Passive immunity to pandemic H1N1 2009 through swine flu parties

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Abstract

The general population is concerned about the probable devastating effects of pandemic H1N1 2009. Based upon the 1918 Spanish flu pandemic, scientific publications and theories, the idea that swine flu parties may achieve passive immunity against pandemic H1N1 2009 has been proposed. Public health officials have asked the general public not to resort to these parties. However, no concrete evidence for the reasoning behind this recommendation has been given. In this paper, we have dynamically modeled the effect of swine flu parties on the immunity achieved and associated mortality for a period of two years. The simulations show that the public should not organize or participate in swine flu parties as they will likely increase swine flu-associated mortality.

Key words: system dynamics, swine flu parties, pandemic H1N1 2009, passive immunity

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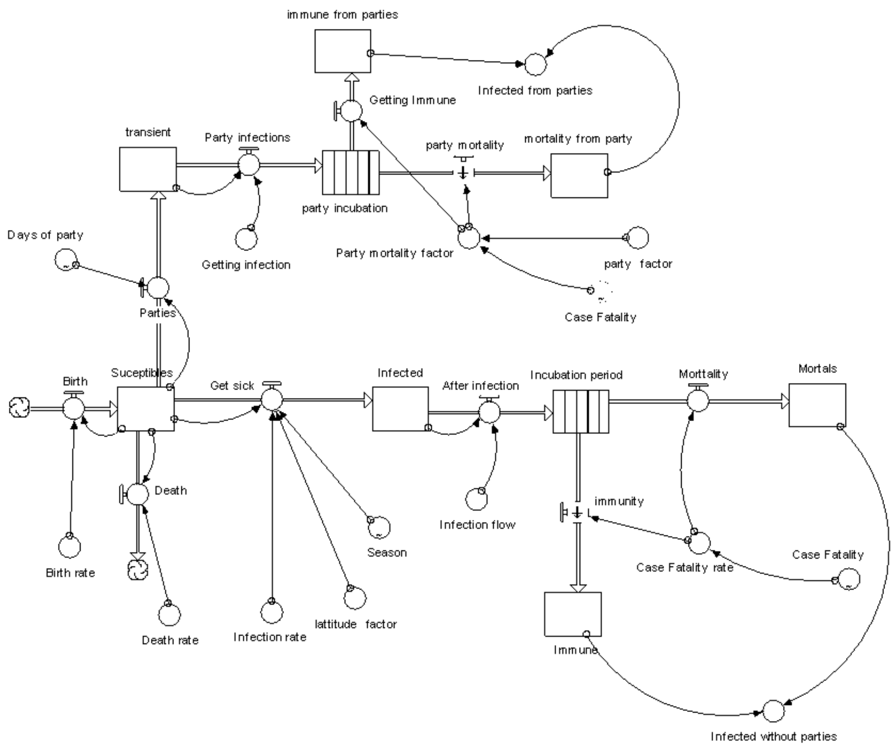
Introduction

Swine flu parties have generated interest among health officials and the general public wary of deadly strains of the virus, especially in developing countries and resource economies. The concept of swine flu parties is based upon achieving passive immunity against the pandemic H1N1 2009 similar to the immunity achieved during the first wave of the Spanish Flu pandemic of 1918 [1] and chicken pox parties. People exposed to a less virulent strain of the virus may achieve immunity from the highly virulent strain of the virus and cross-clade viruses. Officials of the British Medical Association's public health committee and US Centers for Disease Control and Prevention have warned against deliberately exposing people to the virus [2]. Britain's Chief Medical Officer has also stated that such parties are the result of "seriously flawed thinking" [3]. The scientific community is trying to assess the infectivity and pathogenesis of the virus. Scientists have tried to assess these parameters in ferrets, which generally mimic the infection in humans [4]. Pandemic H1N1 2009 colonizes the upper respiratory tract, lower respiratory tract, and the gut [4]. It is more virulent and causes more severe and extensive disease than seasonal influenza, but is much less virulent and lethal than the 1918 Spanish flu virus and circulating H5N1 avian flu [5]. The United Nation's top health official has opined that the spread of the virus worldwide is now unstoppable [6]. It has been suggested that there is relative protection for persons who were exposed to H1N1 strains during childhood before the 1957 pandemic [7]. One expects a reward of lifelong "friendship"—read "immunity"—to pandemic H1N1 2009 after surviving an attack. The general public is not fully aware of the reasoning behind the logic for not attending the parties and is frustrated at not knowing what course of action to take if a highly lethal variant of the virus descends. Through simulation, we attempt to assess the consequences of swine flu parties in the absence of effective vaccination.

Material and methods

Simulation software Stella version 7.0.3 (ISEE systems) was used to develop a compartment model using epidemiological parameters SIR (Susceptibility, Infectivity, and Recovery) [8]. The model was developed and applied to predict pandemic H1N1 2009 progression in the USA, Australia, and Mexico. The infection coefficients for the model were derived using linear regression from the data published up to July 2009 by the World Health Organization (WHO) [9] and Centers for Disease Control (CDC) [10]. The starting date for the initiation of the model for a country was the first date when pandemic H1N1 2009 cases were reported by the World Health Organization for that country. For

Figure 1. Line diagram of the simulation model of immunity and mortality of pandemic H1N1 2009.



Mexico and the United States of America (USA), the basic model data are from 10 weeks, while for Australia they are from 6 weeks. The model is simulated for a period of two years from the first reported date by the WHO. Euler's method of integration was used for the simulation with a time interval (dt) of one day. The initial population, birthrate and mortality rate of the three countries were taken from the CIA World Factbook [11].

Results

The line diagram for the model developed is shown in Figure 1. The pandemic H1N1 2009 infection rate for Australia (6.238 per million population per day) was higher than that of the USA (1.773 per million population per day) and Mexico (1.282 per million population per day). The USA's higher rate over Mexico may be attributed to difference in weather between Mexico and USA as Mexico lies within latitudes 16^{o}N and 32^{o}N while USA lies between 25^{o}N and 50^{o}N. The winter season coefficient factor for USA was calculated to be 3.5 ± 0.37 and is based upon the winter season infectivity rate of Australia. Similarly, the summer season coefficient factor for Australia (0.25 ± 0.04) was calculated based upon the summer season infectivity rate of the USA and Mexico. The crude case fatality rates were 5.70, 11.96, and 1.88 per 1,000 cases for the USA, Mexico, and Australia respectively over the reported period. In the last 15 days, the crude case fatality rates were 7.85, 2.27, and 3.14 per 1,000 cases for USA, Mexico, and Australia respectively and these numbers were used in the model to predict future values. These rates show an upward trend in the USA and Australia but a downward trend in Mexico. Mexico's downward trend may be due to fewer numbers of reported/diagnosed infections during the early stages of the spread of the disease. The model was simulated for two years to predict the number of pandemic H1N1 2009 infected persons and the associated deaths. The results are shown in Table 1.

A second model was built with a swine flu party construct added. Ninety percent of the population going to the parties was assumed to get exposure to the pandemic H1N1 2009 virus. It was assumed that 0.1% of the population per day attends the parties to receive passive immunization. The parties start after

Table 1. Immune population and mortality for Pandemic H1N1 2009 with and without Swine Flu parties as predicted by simulation.

Country	Days since start	Immune without Swine Party	Immune due to Swine Party	Deaths without Swine Party	Deaths with Swine Party
USA	70	37,329	-	213	-
	365	331,837	70,000,283	2,524	54,993
	730	670,920	136,261,232	5,185	107,049
Australia	42	5376	-	10	-
	365	21,873	4,818,028	57	1,513
	730	43,761	9,375,075	126	2,945
Mexico	70	9,746	-	117	-
	365	87,010	25,402,114	293	5,768
	730	176,777	49,653,853	497	11,274

10 weeks of reported cases in a country. The results of the population developing immunity due to parties and without parties are exhibited in Figure 2 and Table 1. The case fatality rate of persons attending parties is assumed to be 10 times less than the mortality from natural pandemic H1N1 2009 transmission, as those exhibiting adverse symptoms are likely to get immediate medical care if needed. In the USA, 22.8% of the population would achieve immunity from pandemic H1N1 2009 after Year 1 and 44.2% after Year 2. Similarly, in Australia, 22.8% of the population would achieve immunity from pandemic H1N1 2009 after Year 1 and 44.2% after Year 2. The corresponding values for Mexico were predicted to be 22.7% and 43.8%. The mortality for the USA, Australia, and Mexico are predicted to be 179.2 per million per year, 71.7 per million per year, and 51.64 per million per year, respectively. These values are compared to natural mortality without swine flu parties in Figure 3. The Monte-Carlo simulations were conducted to simulate the effect of best- and worst-case assumptions based upon the confidence intervals of linear regression model coefficients and changes in mortality rates. The parties were found to be bad in all scenarios except when the mortality rate from H1N1 is less than or equal to the normal mortality rate of a country.

The model has a few limitations. The model is based upon coefficients derived from data published by the WHO and CDC up to 10 July 2009. Patient-specific immune determinants such as age, gender, previous disease, or immunological characteristics have not been considered or adjusted for in the model. Crude case fatalities were used and were not adjusted for any confounders. The effect of any breakthrough vaccination—prophylactic or therapeutic—has not been considered in this model or the simulation thereof. Any mutations of the virus or the effects of different types of influenza infecting the same individual have not been considered. The contribution of swine flu parties to unintended further spread of pandemic H1N1 2009 or mutations of the virus has not been accounted for. Even with these limitations, the model is able to predict the immunity achieved and mortalities expected for guidance and policy analysis.

Discussion

Most of the people who attend a swine flu party will become ill with the virus. Based upon the person's immune system, he or she will develop antibodies against the virus and therefore may become immune to new infections from the virus in the future. However, based upon the virulence and concentration of the virus inhaled, the immune system may not be able to cope with this instance of the disease and the person's health may deteriorate, leading to death. The high use of drugs to combat a surge in cases may increase resistance against the drugs.

Summer camps are like swine flu parties, the exception being that the students are in contact with probable pandemic H1N1 2009 cases for a longer period. Contact pandemic H1N1 2009 cases in an organized setting such as this will be in the initial infectivity stage of the virus colonization. Indeed, some camps have already been hit by flu cases in the United States [12]. The majority of these cases were assumed to be pandemic H1N1 2009 in the absence of proper and speedy tests. "This flu is not over," said Dr. Thomas R. Frieden, the head of the Centers for Disease Control and Prevention, describing its continuing spread in more than 50 summer camps

Figure 2. Immune population (%) at the end of one year of pandemic H1N1 2009 with or without swine flu parties as predicted by simulation.

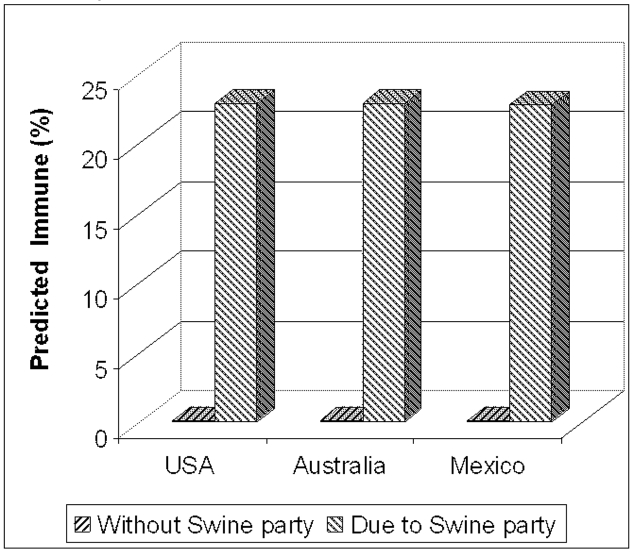
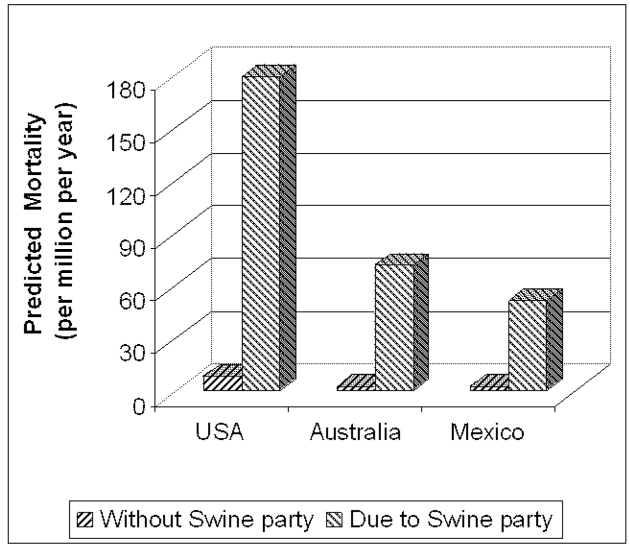


Figure 3. Mortality per million per year of pandemic H1N1 2009 with or without swine flu parties as predicted by simulation.



and the initial detections of three cases resistant to the drug Tamiflu [12].

Per World Health Organization (WHO) guidelines, [13] the following public health measures are recommended to individuals and communities as the most feasible measures available to reduce or delay disease (morbidity) caused by pandemic influenza: social distancing, respiratory etiquette, hand hygiene, and household ventilation. In cases of mild illness, patients should be provided with supportive care at home by a designated caregiver and only referred to health care facilities if they deteriorate or develop danger signs. Separation of sick from well individuals as well as rigorous respiratory etiquette and hygiene measures, should be practiced. In health care settings, a system of triage, patient separation, prioritization of use of antiviral medicines and personal protective equipment (PPE) according to risk of exposure, and patient management should be in place to focus efforts on the most effective interventions to reduce mortality and any further morbidity.

Conclusion

Deliberate exposure of individuals to pandemic influenza would increase morbidity and mortality as observed in measles in Niger, Nigeria, and Chad [14]. This escalation will add an additional burden on the public health systems and hospital facilities of developing countries and resource-limited economies. Individuals with other underlying health conditions as HIV, neurological diseases, respiratory complications [7] and cardiovascular diseases would be at higher risk of complications and higher mortality by deliberate exposure as well as indirect contact with exposed individuals. It is concluded that even though an appreciable amount of the population of a country can achieve passive immunization from swine flu parties in the absence of vaccination, this result comes at the cost of a high number of individuals who might have an adverse outcome by natural pandemic H1N1 2009 transmission. It is recommended that people do not resort to swine flu parties to achieve the low-cost passive immunity as mortality would increase.

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