

## PANDEMIC MITIGATION: BRINGING IT HOME

TOM REICHERT

Entropy Research Institute  
345 S Great Rd, Lincoln MA 01773, USA

**ABSTRACT.** In the US, national, regional and even institutional plans for ameliorating the effects of pandemic influenza focus on stockpiling antiviral medications, early production and distribution of vaccine, mass and personal social distancing, and a number of personal hygiene activities. Essential personnel are the first scheduled to receive preventive and therapeutic pharmaceuticals, followed by high risk groups, the largest of which are the elderly. Specific recommendations for protection embody a bunker mentality with a time horizon of two weeks, emulating preparation for a natural disaster. The epidemiology of pandemic influenza is scarcely considered.

We summarize here the envelope of mortality attributable to epidemic and pandemic influenza in the last 90 years of the last century as a lead in to a presentation of the multinational case age distribution of the novel H1N1 pandemic of 2009. We discuss the sparing of elderly subpopulations in pandemics and the subsequent abrupt resurgence of mortality in the spared age groups as drift variants emerge. The general decline in the baseline of age-specific excess mortality in economically developed countries is characterized and its importance assessed.

Models of acute and chronic care facilities are discussed and an argument is advanced that society as a whole as well as acute care facilities cannot be protected against incursion and widespread infection in pandemics of severity above low moderate. The key findings of models of chronic care institutions and others that can control public access, such as corporations, are used to describe programs with a realistic chance of providing protection in even severe pandemics. These principles are further mapped onto individual residences. Materials directing institutional and home planning are cited.

Key takeaways are

1. Because a subset, often large, of the elderly population is usually spared in pandemics, while younger persons never are, resources, both pharmaceutical and non-pharmaceutical should be directed to children and working adults.
2. The steadily declining baseline of age-specific influenza-attributable mortality has not been affected by rising national programs of vaccination. Nevertheless, pandemic influenza now occurs in a setting of generally lowered mortality/morbidity.
3. Protection from incursion and dissemination of pandemic viruses of more than moderate severity/infectivity is possible only with rigorous implementation of sequestration-in-place regimens coupled with decontamination and quarantine procedures for re-entry together with wearing barrier protection while out in the external world. The social disruption this implies increases with the infectivity of the emerging viruses.

---

2000 *Mathematics Subject Classification.* Primary: 58F15, 58F17; Secondary: 53C35.

*Key words and phrases.* Pandemic mitigation; excess mortality; protecting the home, protecting institutions.

1. **As pandemics go-** In June of 2009, the novel H1N1 pandemic had just begun to unfold. We had only the first reports of cases from Mexico suggesting high levels of toxicity, mitigated somewhat uncertainly by first reports from the US and Europe suggesting a more moderate level. The specter of a catastrophe of the dimensions of the H1N1 pandemic of 1918/9 prevents any of us from dismissing early accounts entirely; but a recent historical perspective is useful.

Figure 1 demonstrates that the terrible swath cut by the 1918/9 pandemic was but a wrathful excursion in a period of extraordinary mortality caused by the influenza virus extending to 1937. Preceding the pandemic was a short period of unprecedented mortality punctuated by the pandemic itself. Thereafter, virulent epidemics echoed the pandemic at 3 or 4 year intervals. This period of pestilence ended abruptly after 1937, the years of first commercialization of antibiotics. Deaths attributable to pneumonia and influenza fell by 50 percent over the subsequent decade. This dramatic decline extended as a new baseline against which the pandemics of 1957/8 (H2N2) and 1968/9 (H3N2) were arrayed. In the cold objectivity of our Figure, these pandemics are even difficult to distinguish from surrounding “severe” epidemic seasons, and we now know that the pandemic of 2009/10 will appear as a mild epidemic when added to the tableau of Figure 1.(Figure 1)

By September of 2009 based on 56,000 case reports, we were able to develop a good estimate of the global picture of cases of novel H1N1 (Figure 2) and provide a rationale there for [1]. In epidemic years in the recent two decades, over 90 percent of cases were older than age 65 [2, 3]; however, in the 2009/10 pandemic, 75 percent of the cases were age 30 or younger. Possibly related to the low median age for cases, the number of deaths attributed to the pandemic, so-called, excess deaths, in the US has been estimated to be 12,000 [4], a remarkably low number compared to seasonal averages of 35,000-43,000; and WHO claims documentation for only a little more than 18,000 deaths worldwide [5]. Of course, the actual number of deaths caused by novel H1N1 was much larger; but this figure is the basis of comparison with other pandemics and with epidemics of seasonal influenza (Figure 2).

On the basis of sequence data and related experiments in mice, we suggested [1]

- that the novel H1N1 virus was similar to viruses that had circulated in humans before 1947, and
- that the antigenic sites of the descendants of the pre-1947 viruses were protected from immunologic scrutiny and reaction by mutation and especially by the presence of sites for the binding of sialic acids adjacent to known immunogenic sites. This surmise has been verified by subsequent structural, point mutation and antibody binding studies [6, 7].

1.1. **In at least 4 of the last 5 pandemics, the elderly were spared.** It is well known that the elderly were relatively spared in the pandemic of 1918. It is a matter of argument (soon to be settled) whether the H2N2 virus responsible for the 1957/8 pandemic was recycled. However, it is clear that in the H3N2 pandemic of 1968/9, persons over the age of 77 were spared [8]; and only persons younger than age 26 were adversely affected in the mini-pandemic of 1976/7 when H1N1 viruses (descendants of viruses dated about 1950) rejoined circulation. Therefore, in at least four of the last five pandemics, the viruses responsible were recycled in the sense that they immunologically resembled viruses that had circulated within the lifespan of living humans [9].

**1.2. In the economically developed world, mortality attributable to influenza has declined steadily.** In economically developed countries (EDC) over the 32 years from the H3N2 pandemic to the end of the century, age-specific all-cause mortality has declined substantially. In the US, mortality rates declined about 50 percent for the non-elderly, and for the elderly, nearly 50 percent for young elderly (ages 65-69) down to about 25 percent for 90 yr olds. Yet, despite this substantial decline, a group including myself found no concomitant decline in mortality attributable to influenza over the same period [3]. In particular, there was no decline in excess mortality after 1980, when vaccination rates among the elderly increased steadily. This was a provocative finding, but it was somewhat weak in that it rested on the inability to find a trend in the admittedly scattered data representing the annual mortality impact of influenza, itself an inferred quantity. A direct extension of this study to other economically developed countries allowed the definition of trends in most elderly age groups in Australia and France. The trends there also showed no change after the widespread dissemination of influenza vaccines; and trends became statistically significant for influenza B- and H1N1-dominated seasons even in the US and Canada when longer data series were considered. (Reichert TA, Pardo SA, Valleron A-J, Tam T, Hampson A, Christensen RA, Sharma A: Trends in influenza-attributable mortality in four countries: Implications for national vaccination programs. Options for the control of influenza VI, Toronto 2007. Proceedings not yet published). The observed trends were such that extrapolation to the present suggested that influenza-attributable mortality during seasonal influenza pandemics has dropped to nearly negligible values for persons below age 70. It should be obvious that the basis of this decline, which

- extends across all age groups,
- extends across at least two A-type virus epochs (H2N2 and H3N2),
- differs in slope by EDC country, but
- preserves an apparently universal exponential increase in mortality with age,
- must lie outside the influenza virus itself, including direct efforts to control it.

Prior to the emergence of the H1N1 pandemic virus of 2009, virtually all seasonal epidemic deaths occurred in persons over age 70. However, the total number of influenza-attributable deaths had remained about the same, despite decreasing age-specific mortality rates at all ages only because all-cause mortality rate decreases have been and continue to be so large that the number of elderly continues to increase everywhere in EDC.

**1.3. Powerful implications for both epidemic control and pandemic planning are great, and are currently not integrated.** In pandemics in which the emergent virus is recycled,

1. Persons born before the date of last circulation of viruses highly similar to the novel virus will not, as a group, need special protection or vaccination
2. Social distancing and other isolation techniques should be focused on the young and working-aged
3. Because the baseline of both all-cause and excess mortality in those not elderly has already become very low and both continue to recede, public sympathy for pandemic increases in mortality is likely to be highly unstable.

Because increases in influenza-attributable (excess) mortality, pandemic over epidemic, will occur largely in the young, if the total number of deaths is large, public reaction will be horror, indignation and outrage directed to inadequate preparation.

If the total number of deaths is small, public integration is likely to be a sense of manipulation by the media and of conspiracy between the government and industry, cf [10]. Preparation for the novel H1N1 Pandemic of 2009 was necessarily inadequate. A comprehensive review of influenza vaccine production and dissemination capacity found that influenza vaccine was produced in only 11 countries with total production at 364 million doses, about 5 percent of the earth's population [11]. Industry and national and international disease control agency cooperation is essential if response to any pandemic is to be rapid and comprehensive. The current rhetoric is lamentable, but predictable.

#### 1.4. **The elderly will get their comeuppance when novel H1N1 drifts.**

There is another concomitant of the pandemic sparing of the elderly, immune escape, or more poetically, the “Wages of Original Antigenic Sin” [12]. Under the doctrine of original antigenic sin, the immune response of an individual is conditioned by their first exposure to an influenza virus in their infancy [13]. This conditioning results in the individual continuing to make a dominant primary response to the original virus, even when presented with drifted descendants of the original virus. The persistent and increasingly deluded original sin response eventually results in susceptibility for individuals previously immune to less drifted variants. In the northern hemisphere, in the winter of 1974/5, age-specific excess mortality rates for elderly above age 77, previously relatively depressed, suddenly leapt up as the not-especially-virulent Victoria variant swept into circulation.(c.f., Figure 1 in ref 6). We should expect recombination with the previously circulating H1N1 human viruses as well as new drift pathways for the emergent viruses. Given the low virulence of novel H1N1, the consequences may well be proportionately less dire. In any case, the observed immunity in those over age 62 should be anticipated to wane, and the apparently universal exponential increase in influenza-attributable mortality with age will undoubtedly reappear.

1.5. **Has the Herald sounded?** Both the 1918 and the 1957/8 H2N2 pandemics were preceded by spring waves of infection which were relatively mild compared to those of the subsequent winter. The H3N2 virus emergent in 1968/9 produced severe infections only in Canada and the US (northern North America, nNA) [8]. The rest of the world enjoyed an influenza season more mild than previous seasonal epidemics. However, the second and third seasons were severe everywhere, except for the sparing of the elderly. The first pandemic season of novel H1N1 was more mild in its total effects but more severe in its impact on children and young adults than recent seasonal influenza. The re-introduction of H1N1 viruses to circulation in 1977 was without a herald event. It remains to be seen whether a drift or recombination event will transform the thus far docile virus into something more sinister.

1.6. **Pandemic mitigation: Can society be protected?** Pandemic viruses, by definition, are highly contagious and the majority of the population is not immune. Therefore, in the ordinary course of unaltered life, such viruses should spread throughout the population. In seasonal epidemics, population attack rates are typically in the range of 5 to 30 percent depending in seasons immediately post-pandemic, on time from emergence, and later, on the drift distance from previous strains. In pandemic seasons, attack rates of 50 percent are plausible in society at large. Physical isolation at the community level offers a degree of protection, but in a highly interconnected world, this barrier to infection is illusory. The tale of

American Samoa and its governor, Cmdr John Poyer, in 1918 is illustrative [14]. After learning of widespread mortality, acting without specific orders, Poyer instituted strict quarantine of the Island. Ships were refused docking privileges unless the matter was urgent, in which case the passengers were held in strict isolation and examined daily. Even mail pouches from neighboring islands were refused. The citizens were enlisted in shore patrols to keep small boats from landing. There were no deaths from influenza on American Samoa. Whereas, 22 percent of the population on neighboring Western Samoa perished; and most of Polynesia experienced mortality rates between 30 and 40 percent.

The cornerstone of the US pandemic plan before 2009 was isolation-in-place of pandemic outbreaks, with the underlying assumption that such outbreaks would involve adaptations of avian influenza and would occur in parts of the world distant from the US. It is wonderfully ironic that the first samples of the novel H1N1 virus were obtained from two children in Los Angeles. The chief tools of pandemic control, vaccination and antiviral medications have been shown to be dramatically inadequate. The first doses of the novel H1N1 vaccine were released in October, 2009, five months after the pandemic began and by which time the virus was circulating freely worldwide. In the US, antiviral medications quickly became generally unavailable, and what resources were available required a clinic visit. Therefore, except for private stockpiles, only a small fraction of patients received oseltamivir (Tamiflu) within 24 hours of onset of symptoms.

The imposition of social distancing practices such as mask wearing, the closing of schools and the cancellation of public assemblies, was widespread but haphazard. I know of no account that claims that the pace of infection was reduced in any instance. There is a literature that suggests that certain American cities were able to reduce the impact of the 1918 pandemic virus somewhat by the imposition of social distancing and other Non-Pharmaceutical Interventions (NPIs) [15], [16]. However, there is also specific refutation [17]. More importantly, even the staunchest advocate characterized the application of these measures as begun too late and halted too soon [15]. We must conclude that absent the sort of control and physical circumstances available to Cmdr Poyer, society as a whole will be unable to prevent infection early in pandemics limited only by the infectiousness of the virus and the actions of small groups.

**1.7. Can institutions within society be protected?** If we take the American Samoa experience, the observations on society in general above, and the limitations on vaccine and antiviral availability as a guide, it would seem unlikely that any institution with unfettered public access will be able to prevent pandemic spread to and within its walls. Indeed, it has been demonstrated that for viruses with an infectivity above moderate (In this study, an  $R_0$  value  $\geq 2$ ), acute-care hospitals will be overrun by the pandemic virus no matter how rigorously they deploy antivirals and NPIs [18].

What then of institutions that do have the capacity to control public access? In the specific context of chronic care hospitals which can control both patient admissions and visitor access, stochastic compartment models suggest that even if current recommendations for patient-visitor interactions and social distancing practices are implemented rigorously, viral introduction and dissemination will occur in all such institutions [19]. These models further identified staff re-entry as the key pathway of contagion. Models that introduced notions of self-sequestration at home while away from the institution and work schedules that keep employees in-residence at

work for multi-day intervals were then able to demonstrate plausibility of protection from both introduction and intramural spread over a large range of pandemic infectivities.

The key insight is that for moderate and severe pandemic viruses, protection of institutions is not plausible without substantial social disruption that increases with the infectivity of the emergent virus. Handwashing, avoiding handshakes and hugs, coughing into sleeves and cancelling meetings are grossly insufficient to achieve control in any pandemic more than mild.

Institutions such as public utilities have developed pandemic preparedness plans that reduce external services to an urgent minimum; and include assumptions of absenteeism of up to 50 percent. These utilities avow a high degree of confidence in the success of these plans. I know of no such institution, however, that has considered a program of multi-day assignments on-site coupled with self-sequestration at home when off-duty. I must, therefore, be somewhat sanguine about the true efficacy of such plans; and therefore, must be guarded in accepting a general assurance that essential services will be maintained in even the most severe pandemic.

Corporations are also institutions that can, in principle, control public access. Pandemic plans for corporations range widely in thoroughness and intent. A general rule for manufacturing facilities using assembly line technology is that the manufacturing process effectively stops at absenteeism rates above about 20 percent. I find it interesting that none of the several corporate plans I have seen have considered a program of calling back older, possibly retired workers in the event of a severe pandemic. A pandemic of more than moderate proportions will be economically debilitating. A severe pandemic could be economically devastating. Companies that do plan for such an event could completely upset pre-existent market structures simply by remaining functional while their competitors falter and cease production entirely.

**1.8. Can the individual home be protected?** The US Center for the Prevention and Control of Disease (CDC) has issued and updated guidelines for mitigating the effect of pandemic influenza in the individual home [20]. This link leads to a checklist, the thrust of which is direction for a two week period of relative (as distinct from 'strict') isolation. The supplies to be assembled are specifically likened to those that might also be needed in "power outages and (natural) disasters". Aside from admonishing adults to stay home from work if they feel ill, the only specific actions are three teaching tasks directed at children in the home, and a conversation on treatment preferences in the event of illness.

The typical epidemic influenza season averages 11 weeks long. Pandemic influenza classically appears in recrudescing waves, each of this length or longer, of varying infectivity and severity. It is plausible to obtain, store and maintain a two week supply of food and emergency equipment. It is not plausible for ordinary folk to do the same for an 11 week period, let alone for a series of waves, each months in length. The models for protecting chronic care facilities demonstrate that there is no viable alternative to a strategy that incorporates strict isolation with at least episodic sojourns into the external world which must be mated with rigorous re-entry procedures. Table 1 lists the tactical elements essential to preventing incursion of a pandemic virus into the home and mitigating its effects. It represents a mapping of the procedure derived from the modeling of chronic care hospitals and adapted for and piloted in use in an operating facility of that type [21] onto the setting of the home [22].

### 1.9. Critical elements of pandemic mitigation.

- Define and Defend a virus-free perimeter
- Stay within the perimeter as much as possible
- Wear protective clothing outside the perimeter
- Practice social distancing religiously
- Follow the Re-entry procedure rigorously
- Isolate and/or Decontaminate everything that must come inside the virus-free perimeter

Table 1. Essential elements in protection of the Home

The cornerstone of home protection is the definition and defense of a virus-free perimeter (Figure 4). For pandemic viruses with infectivity above moderate, the models suggest that sequestration-in-place, i.e., isolation with controlled re-entry, is essential. Pandemics are very different from other “natural” disasters. Unlike fire, earthquake, hurricane, flood and even terrorist attack, failure of basic utilities such as electricity, natural gas, telephone, pre-recorded television programming, water and sewer is much less likely in a pandemic except in the event of a prolonged wave of the most virulent and infectious imaginable viruses. However, also unlike natural disasters, all packaging and all persons considered for entrance into the virus-free home perimeter must be considered to be contaminated and must either be isolated for a period sufficient to presume viral dessication or be specifically decontaminated. (Figure 3)

To survive a moderate or severe pandemic, the models indicate that persons at home will have to remain sequestered except when the re-supply of some essential becomes necessary. Social distancing must be absolutely rigorous. Adults should work from home if this is at all possible. Work outside the home should be considered to be an event in which contamination is likely and quarantine procedures and facilities must be built into re-entry. Children should be home schooled, and as a corollary not permitted to attend public gatherings. All communication should be electronic. Guests should be held in the decontamination space, or if long-term, put through the quarantine process.

Entry into the external world passes through the airlock of the decontamination space. Masks, gloves, hats/hair covering and an external clothing layer are the armor of public travel. Contact should be minimized and distancing procedures of all types possible should be utilized. On return, decontamination should be thorough and begin with the shedding of the external clothing. Those elements that can be washed should be carried to that facility, preferably in a clean bag. Everything that plausibly made contact with external material should be specifically decontaminated, prepared for washing, placed into timed isolation or discarded. Decontamination procedures per se will not be discussed here; however, everything that is to enter the perimeter must be specifically subject to decontamination or isolated for at least 72 (better 96) hours. Even the mail must be decontaminated. Absent certified virus-free kitchens, takeout food will not be safe. If resources permit, a separate living subunit within the perimeter should be defined for the implementation of quarantine procedures. This would be used not only for re-entry but also for the care of any who fall ill

It should be clear at this point, that the identification of an emergent virus with infectivity above moderate should prompt discussion at the level of every family living unit as to the will and capacity to attempt sequestration-in-place. Failure

to make this choice is to accept a risk of roughly 50 percent of suffering infection and the attendant morbidity. The chronic care facility models suggest that a risk reduction of two orders of magnitude is possible. It should be clear, however, that such reduction is realizable only at the price of significant social disruption which must increase in rigor and completeness apace with the infectivity of the virus.

**1.10. Summary and conclusion.** I have argued here that

1. A subset of the elderly have been immune to the emerging virus by virtue of exposure in early life certainly in all but one and possibly all pandemics for which we have detailed information.. For example, nearly all persons older than about 62 were immune in the novel H1N1 pandemic of 2009.

Pandemic vaccination should, therefore, be focused on age groups not known or expected to be pre-immunized. This will invariably include the young and may include a significant fraction of the working class. Models have shown that strategies which adapt to the specific case-age distribution of an emerging pandemic significantly outperform the current international strategy of targeting high-risk groups [23]. Of course, a completely novel influenza virus, e.g., H5N1, would produce mortality and morbidity exponentially increasing with age in proportion to virulence. Also, while elderly persons older than the recycling age will have a decreased likelihood of becoming infected, those who do suffer infection should be expected to have an exponentially higher case fatality ratio than younger persons. Nevertheless, a wide variety of vaccination strategies preferentially targeting young children and working adults have also been shown to be more effective in reducing morbidity and mortality [24]

2. The excess mortality attributable to influenza has steadily declined over the past 50+ years in at least 4 representative economically developed countries (EDC), and probably in all such.

While this lowered baseline provides no true protection against a novel and virulent virus, it does suggest that pandemics in general could be less severe going forward, at least in economically developed countries (EDC).

3. The trend of decline of excess mortality in elderly populations in EDC has not been altered and certainly not steepened by the institution of large multinational programs of influenza vaccination all of which are focused on the elderly subpopulation.

The cause of this lack of effect is not known. It has been suggested that a subset of the elderly with very high mortality rates is truly unvaccinable. Given however, that at least some of the elderly will be pre-immunized, it seems clear that vaccine resources should be directed differently in pandemic settings than in seasonal epidemics. At the same time, as noted above, since those elderly who do become infected should be anticipated to have a much higher case fatality ratio, the therapeutic deployment of antivirals should be especially rapid in the case of elderly infecteds.

4. Protection from the effects of emergent viruses depends strongly on the infectivity of the particular virus. For influenza viruses with more than moderate infectivity,

- (a) It is difficult to see a pathway to protection of society at large;.
- (b) Protection of entities that can control public access (in specific example, chronic care facilities, corporations and private homes.) requires rigorous



implementation of sequestration-in-place processes and adherence to social distancing, decontamination and quarantine procedures for episodic exit and re-entry.

- (c) Social disruption in implementing such sequestration is significant and increases with infectiousness.

**Acknowledgments.** I thank Richard and Claire Griffith (Pomfret, CT) for access to copyrighted DVD/CD material on protecting chronic care facilities and personal residences.

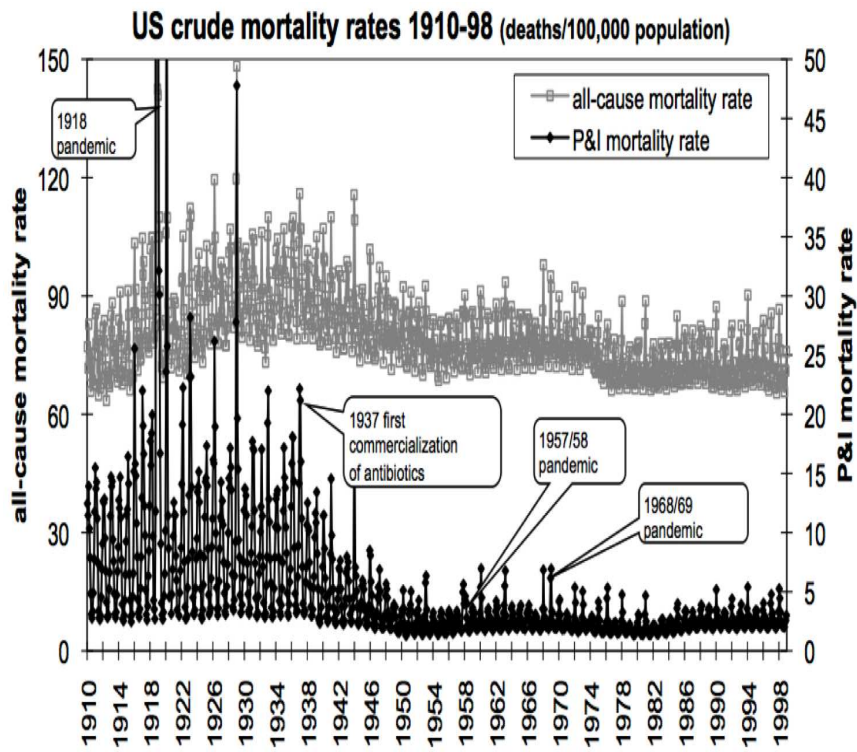


FIGURE 1. All-cause and Pneumonia & Influenza Mortality rates in the US from 1910-1998. The locations of pandemic seasons and the first commercialization of antibiotics are highlighted. The data in this figure are available from the International Infectious Disease Data Archive (IIDDA) at <http://iidda.mcmaster.ca>.

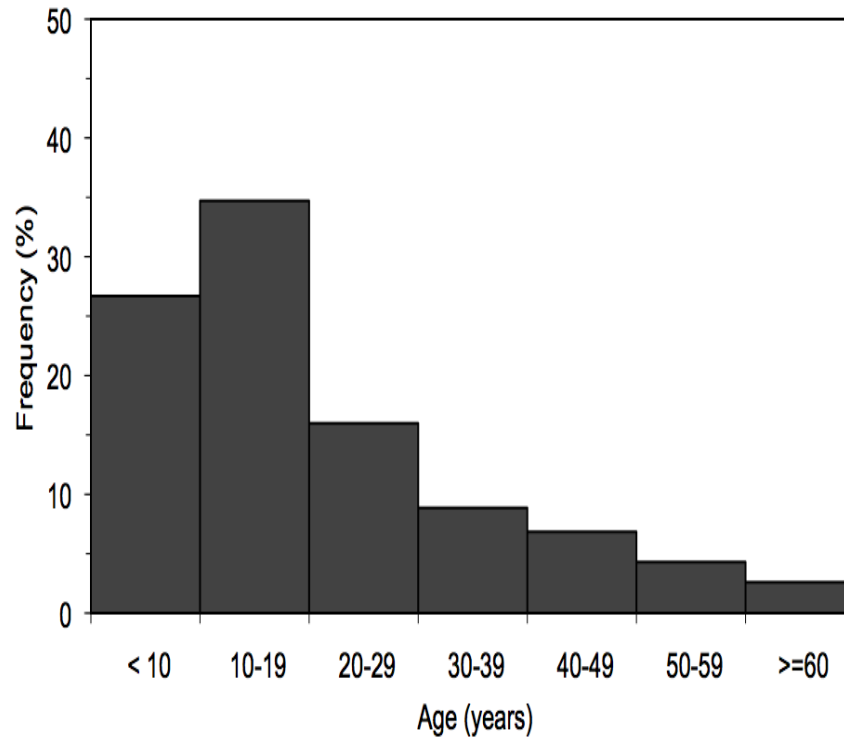


FIGURE 2. The composite age distribution of documented cases of novel H1N1 in 10 countries: Argentina Australia, Canada, Chile, European Union, Japan, Mexico, New Zealand, Peru, Thailand; US data were similar in contour; but the age distribution of data provided by the US CDC is incompatible with that of all other countries on five continents as of 31 July, 2009.

#### REFERENCES

- [1] T. Reichert, G. Chowell, H. Nishiura, R. A. Christensen and J. A. McCullers, *Does glycosylation as a modifier of original antigenic sin explain the case age distribution and unusual toxicity in pandemic novel H1N1 influenza?*, BMC Infect Dis, **10** (2010), 5.
- [2] L. Simonsen, M. J. Clarke, L. B. Schonberger, N. H. Arden, N. J. Cox and K. Fukuda, *Pandemic versus epidemic influenza mortality: A pattern of changing age distribution*, J Infect Dis, **178** (1998), 53–60.
- [3] L. Simonsen, T. A. Reichert, C. Viboud, W. C. Blackwelder, R. J. Taylor and M. A. Miller, *Impact of influenza vaccination on seasonal mortality in the US elderly population*, Arch Intern Med, **165** (2005), 265–272.
- [4] <http://www.cdc.gov/media/transcripts/2010/t100329.htm>.
- [5] [http://www.who.int/csr/don/2010\\_05\\_14/en/index.html](http://www.who.int/csr/don/2010_05_14/en/index.html).
- [6] M. Igarashi, K. Ito, R. Yoshida, D. Tomabechi, H. Kida, et al., *Predicting the antigenic structure of the pandemic (H1N1) 2009 influenza virus hemagglutinin*, PLoS ONE, **5** (2010), e8553. doi:10.1371/journal.pone.0008553
- [7] C.-J. Wei, J. C. Boyington, K. Dai, K. V. Houser, M. B. Pearce, W.-P. Kong, Z.-Y. Yang, T. M. Tumpey and G. J. Nabel, *Cross-neutralization of 1918 and 2009 influenza viruses: Role of glycans in viral evolution and vaccine design*, Sci. Transl. Med, **2** (2010), 24ra21.

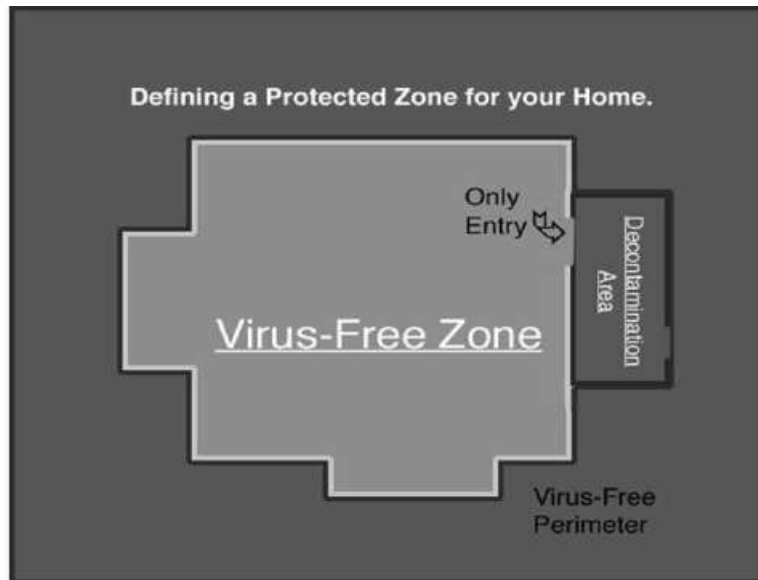


FIGURE 3. Schematic of a Virus-Free Zone within a private residence.

- [8] T. Reichert and R. A. Christensen, *It's not about smoldering or neuraminidase - There were two variants of the A(H3N2) pandemic virus differing in internal genes*, JID, **192** (2005), 1858–1860.
- [9] W. R. Dowdle, *Influenza A virus recycling revisited*, Bull WHO 1999, **77** (1999), 820–828, for a summary of the literature.
- [10] D. Cohen and P. Carter, *Conflict of Interest WHO and the pandemic flu "conspiracy"*, BMJ, **340** (2010), c2912.
- [11] The Macroepidemiology of Influenza Vaccination (MIV) Study Group, *The macroepidemiology of influenza vaccination in 56 countries, 1997-2003*, Vaccine, **23** (2005), 5133–5143.
- [12] D. M. Morens, D. S. Burke and S. B. Halstead, *The wages of original antigenic sin*, EID, **16** (2010), 1023–1024.
- [13] T. Francis, *Doctrine of original antigenic sin*, Proc Am Philos Soc, **104** (1960), 572–578.
- [14] <http://www.arlingtoncemetery.net/jmpoyer.htm>
- [15] H. Markel et al., *Nonpharmaceutical interventions implemented during the 1918-1919 influenza pandemic*, J Am Med Assoc, **298** (2007), 644–654
- [16] H. Markel, A. M. Stern, J. A. Navarro and J. R. Michalsen, "A Historical Assessment of Nonpharmaceutical Disease Containment Strategies Employed by Selected U.S. Communities During the Second Wave of the 1918-1920 Influenza Pandemic," [http://www.med.umich.edu/medschool/chm/influenza/assets/dtra\\_final\\_influenza\\_report.pdf](http://www.med.umich.edu/medschool/chm/influenza/assets/dtra_final_influenza_report.pdf).
- [17] J. M. Barry, *Letter to the editor*, J Am Med Assoc, **298** (2007), 2260.
- [18] M. Nuno, G. Chowell and A. B. Gumel, *Assessing the role of basic control measures, antivirals and vaccine in curtailing pandemic influenza: Scenarios for the US, UK, and the Netherlands*, Proc R Soc Interface, **4** (2007), 505–521.
- [19] M. Nuno, T. A. Reichert, G. Chowell and A. B. Gumel, *Protecting residential care facilities against pandemic influenza: Interactive translational research involving SLIR stochastic models*, PNAS, **105** (2008), 10625–10630.
- [20] <http://pandemicflu.gov/individualfamily/checklist.html>, accessed on 28 July, 2010.
- [21] Flu Pandemic Planning for Residential Care, is a copyrighted DVD/CD combination that provides detailed instruction and templates for developing and implementing a pandemic plan for a residential facility, It is available at [www.entropylimited.com](http://www.entropylimited.com).
- [22] Defending Your Family from a Flu Pandemic, is a DVD copyrighted in 2009 and available from FluDefender, LLC at GriffithVideo@gmail.com.

- [23] G. Chowell, C. Viboud, X. Wang, S. M. Bertozzi and M. A. Miller, *Adaptive vaccination strategies to mitigate pandemic influenza: Mexico as a case study*, PLoS One, **4** (2009), e8164.
- [24] J. Medlock and A. P. Galvani, *Optimizing influenza vaccine distribution*, Science, **325** (2009), 1705–1708.

Received July 30, 2010; Accepted August 31, 2010.

*E-mail address:* treichert@entropylimited.com