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Predictions of Infection and Their Accuracy

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ABSTRACT

Given the recent occurrence of swine flu, many predictions have been made concerning future occurrence. In particular, a strong Fall 2009 outbreak was predicted, motivating the development of a swine flu vaccine to be distributed prior to this predicted onslaught. This is reminiscent of a swine flu scare that occurred in 1976, again predicted as a pandemic. Approximately 25% of the population was vaccinated when there were approximately 200 cases of swine flu in a relatively restricted geographic area. As it turned out, there were some serious side effects from the vaccine, especially Guillain-Barre syndrome that ultimately halted the distribution of the vaccine. No prediction can be accurate if the basic model assumptions and probability of risk are not accurate. In particular, the initial rate of growth of the infection determines the predicted spread of the epidemic. We will demonstrate how data and SAS® can be used to make accurate predictions concerning infections and pandemics. In particular, we will discuss the best way to estimate the initial rate of infection growth.

INTRODUCTION

We want to examine the problem of risk versus benefit when making medical decisions. Since no treatment is 100% safe, there will always be trade-offs when making decisions. This is true when individuals decide for themselves or when providers make general policy in terms of treatment. In this paper, we will investigate decisions that have to examine both risk and benefit. We will look at individual patient choices, as well as societal choices. For societal choices, we will look at the problem of H1N1 flue (also called swine flu). While the pandemic did not occur, the World Health Organization is recommending that the swine flu vaccine become an automatic part of the seasonal flu vaccine. There are risks that need to be examined, and individuals should decide for themselves whether the risks are outweighed by the benefits of the vaccine.

DECISIONS CONCERNING SWINE FLU (H1N1 FLU)

Should you be overly concerned about contracting swine flu? Should you be concerned about the risks of the swine flu vaccine? Just how many individuals are predicted to contract the disease, and how many are predicted to die from swine flu? In order to make a decision concerning the vaccine, we must first look at the accuracy of the predictions. Currently, initial assumptions concerning the level of contagion dictate the final prediction. We show how real data can be used to improve the accuracy of these assumptions. We must also look at the potential risks from the vaccine.

Influenza generally lasts about a week and symptoms usually include
- Fever of more than 100
- Coughing
- Runny nose and/or sore throat
- Joint aches
- Severe headache
- Vomiting and/or diarrhea
- Lethargy
- Lack of appetite

Most people recover with no lasting effects. The danger is in the potential to develop secondary infections, particularly pneumonia. There is also the potential for dehydration. General treatment includes drinking plenty of fluids, the use anti-viral medication, and the use of aspirin or acetaminophen to relieve the symptoms.

Many public health officials predicted a high number of flu cases and a high number of deaths. (Conde and Conde 2009) We want to discuss just how those predictions are made and to what extent we can accept their accuracy. (Wang, Palese et al. 2009) These predictions (as occurred in 1976) can be very wrong. Predictions tend to err on the side of pandemic, giving a worst case scenario. Unfortunately, the worst case scenario is not helpful when individuals are comparing both risk and benefit. We also want to know if these predictions are made so dire to convince people to participate in the vaccine trials. One prediction states that several hundred thousand could die just in the United

States, even though there were very few actual deaths with a death rate of 0.003%. (Fumento 2009) As it turned out, the swine flu was very mild.

Swine flu gets its name because the flu was transferred from pigs to humans. (Kothalawala, Toussaint et al. 2006) The most recent version for 2009 was tracked as originating in Mexico, which is not the usual trend for influenza.

Swine Flu Pandemic of 1976

This was a pandemic that was predicted but never occurred. The estimates and predictions were dire, and there was a real effort to contain the estimated pandemic through the development of a vaccine. While the public health experts tend to assume that it is important to err on the side of caution, there is always a risk to the cure, and this risk should be taken into consideration. Otherwise, those who suffer from the rare occurrences are considered "collateral damage", meaning that they suffer for the greater good of the benefit of the vaccination. While public health officials will make a recommendation based upon society's benefits, the individual must always decide what is in their own best interests. These interests may or may not be the same.

Even though there were only about 200 cases in the United States, 25% of the population was vaccinated within ten months after the first diagnosis of swine flu, which occurred at Fort Dix among a population of soldiers. It did not spread beyond this sub-group within the general population. (Gaydos, Franklin H Top et al. 2006) As it turned out, more people were injured by the vaccine than the flu since the Centers for Disease Control (CDC) guessed incorrectly about the occurrence of the swine flu while the FDA (Food and Drug Administration) approved the vaccine without knowing about the rare occurrence of Guillain-Barre Syndrome. In fact, the vaccinations were stopped because of the appearance of Guillain-Barre Syndrome in the vaccinated population. It is not yet known if Guillain-Barre occurred specifically because of the swine flu vaccine, or if it is a rare occurrence in vaccination generally. The cause has never been identified nor the reason for the spike in cases in the vaccinated population.

Part of the reason that the predictions were so radical is that there was a misunderstanding of the 1918 flu pandemic were many people died. (Roan 2009) The general public generally regarded the entire exercise as a farce subsequently because the predictions were so far from the reality. It is also wise to keep this outcome in mind when subsequent predictions are made. Such a reaction from the general populace can prevent many from taking a subsequent vaccine.

Similarly, there were dire predictions concerning avian flu that turned out to be unfounded as well. The avian flu has yet to be discovered in the United States. (Beckford-Ball and Beckford-Ball 2009) Yet at the time, many people started to panic over the infection because of the predictive models used to estimate the level of occurrence. (Colizza, Barrat et al. 2007)

SWINE FLU PANDEMIC OF 2009

The World Health Organization has now certified that swine flu has become an international pandemic. It estimated that 2 billion people will acquire the flu. (Reuters 2009) Various models have been used to make predictions concerning the number of cases and the number of deaths. (Coburn, Wagner et al. 2009) However, caution is important when relying upon models. They generally require basic assumptions, and these assumptions may not be necessarily true. (Fineberg and Fineberg 2008) The United States has purchased 160 million doses of the vaccine. However, as it turned out, there was a glut of doses by January, 2010. Many individuals opted out of taking the swine flu vaccine.

Because the models indicated millions of cases worldwide, there was a rush to create a vaccine and to make it available as soon as possible. (Donald G McNeil 2009) However, the risks and rare occurrence of the vaccine will be unknown for some time. (Evans, Cauchemez et al. 2009) The general prediction was that the early outbreak in spring, 2009 will come again even worse in the fall of 2009.

People generally are modifying their behavior in terms of basic hand washing and avoidance of infected individuals. (Rubin, Amlot et al. 2009) Hand sanitizers have been placed in many locations to reduce the rate of infection. In addition, the swine flu does not behave in the same way as typical flu strains. Usually, older individuals are more susceptible compared to younger individuals. For the swine flu, older individuals appear to have some natural immunity that is making them more resistant to the infection compared to younger individuals. In addition, there is generally a herd immunity in relationship to the influenza vaccine. If a high enough percentage of the population is vaccinated, those who are not vaccinated can receive protection from the reduced exposure potential from those who are infected.

In a report to the President dated August 7, 2009, it was estimated that half a million people would need to be hospitalized for the flu when only 100,000 beds are available. Similarly, 75,000 people would need to be admitted to

intensive care when there are only 60,000 ICU beds total. This increase in demand would also require an increase in medical professionals, and there is no way to add to the supply in such a short period of time, so that the shortage in the presence of such need cannot be absorbed into the healthcare system. Interestingly enough, the same report predicted that the fall resurgence would likely occur in September, peaking in mid-October. At the same time, a flu vaccine was not projected to be available until the same mid-October, requiring two doses and several weeks to reach protective immunity, bringing into question whether the vaccine would be timely enough to have any impact on the rate of occurrence, herd immunity or not. (Holdren, Lander et al. 2009)

Modeling Assumptions

The basic model depends upon what is called the basic reproduction number, or R_0. (Coburn, Wagner et al. 2009) This is the average number of new infections that one infectious individual can generate in a susceptible population. If this number is greater than one, a pandemic can occur; if this number is less than one, the infection will die out. To model the worst case scenario, the assumption is almost always made that the value of R_0 is greater than one. (Coburn, Wagner et al. 2009) Different values assigned to R_0 will result in different estimates of the total number of cases. If the estimate of R_0 is wildly wrong, then the prediction will be wildly off. This is what happened in 1976 when the infectious rate was wildly over-estimated since it was based upon the 1918 flu pandemic. At that time, the R_0 value was estimated to be between 2 and 3. However, in 1976, the R_0 value was actually less than one, and outside of a local infection surrounding Fort Dix, the swine flu did not spread.

The biggest problem with this approach is that no one actually knows the actual value of R_0. Therefore, it must be estimated in some way. Modelers assumed that there would be a second outbreak of swine flu in October, 2009 and used the number of cases in the spring and summer of 2009 to define a value of R_0. The question is, just how do we translate the number of identified cases of swine flu into the value of R_0? To make this estimate, we must further assume that the value of R_0 is equal to the transmissibility of the strain multiplied by the duration of the infectious period. In other words, we estimate just how infectious the strain of flu is and the multiply by the length of time that an individual is infectious.

In fact, much of what is used to define the value of R_0 is based upon retrospective studies of previous flu epidemics. The problem with this is that previous pandemics do not have the modern medications that can be used to prevent the worst effects of the flu, and many of the deaths. Anti-virals have recently been developed and antibiotics can be used to treat the secondary infections. Another assumption that must be made is to assume that the incubation period of the influenza follows a particular probability distribution, specifically the lognormal. Another study assumed a Weibull distribution. (Nishiura 2007) It is possible to assume that the distribution is of unknown type, but then the remainder of the modeling techniques used to estimate occurrence do not work without assuming a known distribution.

Estimates of Death from Flu

Many people do not go to a physician or hospital when they have the flu; they just suffer and get over it, and return to their normal routine. Therefore, it is not possible to get an exact count of the number of flu cases; these, too, are estimates. There is also the problem of estimating the impact of vaccination on mortality. (Nichol and Nichol 2005) Are the current estimates accurate, or do they assume too many deaths? It is known that death from flu has decreased considerably over the course of the twentieth century. (Doshl 2008)

A study performed in 2003 discussed the modeling of mortality from influenza and other types of respiratory infections. The model is defined by

$$Y = \alpha \exp\{\beta_0 + \beta_1[t] + \beta_2[t^2] + \beta_3\left[\sin(\frac{2\pi}{52})\right] + \beta_4\left[\cos(\frac{2\pi}{52})\right] +$$
$$\beta_5[A(H1N1)] + \beta_6[A(H3N2)] + \beta_7[B] + \beta_8[RSV]\}$$

where Y=number of deaths during a particular week for a specific age group, α is the offset term and is equal to the log of the age-specific population size. The equation is divided into linear and non-linear components. A(H1N1) represents the number of specimens testing positive for a given week. This is an extremely complicated formula. Unfortunately, this study does not give the accuracy of this model, so it is not known just how well it predicts actual deaths. It also does not take into consideration the impact of vaccination on occurrence or death. (Nichol and Nichol 2005) Another problem with this study is that pneumonia is combined with influenza to determine the number of deaths; therefore, it does not compute the number of deaths from influenza by itself. However, for the swine flu, it is assumed that the infection will spread more rapidly compared to seasonal flu, and will infect more people than the standard seasonal flu. The number of deaths is projected based upon the results of seasonal flu.

We can, however, start looking at exact counts by using the National Inpatient Sample. This is a stratified sample of 1000 hospitals across 37 different states. We can see how many patients have the flu, and how many die of the flu. Then, we can multiply the result by a weight of approximately 5.1 to estimate the number of deaths in the United States in a typical flu season. We can use this value to see just how well the estimate of 30,000 deaths annually is compared to the reality. We must assume that those who die from the flu are first hospitalized because of it. Since the deaths will generally come from secondary infections, this is not an unreasonable assumption. In addition, we have to assume that patients who have the flu receive a diagnosis of flu. Since many of the symptoms are similar to those for pneumonia and upper respiratory tract infections, this may or may not be the case.

Flu Vaccine and Guillain-Barre Syndrome

It is not known if the 1976 flu vaccine specifically caused a rare occurrence of Guillain-Barre Syndrome, or if the Syndrome is just a rare occurrence of vaccines generally. (Nachamkin, Shadomy et al. 2008) From an individual's standpoint, it does not really matter outside of the fact that the Syndrome is a risk of the vaccine. This Syndrome can cause muscle weakness and paralysis. It can take days or weeks to develop and can last weeks and months. In some, it can last years. While the number of people who acquire this Syndrome as a result of the flu is very small, the severity is extremely intense.

Once acquired, there is no cure for Guillain-Barre. There are some treatments that can reduce symptoms: (Staff 2009)

- **Plasmapheresis.** This treatment consists of removing the liquid portion of your blood (plasma) and separating it from the actual blood cells. The blood cells are then returned, which manufactures more plasma to make up for what was removed.

- **Intravenous immunoglobulin.** This substance contains healthy antibodies from blood donors. High doses of immunoglobulin can block the damaging antibodies that may contribute to Guillain-Barre syndrome.

In addition, caregivers may need to manually move a patient's arms and legs to help keep the muscles flexible and strong. After recovery has begun, physical therapy may be needed to help regain strength and proper movement. In addition, adaptive devices, such as a wheelchair or braces, may be needed.

It must be emphasized that the condition is rare. However, for those who contract it, it can be devastating and will require a long recovery period. In terms of probability, suppose the likelihood of contracting the flu is p_1 (which can range from 10 to 30 percent). Suppose the likelihood of contracting Guillain-Barre Syndrome or something equally as bad is p_2 (which is about 0.05%). Then we also look at the severity of the flu, which can be relatively benign (say s_1) while the potential of a secondary infection is p_3 with severity s_3. Similarly, the severity of Guillain-Barre is s_2. Then your likelihood of having a problem from the flu is equal to $p_1s_1+p_3s_3$. Your likelihood of having a problem from the flu vaccine is p_2s_2. The problem, of course, is to substitute actual values for these symbols. The value, s_2, will be quite large, as is the value of s_3. If $p_2s_2>s_3p_3$, it is probably better to skip the vaccine. If $p_2s_2<s_3p_3$, then it is better to get the vaccine. Unfortunately, both p_2 and p_3 are only estimated and are unknown. Public health officials in 1976 assumed that $p_2s_2<s_3p_3$ until there were enough cases of Guillain-Barre to halt the vaccinations with an acknowledgement that $p_2s_2>s_3p_3$.

It is possible that these probabilities have to be computed each year for each flu vaccine. They almost certainly need to be computed for the 2009 swine flu vaccine currently under development. Unfortunately, there are not enough subjects in the clinical trials to determine the probabilities and decisions must be made based upon estimates. However, according to the report to the President, "*The case-fatality ratio (i.e., proportion of infected individuals who die as a result of the infection) appears to be similar to seasonal influenza—possibly on the order of 0.1 to 0.3 percent of medically attended cases (i.e., those infections requiring hospitalization or primary care), and perhaps 0.05 to 0.2 percent of all symptomatic cases, whether or not medical care is sought* . However, these numbers are highly uncertain, in particular because the number of medically attended cases is not well measured and the number of mild cases that do not come to medical attention is essentially unknown." (Holdren, Lander et al. 2009) In other words, the estimates are based on uncertainties and may not reflect the actual occurrence. We just do not know these probabilities and cannot make any accurate estimates. (Fumento 2009)

One way of looking at both the risk and the severity is to use the VAERS (Vaccine Adverse Event Reporting System) sponsored by the Centers for Disease Control. While this reporting is voluntary, we can investigate the relationship of Guillain-Barre syndrome to the flu vaccine. We can also see if the risk is greater for flu vaccines, or if it is similar for all vaccines.

To measure the risk, we can examine the number of occurrences through July 24, 2009. There were 43,771 reported cases of swine flu; 20% of these reported cases required hospitalization and 6% of the hospitalizations resulted in

death. As of July 24, there were a total of 593 deaths reported nationally. As of September, the spread appeared to occur largely on university campuses. (Anonymous-AP 2009) These proportions may be exaggerated since not all flu cases are reported to the Centers for Disease Control. As of February, 2010, there were still under 2000 deaths from flu for the flu season. This is considerably less than normal.

## Occurrence of Severe Flu and Flu Deaths

We use data from the National Inpatient Sample for 2006. There are approximately 24,500 patients with at least one diagnosis of influenza. There are 390 reported deaths. Because this sample is stratified, there are weights associated with each observation that can be used to generalize to the population at large. The 390 deaths translate into approximately 20,000 deaths nationally. If we assume that most patients who die from the flu are initially hospitalized, then this number is less than the generally accepted 30,000-36,000 deaths from flu annually. However, we also need to examine the patient co-morbidities to see which problems relate to death with influenza.
In order to examine influenza mortality, we first need to know how such patients are identified. There are DRG codes (Diagnosis Related Groups) that are used for billing purposes; there is no DRG code available for influenza. In addition, there are numerous ICD9 codes (Codes developed by the World Health Organization). There are several related to the flu:

- 488 Influenza due to identified avian influenza virus
- 487 Influenza
- 487.8 With other manifestations
- V04.81 Influenza
- V03.81 Hemophilus influenza, type B [Hib]
- V06.6 Streptococcus pneumoniae [pneumococcus] and influenza

The columns of patient diagnoses are concatenated using the CATX function and then the RXMATCH statement is used to filter down to the patients with the flu. Because some of the diagnoses have different numbers of conditions, the SUBSTR function is used to ensure that only flu patients are extracted. We first examine the patient population of those identified as suffering from the flu. Figure 1 gives the age in days of infants hospitalized with the flu. Figure 2 shows the general age distribution of patients admitted to the hospital with the flu.

**Figure 1. Age in Days for Patients Admitted with the Flu.**
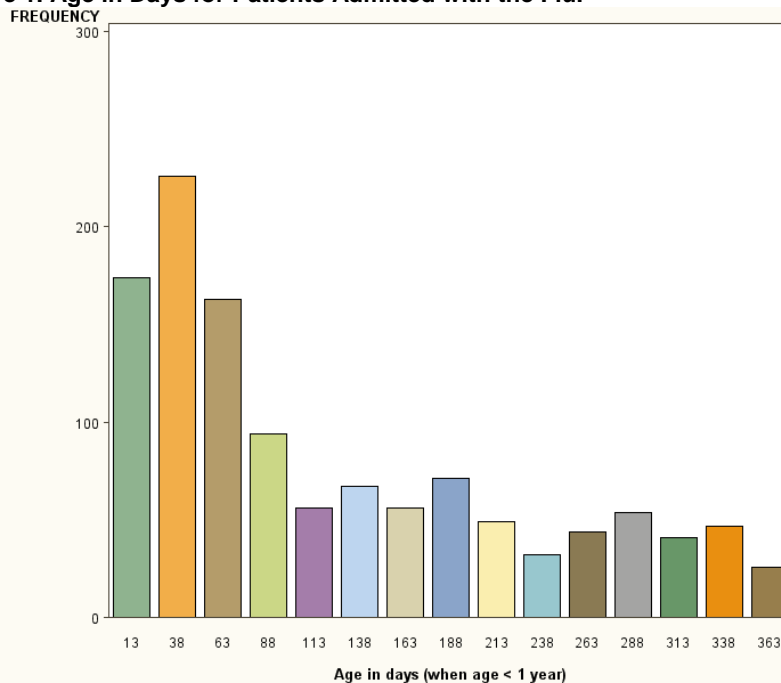
For infants, the distribution is concentrated at younger ages. It is even possible that these infants are infected while in the hospital.

Figure 2. Patients by Age When Admitted for the Flu

Once children reach the level of 3 years, the risk of hospitalization is small, but increases to a peak at the age of 80. It decreases slightly at age 88. It shows that the risk of hospitalization increases as age increases.

We next use association rules in SAS Enterprise Miner to examine the patient deaths (Figure 3). We compare the link graph to that constructed for patients who are hospitalized but who survive the flu (Figure 5).

**Figure 3. Associations of Patient Conditions for Influenza Mortality**

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There are three centers related to these association rules: 4280 (428.0 Congestive heart failure, unspecified), 99592 (severe sepsis), and 4870 (influenza with pneumonia). Just one of the three centers is related to the flu. The other two centers indicate that the patients have very severe health problems that are not necessarily related to the flu. For congestive heart failure, influenza will certainly strain the heart and can contribute to death. Very likely, sepsis was contracted in the hospital after admission and becomes the primary cause of death. We concentrate on the patient conditions centered upon influenza (Figure 4).

Figure 4. Associations Centered at Influenza
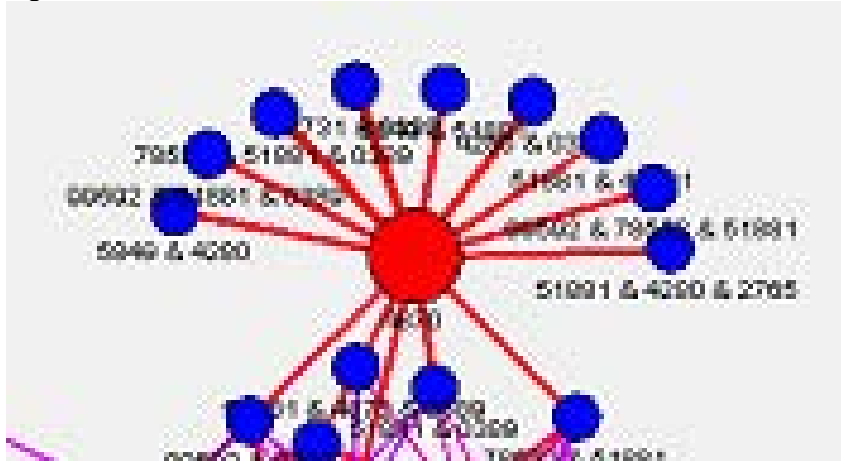
Given the connections, these patients also have some severe conditions, including sepsis and 519.91 (Unspecified disease of respiratory system). In contrast, we examine the associations for patients hospitalized with the flu who survive.

Figure 5. Associations of Patient Conditions for Influenza Survival
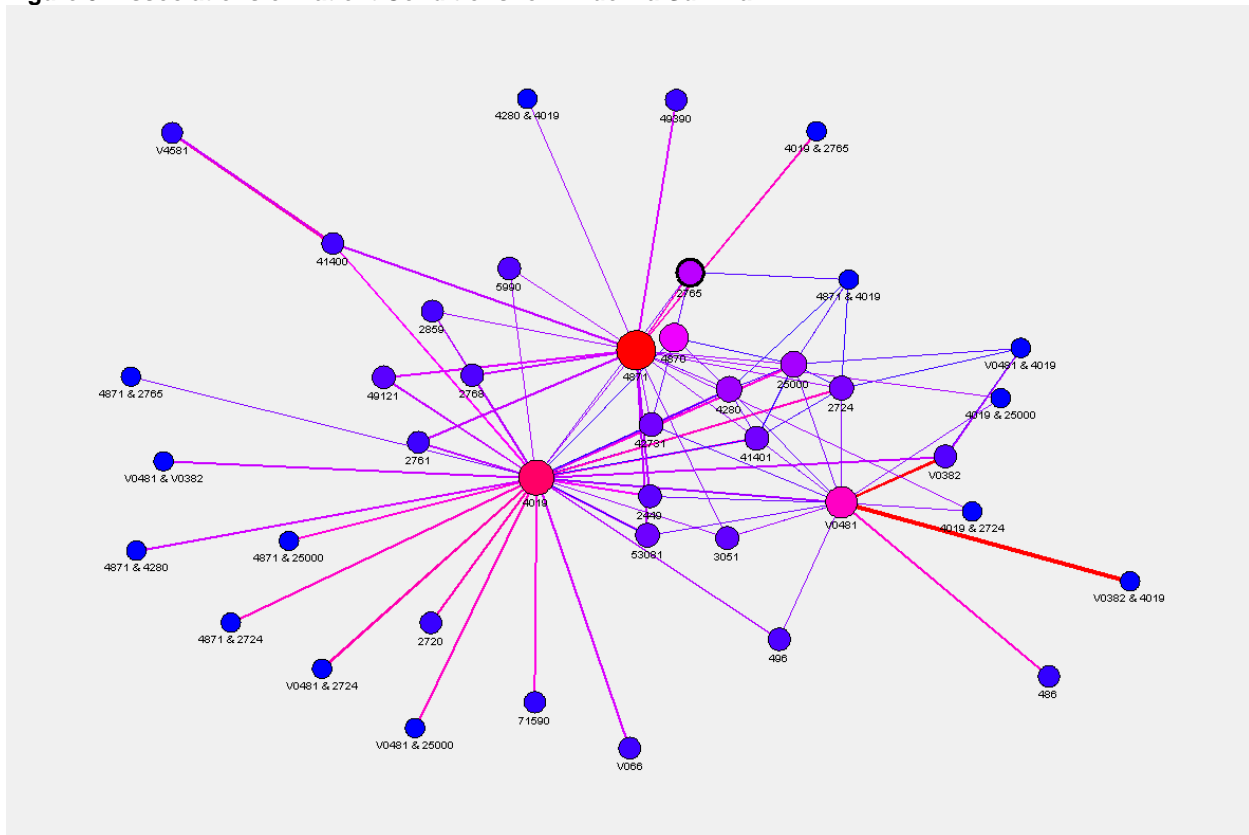
It is clear that this set of association rules is more focused upon influenza. There are three centers at 4019 (unspecified hypertension), 4871 (Influenza with other respiratory manifestations), and v0481 (Influenza), with a secondary center at 4870 (Influenza). The v indicates that the flu was a pre-existing condition prior to admission.

These figures indicate that mortality is related to having or contracting a very severe medical problem that can be aggravated by the flu. It is a question of whether it is the co-morbidity that is responsible for the death, or if the flu is responsible. Those who do not have such co-morbidities appear to survive. We want to drill down into the primary diagnosis to see if these patients are in the hospital primarily for the flu, or for some other problem. As discussed in detail in Cerrito, it is possible to use text analysis in SAS Enterprise Miner to group the patients into levels of severity, and we can then examine the relationship of mortality to these severity groups. (Cerrito 2010)

Table 1. Text Clusters for Patients with Flu

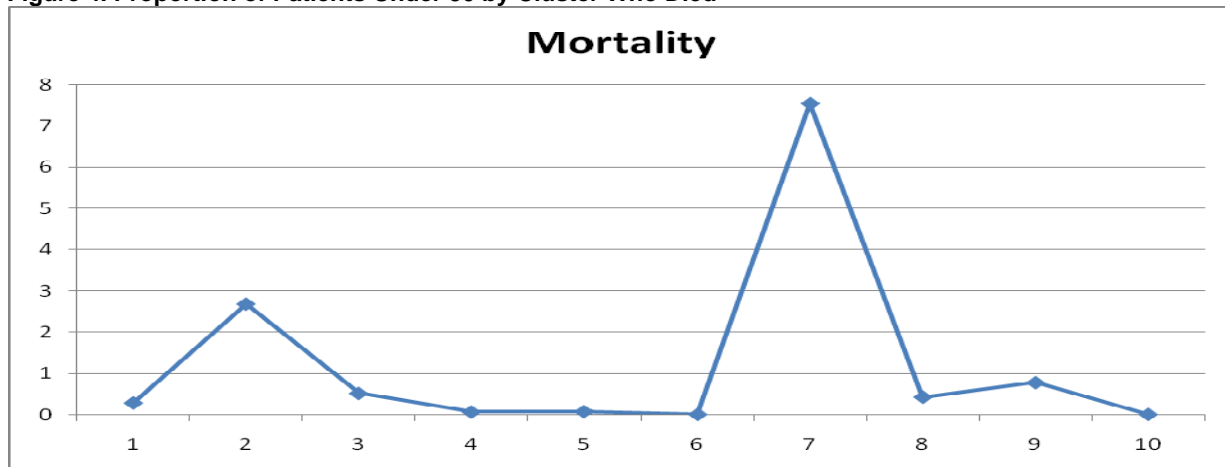| Cluster #	ICD9 Codes	Translation	Frequency	%
1	4870, 799, 5939, 2948, 487, 2768	Influenza with pneumonia, Other ill-defined and unknown causes of morbidity and mortality, Unspecified disorder of kidney and ureter, Other persistent mental disorders due to conditions classified elsewhere, Influenza, Hypopotassemia	4968	0.20
2	491, 4280, 428, 51881, 42731, 427	Chronic bronchitis, Congestive heart failure, unspecified, Congestive heart failure, Acute respiratory failure, Atrial fibrillation, Cardiac dysrhythmias	4569	0.19
3	311, 3051, v0481, 294, 305, 331	Depressive disorder, not elsewhere classified, Tobacco use disorder, Influenza vaccine, Persistent mental disorders due to conditions classified elsewhere, Drug dependence, Other cerebral degenerations	1835	0.07
4	4871, 487, 78791, 3829, 4878, 276	Influenza with other respiratory manifestations, Influenza, Diarrhea, Unspecified otitis media, Influenza with other manifestations, Disorders of fluid, electrolyte, and acid-base balance	2541	0.10
5	49390, 64891, 493, 64893, 66401, v270	Asthma, unspecified, Other current conditions in the mother classifiable elsewhere, but complicating pregnancy, childbirth, or the puerperium, Asthma, First-degree perineal laceration, Single liveborn	1654	0.07
6	V04, 78659, 786, v03, v0481, v0382	Need for prophylactic vaccination and inoculation against certain diseases, Other chest pain, Symptoms involving respiratory system and other chest symptoms, Need for prophylactic vaccination and inoculation against bacterial diseases, Influenza vaccine, Streptococcus pneumonia vaccine	1366	0.06
7	0389, 5849, 785, 51881, 038, 78552	Unspecified septicemia, Acute renal failure, unspecified, Symptoms involving cardiovascular system, Acute respiratory failure, Septicemia, Septic shock	383	0.02
8	04111, 682, 041, 6826, 0414, 5990	Methicillin susceptible Staphylococcus aureus, Other cellulitis and abscess, Bacterial infection in conditions classified elsewhere and of unspecified site, Other cellulitis and abscess, leg except foot	1375	0.06
9	41401, 42731, 428, 414, 2449, 25000	Coronary atherosclerosis of the native coronary artery, Atrial fibrillation, Heart failure, Other forms of chronic ischemic heart disease, Unspecified hypothyroidism, Type II Diabetes Mellitus without mention of complications	4565	0.19
10	V5789, 733, v0481, v57, 715, 73300	Other specified rehabilitation procedure, Other disorders of bone and cartilage, Need for prophylactic vaccination and inoculation against bacterial diseases, Care involving use of rehabilitation procedures, Osteoarthrosis and allied disorders, Osteoporosis, unspecified	1117	0.05

Using this table of clusters, it is clear that most patients have severe co-morbidities so that the flu is just a contributing factor for death, but is not the primary cause. Cluster #1 has patients who contracted pneumonia from the flu. Cluster #4 is focused solely on the flu without additional co-morbidities. Figure 3 gives the relationship of cluster to mortality.

Figure 3. Proportion of Patients by Cluster Who Died
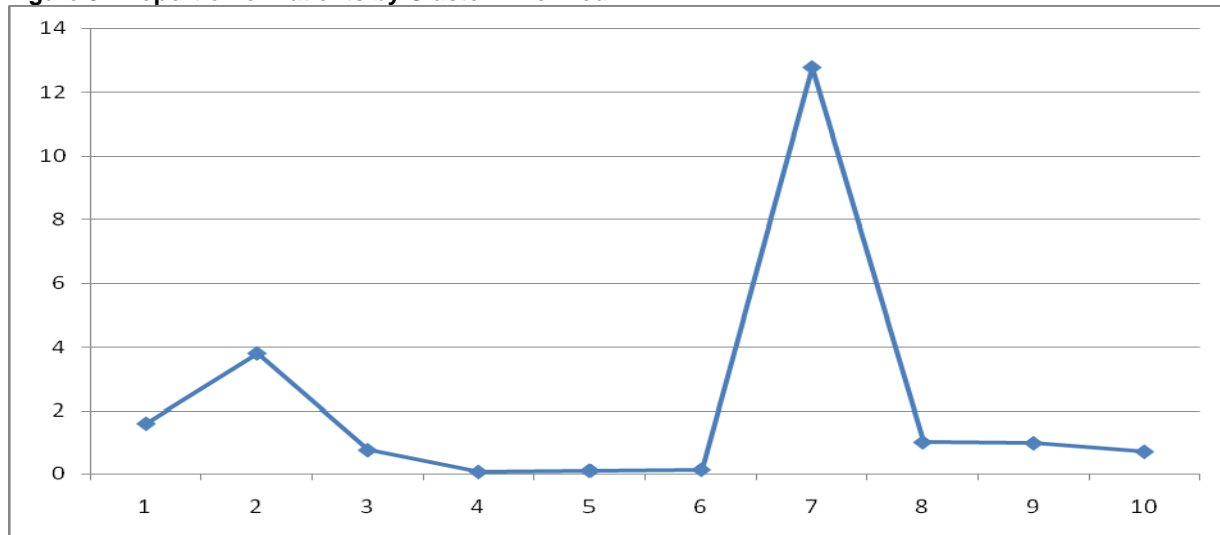
It shows that cluster 7, with septicemia, is at very high risk compared to the remaining clusters and that 4,5, and 6 have negligible mortality. These three clusters have patients with no additional co-morbidities. Clusters 3,8,9, and 10 all have similar mortality risk.

Since the swine flu targets those of younger ages, we filter the data set down to those patients of 30 years of age or less. We want to see what the clusters will be, and the risk of mortality in this population. It will be more relevant to the prediction of swine flu deaths. Figure 3 gives the mortality rate for these patients by the clusters above. Overall, there is a reduction by a factor of 6 in the proportion who died who were also under 30 years of age. Table 2 gives a new set of clusters for this reduced, younger population.

Figure 4. Proportion of Patients Under 30 by Cluster Who Died

Table 2. Text Clusters for Patients Under 30 with Influenza

Cluster #	ICD9 Codes	Translation	Frequency	%
1	487, 4871	Influenza, Influenza with other respiratory manifestations	437	0.080
2	2765, 0340, 034, 4878, 276, 487	Volume depletion, Streptococcal sore throat, Streptococcal sore throat and scarlet fever, Influenza with other manifestations, Disorders of fluid, electrolyte, and acid-base balance, Influenza	156	0.028
3	27651, 2765, 558, 4871, 487, 5589	Dehydration, Volume depletion, Other and unspecified noninfectious gastroenteritis and colitis, Influenza with other respiratory manifestations, Influenza, Other and unspecified noninfectious gastroenteritis and colitis	371	0.068

Cluster #	ICD9 Codes	Translation	Frequency	%
4	493, 3051, 079, 282, v0481, 49390	Asthma, Tobacco use disorder, Viral and chlamydial infection in conditions classified elsewhere and of unspecified site, Hereditary hemolytic anemias, Need for prophylactic vaccination and inoculation against certain diseases-Influenza, Asthma, unspecified	667	0.12
5	008, 288, 2880, 372, 250, 27651	Intestinal infections due to other organisms, Diseases of white blood cells, Neutropenia, Disorders of conjunctiva, Diabetes mellitus, Dehydration	817	0.15
6	V0481, 648, v270, 64891, v27, 659	Need for prophylactic vaccination and inoculation against certain diseases-Influenza, Other current conditions in the mother classifiable elsewhere, but complicating pregnancy, childbirth, or the puerperium, Single liveborn, Other indications for care or intervention related to labor and delivery, not elsewhere classified	303	0.055
7	3829, 78039, 4870, 382, 518, 780	Unspecified otitis media, Other convulsions, Influenza with pneumonia, Suppurative and unspecified otitis media, Other diseases of lung, General symptoms	1902	0.35
8	647, 49391, v03, v30, 49392, 493	Infectious and parasitic conditions in the mother classifiable elsewhere, but complicating pregnancy, childbirth, or the puerperium, Asthma, unspecified with status asthmaticus, Need for prophylactic vaccination and inoculation against bacterial diseases, Single liveborn, Asthma, unspecified with (acute) exacerbation	549	0.10
9	78703, 787, 78701, 78791, 276, 2765	Vomiting alone, Symptoms involving digestive system, Nausea with vomiting, Diarrhea, Disorders of fluid, electrolyte, and acid-base balance, Volume depletion	136	0.02
10	466, 46610, 46611, 4660, 487, 4871	Acute bronchitis and bronchiolitis, Acute bronchiolitis, Acute bronchitis, Influenza, Influenza with other respiratory manifestations	139	0.03

Note that the clusters here are much milder compared to the clusters for the total population. For this reason, a much lower mortality rate should be projected for swine flu compared to the seasonal flu.

Influenza Vaccine and VAERS

We also want to investigate the potential for adverse effects from the vaccine. The Vaccine Adverse Events Reporting System is a voluntary submission process. The reports are not validated, but they are investigated for patterns. We use ten years of reporting for flu vaccine to investigate the reports for patterns. For ten years of data, there are just over 20,000 records of adverse events for the flu vaccine. Of that number, 233 report Gillain-Barre syndrome. In addition, there were 484 reports of life-threatening conditions, 7058 trips to the emergency department, 1552 patients were admitted to the hospital, and 329 reports of disability. The average number of days the admitted patients are hospitalized is 11. These risks must be compared to those that result from the flu.

CONCLUSION

The number of cases of swine flu peaked in November, 2009. The flu vaccine became plentiful in December, 2009 as the number of cases were decreasing. (Anonymous-swineupdate 2009) Yet the CDC still recommended vaccination because the vaccine was plentiful even though the risk of exposure and spread was much reduced. In January, 2010, there was a glut of swine flu vaccines as well as vaccines that were recalled because of a lack of potency. (Anonymous-CBS 2009) Fewer individuals than expected used the vaccine for swine flu. (Anonymous-Swine 2010; Whalen and Gauthier-villars 2010) In fact, the head of health for the Council of Europe suggests that this was a false pandemic spread by the drug companies in spite of the fact that the World Health Organization identified swine flu as a pandemic. (Hills 2010) The fears, too, that hospitals would be overrun because of the number of cases of swine flu were never realized and the healthcare system had no difficulty in managing the number of patients. The number of total cases, too, had to be revised downward (Figure 5). According to the Centers for Disease Control, there were 1735 deaths and 37,778 hospitalizations. (Anonymous-CDC 2010) The 1735 deaths included 293 pediatric deaths. These figures are considerably smaller than predicted using the models and assumptions concerning infection rates. The CDC states, "The proportion of deaths attributed to pneumonia and influenza was below the epidemic threshold."

Figure 5. CDC Graph of Occurrence of Swine Flu (http://www.cdc.gov/flu/weekly/)
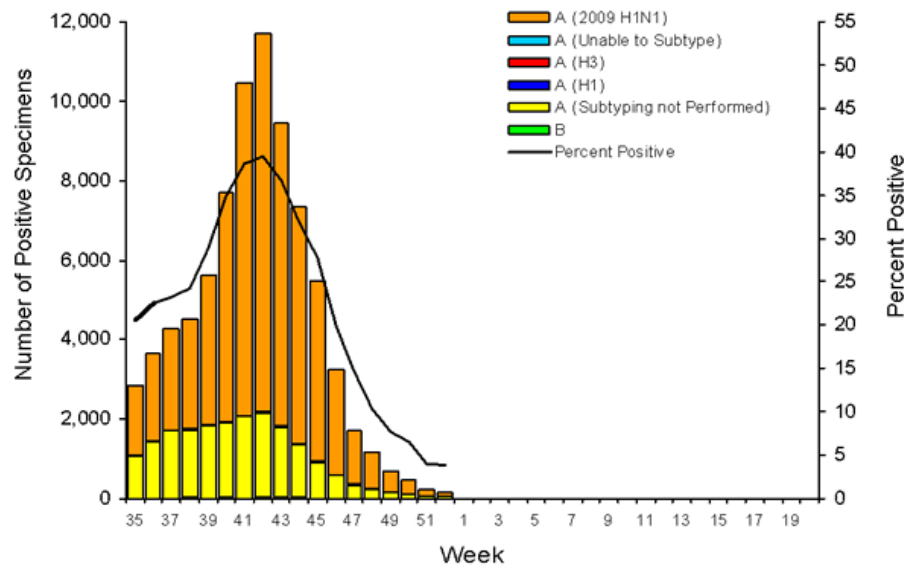
As it turns out, the swine flu may have been beneficial. Because it was more contagious than the more usual seasonal flu, very few people contracted the seasonal flu, instead getting the milder swine flu. Therefore, there were fewer hospitalizations and deaths than usually occur during flu season. At the same time, the swine flu was not as contagious within households, limiting the acquisition of the infection. (Cauchemez, Donnelly et al. 2009)

Public health officials tend to over-estimate the number of people infected with the flu, and the number of deaths. They want to arrive at the worst possible scenario so that preparations can be made to accommodate this worst case. When you as an individual make decisions, you need to examine the predictions of risk in those terms, and to determine your potential exposure to infection, and your potential to have a serious secondary infection because of the flu before making a decision on vaccination.

Public health officials are primarily concerned with society generally and tend to dismiss individual risk and potential for harm. As an individual, you need to investigate the risks and benefits for yourself and to make a decision concerning vaccination for the flu, especially for the swine flu.

In order to examine the occurrence, we need to be able to count the total number of occurrences of the flu in a given year. However, that is difficult to do since not everyone with the flu will see a physician for a diagnosis. Also, as flu symptoms represents many different diseases, the flu diagnoses must be validated in some way in order to have a reasonable final count. The Centers for Disease Control issue a weekly report on flu occurrences at http://www.cdc.gov/flu/weekly/. They rely upon hospital admissions, either inpatient or outpatient, as well as all testing for the swine flu. The report gives a total of 2,110 seasonal human influenza viruses [1,189 influenza A (H1), 227 influenza A (H3) and 694 influenza B viruses] collected by U.S. laboratories since October 1, 2008, and 382 2009 influenza A (H1N1) viruses. The 1,189 H1 cases are related to H1N1. The number of reported cases is considerably different from the high predictions of occurrence. Without more accuracy in the predictions, they will tend to be disregarded. All of this information must be used to estimate the parameters to predict mortality and occurrence.

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