Research Paper

Considerations for the Development of a Pandemic Scenario

Committee on Risk Management and Capital Requirements

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Memorandum

To:	All Fellows, Affiliates, Associates and Correspondents of the Canadian Institute of Actuaries
From:	Tyrone G. Faulds, Chairperson Practice Council Wallace Bridel, Chairperson Committee on Risk Management and Capital Requirements
Date:	October 15, 2009
Subject:	**Research Paper – Considerations for the Development of a Pandemic Scenario**

This research paper was commissioned by the Committee on Risk Management and Capital Requirements to provide information to members about:

- existing pandemic research and models, and

- factors and parameters to consider in the development of pandemic scenarios used for the purpose of Dynamic Capital Adequacy Testing (DCAT).

The purpose of this paper is to assist members in the development of pandemic scenarios and not to recommend any specific DCAT scenarios to be tested.

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TABLE OF CONTENTS

1.   INTRODUCTION

This research paper was commissioned by the Committee on Risk Management and Capital Requirements to provide information to members about:

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2.   WHY A PANDEMIC SCENARIO?

Among adverse scenarios tested under DCAT, the pandemic scenario is an interesting and pertinent scenario to consider for the following reasons:

- Firstly, pandemics are plausible events that can threaten the financial condition of insurance companies. Recent outbreaks of swine influenza A (H1N1) in many countries and outbreaks of highly pathogenic avian influenza in poultry in East Asia (H5N1), Canada (H7N3), and the Netherlands (H7N7), and their subsequent transmission to humans, have intensified concern over the emergence of a novel strain of influenza with pandemic potential.

- Secondly, pandemics are still unpredictable events occurring historically at 10- to 50-year intervals.

- Three influenza pandemics occurred during the 20th century, with varying degrees of severity; outcomes ranged from the high levels of illness and death observed during the 1918 Spanish flu pandemic (estimates of deaths range from 20 to 100 million worldwide) to the much lower levels observed during the pandemics of 1957 and 1968 (≈1 million deaths each).

- Finally, pandemics will impact many of the risk categories examined in DCAT and, as a result, could be considered in the development of integrated scenarios.

3.   CURRENT PANDEMIC KNOWLEDGE AND SURVEILLANCE

3.1   What is a Pandemic?

According to the World Health Organization (WHO), a disease outbreak must meet the following three criteria to be considered a pandemic:

- there is a global outbreak of a disease caused by an agent (virus or bacteria) new to the population (or long absent from the population),

- the agent infects humans, causing serious illness, and

- the agent spreads easily and sustainably from person to person.

A disease or condition is not a pandemic merely because it is widespread or kills many people; it must also be infectious.

3.2   Surveillance of Pandemic Threats

The WHO monitors epidemic and pandemic threats and coordinates the global response to these threats under its Epidemic and Pandemic Alert and Response (EPR) program. Currently, there are 16 diseases being monitored under this program, considering avian influenza, influenza and influenza A (H1N1) as one disease. From all these diseases, influenza is the one that has by far the greatest pandemic potential and the one that has caused the greatest pandemics in recent centuries. Plague, smallpox and other agents have caused notable and severe pandemics and epidemics in the past but they are less likely to cause a pandemic in the future because these agents have more stable DNA and effective antibiotics or vaccines exist for these diseases. The remainder of this research paper will therefore focus only on influenza pandemics. It is important to remember, however, that the next pandemic, or a subsequent pandemic, could be caused by totally different agents.

Experts at the WHO and elsewhere believe that the world is now closer to another influenza pandemic than at any time since 1968, when the last of the previous century's three pandemics occurred. The WHO uses a series of six phases of pandemic alert as a system for informing the world of the seriousness of the threat and of the need to launch progressively more intense preparedness activities. Each phase of alert coincides with a series of recommended activities to be undertaken by the WHO, the international community, governments, and industry. Changes from one phase to another are triggered by several factors, which include the epidemiological behaviour of the disease and the characteristics of circulating viruses. At the beginning of the writing of this research paper, the WHO pandemic alert level was in phase 3 because a new avian influenza virus (H5N1) had caused sporadic cases or small clusters of disease in people, but had not resulted in human-to-human transmission sufficient to sustain community-level outbreaks. Towards the end of the writing of this paper, the WHO raised the pandemic alert level to phase 5, a strong signal that a pandemic is imminent, following outbreaks of swine influenza A (H1N1).

TABLE 1 – Pandemic Influenza Phases
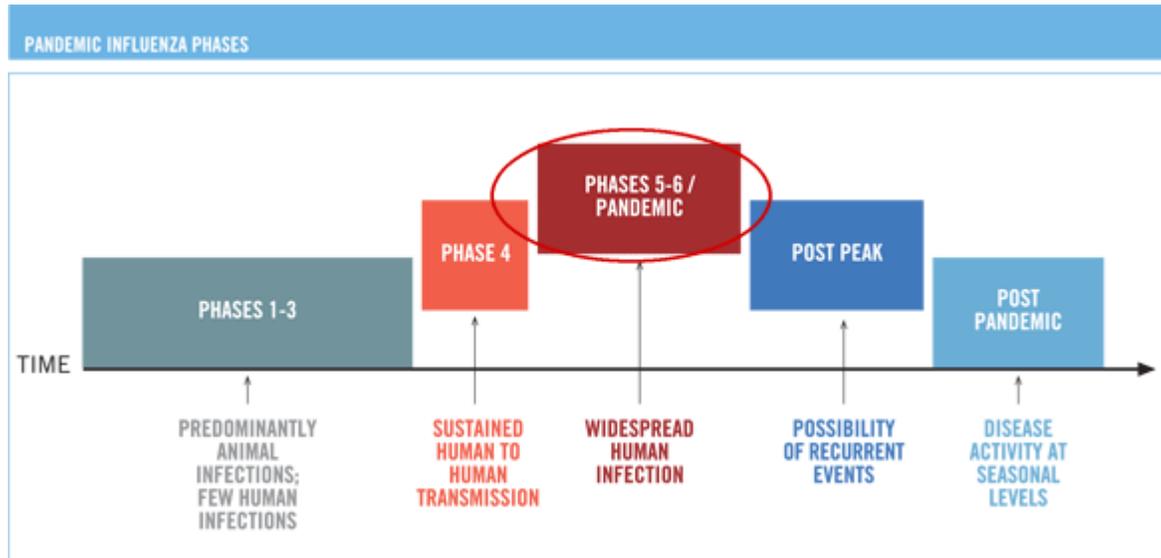
Source: World Health Organization, *Epidemic and Pandemic Alert and Response*

3.3   Avian Influenza

Avian influenza or "Bird flu" refers to a number of influenza viruses that primarily infect birds. These viruses do occasionally cross over to humans and could become the cause of the next pandemic if they mutate into a version that is highly contagious amongst humans.

While there are many strains of Avian influenza, the strain that is of the most concern currently is H5N1. Of all the strains that have crossed over to humans, it has resulted in the most infections and deaths and has crossed over to humans on three different occasions.

The first 18 human cases of H5N1 were reported in 1997. No other cases were reported until 2003. From 2003 to April 23, 2009, 421 cases were reported in 16 countries. 257 of these cases have resulted in deaths, resulting in a 61% case fatality rate.

Evidence, to date, indicates that human infection has been the result of contact with sick or dead birds. There is no evidence to date of direct transmission between humans.

3.4   History of Influenza Pandemics – Prior to the 20th Century

Earliest reports of influenza epidemics date back to 412 BC and were recorded by Hippocrates. A number of epidemics that likely were influenza were described in the Middle Ages, and one that was probably a true pandemic took place in 1510. One of the earliest recorded pandemics occurred in 1580. Like the 1918 pandemic, this one was particularly severe. Table 2 below shows the list of influenza pandemics, or probable pandemics that occurred from the 16th century to the 19th century. The list might vary a little from one author to the next. For example, some authors consider the pandemic from 1830 to 1833 as one pandemic while others consider it as two distinct pandemics: 1830-31 and 1833. Although no pandemic was reported in the 17th century, localized epidemics were reported during that period.

TABLE 2 – History of Influenza Pandemics Prior to the 20th Century

Year(s)	Years since previous pandemic	Origin or first report	Viral Type
1510		Africa	Unknown
1557	47	?	Unknown
1580	33	Asia, North Africa	Unknown
1729-1730	149 (?)	Russia (?)	Unknown
1732-1733	2	Russia	Unknown
1781-1782	48	Russia, China (?)	Unknown
1788-1789 (?)	6	Russia	Unknown
1830-31	41-48	Russia, China	Unknown
1833	2	Russia	Unknown
1836-37	3	Russia (?)	Unknown
1889-1890	52-56	Russia	H2
1899-1900	9	Unknown	H3

Source: Modified from Swiss Re, *Pandemic influenza: A 21st century model for mortality shock*s

Expectedly, there is no detailed and reliable data for these pandemics. However, although the estimates are very rough, mortality rates during the pandemics in the 18th and 19th centuries appear to resemble more those of the mild pandemics of 1957 and 1968 than those of the severe 1918 pandemic.

3.5   History of Influenza Pandemics – 20th Century

Three pandemics occurred during the 20th century, caused by an H1, an H2, and an H3 strain. These are outlined in the table below and then briefly summarized. Currently, H1 and H3 influenza strains are circulating in the human population. Scientists have raised concern about the possibility of H2N2 re-emerging (also referred to as recycling) in humans, particularly through accidental release of a laboratory strain.

TABLE 3 – History of Influenza Pandemics – 20th Century

Years	Years since previous pandemic	Origin or first report	Viral type	Estimated global deaths (millions)	Estimated US deaths (thousands)	US Excess mortality per 1,000	US Clinical Attack Rate (%)
1918-1919 1918-1920 (Spanish flu)	18	France, US	H1N1	40-50 20-100	500-550 660	5.3 6.0	25
1957-1958 (Asian flu)	37	China	H2N2	1-2	70	0.4	31-35
1968-1969 (Hong Kong flu)	10	China	H3N2	1	34	0.2	21

3.5.1 1918-19 (Spanish Flu)

This pandemic was caused by an influenza A (H1N1) strain and was the most famous and deadly pandemic of the 20th century. It began with a mild wave in the spring of 1918 in Europe and in the United States (particularly in military training camps for new recruits headed to the war in Europe). The second, highly virulent and deadly wave spread rapidly around the world in the fall of 1918, with about 80% of cases occurring in a single month in a given location. Additional waves that were not as severe occurred in 1919 and 1920.

Worldwide, about one third of the world's population was infected and had clinically apparent illness. Total deaths are estimated to be in the wide range of 20 to 100 million; corresponding to a mortality rate of 1 to 5% (world population in 1918 was around 1.8 billion). Earlier estimates implied that the death toll was 20 to 40 million, but more recent evidence supports the higher figures, with 40 to 50 million deaths now being the widely accepted range.

In the US, the clinical attack rate was about 25% (the proportion of the population that was infected and had clinically apparent illness). The death toll varies slightly by author from 500,000 to 660,000. The differences in the various estimates appear to result from the period used by the author as the pandemic period: some authors use the years 1918-19 while others use 1918-20. The case fatality rate (the ratio of the number of deaths caused by a specified disease to the number of diagnosed cases of that disease) and the mortality rate related to influenza were estimated to be roughly 2.5% and 0.65%, respectively. Pandemic excess mortality reported in various research papers ranges from 0.53% to 0.60% (depending on the period used by the author, the method used to calculate excess deaths and the treatment of seasonal flu deaths).

An unusual feature of the 1918 pandemic was the age-related mortality: the pandemic strain killed a disproportionate number of healthy young adults. This led to the observation of a "W" shaped age-related mortality curve in the United States, with high rates of mortality among very young children, persons 20 to 40 years of age, and the elderly. Usually the curve associated with influenza mortality follows a "U" shape, with influenza deaths occurring mostly among the very young and the elderly. One striking

feature of the pandemic was its impact on pregnant women: many studies involving pregnant women report case fatality rates that are 10 to 30 times the case fatality rate for the rest of the population.

The excess influenza deaths appear to have involved two overlapping clinical-pathologic syndromes. One pattern was aggressive bronchopneumonia, most likely caused by a secondary bacterial pneumonia (e.g., tuberculosis). The second pattern was a rapidly evolving severe acute respiratory distress-like syndrome. A recent report article from researchers of the National Institute of Allergy and Infectious Diseases published in the The Journal of Infectious Diseases suggests that secondary bacterial pneumonia was the major cause of death during the 1918 pandemic. The authors state that most deaths resulted from poorly understood interactions between the infecting virus and secondary infections caused by bacteria that colonize the upper respiratory tract. The findings of this study may not be generalizable, however, because the population studied included only patients who had an autopsy performed.

3.5.2   1957-58 (Asian Flu)

The Asian flu was caused by an H2N2 strain and originated in China. The pandemic spread to the Southern Hemisphere during the summer of 1957 and reached the United States in June 1957. Globally, approximately one to two million people died during this pandemic.

About 70,000 people in the United States died and mortality was spread over three seasons. Overall, the highest mortality rates occurred among the elderly; however, during the initial season in 1957, nearly 40% of the influenza deaths occurred among persons less than 65 years of age. The high case fatality rate in this age group declined in subsequent years. The excess mortality for this pandemic was less than 10% of the excess mortality of the 1918 pandemic.

3.5.3   1968-69 (Hong Kong Flu)

The Hong Kong flu was caused by an H3N2 strain. The strain acquired two genes from the duck reservoir by reassortment and kept six genes from the virus circulating at the time in humans.

During the pandemic, about 34,000 people died in the United States. The death rate from this pandemic may have been lower because the strain had a shift in the HA antigen only and not in the NA antigen. Although antibodies to NA antigen do not prevent infection, they may modify the severity of disease. Also, an H3 strain had apparently circulated in the United States around the turn of the century, so elderly persons may have had some protective antibody from past exposure to an H3 strain. This could have caused a lower fatality rate in the elderly. The excess mortality for this pandemic was less than 5% of the excess mortality of the 1918 pandemic.

3.5.4   1951 Epidemic

Although not a pandemic, the influenza epidemic of 1951 is worth noting because it caused an unusually high death toll in England; in particular weekly deaths in Liverpool even surpassed those of the 1918 pandemic. That flu epidemic caused by an H1N1 strain (like the 1918 pandemic) which originated from Liverpool, England in late December 1950 hit Newfoundland in January 1951 and within a week spread to the eastern

provinces before heading west. Death rates in the east were some 240% greater than in the west. That epidemic was roughly 50% more severe than the 1957 pandemic in Canada and in England. In contrast to Canada and England, the 1951 epidemic was mild in the United States except in New England which had a death rate 230% greater than the rest of the country. Why this epidemic was so severe in some areas but not in others remains unknown.

4.   PANDEMIC SCENARIO GENERAL CONSIDERATIONS

Below is a discussion of general factors to be considered in the development of pandemic scenarios for DCAT.

4.1   Clinical Attack Rate

The Clinical Attack Rate is the proportion of the population that is expected to become infected and get sick with the disease over the duration of the pandemic. During seasonal flu, the typical Clinical Attack Rate is in the range of 5% to 15%. For pandemic flu, Clinical Attack Rates are typically in the range of 25% to 35%.

It is more difficult to obtain precise and detailed data for Clinical Attack Rates than it is for death rates but some evidence shows that they vary greatly by age. In general, the virus spreads more easily among younger persons than older persons because they tend to have more frequent contact with others. The attack rates are, therefore, typically higher for children than for retirees.

4.2   Demography

Since attack rates and death rates vary greatly by age, it is important to consider the difference between the age structure of the population studied under the pandemic scenario and the population from which the morbidity and mortality assumptions are derived. The overall morbidity and mortality may be significantly different between two populations if they have different age structures.

In addition to mixing patterns described above, pre-existing immunity among older lives may also play a role in people's susceptibility to infection. It is believed that the low numbers of infections and deaths among the elderly observed during the 1918 pandemic is due to pre-existing immunity resulting from exposure to the same or very similar influenza virus many decades before.

4.3   Regional/Country-Specific Characteristics

As with all infectious diseases, the death toll from influenza pandemics was higher in poor countries than in the more developed world. The following characteristics will affect the outcome of a pandemic:

- quality of food and shelter,

- underlying disease burden (larger number of frail people alive today who suffer from chronic medical conditions),

- access to health care,

- preparedness and capacity to face a pandemic:

    health system characteristics,

pharmaceutical stocks,

pandemic plan and surveillance,

- capacity to implement social distancing and travel restrictions.

Companies that have business in different countries would consider these characteristics and use different assumptions as appropriate.

4.4 Changes Since Prior Pandemics

One of the most important considerations in the development of a pandemic scenario is the significant changes that have taken place since the last few pandemics. Compared with all past influenza pandemics, the world is now much better prepared to cope with a pandemic. Here is a list of the most important changes which may result in lower overall morbidity and mortality rates in future influenza pandemics:

- antibiotics (discovery of penicillin in 1928),

- virological research and knowledge (discovery of influenza virus in 1933),

- WHO's global surveillance network (1952),

- influenza vaccines (1950s),

- antiviral drugs (1970s),

- better medical care (ICUs, ventilator and intravenous fluid support, etc.),

- fewer outbreaks of contagious disease, including tuberculosis,

- improved communication and coordination,

- pandemic response planning, and

- lower overall mortality.

The world has also seen significant changes that may increase the impact of future pandemics. Here is a list of the most important changes that may result in higher overall morbidity and mortality:

- higher percentage of the population age at older ages,

- greater population density,

- increase in underlying disease burden, and

- increased travel.

Antibiotics, in particular, played a key role in the battle against tuberculosis, which was an important contributing factor to the high mortality of the 1918 pandemic. As mentioned earlier, a recent report suggests that secondary bacterial pneumonia was the major cause of death during the 1918 pandemic. The influenza virus produced the initial blow by destroying the protection of the lung airways, thereby facilitating the access to the lungs for the tuberculosis bacteria which then caused fatality. If antibiotics had been available in 1918 to treat tuberculosis, the outcome could have been very different.

4.5 Insured vs. General Population

Another important consideration is the difference between the insured population and the general population from which pandemic observations are drawn. It is expected that the impact of a pandemic will be less severe for the insured population because of its generally better health condition. Such impact will depend on the following factors:

- the extent of economic self-selection,
- the level of underwriting and the average attained duration of the portfolio, and
- the actively at work requirement for group insurance.

4.6 Pandemic Duration

A pandemic can last from less than 12 months to as long as 24 months. The 1918 pandemic spread in the United States in three waves over a period of 18 to 24 months, although two thirds of the deaths occurred in a six-month period. Even if it is possible to model a pandemic over multiple accounting periods, it is simpler to assume that all the impacts of the pandemic occur in one accounting period. If the pandemic is modeled over multiple periods, reserves at the end of an accounting period may need to be adjusted to reflect the expected impact on the subsequent period(s). Modeling the impact over one accounting period or over multiple periods may not produce materially different results.

The duration of the pandemic, and the duration of the pandemic wave in particular, will affect the ability of the health care system to cope with the increased demand for hospitalization and health care services. The health care system will presumably be able to treat more patients during a longer period with the same number of people requiring treatment.

The impact on the economy and the financial markets may also be sensitive to the duration of the pandemic. If most of the infections and deaths take place over a couple of months, the economic impact could be less severe than if it lingered on for a year or more.

4.7 Business Continuity Planning

The insurance company's business continuity plan and its state of preparation to face a pandemic may affect the company in many ways:

- the level of claims and possibility of anti-selection if the insurance company does not react quickly and adequately to an emerging pandemic,
- the level of expenses resulting from the application of the business continuity plan or from the absence of adequate planning, and
- the level and quality of services provided during the pandemic, including the ability to process claims promptly and efficiently may have a significant impact on the company's future level of new business and market share after the pandemic.

5. EFFECT OF PANDEMIC ON MAJOR DCAT RISK CATEGORIES

The mortality risk of life insurance products is probably the risk that can be most affected by a pandemic but the possible impacts on all other risks would be considered as well. Below is a discussion of specific factors to be considered in the development of pandemic scenarios for the major risk categories tested under DCAT.

5.1 Mortality Risk

5.1.1 Shape of Excess Mortality Curve

As mentioned earlier in this paper, influenza mortality by age typically has a "U" shape, i.e., high mortality among the very young and the elderly. The excess mortality curve for a pandemic, which represents the difference between influenza pandemic mortality and expected seasonal influenza mortality, may have a different shape however. The mortality curve of the 1918 flu pandemic (for all influenza deaths) was unusual and had a "W" shape with a peak in the middle representing young adults. The resulting excess mortality curve of the 1918 pandemic, however, is said to have a "V\" shape to visually cue the lack of excess deaths in the older ages (older age mortality was lower during the Spanish flu pandemic years than the preceding non-pandemic years). The excess mortality curve was very different for the 1957 pandemic: no excess mortality at age 0, no peak at middle ages but significant excess mortality for ages 65 and older. The excess mortality curve of the 1968 pandemic followed a "U" shape.

Considering the rather limited knowledge about the excess mortality curve of pandemics (data is available for only three pandemics), one of the first assumptions to make about mortality is the shape of the excess mortality curve. Is it going to be flat, "U"-shaped, "V\"-shaped or "W"-shaped? Depending on the mix of business by age, the overall expected cost caused by a pandemic can vary greatly according to the shape of the excess mortality curve used.

The SOA's Flagship Pandemic Research Study is a valuable source of information about pandemics. In particular, the study on the Potential Impact of Pandemic Influenza on the U.S. Life Insurance Industry provides insight into pandemic mortality. The study provides multiple general population excess mortality curves (flat, "U", "V\" and "W" shapes) based on historical data: 1957 and 1968 pandemics for the "U" shape, 1918 for the "V\" shape and some extrapolation for the "W" shape.

The pandemic excess mortality assumption would ideally be applied consistently for all products and all lines of business. For products or lines of business where information about age is not readily available, it will be necessary to use an appropriate factor that in the actuary's best judgement is equivalent to the assumed mortality curve.

Excess life insurance claims could be offset by gains on payout annuities. However, no significant annuity mortality gain is expected to result from the "V\"-shaped excess mortality curve consistent with the 1918 pandemic.

It would be appropriate for the actuary to test multiple plausible curves as the most relevant or adverse scenario may depend on the insurance company's specific mix of business by product and by age. The curve that produces the most adverse results for one company may not be the one that will also produce the most adverse results for another company. An example of this is illustrated later in this paper.

5.1.2   Insured vs. General Population Mortality

The availability of information on the effect on the insured population is scarce but there is some evidence that the effect of the 1918 pandemic was less severe among the insured population than the general population.

The SOA Study of the Effect of the Flu Pandemic on Insured Mortality Using the Delphi Method can provide further guidance about the expected difference between the insured and general populations. That study led the author of the SOA study on the Potential Impact of Pandemic Influenza on the Life Insurance Industry to apply an insured population factor of 76.9% to the general population excess mortality assumption for the severe scenario, which factor corresponds to the median result observed in the Delphi study.

The insured population factor used would vary according to the level of underwriting and economic self-selection present in the portfolio. Business subject to little or no underwriting such as guaranteed and simplified issue products, group life insurance and annuities would have a higher factor closer to one.

5.1.3   Guaranteed Minimum Death Benefits

For guaranteed minimum death benefits of segregated funds, savings and investment products, it would be appropriate to consider the combined effect of the excess mortality and the likely increase in net amounts at risk caused by declines in capital markets as a possible reaction to the pandemic. If equity market values decline and policyholders die, insurers will have to make good on those minimum death guarantees.

5.1.4   Post-Pandemic Mortality Levels

It would be appropriate for the actuary to consider the possible impact of a rebound effect or survivorship echo theory. According to this theory, the mortality rates improve for periods following the pandemic because additional deaths due to the pandemic flu occur to individuals whose health is below average. The remaining population would then have above average health and better mortality. That is the health of the remaining population is better as many unhealthy lives have not survived.

The impact of the rebound effect is to offset some of the additional mortality incurred during the pandemic. The rebound effect will be impacted by the shape of the excess mortality curve used to project the pandemic mortality. It would not be prudent, however, to reflect this rebound effect in the actuarial liabilities.

Caution is recommended in using this theory. It may be reasonable for older ages where the proportion of unhealthy individuals is greater but only if excess mortality is assumed at those ages.

It would also be appropriate for the actuary to consider the opposite theory which holds that higher mortality than pre-pandemic mortality will be observed for some time following the pandemic due to weakening of those who were infected but survived the pandemic.

5.1.5   Pandemic Mortality Models and Studies

Actuarial organizations and reinsurers have developed models and prepared studies to estimate the potential impact of an influenza pandemic on the insurance industry. Some of these models and studies are outlined in the table below and then briefly summarized. This is not necessarily an exhaustive list of all models and studies available.

TABLE 4: Comparison of Pandemic Mortality Models

Author (Year)	Model Assumptions			Excess Mortality Rate per 1,000			
	Scenario	Shape of Mortality Curve	Ins/Gen Population Mortality Ratio	General Population	Insured Population		
				Number	Portfolio	Number	Amount
SOA (2007)	Moderate (1957)	U	57.1%	0.70	US Indiv.	0.45	0.30
					US Group	0.32	0.27
					US Total	0.38	0.29
	Severe (1918)	V\	76.9%	6.50	US Indiv.	4.38	5.22
					US Group	5.19	5.46
					US Total	4.79	5.31
Gen Re (2007)	Spanish Flu (1918)	W	100%	6.40	Germany	4.6	5.1
GCAE (2006)	"Worst-case"	Flat	60%	2.50	Europe	1.5	1.5
Swiss Re (2007)	99th Percentile	Multiple	100,00%		Canada	0.3	
					US	0.6	
					China	1.0	
					India	1.3	
	99.5th Percentile	Multiple			Canada	0.7	
					US	1.0	
					China	1.7	
					India	2.5	

5.1.6   SOA - Study on the Potential Impact of Pandemic Influenza on the US Life Insurance Industry

This study sponsored by the SOA and published in May 2007 evaluates the financial effects of different flu pandemic scenarios on the US Life Insurance industry. It examines two different scenarios consistent with US Government figures used for planning purposes:

1. a *moderate* scenario approximating the effect of the 1957 pandemic, and

2. a *severe* scenario approximating the effect of the 1918 pandemic.

The moderate scenario is based on the following assumptions:

- general population mortality excess rate of 0.07%,

- "U" shaped distribution of excess deaths based on information from the 1957 and 1968 pandemics in the United States, and

- insured to general population mortality ratio of 57.1% (for all ages).

The severe scenario is based on the following assumptions:

- general population mortality excess rate of 0.65%,

- "V\" shaped distribution of excess deaths based on information from the 1918 pandemic in the United States, and

- insured to general population mortality ratio of 76.9% (for all ages).

Two interesting results of this study are the difference in the results obtained by line of business (individual vs. group life) and by number vs. by amount for each scenario, as illustrated in the above table:

- the pandemic excess mortality rate is higher for individual life than group life under the moderate scenario and lower under the severe scenario, and

- the pandemic excess mortality rate is higher by number than by amount under the moderate scenario and lower under the severe scenario.

Both of these results are explained by the difference in the shape of the excess mortality curve used in each scenario. The "V\" shape of the severe scenario is hurting group life business relatively more than the "U" shape of the moderate scenario because the group life population is younger than the individual life population. The "V\" shape of the severe scenario is also hurting relatively more the results by sum insured because it puts more emphasis on larger size policies which tend to be more recent policies characterized by a much younger attained age than older policies.

In addition to the research report, there is an accompanying spreadsheet tool that insurers can use to better understand the associated financial risks that a flu pandemic can have on their company. This spreadsheet contains the two distributions of excess deaths above and also contains two other distributions: a flat curve and a hypothetical "W" curve. The spreadsheet is easy to use with separate tabs for scenario inputs, company data and results. It is a straightforward matter to include additional parameters or to add or modify mortality curves.

5.1.7   GenRe - Influenza Pandemic: The Impact on an Insured Lives Portfolio

Gen Re developed a model in 2006 to estimate the cost of a pandemic on an Insured Lives Portfolio. Gen Re used American data from the 1918-19 pandemic to develop infection rates and case fatality rates by 10-year age groups for each of the three waves modeled in their pandemic scenario (rates for waves 1 and 3 were assumed to be identical). These Spanish Flu Base Model infection rates and case fatality rates were then applied to the German population and a "typical" German life insurance portfolio to derive the increased mortality among insured lives. The results are shown in the table

above. The Gen Re study also reported the impact of using multiples (0.5X and 2X) of the Base Model infection rates and case fatality rates.

The Gen Re study is very similar to the SOA study described earlier. The major differences are:

- Gen Re uses 10-year age groups compared to 5-year age groups in the SOA study,

- Gen Re proposes only a severe 1918-like "W" shape mortality curve that includes all flu deaths and not only pandemic excess deaths like the SOA severe scenario "V\" shape curve (but the SOA "V\" curve is calibrated to produce the same overall mortality rate of 0.65% as Gen Re "W" shape curve), and

- Gen Re assumes no difference in pandemic mortality between the general population and the insured population (in other words, a ratio of insured to general population mortality of 100%).

The author notes that the United States was hit harder by the Spanish flu than Germany with a reported rise in mortality of 0.65% for the United States compared to 0.38% in Germany.

5.1.8   GCAE - Actuarial Reflections on Pandemic Risk and Its Consequences

A working party comprising representatives of the Groupe Consultatif Actuariel Européen (GCAE) and the European Commission produced a paper in May 2006 that gives a brief overview of the possible impact of a pandemic on the insurance industry. This paper presents the individual viewpoints of the members of that working party and does not represent an official opinion of the European Commission.

The main conclusions and assumptions of this paper are as follows:

- Probability for a pandemic to occur in any given ten years: 30%, roughly,

- Probability of occurrence of a severe pandemic like 1918: less than 0.25%,

- Infection rate: 25%-30%,

- Excess mortality rate (general population): flat 0.25% (the paper states that several governments are preparing for this "worst case" scenario), and

- Insured to general population mortality ratio: 60%.

This paper also discusses the possible impact on:

- the economy (GDP cost between 0.5% to 6.5%),

- the financial markets (flight to safety and drop in interest rates),

- the workforce and operational consequences (absence rate up to 28%), and

- insurance companies and various product lines: life, pensions, health, non-life, and reinsurance.

5.1.9   Swiss Re - Pandemic Influenza: A 21st Century Model for Mortality Shocks

Swiss Re published a report in July 2007 discussing influenza pandemics, describing the sophisticated epidemiological model they had developed and presenting the major results obtained from such model.

Swiss Re's model is very different and a lot more sophisticated than the other models discussed in this paper. It works by simulating many thousand hypothetical pandemics, with each simulation producing an estimate of the resulting excess mortality. It factors in the different features of the three pandemics of the 20th century: the rate of spread of the virus, its lethality and differences in infection rates and lethality by age groups. It also factors in the demographic characteristics of the population of the 37 geographical territories comprised in the model: total population and age structure, human-to-human contacts according to age, pre-existing immunity and travels (by air or surface) between territories. It allows for advances in pharmaceutical interventions (availability of antibiotics, vaccines, antivirals and health care resources) and behavioural interventions (contact modification and travel restrictions). Finally, pandemics are assumed to occur every 30 years, which means that there is a 3.33% probability of observing pandemic deaths in any given year.

The key results from this model are:

- The 1918 pandemic, a unique event in 420 years, would have a much lower impact on mortality today than it did in 1918.

- In most developed countries, a 1-in-200-year pandemic event (0.5% probability or 99.5th percentile) would give rise to excess mortality between 1 and 1.5 deaths per 1,000 insured lives, given current intervention capabilities.

- Canada, Australia and New-Zealand are the countries that are expected to be the least impacted by a pandemic. At the opposite end, India, Pakistan and Indonesia are the countries that are expected to be the most impacted.

- The excess mortality rate corresponding to the 99th percentile (the upper range for a scenario to be deemed plausible under the current DCAT standard) and the 99.5th percentile (the solvency standard under Solvency II) is indicated in Table 3 above for selected countries.

5.2   Morbidity Risk

5.2.1   Disability Incidence Rates

A pandemic may cause an increase in disability incidence rates for plans with very short elimination periods. No material impact is expected for plans with longer elimination periods.

Many short-term disability plans have a "first day hospital" provision, in which coverage kicks in on the first day of an illness if the insured is hospitalized. In a severe pandemic scenario, where 25% plus of the population is infected, and access to hospitalization is severely restricted, there is a risk that a large segment of the insured population would have a reasonable argument that short-term disability coverage begins on day 1 of the infection. Complicating this risk is the segment of the population that "self-quarantines"

out of fear, which according to some estimates could be another 25%+ of the population. How can the insurer distinguish between true infection and quarantine, especially if most of the people submitting claims don't have the ability to see a physician, and the insurer's claims department is overwhelmed with volume? How can the insurer deny "quarantine claims" under these circumstances?

5.2.2   Disability Termination Rates

Increase in both short-term and long-term disability termination rates could be expected if pandemic mortality is high. The excess mortality may be higher for disabled lives because they tend to have poorer health than active lives. On the other hand, increased illness and workload among claims adjudicators and medical workers may mean that claims stay open longer. The decrease that might result in disabled lives reserve, if any, would contribute to offset some increase in death claims and in short-term disability claims.

5.2.3   Hospitalization and Medical Expenses

Health insurance products that pay benefits or daily allowances for hospitalization or that reimburse medical expenses caused by sickness, including travel insurance, can be severely affected by a pandemic. The costs, however, can be limited by the capacity of the health care industry to satisfy the increase in the demand for health care services.

5.2.4   Pandemic Morbidity Models and Studies

It is difficult to find detailed information about morbidity rates and hospitalization rates during the last pandemics. Some interesting information can be found on the [CDC Pandemic Influenza Resources Website](). Spreadsheet-based models that estimate the surge in demand for hospital-based services, the impact in terms of deaths, hospitalizations, and outpatient visits and the potential number of days lost from work due to pandemic influenza can be downloaded from the website. These models could possibly be used or adapted to estimate the morbidity costs for insurance products.

The research article titled, [The Economic Impact of Pandemic Influenza in the United States: Priorities for Intervention]() available from the CDC's Website contains useful information for estimating or modeling pandemic morbidity costs. This research estimates the possible economic impact of deaths, hospitalizations and outpatient visits caused by an influenza pandemic in the United States using a Monte Carlo simulation model.

Phase 2 of the SOA's Flagship Pandemic Research Study may also contain very useful information. Phase 2 examines the potential impact of a flu pandemic on the US health insurance industry like Phase 1 did for the life insurance industry. At the time of writing this research paper, Phase 2 was under way but not completed.

5.3   Persistency and Lapse Risk

During the course of the pandemic and for some time afterwards, it is likely that persistency rates for all types of insurance products will increase. Policyholders will likely be concerned about the financial impact of the pandemic and the uncertainty of being able to qualify for a new policy and, for group insurance products groups

(employers, creditors, associations, etc.) will likely be lacking the human resources to go to market.

Increased persistency may not be the case for savings type products that have little or no insurance risk. Policyholders may surrender the savings type products in order to pay for increased medical expenses and drugs or to compensate for reduced income due to loss of work or absences from work to the extent that these costs are not covered by other insurance products. Policy loans on whole life type products and partial withdrawals of funds from universal life policies may increase as well.

5.4   **Cash Flow Mismatch Risk**

Sharp increase in claims and withdrawals from savings products and universal life funds could create a material, unexpected asset/liability mismatch. Insurers may have to liquidate assets to pay claims but this may be partially offset by higher than expected premiums collections due to increased persistency.

5.5   **Deterioration of Asset Values**

The economic cost of a severe pandemic comparable to 1918 is a controversial subject. Estimates range from a setback in GDP of less than 1% (Department of Finance of Canada) to more than 4% (US Congressional Budget Office, Oxford Economics Forecasting). The Department of Finance is estimating that a severe pandemic like 1918 (0.44% excess mortality assumption) could have an impact on GDP between -0.35% (assuming low absenteeism impact on output, no workplace avoidance and full demand reallocation) and -1.07% (assuming high absenteeism impact on output, workplace avoidance and no demand reallocation). The model, the assumptions and the supporting data used to obtain these estimates are described in the Working Paper 2007-04 from the Department of Finance Canada titled, [The Economic Impact of an Influenza Pandemic](). The impact of a 1957 pandemic is also examined in this paper and the results are compared to other studies.

The reaction of capital markets is even more difficult to predict. The uncertainty caused by the pandemic could create a psychological "flight to safety" reaction that will push investors to sell stock and corporate bonds in favour of safer investments like government bonds, gold and cash. Equity markets may fall sharply, reflecting the economic and profit uncertainty, particularly in the industries most affected by the pandemic. The extent and duration of the drop in markets may depend greatly on the severity of the pandemic and its impact on the real economy. Credit spreads could surge resulting from the sales of corporate bonds. The central banks would likely respond to such crisis by pumping liquidity into the markets and driving a drop in interest rates. The reaction in the currency market could favour safe haven currencies like the US dollar, as observed recently in the subprime crisis.

A severe and long pandemic could threaten the survival of some firms, particularly those in the sectors of the economy most affected by the pandemic. An increase in asset defaults may result if the weaker firms fail.

It would be appropriate to review investments in the following industries which may be more adversely affected by a pandemic:

- Poultry and pork,

- Industries requiring social contact: entertainment, sports, restaurants, tourism, travel, public transportation,

- Retailers of non-essential goods,

- Providers of non-essential services,

- Construction,

- Oil and gas,

- Industries strongly dependent on the state of the economy (e.g., automobile industry), and

- Insurance industry and the broader Financial Services Industry.

It is worth mentioning that the SOA has conducted a [Study of the Effect of the Flu Pandemic on Economic Values Using the Delphi Method](). This study attempted to determine the expected impact on economic values by surveying life insurance industry experts on the subject. Unfortunately, the results were inconclusive due to the limited number of participants to the survey. However, the study may still be somewhat useful for the development of some capital market assumptions.

5.6   New Business (and Business Continuity) Risk

Some factors to consider in the area of new business risk include:

- The possible decrease in demand for sophisticated insurance products sold by agents and brokers if customers are not willing to meet sales people,

- The possible increase in demand for simple insurance products that are not sold face-to-face (e.g., Internet, telemarketing, optional group life and term),

- The possible increase in exercises of guaranteed insurability benefits,

- The possible decrease in new business for payout annuities, investment/savings products, travel insurance and group insurance,

- The impact of the insurance company's business continuity plan and its commercial strategy during a pandemic:

    The state of the business continuity plan and level of preparedness to face a pandemic,

    The level of sales staff and new business staff to process new business,

    The availability of resources to obtain evidence (APS, MVR, etc.),

    The ability of third-parties to deliver outsourced services,

    The level of new business after the pandemic: the success of the company may depend on its ability to deliver services and pay claims promptly to existing policyholders and beneficiaries during the pandemic,

- The state of maturity of the insurance market, and

- The impact of travel restrictions (e.g., the possible decrease in sales of travel insurance policies).

5.7   Expense Risk

A pandemic may cause a temporary increase in expenses such as additional staffing costs to replace sick people and to handle the extra volume of claims, with due consideration of the business continuity plan (or absence of such plan).

5.8   Reinsurance Risk

Some elements to consider about the reinsurance risk include:

- Increased risk of reinsurer insolvency:

    What is the estimated impact of the pandemic scenario on the reinsurer's balance sheet?

    Does the reinsurer have other business to offset or hedge some of the mortality risk (e.g., life annuities or LTD business)?

    Does the reinsurer have significant exposure to financial markets?

    Opinions of rating agencies on ability of reinsurer (or reinsurers) to sustain a pandemic, and

    Risk concentration.

- Reinsurer's preparedness for a pandemic:

    Liquidity of assets and ability to make timely payments,

    Ability to support new business, and

    Business continuity plan.

- Reinsurance market situation after a pandemic: What is the impact on the company of:

    A reduction in market capacity?

    Inability to renew some coverage?

    A price increase on new business or in force business?

- Reinsurance agreements with profit sharing (and typically higher margins)

    Improves reinsurer's solvency, and

    Loss carry-forward provisions mean no experience refunds for cedants in the years following pandemic.

5.9   P&C Claim Risk

P&C insurance business is not expected to be directly affected by pandemics to the same extent as the life and health insurance business. A pandemic could, in fact, lead to improved loss ratios for some lines of business. For example, loss ratios for automobile and home insurance may be expected to improve if people spend more time at home

(fewer thefts) and use their automobiles less (fewer accidents). However, the following exposures exist:

- Business interruption insurance: possible increase in claims in response to quarantines and the closing of buildings or public transportation (if infectious diseases are not excluded).

- Travel insurance: increase in claims for trip cancellations (before travel) and trip interruptions (during travel) due to sickness. Reduction of new business due to travel restrictions (imposed by governments or self-imposed) may also be expected.

- Product liability insurance:

    possible claims from vaccine makers for products causing adverse reactions, and

    transmission of disease through infected food.

- Products covering fire perils: possible increase of incidence and severity of fire claims if fire departments have fewer firefighters on staff to effectively combat fires.

6.   CONCLUSION

The impact of a pandemic on a company's capital and surplus position and its success following a pandemic will vary significantly from company to company depending on the pandemic characteristics (rate of spread, lethality, etc.), its mix of business and risk exposures (by product, type of risk, region, age, rate guarantees, etc.), and its level of preparation to face a pandemic. There are little data, particularly for insured populations, to help construct DCAT scenarios and there is a lot of uncertainty surrounding the effects that the important changes in human society will have on future pandemics. Construction of pandemic scenarios thus involves a significant part of actuarial judgement. The actuary needs to consider multi-risk factors and the various options embedded in insurance products. The actuary may want to test several scenarios and evaluate the sensitivity of results to various assumptions in order to get a better idea of the range of potential outcomes.

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