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Pandemic Risk

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Recent increasing focus on tail risk has brought more attention to pandemic risk. Life insurers are recognizing that pandemics pose one of the most important tail risks in their operations. Financial losses from a 1-in-200-year pandemic could rival those from a major earthquake or major storm.

We will present recent perspectives on the understanding and measurement of pandemic risk:

- Pandemics are caused by different pathogens. A pandemic risk model should consider all the potential sources of pandemic risk.
- There are several approaches to modeling pandemic risk. Stakeholders should select the approach that is appropriate to the intended use and the available resources.
- A pandemic may impact different groups in different ways. Age, underlying health condition and socio-economic status may drive pandemic-relevant factors such as (1) access to, or availability of, high-quality medical facilities and personnel; (2) ability to isolate persons, even temporarily, from exposure to the general population; and (3) individual ability to withstand or survive an infection. Understanding these relationships could help in designing public health measures, risk mitigation programs and capital planning processes.
- Issuing mortality index-linked securities is one approach used by insurers in the management of extreme mortality risk. In order to succeed, a company will require robust models that reflect the nature and magnitude of the risk appropriately.

THE NATURE OF PANDEMICS TODAY

There are accounts of pandemics going back to 400 B.C. The most significant outbreak in the last hundred years was the 1918 influenza pandemic, also referred to as the Spanish flu. Medical science has been successful in eradicating some diseases or in developing pharmaceutical interventions designed to combat the spread of known infectious diseases. However, new diseases continue to emerge from new pathogens or from mutations of existing viruses. It is likely the new and unknown disease or strain that will cause the most extreme pandemic threat in the future. Understanding is limited or nonexistent, and the availability of pharmaceutical intervention is uncertain. In addition, the speed and success of pharmaceutical development and production are difficult to predict.

Figure 1 shows examples of emerging and re-emerging infectious diseases as provided by the National Institute for Allergy and Infectious Diseases (NIAID), an agency

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Figure 1: Global Emerging and Re-emerging Infectious Diseases

of the National Institutes of Health (NIH) in the United States.

A pandemic would affect the world differently today than in the past. Global travel is faster, more affordable and readily accessible. This allows infectious disease to spread more rapidly, often before any symptoms of infection have occurred. The emergence of drug-resistant strains of bacteria has added to the potential increase in mortality due to a pandemic. On the other hand, modern communication tools, particularly the Internet and mobile communication, accelerate the sharing of information, aid in better surveillance, and result in earlier and speedier deployment of public health measures, including quarantines and vaccine production and distribution. Improvements in virology have led to better detection of viruses and the subsequent vaccine development. Vaccines and antibiotics were not available during the 1918 pandemic; these, combined with antivirals and other medications, serve to reduce the incidence and severity of an infection, and have helped reduce mortality in a pandemic.

Figure 2 (below) shows how the decline in infectious disease relative mortality has contributed to 60 percent of the overall decline in mortality from 1900 to 2008.

CHARACTERISTICS OF PANDEMICS

Classical epidemiology defines a pandemic as "an epidemic occurring worldwide, or over a very wide area, crossing international boundaries and usually affecting a large number of people."[2] A pandemic is defined not by the severity of the disease but rather by its spread.

Two parameters used by epidemiologists to describe a pathogen and its impact on a population are transmissibility and virulence. A widely used measure of transmissibility is the Basic Reproduction Number (R_0), the mean number of secondary infections caused by a primary infection in a totally susceptible population without intervention. If $R_0>1$, the infection is highly likely to spread if there is no intervention. If $R_0<1$, the infection will not spread into a pandemic.

Case Fatality Ratio (CFR) is a measure of virulence used in models concerned with the mortality impact of a pathogen. It is the proportion of infections that result in death during a particular period.

Severity and timing of manifestation of symptoms are factors that may impact continued spread of a disease. Early manifestation of serious symptoms increases the likelihood of detection, possibly resulting in earlier implementation of containment efforts that reduce the risk of exposure to the rest of the community. The 2003 SARS outbreak was quickly brought under control after the initial spike in infections. Containment measures were effective due in large part to specific characteristics of the SARS virus, namely the relatively short infectious period before serious symptoms appeared.[3,4]

Figure 2: Top Causes of Death in the United States, 1900 and 2008 (crude deaths per 1,000)[1]

1900		2008	
All Infectious Diseases	**5.8**	Cardiovascular Diseases	2.6
Cardiovascular Diseases	2.4	Cancer	1.9
Accidents	0.7	Lower Respiratory Diseases	0.5
Kidney Diseases	0.6	Accidents	0.4
Cancer	0.6	Alzheimer's Disease	0.3
Senility	0.5	Diabetes	0.2
	↓	**All Infectious Diseases**	**0.2**
			↓
Total	**17.2**	**Total**	**8.1**

Numerous studies have focused on the varying effects of an outbreak on different populations. Insurers are interested in age, time since policy issuance, health condition and socio-economic status, and their impact on pandemic mortality since these factors may distinguish an insured portfolio from the general population. Findings from research focused on the general population should be evaluated with care when applied to insured business.

Infectious diseases have been found to have varying impacts on different age groups. Typically, seasonal influenza causes the worst impact on the youngest and the oldest age groups. However, during the 1918 influenza pandemic, the younger working ages suffered severe mortality, just as much or even more than the youngest and oldest age groups. Figure 3 below shows the "U-" and "W-" shaped combined pneumonia and influenza (P&I) mortality, by age at death, per 100,000 persons in each age group for the United States, 1911 to 1918.

The age profile of an insured block is generally different from that of the general population and may also vary significantly among different markets and insurers. It is important to have the ability to properly reflect the pandemic impact by age or age group in order to determine the true impact on a block of business.

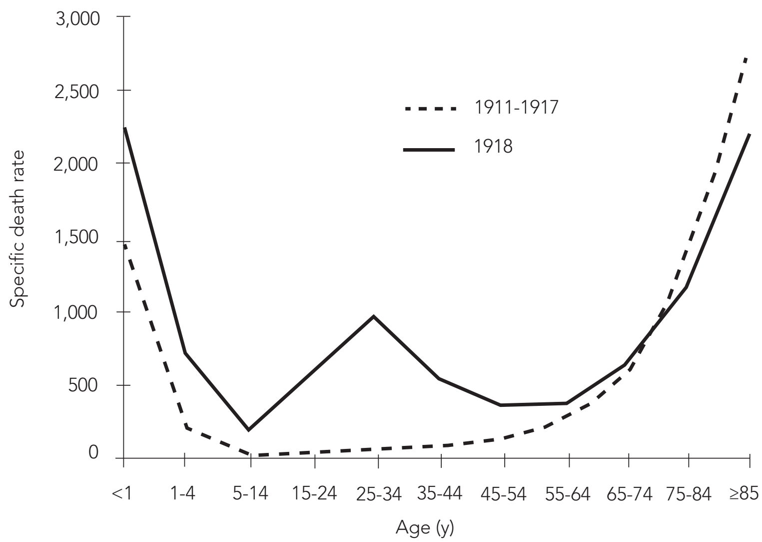
There continue to be many studies on the relationship of underlying health condition to the mortality risk in a pandemic. Scientists have studied the 1918 pandemic and the 2009 H1N1 pandemic and have found that certain pre-existing conditions sharply increased the risk of death from a severe infectious disease. These conditions include: respiratory and cardiovascular diseases, liver diseases, diabetes, kidney diseases, neurological diseases, immune system deficiency and obesity.[5] Other studies have analyzed the risk of other infectious diseases for people with different pre-existing conditions such as those listed above.[6]

Risk selection or underwriting drives the underlying health condition of an insured population. In the United States, various preferred, standard and substandard risk classes are widely used to segment the applicants. Most of the conditions that increase the mortality risk during a pandemic are screened out by preferred underwriting programs. Thus, a portfolio that is heavily weighted toward preferred risks is likely to have a different pandemic risk profile from the general population or even from another insured block with a different base mortality risk profile.

The ability of an insurer to understand its own book of business and how a pandemic might affect it would provide excellent tools for risk and return optimization as well as aid in the most efficient use of capital.

"INSURERS NEED TO CONTINUE TO ... FULLY UNDERSTAND HOW A PANDEMIC WILL IMPACT THEIR BUSINESS AND DEVELOP STRATEGIES TO ADDRESS THE RISKS."

Figure 3: Age Impact of Seasonal vs. Pandemic Influenza



MEASURING PANDEMIC RISK

Epidemiological models are used to understand the dynamics of the spread of a pandemic. Pandemic models tend to be very complex with uncertainty in numerous inputs, assumptions and outputs. Some of the sources of uncertainty are:

- Nature of pathogen,
- Pandemic preparedness and efficiency of medical response,
- Behavioral factors.

In general, the transmissions that occur from each infection (R0), the length of each stage of a disease and the ability to identify symptoms tend to have the most impact. Various containment measures such as quarantine, travel restrictions and social distancing have been found to have varying degrees of impact on the timing of the spread and on the severity of an outbreak.

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Two characteristics of pandemic modeling need to be pointed out. First, pandemics are rare events, and thus intrinsically difficult to predict. Modeling will help us understand pandemics, but models have to be used wisely. Second, using solely historical pandemics to infer future pandemic risk is not sufficient since the frequency of pandemics is quite small (much less than earthquakes or tropical storms). Furthermore, significant advancements and developments in society and medicine have come about since these past events have occurred. These have to be taken into account when evaluating historic data.

Deterministic epidemiologic approaches offer several advantages, including the following:

- Ability to add different interventions and to compare the impact of various interventions;
- Insight provided on the dynamics of transmission; and
- Ability to start with a simple model with minimal parameters and no interventions and to add parameters to determine incremental impacts of various parameters.

Deterministic models do not readily provide insight into probabilities and uncertainty; however, they can be used as a framework for combining with simulation approaches. Such combined models can provide insight into probabilities, which in turn aid in understanding the behavior in the tail. Various stochastic versions of epidemiological models have been developed. Computational costs are usually driven by the number of stochastic simulations, allowing stochastic models to more easily introduce complexity without exponentially increasing computing power demands.

Modeling and measuring pandemic risk are necessary in order for an insurer to be able to manage its risks and determine its capital needs. Approaches in managing pandemic risk include:

- Reducing the exposure by limiting the in-force volume within a given risk limit;
- Purchasing tail stop-loss coverage;
- Selling mortality catastrophe bonds;
- Arranging mortality swaps;
- Selling the risk by utilizing non-recourse embedded value securitization;
- Diversifying and hedging the risk—for example, by writing longevity business; or
- Any combination of the above.

CURRENT ISSUES

The research community recently lifted its year-long self-imposed moratorium on research into lab-created viruses. Much of the debate centers on the biosafety levels required in the laboratory. Recent research presents increased risk of accidental or malicious escape from the laboratory.

Since early April, Chinese public health authorities have been reporting a number of confirmed cases of human infections of avian influenza (H7N9) virus, resulting in 17 deaths as of this writing.[7] It is too early to tell if the virus is transmissible among humans; authorities are closely watching individuals who came in contact with the confirmed cases. In addition, recent flu or flu-like cases are being investigated to determine if they were caused by the H7N9 virus.

Virus surveillance and reporting has improved exponentially in recent years. The U.S. Centers for Disease Control (CDC), the World Health Organization (WHO) and national governments work together to ensure timely sharing of information. Google and other Internet search entities are able to use tracking technology to identify or predict outbreaks. Virus and disease tracking stations have been set up in various parts of the world, particularly in parts of Africa and Asia where many emerging infectious diseases originate.

CONCLUSION

We will continue to see the emergence or re-emergence of pandemics. Various experts in a wide range of fields are working to further the knowledge and understanding of pandemics and their impact on society and capital markets. Insurers need to continue to keep up with these developments in order to fully understand how a pandemic will impact their business and develop strategies to address the risks. ■

END NOTES

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