, use and administration of vaccines and antiviral drugs, surge capacity, supply chain and access to critical inventory needs, and mortuary issues” (DHHS, 2009: S3-2). Many of these sections – disease surveillance, triage and clinical evaluation, occupational health, use and administration of
vaccines and antiviral drugs, and mortuary issues – are conserved throughout most of the country. Disease surveillance, which refers to the ability to identify possible infected patients, requires the screening of in and out patients usually using questions like, “Have you developed a cough in the last 10 days?” Most medical facilities use the same screening methods and begin this disease surveillance when the pandemic alert period begins (OSHA, 2005).

However, hospital communications, which refer to internal communications as well as communications with government health agencies and other hospitals locally, can differ across state lines. Often, this part of pandemic response is addressed through the formation of healthcare coalitions. In Arizona, for example, the state is divided into four sections, each of which is equipped with a certain number of medical facilities that are to treat a certain percentage of the population during a pandemic (AZDHS, 2014). The medical facilities in a given coalition share resources, communicate, and respond in accordance with each other (AZDHS, 2014). However, other states allow for variations in individual response by healthcare facilities. Occupational health can often be addressed differently by different facilities as well. A large part of pandemic influenza response requires keeping healthcare workers healthy so they may continue to act during the pandemic. Most hospitals offer free flu vaccines to their employees, but not all require their employees to be vaccinated. Banner Health is an example of a medical facilities group that requires all employees to be vaccinated annually, only exempting those with health or religious concerns (Bessel, 2012).

During the interpandemic period, there is relatively little clinical response. Clinicians generally encourage seasonal flu vaccination for their patients and otherwise carry on as usual.

Pandemic Alert Period
The pandemic alert period refers to the period during which pandemic flu activity has been detected anywhere in the world where it is judged to have the capacity to become a significant global pandemic (DHHS, 2009). Annually, several strains of influenza circulate that are considered normal. These strains cause seasonal influenza. However, more serious and virulent strains of influenza, as well as newly evolved strains, cause influenza pandemics, which threaten the global population. The pandemic alert period corresponds to the WHO Phases 3, 4, and 5, where 3) humans have been infected with such an influenza strain but there has been no human-to-human transmission, 4) small groups of humans have been infected with a novel strain but the infection is localized, and 5) large groups of people have been infected with a novel strain but the infection remains fairly localized (WHO, 2005). These phases follow the usual evolution of a novel influenza strain. The strains often originate in animals, as mentioned in phases 1 and 2, and then slowly adapt to infecting a select group of humans, before further evolving to allow for slower and then more rapid transmission between humans (DHHS, 2009).

However, a pandemic alert period does not necessarily result in a pandemic period. The influenza strain may not be virulent enough to cause more than a localized infection. If that infection is contained, the medical community reverts back to the interpandemic period. Further, the medical community of a given area may move directly from an interpandemic period to a pandemic period, if the initial infection begins in that area. The pandemic alert period is in many ways an interim period meant to address possible pandemic threats, threats that may develop so quickly that the alert period transitions directly into a pandemic period, or threats that never develop, initiating a shift back to the interpandemic period.

During the pandemic alert period, the medical community continues to plan and prepare for a pandemic outbreak, implementing some aspects of preparedness plans, but much of their
focus shifts to screening and detection. Administratively, the committees and groups set up during the interpandemic period continue to meet and develop response plans in case of a pandemic. Clinically, parts of those plans like disease surveillance and facility access are implemented to aid in screening and detection. Clinicians are now on alert for patients possibly infected with novel influenza strains. Every patient is asked about possible symptoms of influenza, like the development of a cough or fever, as well as possible contact with other infected individuals (DHHS, 2009). A full clinical flow chart for patients during this period can be found in Appendix B. Clinicians also start taking more precautions during this time, wearing surgical masks during consultations with patients who show some symptoms of influenza.

**Pandemic Period**

The pandemic period occurs when a novel influenza strain infects a large portion of the global population. It corresponds to the WHO Phase 6, where there is “increased and sustained transmission in the general population” (DHHS, 2009: C-8). The WHO announces the beginning of the pandemic period. During this period, the medical community continues to plan and screen, but the focus is on treatment of infected patients and prevention of infection in other patients. At this point, all aspects of the pandemic preparedness plans developed by medical facilities go into action – facilities begin preparing for a large number of infected patients.

According to national influenza pandemic preparedness plans, when a patient goes to a medical facility during the pandemic period, they are immediately assessed for possible influenza infection. Clinicians conducting these assessments take extra precautions to ensure that they are not exposed to influenza, wearing gloves, gowns, masks, and goggles (Scottsdale Healthcare, 2013). Clinicians also take precautions to prevent transmission between patients,
isolating patients with possible influenza infection almost immediately after they enter the facility (DHHS, 2009).

Once a patient is identified as having influenza, clinicians must determine whether they need to be hospitalized or not (DHHS, 2009). Because capacity is limited in any medical facility, and during a pandemic that capacity is pushed, only those patients who require hospitalization are admitted. All other patients with influenza are sent home with treatment and orders to remain isolated (DHHS, 2009). The full clinical flow chart can be found in Appendix C. Those who are admitted to the hospital, often the elderly or immune-compromised, are also treated and kept isolated. Both patient groups are treated with antiviral medications, of which there are four on the market, in accordance with patient priority. Because antivirals are limited, certain individuals are given priority in receipt of this treatment according to the diagram in Appendix D – the elderly and immune-compromised first, then children and pregnant women, ending in healthy adults. Once the hospital or medical facility reaches patient capacity, they will begin diverting patients to other medical facilities, creating temporary medical facilities in local gyms and schools, and discharging as many patients as possible to free up bed space (DHHS, 2009).

Another focus of the medical community during the pandemic period is vaccination. The most effective way to prevent transmission of the influenza virus is the vaccination of unaffected individuals. A vaccination targeting the prevalent influenza strain can reduce or prevent influenza in 75%-80% of healthy adults (Stiver, 2003). During a pandemic outbreak, a vaccination can take anywhere from five to six months to develop (DHHS, 2009). After the vaccine is developed, clinicians begin administering the vaccine according to vaccination priority groups, starting with health care workers, then the elderly, then children and pregnant women, ending with healthy adults (DHHS, 2009) A full list can be found in Appendix E. Healthcare
workers are vaccinated first in order to ensure that they can continue to work during the pandemic (DHHS, 2009). A pandemic may last anywhere from a couple of months to several years, and the medical community must be prepared to treat patients for the entirety of this time.

Once the pandemic ends, a proclamation made by the WHO, the medical community focuses again on planning. The response to the previous pandemic is evaluated, and changes are made to incorporate new knowledge (DHHS, 2009). Clinicians and medical facilities also try to rebuild themselves after a pandemic. Often, individuals undergo psychological evaluations to ensure mental health (DHHS, 2009). Stockpiles are started again, facilities are decontaminated, and usual clinical care ensues.

Response During the Last Influenza Pandemic

The above results are an influenza pandemic response according to the available plans and planning materials. The following section details the medical community’s response during the last influenza pandemic, the Swine Flu pandemic in 2009.

In April of 2009, the World Health Organization detected a novel strain of influenza with the potential to become pandemic (Chan, 2009). That same month, hospitals in California detected the first human-to-human transmission of the H1N1 (Swine Flu) virus and alerted the CDC (CDC, 2009). Most of the medical community in the United States went in to the pandemic alert period – infection had been detected in the US, but it was localized and controlled. Those hospitals where the influenza infection was detected moved straight to the pandemic period.

In June 2009, the WHO declared the Swine Flu pandemic, after 30,000 cases of swine flu in 74 different countries had been reported (Chan, 2009). One study of patients in the US showed that most of those hospitalized presented with symptoms of fever and cough, while 39% also showed diarrhea and vomiting, symptoms that are usually not associated with pandemic
influenza (Jain, 2009). Most of the patients who were hospitalized also had underlying medical conditions like asthma, seizure disorders, and pregnancy, making them all high-risk groups for influenza infection, and 95% of them were under the age of 65 (Jain, 2009). Seventy-five percent of those hospitalized received anti-viral treatment of Tamiflu, Relenza, or some combination of Tamiflu or Relenza with Flumadine and Symmetrel (Jain, 2009). Of those patients that received treatment, only 39% received it within the first 48 hours of the onset of symptoms, the optimal time to administer anti-virals (Jain, 2009). Fifteen percent waited more than 48 hours after being admitted to a hospital to receive anti-viral treatment (Jain, 2009). The study also reported 19 deaths in those hospitalized, and the mean age for those deaths was 26 (Jain, 2009).

In October 2009, the FDA approved a vaccine for the Swine Flu (CDC, 2009). By December of 2009, only 15.3% of the US population had received this vaccine, and over the entire course of the pandemic, only 80 million people in the US were vaccinated (CDC, 2009; Flu, 2010). The WHO declared the end of the Swine Flu pandemic in August 2010 (Flu, 2010). The Swine Flu pandemic killed 700,000 people globally, and between 8,870 and 18,300 people in the US (Flu, 2010).

Response by Other Actors

After compiling my own research, I then met with the group to bring together all of our research to answer the larger question of whether we are prepared for an influenza pandemic. Each of my team members performed their own research on different actors and their preparedness for and response during an influenza pandemic. We found two major points of discussion. First, that the preparedness and response of each actor is limited in scope, focusing on vaccines as the major method for dealing with influenza pandemics, and second, that the
preparedness and response of each actor is relatively individual, with few connections and interactions between actors.

Kenneth Aiello looked at the different levels of government in Germany and the United States, finding that preparedness and response of governments is largely focused on stockpiling vaccines and anti-virals before a pandemic, and distributing them during the pandemic. This is largely due to the reasons Kara Karaniuk found—that researchers and pharmaceutical companies spend the time before an influenza pandemic researching antivirals and producing seasonal flu vaccines and the time during a pandemic developing a vaccine for the given strain and selling these vaccines for the most profit. Unfortunately, Rachel Gur-Arie and Rebecca Chudaska’s results regarding individual response to influenza (quantified through the survey of students on both ASU and LUL’s campus), showed the individuals do not get vaccinated or seek medical attention for influenza, making the preparedness and response plans of the other actors relatively moot.

**Discussion**

Medical facilities and clinicians respond to influenza pandemics through planning, prevention, and treatment. Prior to a pandemic, the medical community plans for all contingencies during a possible pandemic to ensure a coherent and long-lasting response. Once the pandemic begins, the focus shifts to prevention of transmission through aggressive screening and isolation of infected individuals, treatment through antivirals, and prevention of further infection through vaccination.

These responses are not without critique. First, much of the literature regarding influenza response by medical facilities and clinicians refers to response plans that were not developed
until recently. The majority of the literature comes from either 2005, after the emergence of a highly pathogenic influenza strain, or from 2009, directly after the Swine Flu pandemic (Berkman, 2009). With literature coming from 2005, the plans and procedures have only had one trial run, the Swine Flu pandemic. This pandemic was relatively moderate. Most individuals suffered only mild symptoms, and much of the older population in the US showed immune to the strain due to prior to exposure to an earlier influenza virus (Leung, 2010). Even so, the medical community in the US did not respond as recommended, administering anti-virals far after the optimal period of 48 hours and using anti-virals that the H1N1 virus showed resistance to (Jain, 2009). The Swine Flu pandemic did not necessarily give the medical community an accurate idea of the required response to a pandemic such as the one seen in 1918. The literature authored after the Swine Flu pandemic has never been tested in an actual pandemic scenario, making many of the proposed responses hypothetical until actually tested. Further, most of these plans are incomplete or have not been reviewed since original authorship.

Another critique deals with the tools used by the medical community to respond to pandemic influenza. The default treatment for influenza is antiviral drugs, of which there are four currently approved by the FDA – Relenza, Tamiflu, Flumadine, and Symmetrel (FDA, 2013). Influenza A viruses have been shown to be 92% resistant to both Flumadine and Symmetrel, quite possibly rendering them useless in a pandemic situation (CDC, 2014). Seasonal influenza A viruses have also shown a 27% resistance to Tamiflu (CDC, 2014). This poses a risk not only to patients during an influenza pandemic, but also clinicians, leaving them little recourse in terms of treatment other than bed rest and ventilation. The second major tool of medical intervention during a pandemic is vaccination, which takes five to six months to produce (WHO, 2009). It takes two doses of a given vaccine to fully protect an individual, and vaccines during a pandemic
are scarce commodities, as the U.S has few producers (Berkman, 2009). Though development of these tools does not rest solely with the medical community, heavy reliance on these technologies in influenza pandemic preparedness plans leaves clinicians and medical facilities at a disadvantage.

As well, other capacities to respond are also challenged by influenza pandemics. It is estimated that during a severe influenza pandemic, 90 million individuals in the US will become infected, and 45 million of those individuals will receive outpatient medical care (DHHS, 2009). Close to ten million individuals will be hospitalized, and 750,000 of them will be ventilated due to respiratory problems caused by influenza (DHHS, 2009). Currently in the United States, there are 1,721,395 hospital beds and approximately 20 ventilators per 100,000 Americans, bringing the total number of ventilators in the US close to 62,000 (AHA, 2014; Rubinson, 2010). During a pandemic, these resources would be severely taxed. By these statistics, the medical community is unprepared for the number of patients they will be required to treat during and influenza pandemic.

Other issues involved with the medical community’s response to influenza pandemics revolve around ethics. The first is vaccine and anti-viral allocation. Generally, vaccines and anti-virals are allocated during a pandemic with the goal of “reducing morbidity and mortality for those most at risk” (Berkman, 2009: 9). Much of the literature interprets this by assigning priority to certain patients as shown in the list found in Appendix D and E – placing the elderly and immune-compromised first, then children and pregnant women (DHHS, 2009). Much of the literature refers to elderly as the group who must be vaccinated and treated first in the case of a pandemic; however, during the Swine Flu pandemic, most individuals admitted to the hospital as well as those who died, were young adults in their twenties (Jain, 2009). This leads to questions
whether the elderly should be the first priority group when it appears that they are not at the most risk from influenza. Arguments can also be made for vaccinating those most important to infrastructure and societal continuance first, or vaccinating equally and justly instead of singling out groups, and the question of who should be vaccinated first may never have a satisfactory answer (Berkman, 2009).

Other concerns include healthcare workers’ unwillingness to work during pandemic situations and the proper response to this unwillingness (Vawter, 2008). Additionally, isolation and quarantine, two common techniques in the prevention of influenza pandemics, call into question the balance between personal freedom and societal good (Letts, 2006). Many of these issues will remain regardless of the pandemic response plans put in place due to the variety of differing opinions. However, they should be considered when formulating an influenza response plan.

The research carried out by the group as a whole revealed a focus and reliance on vaccines that lead to several problems with the preparedness and response plans of the different actors. First, the plans of all the actors except individuals – governments, pharmaceutical companies, and medical professionals – assume the cooperation of the individual, namely that they will get vaccinated. Our survey data shows that only 6% of LUL students and 33% of ASU students are getting vaccinated. Given that most of the preparedness and response plans of the different actors almost exclusively focus on individual vaccination as the means for halting the spread of an influenza pandemic, we questioned the effectiveness of these plans.

Further, the production of vaccines is controlled by a profit driven market. Each country can only distribute as many vaccines as they can pay for, and the vaccines produced by companies in a given country are not promised to that country. This means that during an
influenza pandemic, most countries will not have access to vaccines enough to protect the majority of their populations. Pharmaceutical companies are not able to produce enough vaccines to vaccinate the majority of a single country’s population, much less the population of the globe. It would also take a pharmaceutical company close to 6 months to produce a viable vaccine for an influenza pandemic strain. It would only take 3 months for that same strain to infect most of the globe. The actor’s reliance on vaccines in their preparations and response to influenza constitutes a major wrinkle in overall preparation for and response to influenza pandemics.

The second point of discussion is on the connectivity of influenza preparedness and response. Collectively, we went into this project believing that there would be easily definable connections and interactions between the actors before and during an influenza pandemic, seeing as pandemics are catastrophic global events that threaten the continued existence of the global population. However, what we found was that each of these actors was easily researched as a singular actor, meaning that the interaction between them was so minimal as to not permeate the processes of any individual actor. Further, preparedness and response of each actor was not coordinated between actors nor within the actors. For example, each governmental entity at each level of regulation has its own preparedness and response plan that does not need to coordinate with any other plan. These plans are not required to coordinate with the plans and response of the medical community, leaving each actor to prepare and respond independently of the other.

**Conclusions**

Our individual research on the preparations and responses of the different actors to an influenza pandemic, and the problems we found with these preparations and responses, led us to conclude that we, as a global entity, are not prepared for an influenza pandemic. This research
answered my individual question – how do clinicians and medical facilities respond to influenza pandemics in the United States, with a particular focus on Phoenix? – as well as the larger question of whether we are prepared for an influenza pandemic.

This lack of preparation stems from the heavy reliance on vaccines in preparedness plans and the lack of communication between actors. The reliance on vaccines poses a problem due to the length of time required to produce a vaccine, the limited number of companies producing vaccines, and the questions regarding who vaccines go to first. Lack of communication between actors creates an uncoordinated response with little sharing of resources, leading to an inefficient response to a pandemic.

Best practices going forward should attempt to address these gaps and questions in preparedness and response. Governments can mitigate the reliance on limited resources like vaccines by offering incentives to the private sector for the production of influenza vaccines, either subsidizing their production or purchasing a large percentage of total vaccines prior to their production. Further, governments can establish state owned vaccine production facilities to augment private sector vaccinations and address the limited number of vaccines available during a pandemic. Administration of vaccines should be reorganized to limit the spread of influenza, vaccines first going to first responders and medical professionals before being used to target the highest risk groups – children and young adults.

Communication gaps between actors can be addressed using a more top down approach with regard to preparedness. Plans should be uniform across states, following recommendations established by government agencies like the CDC and DHHS, and should coordinate with national response. Though this type of hierarchical response does have its drawbacks, as they are slow, especially when waiting for higher-level recommendations to move down through the
different levels of regulation. But they can be powerful, given their ability to streamline response and information transfer, allowing for quick changes in response and mobilization of limited resources.

Though it is difficult to predict how these changes will play out during an influenza pandemic, they do address some of the gaps and questions found throughout the course of this research and offer some direction for improvement in preparedness and response.

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References


Appendix A

Influenza, Society, and Sustainability

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Rebecca Chudaska

November 22, 2013
Topic and Motivation

“Plagues are as certain as death and taxes”… Richard Krause

Influenza, or “the flu”, has plagued mankind repeatedly through the course of human history. Hippocrates first described influenza in the 4th century BC (Crawford, 1900) and by the 9th century it was known as the “catarrhal fever” or “Italian fever” (Crawford, 1900). Early outbreaks of influenza, though, were small-scale confined outbreaks and died out quickly due to the relatively small size of isolated rural areas (Weisberg, 2007). Urban areas or cities brought together large populations of people in close quarters to one another (Vaughan, 1921). In general, large populations moving to cities allowed the flu to spread faster and to reach more people than ever before.

The history of influenza outbreak is strongly linked to the rise of large cities. The first recorded epidemic influenza broke out in England in 1510 (Crawford, 1900). The first “Russian Flu” pandemic devastated large parts of Europe, Asia, Africa, and the Americas in 1889 (Weisberg, 2007). In the 20th century, the “Spanish Flu” (1918-1920) caused nearly 70 million deaths and was followed by the “Asian Flu” (1957-1958) which claimed about 2 million lives, the “Hong Kong Flu” (1968-1969) killing 2 million more, and the “Russian Flu” (1977) which killed 1 million people. Most recently the “Swine Flu” (2009-2010) caused nearly 700,000 deaths and spread all over the globe, rapidly becoming a severe problem. In each of the above cases, human activity within the city has shaped the rise and fall of the flu in different ways.

Attempts to respond to, plan for, or prevent infectious influenza are necessary for the sustainable maintenance of populations within cities. When an influenza pandemic strikes, large parts of the population fall ill and die as demonstrated historically above. This causes
infrastructure failure, widespread panic, and general upset to the order and sustainment of the city. For example, the outbreak of “Avian Flu” in 2005 started with the infection of chickens in 2001, forcing a mass chicken culling in Hong Kong (Nature, 2013). The avian infection continued to spread through most of the large cities in China and the surrounding countries, costing Asian farmers an estimated $10 billion and severely limiting available food (Nature, 2013). The infection then jumped to pigs, before mutating and infecting humans. With this viral transfer, the “Avian Flu” has spread through much of the world, and killed more than half of those it has infected (Nature, 2013). Not only did this outbreak cause widespread panic and death, it also upset the agriculture, economics, and infrastructure in much of the eastern world.

Influenza as an infectious disease in many ways transcends each city to become a pandemic or global problem. With the increasing connectivity of the globe, with the ease of travel and the ever-growing global population, the world has become in many ways a single epidemiological entity (Pain & Smith, 2008). As seen with Indonesia’s recent withholding of information regarding the outbreak H5N1, responses must be coordinated and synchronized at both the local and global level in order for influenza to be controlled (Fidler & Gostin, 2011).

In 1992, the US Institute of Medicine identified six factors in the prevention and management of infectious diseases like influenza – ecological changes, human demographics and behaviors, international travel and commerce, technology and industry, microbial adaptation and change, and breakdown in public health measures (Barrett 1998). These factors still apply today and will all be targeted by this project through the analysis of different aspects of the response to influenza and how these responses interact – the response by the public, the government, clinicians and the medical community, and technology and science.
Both locally and globally, an ideal sustainable city requires a number of critical infrastructure components to work together effectively during an outbreak of the flu. The response of governments, individual clinicians and medical facilities, technology and science, and the public perception of different populations all interact to create a network:

Local, state, and federal governmental bodies must communicate information quickly and accurately to other governmental bodies across each relevant area and across the globe. Multinational regulatory bodies, like the WHO, assist national level agencies by pooling resources to prevent large-scale pandemics and fund scientists to develop technology to treat and prevent influenza. The WHO and national agencies like the US Centers for Disease Control (CDC) or German Ministry of Health work with state and local public health officials as well as medical institutions and clinicians to design response plans. Governments regulate and fund much of the treatment, prevention, and management of influenza. They are also the major communicators with the public, shaping public perceptions and response. Furthermore, during a pandemic, governmental bodies are often the ones that ensure people have access to food and water, in order to allow for the population to sustain itself.

The work scientists’ carry out is regulated and funded by governmental agencies and often carried out in a medical setting. Scientists and vaccine developers must work with government agencies for funding and with public health officials to spread information about the flu and distribute vaccines. Inevitably, they must communicate their findings to the government. They must also develop the tools that medical institutions and clinicians will use to distribute prevention technologies and treatments. Scientists are also in part responsible for public perceptions regarding vaccines, influenza treatment, and other technological developments to manage influenza.
Hospitals and doctors must join forces with government agencies, vaccine developers, and media to ensure preparedness at the local level. Clinicians and medical facilities work to develop protocols for treatment of influenza and pandemic management alongside public health officials and other governmental forces. These institutions and doctors are responsible for the maintenance of hospitals and medical services, ensuring that people get vaccines and treatments where possible, and often determining which parts of the population receive these treatments and vaccines when there is not enough. This further requires cooperation with scientists to design easily distributable vaccines that can be developed in large quantities. Hospitals and clinicians are also those who interact with the public on a one on one basis, explaining individual symptoms, giving care, and in more severe circumstances, quarantining. These interactions further shape public and individual perceptions and responses to influenza.

The citizens of a city play a crucial role in the network described above because they are the individuals that need to react to an outbreak of influenza in order to sustain the urban environment and the infrastructure. Thus, dealing with public health issues of any kind requires an in-depth understanding of public perception and response to the problem, in order to effectively communicate information as well as deal with the inherent panic. Any response plan will not help if it is not correctly communicated and understood. The city’s function depends on how the city population perceives influenza and how the institutions above can use their power to responsibly prepare citizens.

**Goal and Driving Question**

*Given previous historical reactions to infectious influenza, serious recurring infectious influenza outbreaks challenge the sustainability of the populations in cities with large, dense populations:*
Major actors involved in responding to influenza outbreaks include governments, medical personnel, technological innovation, and public perceptions. How do these critical contributors each respond, and how do they interact in the case of influenza outbreaks?

Methods and Research Design

To address the driving question, we will each start with a literature review of historical, scientific, and governmental documents from online databases and journals, government databases and regulations, and public media (such as newspaper articles) as well as other supplemental data collection techniques like interviews and surveys. We will focus on both the historical responses to influenza to establish background and context, as well as the current responses, especially in Phoenix and Hamburg. These literature reviews will be specific to a particular actor or node and will be completed individually to begin to illustrate the role of different sectors in the response to influenza. More specifically, in terms of literature review:

The response of clinicians and medical institutions will be understood through an examination of documented protocols created by hospitals and clinics to manage influenza outbreaks and a categorization of previous influenza responses in terms of past vaccination procedures, previous treatments, and techniques for containing the infection particularly in a hospital environment. Further, case studies of previous influenza outbreaks, clinician responses, and the characterization of these responses as well as whether these characterizations changed the responses in the next outbreak will be examined. (See Appendix A (Clinician and Medical Facilities) for more information).

The governmental focus will review academic articles, policies, and regulations of governments’ world wide, focusing on the governmental bodies of both Phoenix and Hamburg,
while working with historical research to provide context for such policies. Different time periods directly affect what policies are instituted and therefore what technologies and research innovations are funded and supported. Political, social, economic, and academic factors shape what technological advances are occurring (See Appendix B (Government) for more information).

To understand the response of technology and science, we will review scientific literature regarding advancements in prevention, novel vaccine distribution technologies, and innovations in treatment. Then, we will interview experts at institutions such as the Biodesign Institute at ASU to get insight from leading researchers that are directly involved with developing technologies that will be used to combat influenza. These interviews will be used to learn the difficulties in dealing with the influenza virus and also how research in a lab setting is transformed into a new technology that is used in the medical field. Another benefit of performing these interviews is that they can provide direction for further literature review by giving insight into different technological responses. (See Appendix C (Technology) for more information).

To study public perception and knowledge of influenza and influenza outbreak, we will focus on the university, since universities are in some ways analogous to cities due to their densely packed quarters and large population. Students are also generally unprepared for influenza infection. Previous literature review shows that mis-education and incorrect knowledge of infectious diseases, and influenza in particular, play a large role in how influenza is addressed and contained within a given population. Influenza information assessments and perception surveys will be administered to university students on ASU and LUL campuses to gauge the relationship between influenza knowledge, information management, perception, and cultural
differences. Data gathered from those assessments and surveys will display how historical, governmental, and technological influences affect decisions made about addressing influenza. (See Appendix D (Perceptions and Knowledge) for more information).

Each of us will then write up a summary of the actor we examined and their role in the response to influenza. In this summary, the focus will be on the interactions and connections between actors, to begin building a network of influenza response.

As a group, we will then come together to determine how best to represent these interactions and connections. Using a traditional approach, we will use lines and arrows to indicate influence, connection, and conflict. Our network analysis approach will review literature and identify critical components of the actor’s response to influenza while identifying blatant or covert relationships between the different critical actors and their roles.

We will then use computational methods to analyze the literature we have collected to create a computational network highlighting causal relationships and patterns of interaction. This final analysis will be used to test the network we will have developed qualitatively and to discover whether this uncovers new connections we did not find through more qualitative methods.
Team Communication Rules and Roles and Responsibilities

Rebecca and Alexis: Project Managers: Keeps team working together, on schedule, setting and moving toward goals; keeps team on task and works to keep morale high. There will be a PM on both the German and United States side. They will be responsible for coordinating with each other.

- Contact group members 12 & 4 hours prior to individual group submission deadlines.
- Initiate Conflict Resolution Protocol
- Sets agenda for Team Meetings
- Intergroup communication
- Email Instructor(s) final group assignments

Kara: Research Manager: Organizes and maintains all research material, helps team keep track of knowledge gaps, keeps team thinking about evidence.

- Management of Google docs and research material
- Collecting outside material and resources for presentation
- Emails instructor or group is Project Manager is unable
- Updating and management of timeline and workflow

Rachel: Communication Manager: Works with all members of team to organize team files creating a team knowledge base, focuses on ease of access to information and team files.

- Notify group of any changes to syllabus or schedule
- Plan outside of classroom meeting; location, time
- Intragroup communication - weekly updates within the group, including Jane and Sean
- Note taking during GCE group session and group meetings

Ken: Technology Manager: Troubleshoots tech issues, liaison with ASU tech support (or Instructors), utilizes useful technologies, and finalizes presentations and assignments submitted electronically.

- Troubleshoots Adobe Acrobat, Google docs, Trello, and Evernote
- Records submitted assignments via screenshot folder
- Provides guidance and direction on technology and software
- Check compatibility and accuracy of presentations with Instructor Software/Hardware
- Responsible for updating Trello with Google Docs submission, milestones, meeting minutes, etc.
Workplan

December 3: Groups present Interim Report I

December 5: Individual Contribution to Project Assignment

December 13: CITI training finished for all Americans by December 5

December 14: Classes end for ASU

December 14-January 14: Group will not meet during winter break. Individuals will continue literature reviews.

December 21-January 5: Christmas Holidays for LUL

January 14: Spring semester starts for ASU

January 13: Rebecca and Rachel have drafted Interview questions for surveys.

January 15: Group will meet briefly to discuss major breakthroughs in research and receive peer feedback on direction. Group will give feedback on whether or not each member is accomplishing research in a direction that is healthy for the group and evaluate research this far. Preliminary research must be started by this point.

January 16: IRB approval application finished.

January 16-30: Group will meet on a weekly basis outside of class to report research to one another and to begin compiling a progress report of what has been done thus far.

January 25: Literature reviews finished and results added for Interim Report II.

January 30: Interim Report II

February 1: Supplemental Data Collection begins; surveys, interviews, and clarification by authors.
February 1-March 9: Group will continue to meet on a weekly basis outside of class. Individuals will continue to report findings in research to other members of the group and group will analyze in-depth connections between projects.

February 15: Supplemental data collection complete. Individual and integrative analysis using primary review data and supplemental data.

February 18: Results of analysis used for creation of networks.

February 21: *Semester ends for LUL*

March 9-16: *Spring break for ASU*

April 13: *Semester begins for LUL*

April 13-April 25: Group will meet on a weekly basis outside of class. Most research will be completed by this point and group can begin work compiling gathered research into a cohesive project.

April 25: Final Project Due for Grading

April 28-May 2: Group will meet if necessary to make any necessary adjustments to presentation that will be given in Lüneburg.

May 10: *Classes end for ASU*

May 18: Final Project Due for Presenting
Sources


Laubichler, M.D., Maienschein, J., & Renn, J. (2013) Computational Perspectives in the History of Science: To the Memory of Peter Damerow. *Isis, 104*(1), 119-130.


World Health Organization Executive Board. (2012). *Social Determinants Health* (Provisional Agenda Item 7.3). World Health Organization.
Appendix B

The following flow chart shows the steps clinicians must go through to identify possible cases of influenza in the period prior to a pandemic.
Appendix C

The following figure shows the process a patient goes through when suspected of influenza infection during a pandemic. The goal is to identify and isolate cases as quickly as possible. It is of note though, that the majority of patients will be set home under the criteria, where the clinician cannot control who else they infect.

**FIGURE 2. CASE DETECTION AND CLINICAL MANAGEMENT DURING THE PANDEMIC PERIOD**

Illness with both of the following:
- Temperature > 38°C
- Cough, sore throat, or dyspnea

Yes

No

If no to either, treat as clinically indicated, re-evaluate if suspicion

- Initiate Standard and Droplet precautions
- Test for pandemic influenza virus in a subset of cases

Requires hospitalization?

Yes

No

- Admit to cohort or single room
- Initiate work-up, as clinically indicated
- Treat complications, such as secondary bacterial pneumonia, as clinically indicated
- Follow current antiviral treatment strategies
- Notify health department

- Give instructions to return if worsens
- Give instructions for home isolation and care
- Arrange home health care or other follow-up (if needed)
- Follow current antiviral treatment strategies
- Provide other supportive therapy as indicated

**Situation:** Pandemic influenza viruses are circulating in the community.
Appendix D

This table shows the priority groups for antiviral administration during a pandemic when quantities are limited.

<table>
<thead>
<tr>
<th>Group</th>
<th>Estimated population (millions)</th>
<th>Strategy</th>
<th># Courses (millions)</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Patients admitted to hospital</td>
<td>10.0</td>
<td>T</td>
<td>7.5</td>
<td>Consistent with medical practice and ethics to treat those with serious illness and who are most likely to die</td>
</tr>
<tr>
<td>2. Health care workers (HCW) with direct patient contact and emergency medical service (EMS) providers</td>
<td>9.2</td>
<td>T</td>
<td>2.4</td>
<td>Healthcare workers are required for quality medical care. There is little surge capacity among healthcare sector personnel to meet increased demand.</td>
</tr>
<tr>
<td>3. Highest risk outpatients—immunocompromised persons and pregnant women</td>
<td>2.5</td>
<td>T</td>
<td>0.7</td>
<td>Groups at greatest risk of hospitalization and death; immunocompromised cannot be protected by vaccination.</td>
</tr>
<tr>
<td>4. Pandemic health responders (public health, vaccinators, vaccine and antiviral manufacturers, public safety (police, fire, corrections), and government decision-makers)</td>
<td>3.3</td>
<td>T</td>
<td>0.9</td>
<td>Groups are critical for an effective public health response to a pandemic.</td>
</tr>
<tr>
<td>5. Increased risk outpatients—young children 12-23 months old, persons ≥ 65 yrs old, and persons with underlying medical conditions</td>
<td>85.5</td>
<td>T</td>
<td>22.4</td>
<td>Groups are at high risk for hospitalization and death.</td>
</tr>
<tr>
<td>6. Outbreak response in nursing homes and other residential settings</td>
<td>NA</td>
<td>PEP</td>
<td>2.0</td>
<td>Treatment of patients and prophylaxis of contacts is effective in stopping outbreaks; vaccination priorities do not include nursing home residents</td>
</tr>
<tr>
<td>7. HCWs in emergency departments, intensive care units, dialysis centers, and EMS providers</td>
<td>1.2</td>
<td>P</td>
<td>4.8</td>
<td>These groups are most critical to an effective healthcare response and have limited surge capacity. Prophylaxis will best prevent absenteeism.</td>
</tr>
<tr>
<td>8. Pandemic societal responders (e.g., critical infrastructure groups as defined in the vaccine priorities) and HCW without direct patient contact</td>
<td>10.2</td>
<td>T</td>
<td>2.7</td>
<td>Infrastructure groups that have impact on maintaining health, implementing a pandemic response, and maintaining societal functions</td>
</tr>
<tr>
<td>9. Other outpatients</td>
<td>180</td>
<td>T</td>
<td>47.3</td>
<td>Includes others who develop influenza and do not fall within the above groups</td>
</tr>
<tr>
<td>10. Highest risk outpatients</td>
<td>2.5</td>
<td>P</td>
<td>10.0</td>
<td>Prevents illness in the highest risk groups for hospitalization and death.</td>
</tr>
<tr>
<td>11. Other HCWs with direct patient contact</td>
<td>8.0</td>
<td>P</td>
<td>32.0</td>
<td>Prevention would best reduce absenteeism and preserve optimal function.</td>
</tr>
</tbody>
</table>
Appendix E

This table shows the priority groups for vaccine administration.

<table>
<thead>
<tr>
<th>Tier</th>
<th>Subtier</th>
<th>Population</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A</td>
<td>Vaccine and antiviral manufacturers and others essential to manufacturing and critical support (~40,000)</td>
<td>Need to assure maximum production of vaccine and antiviral drugs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Medical workers and public health workers¹ who are involved in direct patient contact, other support services essential for direct patient care, and vaccinators (8.9 million)</td>
<td>Healthcare workers are required for quality medical care (studies show outcome is associated with staff-to-patient ratios). There is little surge capacity among healthcare sector personnel to meet increased demand.</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>Persons ≥ 65 years with 1 or more influenza high-risk conditions, not including essential hypertension (approximately 18.2 million)</td>
<td>These groups are at high risk of hospitalization and death. Excludes elderly in nursing homes and those who are immunocompromised and would not likely be protected by vaccination</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Persons 6 months to 64 years with 2 or more influenza high-risk conditions, not including essential hypertension (approximately 6.9 million)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Persons 6 months or older with history of hospitalization for pneumonia or influenza or other influenza high-risk condition in the past year (740,000)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>Pregnant women (approximately 3.0 million)</td>
<td>In past pandemics and for annual influenza, pregnant women have been at high risk; vaccination will also protect the infant who cannot receive vaccine.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Household contacts of severely immunocompromised persons who would not be vaccinated due to likely poor response to vaccine (1.95 million with transplants, AIDS, and incident cancer x 1.4 household contacts per person = 2.7 million persons)</td>
<td>Vaccination of household contacts of immunocompromised and young infants will decrease risk of exposure and infection among those who cannot be directly protected by vaccination.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Household contacts of children &lt;6 month olds (5.0 million)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>D</td>
<td>Public health emergency response workers critical to pandemic response (assumed one-third of estimated public health workforce = 150,000)</td>
<td>Critical to implement pandemic response such as providing vaccinations and managing/monitoring response activities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Key government leaders</td>
<td>Preserving decision-making capacity also critical for managing and implementing a response</td>
</tr>
<tr>
<td>Tier</td>
<td>Subtier</td>
<td>Population</td>
<td>Rationale</td>
</tr>
<tr>
<td>------</td>
<td>---------</td>
<td>-----------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>2</td>
<td>A</td>
<td>- Healthy 65 years and older (17.7 million)</td>
<td>Groups that are also at increased risk but not as high risk as population in Tier 1B</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- 6 months to 64 years with 1 high-risk condition (35.8 million)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- 6-23 months old, healthy (5.6 million)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>- Other public health emergency responders (300,000 = remaining two-thirds of public health work force)</td>
<td>Includes critical infrastructure groups that have impact on maintaining health (e.g., public safety or transportation of medical supplies and food); implementing a pandemic response; and on maintaining societal functions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Public safety workers including police, fire, 911 dispatchers, and correctional facility staff (2.99 million)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Utility workers essential for maintenance of power, water, and sewage system functioning (364,000)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Transportation workers transporting fuel, water, food, and medical supplies as well as public ground public transportation (3.8 million)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Telecommunications/IT for essential network operations and maintenance (1.08 million)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>- Other key government health decision-makers (estimated number not yet determined)</td>
<td>Other important societal groups for a pandemic response but of lower priority</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Funeral directors/embalmers (62,000)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>- Healthy persons 2-64 years not included in above categories (179.3 million)</td>
<td>All persons not included in other groups based on objective to vaccinate all those who want protection</td>
</tr>
</tbody>
</table>
Appendix F

The figure below shows the cycle of pandemic phases (United Nations, 2013).

Figure 1. The continuum of pandemic phases

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This continuum is according to a “global average” of cases, over time, based on continued risk assessment and consistent with the broader emergency risk management continuum.