SOCIETY OF ACTUARIES

Society of Actuaries Research Brief Impact of COVID-19

April 3, 2020

April 2020

SOCIETY OF ACTUARIES

Society of Actuaries Research Brief
Impact of COVID-19

April 3, 2020 (rev. April 4, 2020)

AUTHOR

R. Dale Hall, FSA, MAAA, CERA, CFA
Cynthia S. MacDonald, FSA, MAAA
Peter J. Miller, ASA, MAAA
Lisa A. Schilling, FSA, EA, FCA, MAAA
Steven C. Siegel, ASA, MAAA
J. Patrick Wiese, ASA

REVIEWERS

David E. Heppen, FCAS, MAAA
Jing Lang, FSA, FCIA
Max J. Rudolph, FSA, MAAA, CERA, CFA
Nazir Valani, FSA, FCIA, MAAA
Greger Vigen

Revised pages are marked "Revised" in the lower left-hand corner.

Caveat and Disclaimer

CONTENTS

Society of Actuaries Research Brief
Impact of COVID-19

April 3, 2020

Introduction

In late December 2019, doctors in the city of Wuhan, China, began to piece together information from several medical cases showing similar symptoms. As 2019 ended, Chinese officials announced a pneumonia-like outbreak and began to identify a "novel coronavirus" linked to the cases. As the Lunar New Year banquet tradition occurred in Wuhan, a city in Hubei, in mid-January 2020, infections began to rapidly increase. By January 23, over 600 cases had been confirmed, and Wuhan and other areas in China instituted social distancing policies and, in some cases, quarantines.

By April 2, 2020, the disease spread to nearly all corners of the world. The number of confirmed cases involving the novel coronavirus now named "SARS-CoV-2"—which causes the respiratory disease now named "coronavirus disease 2019" (COVID-19)—exceeded 1,000,000 worldwide with general agreement that the number is higher due to delays in full testing and reporting in many countries. On March 11, WHO publicly characterized COVID-19 as a pandemic, and shortly thereafter, the United States declared the COVID-19 outbreak a national emergency.

As of April 2, 2020, approximately 170 World Health Organization (WHO) countries/regions have reported at least one case, and nearly 53,000 deaths worldwide have occurred. To stem the spread of the virus, several countries worldwide and many U.S. states and cities have issued "shelter in place" or "stay at home" orders. Some markets that were early to detect and treat the virus, are contemplating easing their quarantine restrictions. Others that began loosening restrictions have reverted after noticing new upticks in contracted cases. It is important to recognize that the number of reported cases for any disease typically lags behind the number of actual cases. As a result, the number of reported cases typically continues to rise after the actual number of new cases declines. A key differentiation among some countries is the speed at which they have ramped up testing and identification processes across their populations.

The health, mortality and economic focus has become one of international concern. The impact of travel and shipping restrictions in a modern, interconnected international economy has had an exacerbating effect of the outbreak into logistics and the financial markets. Financial markets have seen high volatility as new economic information becomes available, monetary policies are implemented, and value and opportunity come in and out of favor with investors. Supply chains of international operations are greatly impacted as well, as many major worldwide manufacturers are evermore connected across continents. Unemployment rates have started to rise as the world adjusts to new, lower levels of economic activity.

The result in early April 2020 has been one where a confluence of risks has come together. Additional operational and financial risks may emerge as additional events compound on the current situation. Actuaries will be watching for any additional risk events that layer on to the current environment, especially ones that may cause additional property, mortality and health risks such as catastrophic weather events. Morbidity, mortality, asset/liability management and operational risks are all a part of the initial and evolving story. This update to the Society of Actuaries Research Brief has been constructed to highlight some of the key continuing and new features of the pandemic all around the world and contemplate the risks for the actuarial profession to consider in their work.

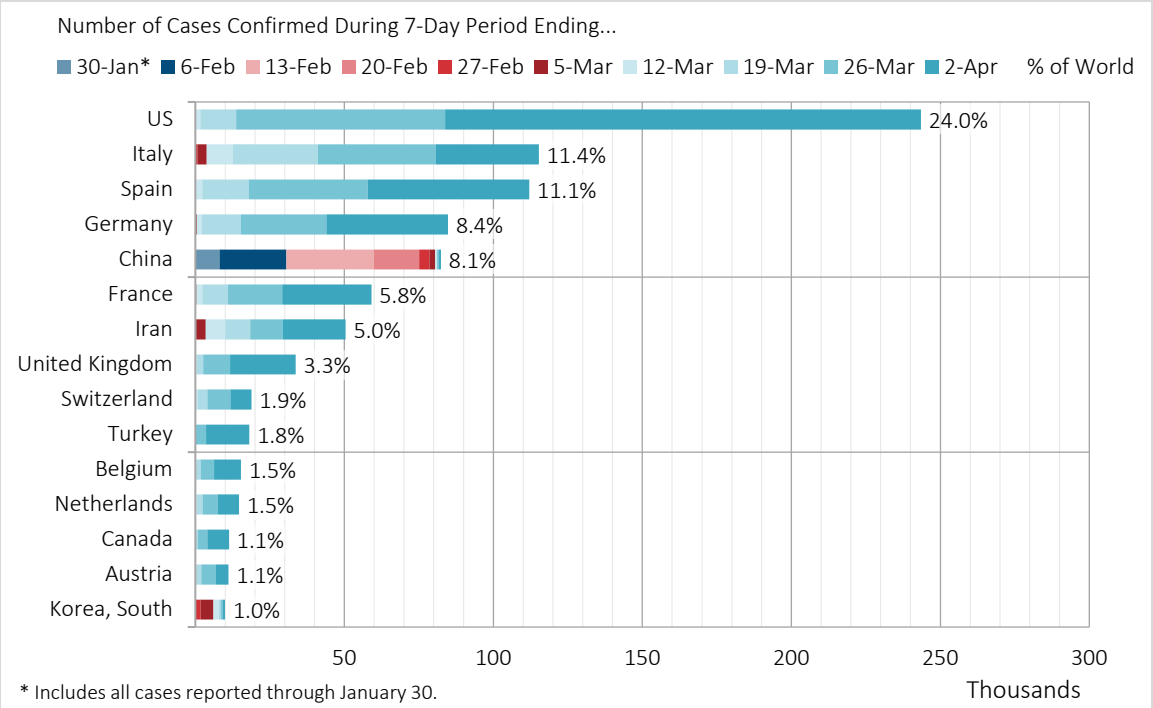
Key Statistics

REPORTED CASES

National health organizations around the world have been fast at work in connecting with health care providers to collect current case information. Confirmed case are a function of the ability for any public health agency across countries to distribute, administer and collect results from their respective health systems. Through April 2, 2020, approximately 1,013,000 cases have been reported worldwide, with 55% of the cases in three countries: U.S., Italy and Spain. Figure 1 shows the weekly progression of confirmed cases for the 15 countries that have reported the most COVID-19 cases as of April 2, 2020.

Figure 1

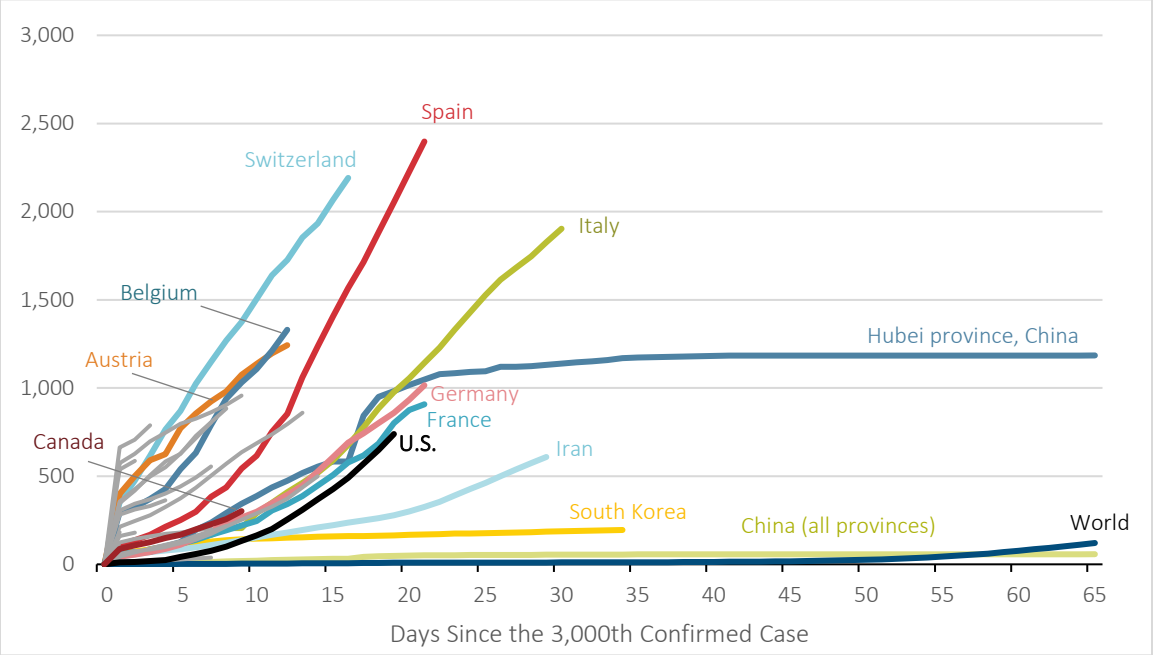
CONFIRMED COVID-19 CASES FOR 15 COUNTRIES WITH THE MOST CASES, APRIL 2, 2020



To put the number of reported cases in context of country size, consider the number of confirmed cases per million of population. Figure 2 shows that cases per million vary significantly by country. For Figure 2, the day that a country first reported 3,000 or more cumulative cases of COVID-19 is considered day zero (day 0). Even though Switzerland, Italy and Spain are much earlier in the pandemic than Hubei province, China, the epicenter of the COVID-19 pandemic, their cases per million have exceeded those of Hubei. The appendix shows additional graphs of cases per million.

Figure 2

CONFIRMED COVID-19 CASES PER MILLION THROUGH APRIL 2, 2020



Sources: Johns Hopkins University for confirmed cases; United Nations, World Bank and World Atlas for population.

Within the U.S., as of April 2, 2020, 15 counties contain approximately 50% of the confirmed cases and 46% of COVID-19 deaths (Table 1). In total, those 15 counties comprise only about 11% of the U.S. population.

It is important to recognize that these data show **reported** cases, not actual cases. Major differences exist between testing and reporting, and the differences vary by country. Countries with the highest reported case rates likely reflect serious infection rates, while countries with low reported case rates may reflect slower or underreporting. For example, as of early March, Indonesia, the world's fourth most populous country, had reported only two cases. Epidemiologists noted this was implausible and statistically impossible, especially given Indonesia's close ties to China and visits between the two countries.

Table 1

TOP 15 U.S. COUNTIES FOR COVID-19 CASES, APRIL 2, 2020

	Number			Percent of U.S. Total		
	Cases	Deaths	Population	Cases	Deaths	Population
New York, NY	51,809	1,397	5,803,210	21.3%	23.6%	1.7%
Westchester, NY	11,567	64	967,506	4.8%	1.1%	0.3%
Nassau, NY	10,587	76	1,356,924	4.3%	1.3%	0.4%
Suffolk, NY	8,746	69	1,476,601	3.6%	1.2%	0.4%
Cook, IL	5,575	107	5,150,233	2.3%	1.8%	1.5%
Wayne, MI	5,069	194	1,749,343	2.1%	3.3%	0.5%
Bergen, NJ	4,099	120	932,202	1.7%	2.0%	0.3%
Los Angeles, CA	4,045	78	10,039,107	1.7%	1.3%	3.0%
Rockland, NY	3,751	18	325,789	1.5%	0.3%	0.1%
Orleans, LA	3,148	125	390,144	1.3%	2.1%	0.1%
Oakland, MI	2,183	119	1,257,584	0.9%	2.0%	0.4%
Miami-Dade, FL	2,886	20	2,716,940	1.2%	0.3%	0.8%
King, WA	2,656	175	2,252,782	1.1%	3.0%	0.7%
Essex, NJ	2,617	99	798,975	1.1%	1.7%	0.2%
Hudson, NJ	2,270	44	672,391	0.9%	0.7%	0.2%
Total	121,008	2,705	35,889,731	49.7%	45.6%	10.7%

Data source: Johns Hopkins University

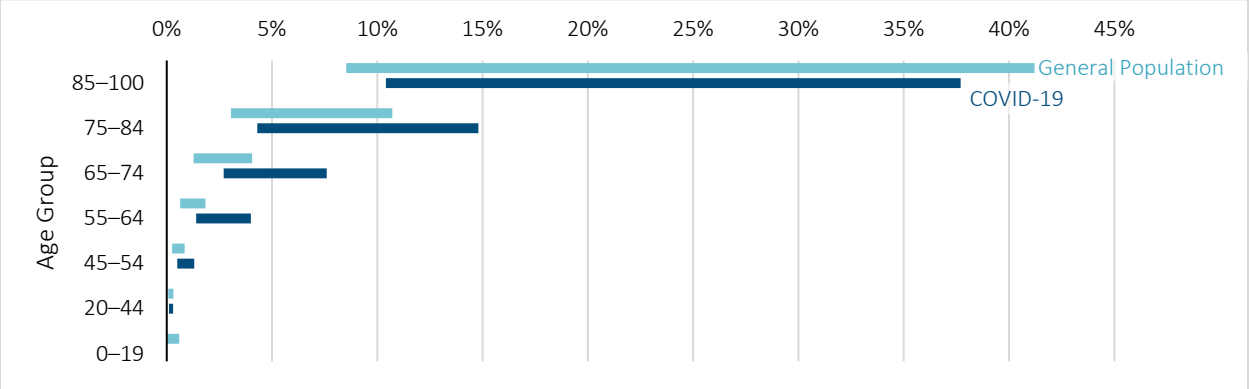
CASE FATALITY AND MORTALITY RATES

At the start of a pandemic, mortality rates are crudely estimated using a statistic known as the "case fatality rate" (CFR), which divides the known deaths by the identified number of cases. Using this methodology, the CFR across the worldwide set of case information is roughly 4.5% and is generally reported by health and media publications in the 3.0%–5.0% range. These raw estimates, however, often are adjusted to produce updated rates, due to the current likelihood of under-reporting of actual cases. Many potential cases may yet be identified in some countries due to limited supply of testing kits, and a reduced ability to process tests in laboratory settings. In addition, asymptomatic and mild cases of the disease may not actively seek treatment in the local health care systems. Death rates are also substantially impacted by other factors such as age, smoking and social interactions in each country.

Initial CFRs in the U.S. started in the 3.5%–4.5%, slightly higher than the worldwide rate, primarily due to the disease initially being seen in higher age groups, per the Centers for Disease Control and Prevention (CDC). As more cases have been identified, CDC's estimate of the U.S. CFR has trended downward to the 1.8%–3.4%. Figure 3 compares the CDC's estimated case fatality rates by age group to general U.S. population mortality from all causes. As of April 2, 2020, based on Johns Hopkins University data, the U.S. CFR was 2.4%.

Figure 3

U.S. GENERAL POPULATION MORTALITY AND COVID-19 CASE FATALITY RATE RANGES BY AGE GROUP



Source: Centers for Disease Control and Prevention, *Morbidity and Mortality Weekly Report,* March 18, 2020; Social Security Administration Period Tables for 2016, the most current tables available.

The case and death data from Johns Hopkins University's Coronavirus database can be used to estimate the case fatality rate by dividing the number of cumulative deaths by the number of cumulative cases. This approach generally leads to overestimates when it is applied to a rapidly evolving epidemic in which the number of cases is increasing significantly with each passing day. However, for Hubei province, China, the number of new cases declined to a relatively small level in the beginning of March, and few new cases have been reported since that time. The stability of the data reduces the risk of CFR overestimation.[1] Using total case and death data for Hubei province as of March 24, the CFR is equal to 3,160 deaths divided by 67,801 cases, or 4.66%.

While the CFR is a useful starting point for mortality analysis, it does not address the fact that some symptomatic individuals—particularly those with mild symptoms—may be excluded from the data. With sufficient time, researchers may be able to assemble the information required to estimate the size of this pool of individuals. The estimate can be used to calculate the symptomatic case fatality rate, which is equal to the number of deaths divided by the estimated number of individuals who developed symptoms associated with the virus. Joseph T. Wu and other researchers estimated the COVID-19 symptomatic case mortality rate for Wuhan to be 1.4%, with a 95% confidence interval running from 0.9% to 2.1%. Note that Wuhan is the capital of Hubei province and the location of most of the COVID-19 deaths in that province.

The ultimate rate of mortality from COVID-19 will evolve over time. Some key health officials in the U.S. expect an ultimate case fatality rate from the disease, once all known cases are included in the denominator of the calculation, to settle in the 0.5%–1.0% range.

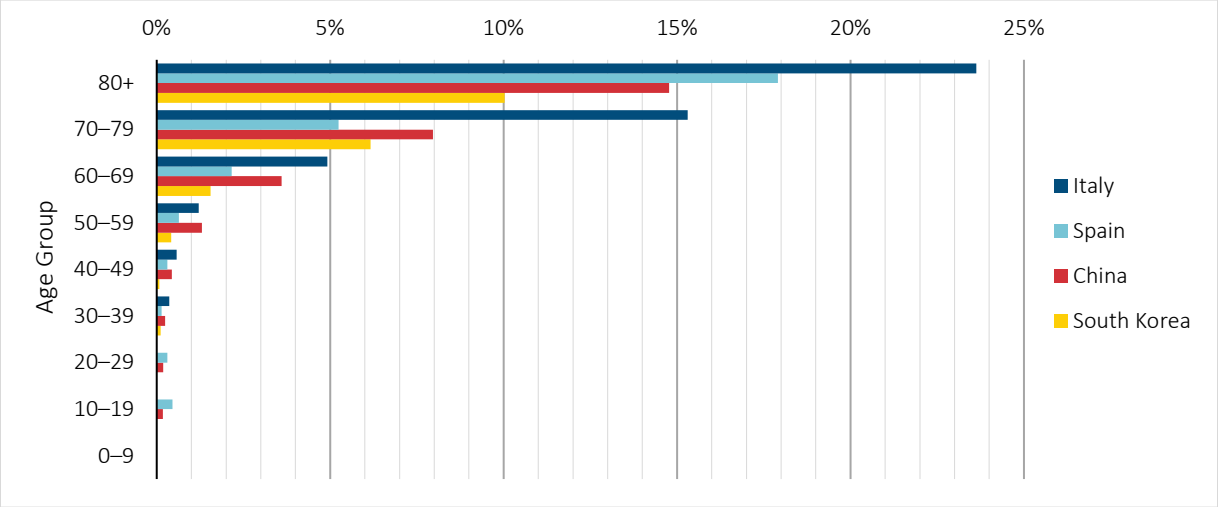
CFR and mortality rates by age have become available as the pandemic progresses. Figure 3 compares ranges of COVID-19 CFR by age group in the U.S estimated by the CDC to the most recent mortality rates for the U.S. general population computed by the Social Security Administration. For someone between the ages of 45 and 84 who contracts COVID-19, the probability of dying from COVID-19 is generally higher than the probability of dying from all other causes combined. However, the chance that children who become infected with COVID-19 die from it is nearly zero, much lower than their mortality rates from all other causes combined. CFRs have also been calculated by age

[1] When dealing with unstable data, a possible approach is to divide the number of deaths as of date "x" by the number of cases reported at an earlier date, such as 14 days prior to "x". This adjustment accounts for the fact that death does not generally occur rapidly after infection.

group in China, Italy, Spain and South Korea as shown in Figure 4. Italy has the highest rate in most age groups, while South Korea has the lowest CFR in most age groups. The range of CFR across these countries is greatest at the older age groups. CFR for the 70–79 age group ranges between 5.2% in Spain and 15.3% in Italy. And for those above age 80, CFR ranges between 10.0% in South Korea and 23.6% in Italy.

Figure 4

SELECTED COUNTRIES COVID-19 CASE FATALITY RATES BY AGE GROUP

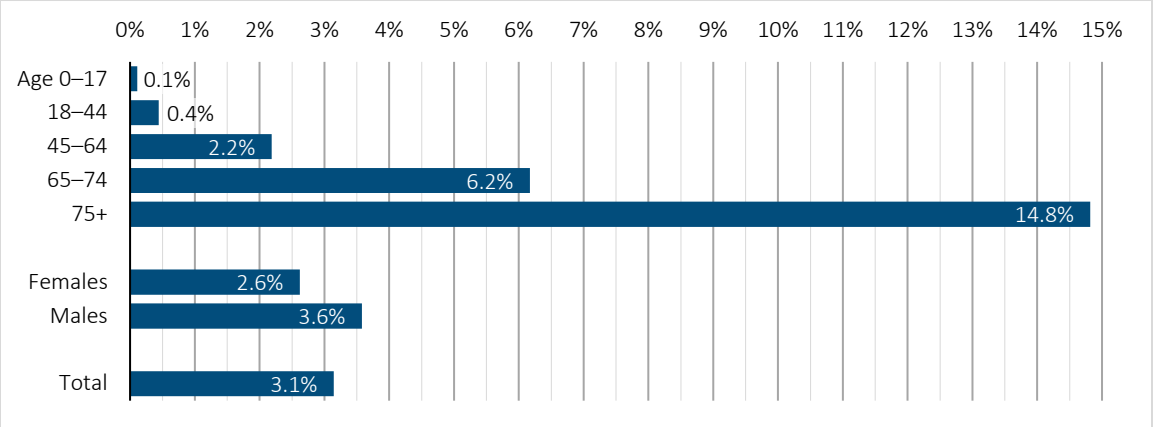


Source: Sánchez, R.; Ordaz, A., Mendoza, S. P., *eldiarios.es,* March 22, 2020

Gender differences in CFRs have also been emerging in the available data, and men have fared worse than women. In mainland China as of February 11, 63.8% of the deaths are male. In Spain, as of March 27, 65% of the deaths have been male. These higher rates could be a product of behavior such as smoking. In China, 48% of the men above age 15 smoke compared to 2% of the women. Other risk factors are also prevalent in those who have died. Of the 1,044 people who died in Spain as of March 27, 85% had one or more risk factors such as heart disease, respiratory disease or diabetes. In the U.S., 71% of the non-ICU hospitalizations and 78% of the ICU patients have had multiple risk factors.

Figure 5

NEW YORK CITY CFR, APRIL 2, 2020



Data source: New York City Department of Health

New York City also has updated statistics on the number of cases and deaths by gender and age group. As of April 2, 2020, the New York City CFR for males is 3.6% and for females is 2.9%, as seen in Figure 5. Because the city's age groupings do not align with those shown for Italy, China, Spain and South Korea, it is difficult to compare results. However, New York City's CFRs appear to be falling within the estimated CDC ranges in Figure 3.

It should continue to be reinforced that emerging statistics on the pandemic contraction and case fatality rates lag real-time information. In the early onset of the disease, cases might often be realized in datasets between one to two weeks after the first identification of the case occurred. The amount of time between contraction of the disease, onset of symptoms and its ultimate treatment and identification in public health statistics could be much longer in counties without complete implementation of test processing. Deaths also occur on a lagged basis. Deaths and death rates will greatly increase in many countries and communities over the next month.

As happens with other viruses such as influenza, climate conditions may have an impact on the ability of the virus to survive. Viruses often survive better in cold weather because of the coatings that allow them to survive in the air and be passed on from person to person. These features degrade in warm temperatures. However, it is questionable whether COVID-19 is similar to other viruses in this regard. In the Southern hemisphere, South America and Australia have seen significant outbreaks even in their warmer seasons.

Death rates and reported cases will grow rapidly over coming weeks. However, the pace will be very different in each community and country. It is important to understand the different timing of different numbers. Deaths are a lagging indicator. Deaths will greatly increase in many communities over the next month—even if the personal and private actions have slowed the growth of the virus. The same is true for reported cases. The numbers of reported cases will greatly increase over the next months.

One technique to limit wild fluctuation in and gross under- or overstatement of CFRs that often occur during early reporting is to "lag" the number cases in the denominator by 7 or 14 days. The lag better aligns the deaths with an appropriate exposure for calculating a CFR. However, CFRs calculated with a "lagged" case number could potentially be significantly higher than a CFR using a non-lagged case number, especially during the early days of an epidemic.

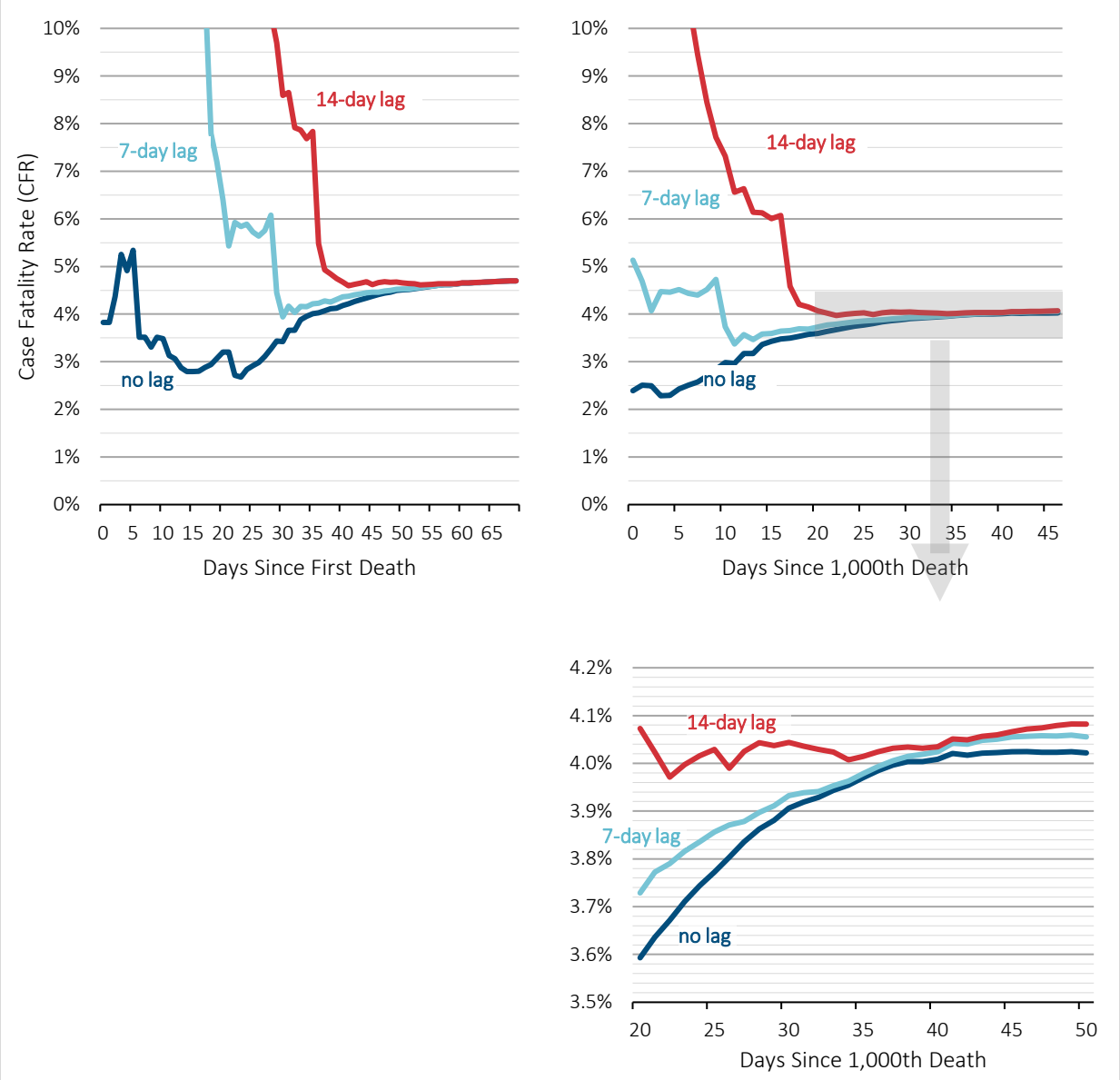
Another approach for avoiding misrepresentation of mortality rates because of early reporting issues is to analyze data for a location only after a certain number of deaths have been recorded there.

A word of caution: The CFRs shown in and quoted in the accompanying paragraphs have been pulled from various sources that have not clearly documented whether a lag is included. The reader should be aware of these potential shortcomings when reviewing these statistics and other reported CFRs.

Figure 6 highlights the effect of using lagged CFRs for Hubei province, China, as well as the impact of analyzing data only after 1,000 deaths were recorded in Hubei province. It appears the CFR for Hubei province may stabilize between 4.0% and 4.1%.

Figure 6

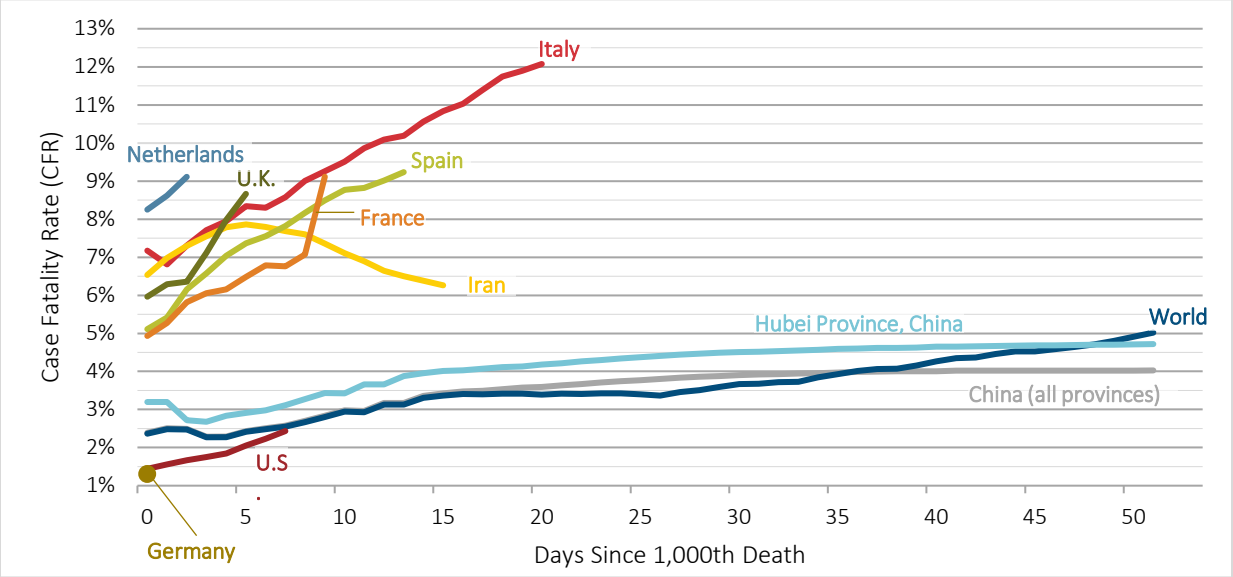
COVID-19 CASE FATALITY RATES FOR HUBEI PROVINCE, CHINA, THROUGH MARCH 31, 2020



Data source: Johns Hopkins University, March 26, 2020.

The reader can see in Figure 7 that COVID-19 CFRs show clear effects of early reporting for all countries with at least 1,000 deaths through April 2, 2020, with the possible exception of Hubei province and all provinces of China. Although it is too early to draw conclusions about the likely long-term CFRs among countries, the differences are striking. At this early stage, CFRs in Italy significantly outpace those of all other countries that have suffered at least 1,000 COVID-19 deaths. Italy's higher CFRs may be in part because in Italy the cases are geographically concentrated, which is overwhelming Italy's health care system, while in other countries, the cases are more geographically spread out.

Figure 7
CFRS WITHOUT LAG FOR COUNTRIES WITH AT LEAST 1,000 COVID-19 DEATHS, THROUGH APRIL 2, 2020



COMPARISON TO PAST PANDEMICS AND INFLUENZA

By comparison, the spread of COVID-19 has been much greater than similar epidemics witnessed in the 21st century, but also with much lower mortality rates. SARS-CoV-2 is one of seven distinct coronaviruses that can infect humans and get their name from the crown-like spikes on their surfaces. Four common coronaviruses (known as 229E, NL63, OC43, and HKU1) rarely cause serious complications or mortality events. Two other coronaviruses have been more prominent in their impact on human illness and mortality. The SARS-CoV virus caused the severe acute respiratory syndrome (SARS) outbreak of 2003 and the MERS-CoV virus created the Middle East Respiratory Syndrome (MERS) in 2012.

The following table shows comparative statistics of COVID-19 compared to the severe acute respiratory syndrome (SARS) outbreak of 2003 and the Middle East Respiratory Syndrome (MERS) in 2012.

Table 2
COMPARISON OF SELECTED CORONAVIRUS EPIDEMICS

Coronavirus Epidemic	Number of Countries Reporting Cases	Estimated Deaths	Estimated Contracted Cases	Estimated Case Fatality Rate
SARS (2002–2003)	29	774	8,098	9.6%
MERS (2012–2014)	27	858	2,494	34.4%
COVID-19 (2019–4/1/2020)				
No lag	179	53,000	1,013,000	5.2%
Lag-7	- -	- -	- -	10.0%
Lag-14	- -	- -	- -	21.8%

Note: Significant differences between the estimated COVID-19 case fatality rates (CFRs) with and without lags indicate that CFRs are likely distorted by reporting issues that often exist in the early stages of epidemics. COVID-19 CFRs are expected to change as the epidemic matures.

The U.S. was a very small part of these previous outbreaks in comparison to the level of activity seen with COVID-19. Eight U.S. patients had evidence of the SARS infection, and no deaths occurred in the U.S. due to SARS. The U.S. saw only two cases and no deaths due to MERS in 2014, both associated with individuals who had lived or worked on the Arabian Peninsula. As of April 1, 2020, the U.S. reported approximately 243,000 cases of COVID-19.

In addition, it can be beneficial to compare the extent of the impact of a sample influenza year to understand the magnitude and strain on health care systems and population mortality. The most recent full year of mortality in the U.S. is from 2018, which was also a fairly harsh year for the age-adjusted influenza mortality rate. The U.S. influenza season across 2017–2018 saw over 48 million people become ill, with over 950,000 people hospitalized and over 79,000 deaths. The annual case fatality rate for influenza in the U.S. typically is observed between 0.1% and 0.2%, with population mortality generally in the range of 12 to 20 deaths per 100,000 of population (0.012% to 0.020%) depending on the severity of the season.

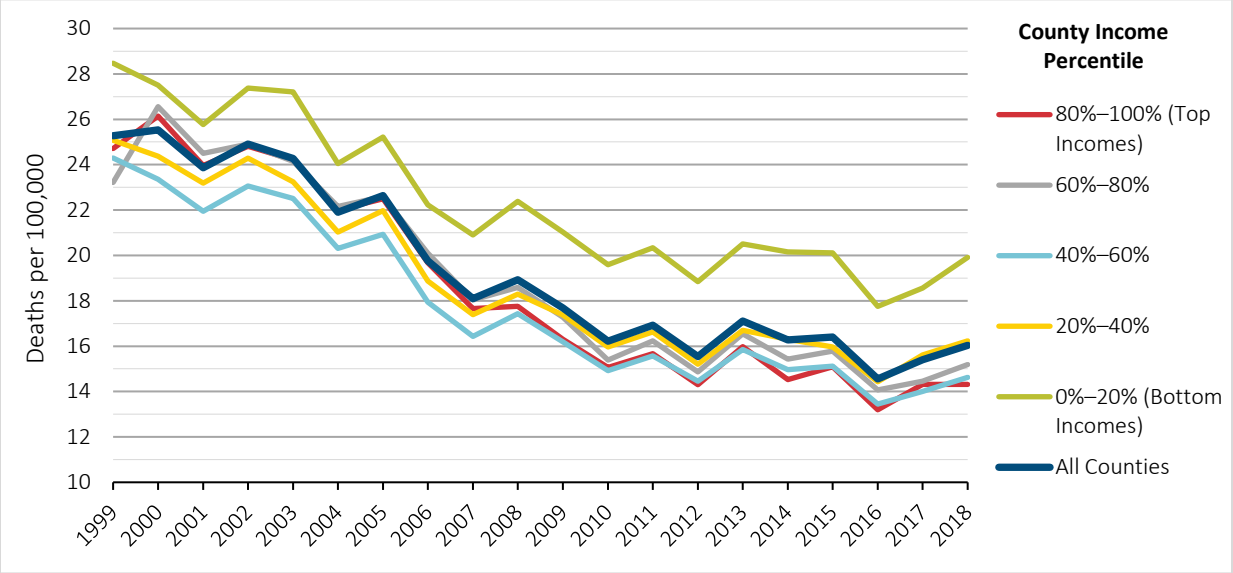
During the 1918 influenza H1N1 pandemic as World War I was ending, mortality was high in people younger than 5 years old, people aged 20 through 40, and in people age 65 years and older. The high mortality in healthy people, including those in the 20-40-year age group, was a unique feature of this pandemic. Health officials estimate mortality was approximately 50 million deaths worldwide. Since 1918, the world has experienced three additional pandemics, in 1957, 1968 and most recently in 2009. These subsequent pandemics were less severe and caused considerably lower mortality rates than the 1918 pandemic. The 1957 H2N2 pandemic and the 1968 H3N2 pandemic each resulted in an estimated 1 million global deaths, while the 2009 H1N1 pandemic resulted in fewer than 300,000 deaths in its first year.

Besides total number of deaths, each influenza outbreak can differ by the time of year it will peak, the severity by age group, the number of outpatient influenza-like illness visits, and the number of hospitalizations required. A flu-season in the U.S. is measured by week and typically begins in week 40 of a calendar year through week 39 in the following calendar year. Week 40 in a calendar year will be flu week #1. The 2009-2010 season was unusual in that it peaked early in flu week 3, whereas the 2011–2012 flu-season peaked in flu week 24. Cumulative hospitalizations were higher for flu seasons 2014–2015 and 2016–2017 than the 2009-2010 pandemic. The 2009-2010 pandemic was unusual in that it tended to affect younger people, whereas most flu outbreaks impact older people. Emerging data on the COVID-19 pandemic indicates that older people are at greater risk, unlike the 2009-2010 pandemic.

Insurers who can segment their policyholders into various income level groupings may be able to make use of U.S. population mortality data, shown in Figure 8, to benchmark their own flu/pneumonia experience. Figure 8 demonstrates how flu and pneumonia death rates in the U.S. have varied historically by various county level income percentile groups. U.S. counties were ranked based on median household income. The 80-100% group represents the quintile of counties with the highest income and the 0–20% group is the quintile of counties with the lowest income. The bottom income quintile (0%–20%) has had significantly higher mortality, ranging from 8 to 24% higher, than the total population. The other quintile groups have clustered together, and their rank order has shifted over time. However, the top income quintile (80%–100%) has had lower mortality rates (2%–11% lower) than the total population since 2007.

Figure 8

U.S. POPULATION DEATHS FROM FLU AND PNEUMONIA BY COUNTY INCOME PERCENTILE



Life insurance companies will focus on how general population mortality rates translate into the ultimate mortality of their own insured populations. Socioeconomic factors may be a key driver of how mortality plays out, because an individual's access to healthcare services and current health condition are often factors that drive survival rates in a confirmed case.

HEALTH CARE COST AND UTILIZATION

Data on the cost and utilization of treatment for individuals who are diagnosed with COVID-19 still appear to be emerging. On March 24, Covered California, an independent part of the California state government whose job is to make the health insurance marketplace work for California's consumers, released a national projection of health care costs due to COVID-19. Estimated one-year projected costs related to treatment and care of COVID-19 in the U.S. commercial health insurance market, which covers a population of approximately 170 million people, ranges from a low of $34 billion to $251 billion or more. As a percent of commercial health premium, these costs could range from about 2% to over 21% of premiums. Covered California also estimated that 2021 premium increases could range from 4% to 40% if carriers look to recoup 2020 costs, price for the same level of costs for the 2021 calendar year and look to protect their solvency.

The financial impact of COVID-19 is seen through increases in underlying expenses for providers and is driven by costs for testing, special equipment, protective systems for health care workers and additional staffing needs. In some locations, additional hospital beds are needed, and they are being built or converted from other sources. These increased costs may be passed onto payers immediately through fee-for-service claims or later in other payment arrangements.

Increases in costs are directly connected to the critical care needed for the sickest patients who have contracted the virus. Intensive care units for these patients are very expensive and the costs are further compounded by the need for isolating them. The impact also varies by the outbreak situation in local areas depending on demographics and efforts such as social distancing to slow the spread.

An issue in many countries, including the U.S., is that the supply of many testing and critical care resources is lower than the current demand. Countries around the world are looking to find ways to improve their ability to meet this

demand. As an example, medical centers within the University of California system have been converting laboratory space into in-house coronavirus testing centers.

Testing for the virus involves collecting respiratory specimens from a patient and running it through test kits at public health laboratories that perform real-time RT-polymerase chain reaction (rRT-PCR) detection of the SARS-CoV-2 virus. Inside the labs, reagents are required to test the specimen provided. Supply of test kits is appearing to grow, but one constraint may also be the amount of public and clinical lab capacity that can be used or increased.

Some countries have dramatically increased capacity for testing over recent weeks, leveraging off past investments in health care infrastructure. As an example, South Korea has had a high number of detections of SARS-CoV-2 but has also seen the number of new cases decline since the start of March 2020. In many parts of the country, drive-through test centers have been established to expedite the process and extend testing ability. These methods also help limit health care workers from having extended direct exposure to the virus.

The U.S. has also commenced this process through health facilities in some states and is also eyeing expansion to private sector pharmacy partners. A new test that could expedite detection was granted "emergency-use authorization" by the Food and Drug Administration (FDA) on March 27 and is being rolled out the week of March 30. It is expected that this test can be given about 50,000 times per day. From insurer and consumer cost perspectives, on March 18, 2020, Congress passed a new law, the Families First Coronavirus Response Act, that requires most private health plans to cover testing for the coronavirus with no cost-sharing during the current emergency period.

Testing is most important early in the cycle of a pandemic to help detect infections and contain the spread of the virus. As the infection has spread and containment is no longer possible, the strategy has shifted from containment to protection of the most vulnerable through social distancing and self-isolation.

Based on analysis of data from China, the CDC found that 12% of COVID-19 patients were hospitalized, a much higher percentage than the hospitalization rate of 1%–2% for influenza patients. Imperial College also analyzed data from China and found that far more than 2% of COVID-19 patients were hospitalized.

The critical focus has now shifted away from testing kits towards having adequate numbers of hospital beds and ventilators for COVID-19 patients and sufficient personal protective equipment for front-line health care professionals and other critical service employees like police. The number of hospital beds per 1,000 people in the U.S. is 1.8 and lags Italy (3.2 per 1,000), China (4.3 per 1,000) and South Korea (12.3 per 1,000). Models and projections of hospital bed usage in the U.S. produced by ProPublica, *https://projects.propublica.org/graphics/covid-hospitals,* demonstrate why public health officials are so intent on "flattening the curve."

New York City released data of cumulative number of COVID-19 cases and hospitalizations in the city, as shown in Figure 9 and Figure 10. The data show that persons age 18 to 44 are more likely than other age groups to contract COVID-19. However, compared to all older age groups, a much smaller percentage of persons age 18 to 44-who contracted COVID-19 have been hospitalized.

Figure 9

CUMULATIVE NUMBER OF NEW YORK CITY COVID-19 CASES AND HOSPITALIZATIONS, APRIL 2, 2020

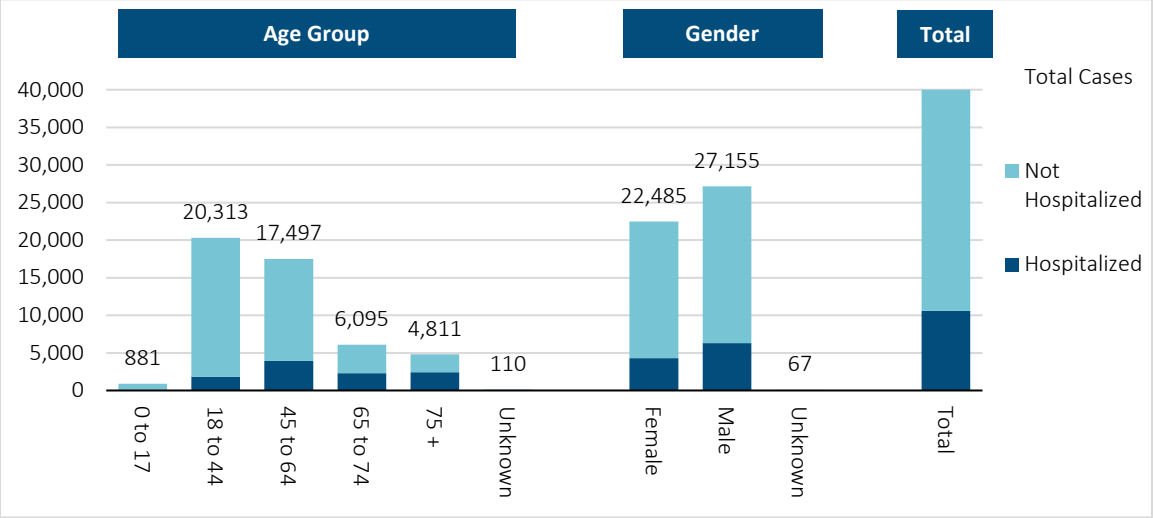
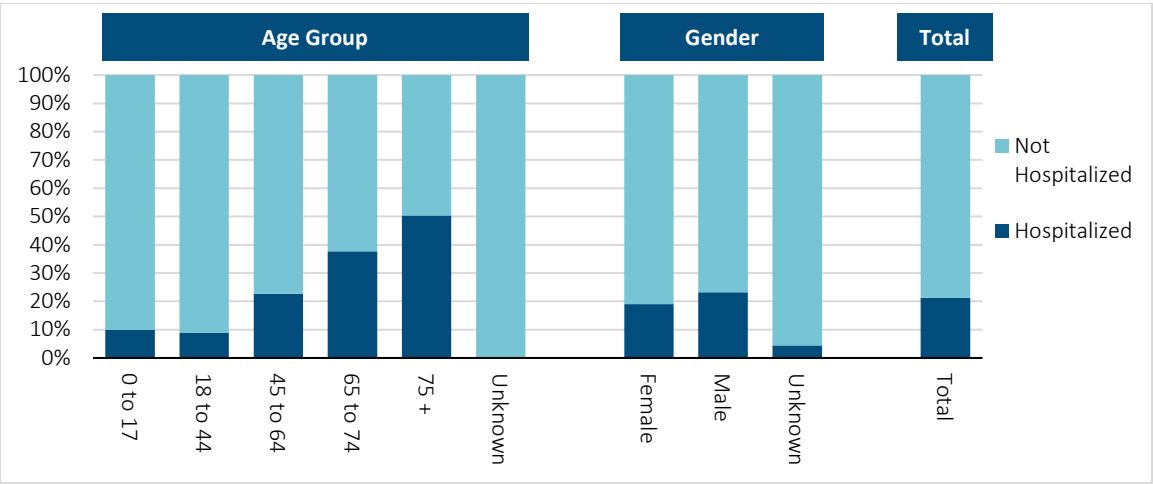


Figure 10

PERENTAGE OF NEW YORK CITY COVID-19 CASES THAT HAVE BEEN HOSPITALIZED, APRIL 2, 2020



New York City's data shows that 19% of COVID-19 patients have been hospitalized. It also shows that males are more likely than females to contract COVID-19, and they are more likely to get sicker from COVID-19 than are females. While males have contracted 55% of the cases, 59% of the hospitalized cases have been males.

This report previously mentioned that during the 2017–2018 influenza season, about 8% of hospitalized influenza patients died. The New York City COVID-19 data indicates that about 12% of hospitalized COVID-19 patients died.

On a cautionary note, data from China and New York City are instrumental to understanding the COVID-19 situation in those specific locales; however, experience in other locations may differ.

Several companies have been developing and testing treatments for symptoms of COVID-19, though results are still preliminary. In addition to these antiviral and anti-infective treatments, preventive medicines and therapeutic antibodies are being reviewed. The newness of the virus complicates research efforts, even with increasing information coming from early cases in China to help guide what might be potential treatments or solutions. On March 30, the FDA issued an emergency-use authorization for two anti-malarial drugs for use in treating patients

infected with COVID-19. The drugs, chloroquine phosphate and hydroxychloroquine sulfate, have been previously used off-label anecdotally.

In addition, efforts to develop vaccines are well underway. More than 30 companies and academic institutions are racing to create such a vaccine, several of which already have candidates they have been testing in animals. It is expected that human trials will begin soon. Some estimates indicate that it may take up to 12–18 months to know the effectiveness and safety of any proposed vaccines.

Overall health care cost and utilization in many countries will also be impacted by the decisions that individuals make surrounding other typical illnesses that may arise and elective procedures that have been scheduled. Some patients have procedures that may not be able to be deferred indefinitely due to the nature of the illness, such as scheduled chemotherapy treatments. In these cases, hospitals are looking to make sure high-risk patients with compromised immune systems are not exposed to the virus. With more encouragement by public health officials to reduce social interaction, however, and individuals potentially nervous about entering a hospital setting where the virus may be present, more deferrals of services may occur, and minor ailments may not be seen as frequently. In addition, health officials are strongly encouraging patients to carefully consider use of emergency room services and not to use them for minor health issues. Telemedicine providers may see an expected rise in utilization. Low utilization of telehealth services in the U.S. to date have been typically attributed to lower consumer awareness and higher comfort with traditional methods but are expected to grow with increased emphasis on technology for social engagement and remote work. Related to this, insurers should be prepared to see an increase in short-term disability claims as patients recover from the disease and other complications.

In the U.S., Humana and Cigna, two large health insurers, decided to waive out-of-pocket costs for healthcare treatment related to COVID-19.

Mental health concerns and treatments may see an increased demand in the coming weeks as populations deal increasingly more with self-isolation and reduced social interaction. Mental side effects of the COVID-19 crisis are increasingly looking to be address by health professionals and heightened as health resources are diverted to the most immediate concerns. In past national disasters, such as terrorism attacks or large-scale weather catastrophes, the primal human social instinct has been to seek comfort in a larger group—whether it be family, friends, neighbors or co-workers. In the COVID-19 pandemic, isolation is recommended to reduce the spread of the virus. While social media outlets have certainly increased since past national disasters in the U.S., such as 9/11 and Hurricane Katrina, it may not be a full replacement for social interaction or as available and used by older or more remote segments of the population. To give perspective on the stress of isolation, and to offer advice on ways to contend with living in confined spaces for long periods of time, the U.S. National Aeronautics and Space Administration (NASA) identified key skills the public can consider. Using insights from NASA astronauts, the agency promoted personal skills including maintaining a plan and schedule, taking time for creative and fun activities and finding time, if possible, to get in a daily walk and fresh air.

Other factors that may impact resource demand include the region where a facility is located. Regions prone to extreme weather or other disaster events should plan for additional healthcare resource strain and the need for more beds in case should such an extreme event occurs concurrently with the pandemic. The level of additional strain will vary based on how well these regions have planned previously for future extreme events and the need for increased capacity.

INFECTION SPREAD RATE

Transmission rates for diseases, and the intensity of an outbreak, are highly dependent on how the pathogen travels between people. Coronaviruses generally can travel up to six feet from an infected person, as they move through respiratory droplets produced through sneezes, coughs or conversations. Some estimates suggest that each person

with the new coronavirus could infect between two and four people over the course of the illness without effective containment measures. The incubation period for COVID-19 is also relatively long compared to other diseases, with estimates running from 2–14 days from the time of exposure to when the individual shows symptoms. With concerns about the spread of the disease and the length of the incubation period, many countries have implemented social distancing policies. The policies vary broadly, including limitations on entering the country and restrictions on movement within a region or country. A report was released on March 16 indicating the potential for infection spread on the virus from a team at Imperial College in London, led by Neil Ferguson. It warned that spread of the disease could cause over 500,000 deaths in the United Kingdom if a more forward government response on reducing population mobility was not taken. The report also noted that up to 2.2 million deaths in the U.S. could occur if there were no risk-mitigating response to the virus.

In early March, the Italian government declared the entire country a "red zone," meaning people should stay home except for work and emergencies. Since that time, several additional countries including Spain, New Zealand and England have issued stay-at- home orders. On March 24, India issued a lockdown of the entire country of 1.3 billion people for three weeks. Businesses are taking action for their employees, such as offering or mandating remote work. Action is also specific to particular regions and communities. As of this writing, at least 15 U.S. states have issued "stay at home" or "shelter-in-place" orders, although businesses, such as grocery stores, that provide essential services can remain open. At least 1.5 billion people—more than a third of the world's population—have been asked or ordered to stay home to try to dampen the spread of the coronavirus.

The concept of "social distancing," or "physical distancing," has become common vocabulary. This includes personal action as people are encouraged to maintain distance between themselves and others to reduce the spread of the disease. Actuarial model simulations can illustrate the impact of social distancing. The SOA has made available a simple example of a social distancing model (*https://www.soa.org/resources/research-reports/2020/impact-coronavirus/).* This model simulates the proportion of a population in various states of health across time: healthy, mild illness, severe illness and death, using probabilities from a hypothetical virus. Because this is a simplified model for illustration purposes only, these health states are conceptual and are not explicitly defined.

Figure 11 and Figure 12, which were created from the model, illustrate the potential impact over time of low social distancing (Figure 11) compared to increased social distancing (Figure 12). For this modeling exercise, the healthy state includes persons who have contracted and recovered from the disease. Through these examples, one can observe the potential benefit of moderating the disease's overall impact by spreading the strain of health care systems across time. The maximum peak of both the mild illness and severe illness states are lowered, and also pushed out further in time, helping defer onset and spread the stress on the health care system. In the current environment, this phenomenon has been referred to as "flattening the curve" through a much slower pace and accumulation of ill patients.

These examples are for illustration only and do not represent actual estimates of probabilities for transition between health states due to COVID-19 or any other virus.

Figure 11
Low Social Distancing

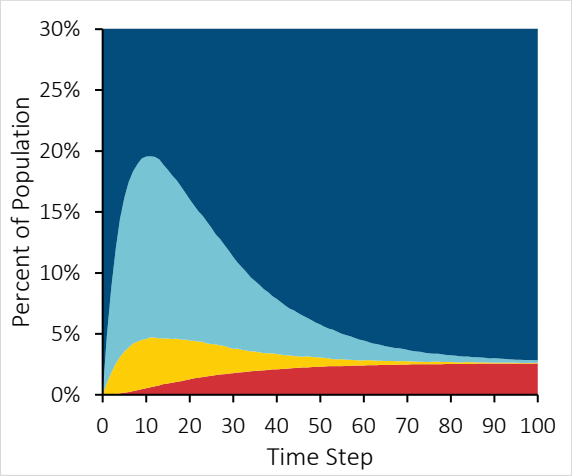
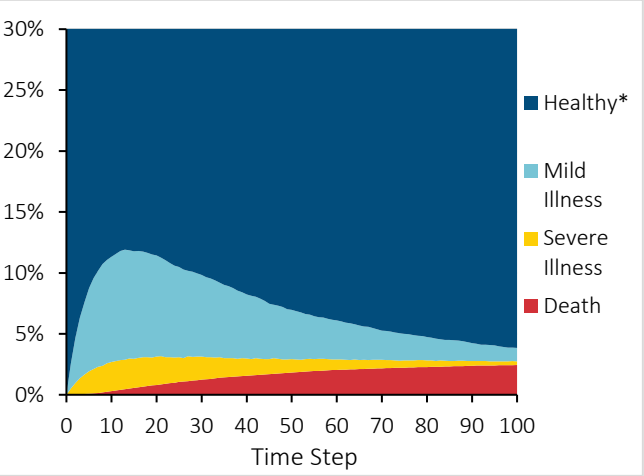


Figure 12
Increased Social Distancing



*Healthy includes indiviudals who have recovered as well as those not yet infected.

By comparison to COVID-19, other pathogens more easily travel through the air for longer distances, such as up to 30 meters for tuberculosis, chickenpox and measles. With the SARS coronavirus in 2003, world health authorities were able to eventually track and isolate cases. The result was to bring the average number each sick person infected down to 0.4, suppressing the outbreak.

The question remains on whether a person who has recovered from COVID-19 has immunity from becoming sick again. For now, it appears people who have had the disease are unlikely to get it again, at least within the timeframe of the current outbreak. Researchers will need more time and data as the virus plays out before any definitive conclusions can be made. Health and public officials have responded in several cases by canceling spectator events that would bring large groups of individuals in close proximity. Examples are numerous, including the cancellation of the U.S. National Collegiate Athletic Association's (NCAA) basketball championships, commonly referred to as "March Madness," as well as suspension of many worldwide professional sports leagues such as the National Basketball Association, National Hockey League and football (soccer) matches in the English Premier League. The International Olympic Committee has postponed the 2020 Summer Olympics in Japan until 2021.

Economic and Asset Impact

MACROECONOMIC VARIABLES

With COVID-19 impacting business around the world, domestic and international financial markets have reacted to reflect potential lower levels of economic activity. Travel restrictions across many countries have been implemented with intentions to slow the spread of the virus. In cases where citizens and legal permanent residents are returning to countries from high-risk areas, their return often has been required to be to designated airports set up to review and inspect the returning travelers.

On Tuesday, March 3, in an attempt to limit the economic and financial fallout from COVID-19, the U.S. Federal Reserve reduced the benchmark U.S. interest rate by half a percentage point to just below 1.25%, down from about

1.75%. In a similar move, on March 11, the Bank of England reduced the rates used by banks and lenders by 0.50%, from 0.75% to 0.25%, to tackle the impact the coronavirus outbreak is having on the economy.

These moves were then followed up by an additional round of quantitative easing on Sunday, March 15 as the Federal Reserve announced dropping the benchmark interest rate to 0.00%. With an anticipation of volatile financial markets, the Federal Reserve makes funds to banks available at these benchmark rates to support the liquidity and stability of the banking system and the effective implementation of monetary policy and to support the flow of credit to individuals and businesses. The Bank of England also followed suit by bringing down its benchmark rate to 0.1%, which is the lowest rate recorded in the history of the bank, since its establishment over 325 years ago in 1694.

Since then, many central banks around the world have continued to use monetary policy levers to help stem the tide of low economic activity due to travel, trade and shelter-in-place restrictions. The Federal Reserve rolled out an array of programs to make loans available to companies and governments, so they can cover current expenses and potentially avoid laying off employees. It also committed to buy as much government debt and mortgage-backed securities it deems necessary to ensure functioning liquidity in these markets and ensure cash is available to the financial system.

Of even further importance to the actuarial profession, the Federal Reserve announced in the release that it would buy corporate bonds, including the riskiest investment-grade debt, for the first time in its history. Corporate bonds rated at BBB or higher by Standard and Poor's or Moody's, which are key investments for many financial institutions, would be eligible and help ensure liquidity in these markets under this program. However, some analysts are concerned that COVID-19-related disruptions could result in demotion of many companies currently rated BBB into junk bond status. Financial institutions that hold such bonds may be incented to sell them, likely during a time that prices reflect a large number of sellers relative to buyers.

Similarly, Australia's central bank proposed to buy $2.35 billion in government bonds and Germany agreed for a package worth up to $808 billion. The Bank of Korea cut its benchmark rate on March 16 by 0.50% to a level below 1.00% for the first time and did so during its first emergency meeting since the financial crisis of 2008. The European Central Bank (ECB) announced a 750 billion euro emergency purchase program aimed to mitigate the financial risks and maintain higher economic outlook for the European countries impacted by the outbreak. It can be challenging in the current environment for the ECB to make large alterations to benchmark interest rates, because the key deposit facility rate, which banks may use to make overnight deposits with the Eurosystem, already sits at −0.50%.

Legislative branches of many countries are developing ways to use fiscal policy to maintain economic activity amid the COVID-19 pandemic. On March 27, the U.S. adopted and signed into law The Coronavirus Aid, Relief, and Economic Security (CARES) Act, the largest stimulus package in U.S. history. The CARES Act aims to inject $2 trillion into the economy, which equates to approximately 10% of gross domestic product (GDP), with benefits and programs from the wide-reaching provisions available to individuals, small businesses, large corporations, hospitals and public health organizations, state and local governments, and education institutions. The act helps facilitate direct payments to households depending on income and family size, with payments being shaped as an advance on a tax credit that is available for the entire year of 2020. Unemployment benefits have been widely expanded under the law, with primary focus on those who are unable to work from home. The expanded coverage is available to workers newly eligible for unemployment beginning in late January 2020 through the remainder of the year. The act also has options for small businesses and nonprofit organizations to receive federal government loans with the opportunity to have the portions of the loans used for covered payroll costs, interest on mortgage obligations, rent, and utilities to be forgiven. The CARES Act also had new and broader application to retirement accounts, including removing requirements to force required minimum distribution from individual retirement accounts or retirement savings plans during 2020, like a 401(k) plan or IRA.

As labor and production reports begin to emerge in March, several reports are noting the impact on worldwide service providers and manufacturing. IHS Markit, an international economic information and analytics firm, noted that its U.S. services Purchasing Managers Index (PMI) declined to a record low of 39.1 for the month, falling from a reading of 49.4 in February. Readings below 50 on the index note signals of economic contraction. Employment in key economic markets around the world are being heavily influenced by the current COVID-19 environment. With travel restrictions anticipated to be in place for extended periods of time and less of an ability to convert work or services to a remote work basis, the transportation, travel planning, and leisure and hospitality labor sectors are expected to be among the industries highest at risk for reduced work or unemployment. Conversely, industries allowed to stay open and operate, even in shelter-in-place scenarios, such as pharmacies and grocery markets are hiring at a rapid pace to meet the demand created.

In the U.S., persons who lose their jobs may lose their health insurance simultaneously, although some employers have furloughed their employees to allow continued coverage. Some firms have announced halts to their stock buy-back programs and are contemplating cuts to 401(k) matching contributions.

Among the most dramatic and indicative economic reports received were the U.S. Department of Labor's Unemployment Insurance Weekly Claims reports, released to the anticipation of the financial markets at 8:30 a.m. Eastern Time on Thursday, March 26, 2020, and Thursday, April 2, 2020. In their opening sentences, the News Releases by the Department of Labor simply put:

> *"In the week ending March 21, the advance figure for seasonally adjusted initial claims was 3,283,000, an increase of 3,001,000 from the previous week's revised level. This marks the highest level of seasonally adjusted initial claims in the history of the seasonally adjusted series. The previous high was 695,000 in October of 1982."*
>
> *"In the week ending March 28, the advance figure for seasonally adjusted initial claims was 6,648,000, an increase of 3,341,000 from the previous week's revised level. This marks the highest level of seasonally adjusted initial claims in the history of the seasonally adjusted series. The previous week's level was revised up by 24,000 from 3,283,000 to 3,307,000."*[2]

In early March, before closures of businesses swept across vast swaths of the U.S., the number stood at 211,000, close to a half-century low.

Additional upcoming reports expected on international production and purchasing and on labor markets will further indicate the level of unemployment changes, and the types of industries that could be subject to lower capital levels and taking advantage of financial assistance from government sources.

Reductions in expected growth in Gross Domestic Product (GDP) for high-GDP countries have been made over the past weeks from many sources with nearly daily changes in the expectation and timing. Updated estimates depend heavily on monetary policy moves and legislative approvals. Most consistently, economic outlook for a majority of economists expected large downturns in second quarter 2020 GDP, with early impacted markets like China having growth rebound in the near term. Early indicators such as traffic patterns and shipping data within some early onset COVID-19 Asia-Pacific markets show signs of potential. On March 23, International Monetary Fund Managing Director Kristalina Georgieva made the following statement, "…the outlook for global growth for 2020 is negative—a recession at least as bad as during the global financial crisis or worse. But we expect recovery in 2021." Many of these outlooks for growth are very strongly tied to the progression, treatment and containment of COVID-19. Short-

[2] United States Department of Labor. (2020, April 2.) News Release. "Unemployment Insurance Weekly Claims." *https://www.dol.gov/ui/data.pdf*

term projections over the coming weeks or months might be more easily modeled, but long-term impacts can be harder to pin down with precision. While some economists expect a V-shaped recovery, others anticipate lack of demand could lead to a slow rebound, resulting in a U- or even L-shaped recovery.

ASSET VALUES AND VOLATILITY

International financial markets have reacted to COVID-19 as some investors sought increasing shelter in government bonds amid uncertain future economic activity arising from the impact of COVID-19.

The week of March 9 saw one of the most volatile swings since the worldwide financial crisis of 2008. Major financial indexes ended the week with a 9% surge on Friday March 13 following a 10% decrease the day before. For the week of March 9, indexes were generally down 4–5% and over 20% from recent highs seen in early February 2020. The downturn continued in equity markets on Monday, March 16, with circuit breakers being hit in early trading due to initial losses on indexes and ending with a nearly 12–13% drop in the main U.S. equity market indexes. Volatility continued to be the main song of the international markets through the week of March 16 and through the time of this writing. On Friday March 13, the Dow Jones Industrial Average climbed 9.3% on new economic news, only to drop 12.9% on Monday, March 16. By Monday, March 23, indexes were down more than 30 percent since their peak in February. However, on Tuesday, March 24, the Dow Jones Industrial Average saw its best one-day gain since 1933, increasing 11.3% on news of a potential economic stimulus package, which was enacted three days later. As of the time of this writing, equity markets remain approximately 25% down from their peak highs in mid-February 2020.

An additional item of note is the length of magnitude of past economic financial market downturns. Using the U.S. S&P 500 as a barometer, some notable downturns in equity markets have occurred over time. Table 3 notes occurrences in the past 100 years where a decrease in the index has eventually reached over 40%, the amount of time it has taken from its starting high point to final low point and how the index performed for the 12 months after completion of the downturn. Historically, many of the most severe financial downturns have been more prolonged events, with large declines occurring over at least a one- to two-year period, though notably having some strong declines over a one-month period.

Table 3
HISTORICAL 40% DROPS IN S&P 500 INDEX

Start	Finish	Duration (months)	Decrease in S&P 500 Index over 1 month	Decrease in S&P 500 Index over Full Duration	1-Year Index Return after Finish
Sep 3, 1929	Jul 8, 1932	34	−20%	−86%	124%
Mar 10, 1937	Apr 28, 1942	61	−9%	−60%	59%
Oct 9, 2007	Mar 9, 2009	17	−2%	−59%	68%
Mar 24, 2000	Oct 9, 2002	31	−3%	−49%	34%
Jan 11, 1973	Oct 3, 1974	21	−41%	−48%	38%
Feb 19, 2020	Mar 23, 2020	1	−34%	−34%	TBD

LOW INTEREST RATE ENVIRONMENT

Low interest rates for investment in major international financial markets have been more the norm over recent years, and the current impact of COVID-19 has further driven down interest rate levels. Benchmark Treasury yields in the U.S. fell nearly 100 basis points in early March since levels seen in mid-February, with the benchmark 10-year Treasury yield temporarily reaching a record low of under 0.40% and the 30-year Treasury moving below 1.00% for

the first time ever. Some reversion has occurred from the lowest interest rate levels. As of April 2, the 10-year Treasury yield was 0.63% and the 30-year Treasury yield was 1.26%.

Using the date of February 19, 2020, as the start of financial market impact in the US, Treasury rates at the long end of the curve are down approximately 70–90 basis points (bps). Corporate spreads, while initially stable through early March, have widened substantially in the most recent weeks. Current credit spread levels, while still below those seen in the financial crisis of 2008–2009, are higher than those seen in other economic environments such as the tech bubble and Enron / MCI WorldCom accounting crises of 2002.

REINVESTMENT RISK

With the material drop in interest rates to even lower levels, the opportunity to reinvest maturing assets becomes even more difficult for financial institutions. Maintenance of fixed income portfolio yields that support fixed interest crediting rates will pose a continuing challenge as the prolonged low interest rate environment continues. Insurers have an advantage in that, for many contracts, premiums are required to keep a policy in force, and for those contracts, cash flow is not as dependent on investment income.

Impact on Insurance Industry

IMPACT ON LIFE INSURANCE COMPANIES

The individual life application process has seen some changes due to COVID-19. In a recent survey conducted by LIMRA, about one-third of life insurance companies are seeing a decrease in the number of applications and 24% have seen an increase in online/mobile applications.

The manual underwriting process for life insurers has also been disrupted because of the difficulty to obtain paramedical exams and lab reports in the current environment. Some companies are waiving paramedical exam requirements or postponing exams. Life insurers are looking at alternative sources for underwriting information to process life insurance applications. The use of attending physician statements and phone or face-time screenings are potential replacements. Several carriers have also added screenings for COVID-19 on their applications, adding questions on travel history and close contact with known COVID-19 persons.

Insurers are also looking for ways to use automatic underwriting programs to avoid the issues with manual underwriting. The LIMRA survey indicated that 26% of insurers are expanding their automated underwriting programs. Some state regulators have requested insurers extend the grace period on premium payments, a common practice used for disaster reliefs after hurricanes. For example, California has requested that all insurance companies provide a minimum 60-day grace period for policyholder to pay premiums before the policy is cancelled for the nonpayment of premium. Per the LIMRA survey, 77% of companies are extending grace periods.

It is yet to be seen if insured death claims will increase due to COVID-19. However, given the impact the pandemic has had on the economy and unemployment, the potential for increased suicides will be an area to monitor.

IMPACT OF PROPERTY/CASUALTY COVERAGES

In addition to the impact on life and health insurance coverages, the impact of current events impacts the concepts of business interruption and personal and commercial auto coverages.

With the large amount of reduced or stopped economic activity occurring in most major international markets, business interruption insurance coverages are getting prominent attention among insurers and their customers,

Congress, the insurance regulatory community and insurance trade organizations. Business interruption insurance generally compensates the insured for the financial loss of a business being unable to operate, as well as physical loss to property. Contingent business interruption insurance policies additionally protect the insured against supply chain disruptions but often may require that property damage has occurred. Typically, business interruption policies will include mandatory exclusions to not cover business losses prompted by virus-related events. Policies often look to some form of physical damage linked to business losses to enable a claim and may have intentional exclusions for losses in connection with viruses. Contingent business interruption insurance policies protect against losses from supply chain disruptions but may require the occurrence of the typical property damage to trigger coverage. Cancellation insurance provides coverage for expenses arising from delays, rescheduling or cancellations due to unforeseen covered events. Current circumstances, however, are likely unprecedented. Policies may contain civil authority provisions, which may provide coverage for losses suffered in connection with a governmental order prohibiting access to a covered location. Issues of what constitutes physical damage or loss will likely arise. Driven by legislators, some states are looking to draft bills that will cause insurers to provide coverage for these types of losses. Typically, these updated rules or proclamations specifically cite property damage from COVID-19 as part of the basis for prompting the shutdown of local business.

Workers Compensation coverages in the U.S. have also been discussed in industry as employee health issues or injuries could be associated with the emergence of COVID-19. Similar to business interruption insurance, often there may be specific limitations or exclusions in state laws that would apply to "ordinary diseases." Often these types of diseases would include viruses such as the common cold or commonly recurring seasonal diseases such as influenza. Occupational diseases that would arise out of the typical time spent in employment would generally be covered. Some U.S. states are contemplating creating new laws, or amending their current statutes, to expand the coverages. As an example, legislation introduced in several states, including Ohio, New Jersey, Alaska and Washington, would specifically designate COVID-19 as an occupational disease for frontline healthcare and protection workers such as police, firefighters and emergency medical workers. Complicating the impact of workers compensation insurance in the new interaction of federal and state programs that allow or encourage employers to continue with payroll payments to workers, even if they are furloughed. Insurers and businesses will need to sort out how wages and salaries paid to employees while they aren't working due to the stoppage of business operations will be included in exposure amounts that lead to premium determinations.

The amount of vehicle miles traveled and degree of road congestion will be important variables to watch over the coming months because they are a key indicator for personal and commercial auto claim frequencies. Federal authorities in many countries will specifically track mileage and mobility statistics using a wide array of data sources. In the U.S. the Department of Transportation actively gathers information so that vehicle activity can be monitored and analyzed. In addition, local authorities responsible for toll roads and maintenance of highways and bridges will continuously review vehicle statistics. Already, data are showing the impact of increased social distancing and remote work leading to less auto coverage exposures. In early March, as the San Francisco Bay area began to implement more shelter-in-place initiatives, bridge officials at the Golden Gate Bridge noted a 70% reduction in traffic during peak rush hour times.

The use of telematics to determine vehicle miles traveled, speed and acceleration trends and to use as a basis for "Pay as You Drive" auto insurance programs has grown in recent years. Advocates of these pricing mechanisms from consumer and auto insurance industry groups note the ability to provide more accurate pricing, because it depends on individuals' own behavior and is directly based on exposure to risk. In addition, subsidies across rating category groups have the potential to be decreased, and some studies have noted the ability to reduce the proportion of uninsured driving.

With reduced vehicle miles traveled leading to anticipated fewer auto insurance claims over the short-term environment, some consumer advocates have started to publicly call for the auto insurance industry to lower or refund premiums due to the extensive and growing shelter-in-place rules in many markets.

CHANGES IN INSURANCE REGULATION AND CONTRACTUAL REQUIREMENTS

In times of crisis or catastrophe, insurance regulators and supervisors often move to ensure consumers have flexibility to meet their payment obligations and claim filing opportunities. In such times, consumers may be displaced from their residences, be contending with higher priority activities involved with recovering from catastrophe or have less of an ability to communicate with their insurance carrier. These crisis situations tend to occur due to natural extreme weather events or terrorism events. With the development of COVID-19 internationally, many insurance regulatory authorities have begun to work with their local insurance markets to set new temporary rules for insurance contracts. In similar situations in the past insurance regulators have taken steps to ensure that policies across all lines of business are not inadvertently cancelled due to an inability of policyholders to make timely payments.

One example is with the supervision of the insurance industry in Hong Kong, where the local regulator and the Hong Kong Federation of Insurers (KFI) have seen the market adapt to the new environment. In late February 2020, HKFI announced the creation of an "Insurance Dashboard on COVID-19" at *https://www.hkfi.org.hk/covid19,* noting actions the local industry had taken to respond to shelter-in-place requirements. Among the alleviation measures taken by insurers were to waive waiting periods on medical insurance and critical illness policies, extend premium grace periods for several lines of business and adopt simplified or express claim filing procedures.

Similarly, in the U.S. the National Association of Insurance Commissioners (NAIC) and industry trade associations have been monitoring how policy contract requirements, such as the lengthening of grace periods and extending coverage requirements. As an example of many quickly evolving requirements put in place is the emergency proclamation by the New York State Department of Financial Services regarding the requirement for coverage of telehealth services. On Friday March 20, the NAIC held a full-day special virtual session to discuss state response, coordination and potential guidance for the U.S. insurance industry around COVID-19. Presentation topics included pandemic modeling, information around policy coverage, financial impact to the insurance industry and insurer readiness. The remainder of the NAIC Spring National Meeting was suspended to allow participants to focus on the health emergency. A Society of Actuaries(SOA) *Research Insights Podcast* interview with NAIC CEO Mike Consedine, highlighting the U.S. insurance regulatory perspective on COVID-19 implications, can be found on the SOA website at *https://www.soa.org/resources/newsroom/covid-19-updates/#research*.

CYBER RISK

Cyber criminals may take the opportunity, with both less physical presence at offices and more remote nodes connecting to an organization's network, to increase cyber-attacks. Distributed denial of service (DDoS) attacks may increase where attackers flood the bandwidth or resources of a targeted system, usually one or more web servers. These types of attacks can severely slow or cut off system access at critical times for organizations. As example, on Monday March 16, the United States National Security Council acknowledged a cyber incident aimed on the U.S. Health and Human Services network.

Organizations will look to refresh or implement additional cyber protections, such as ensuring devices use full disk encryption. If a physical computer asset is lost or stolen, organizations will look to further ensure that data on the device would not be accessible. Virtual private network (VPN) connections are expected to further increase in their usage to enable access to corporate networks remotely, but also creating a higher risk of unauthorized access and data leakage. The use of personal internet service providers (ISPs), and an expected growth in the use of public Wi-Fi services, create opportunities that enhance cyber risk. In a growing era of data privacy, and the costs associated with reconciling the loss of customer data, this risk may become more prominent.

Operational and Emerging Risks

As businesses around the world work with their employees to minimize the impact of COVID-19, new operational risks and concerns begin to emerge. The following risks have been identified as key ones to watch through discussions with actuarial profession thought leaders.

HOSPITAL OPERATIONS

A significant portion of the risk for public health systems in combating the virus outbreak and for private health care providers and insurance carriers to monitor is the ability for hospitals to contend with the increasing cases. The volume of hospital beds and rooms in some markets will be stressed by the outbreak. In addition, equipment that is critical to responding to respiratory diseases will be in strong demand. Equipment such as ventilators are key to the health care response and treatment of COVID-19, especially as the disease strains the breathing of patients who are already weak or have other health conditions.

Governor Andrew Cuomo of New York issued an emergency order to hospitals in New York State to increase capacity by at least 50% to contend with the sharp increase in case. As of March 23, New York City had 2,000 ventilators, but is expected to need 15,000 by the end of May, according to Mayor de Blasio, demonstrating further capacity strains.

Some countries have taken early measures to convert available spaces into hospitals or additionally construct pop-up hospital settings. The number of hospital beds per 1,000 people in the U.S. is 1.8 and lags Italy (3.2 per 1,000), China (4.3 per 1,000) and South Korea (12.3 per 1,000). U.S. Navy hospital ships are being deployed to areas with the greatest need such as Los Angeles and New York City. Large empty spaces such as convention centers are being converted to house temporary hospital units. In addition, hotels in some cities like Chicago are renting empty hotel rooms to isolate individuals and patients who need to be quarantined. Health system capacity will be a substantive issue and risk that will be emerging in the U.S. in the next few weeks.

Health care systems are also looking to take advantage of technology, and prevent the spread of potential virus cases, by emphasizing screening that can be done through online methods. Many healthcare systems are encouraging diagnosis through online screening methods or through the use of chatbots that can analyze patient symptoms and give advisement on what steps individuals should take next. Through these methods, health care systems are looking to avoid the spread of the virus in common health care settings such as physician's offices and emergency rooms and avoid situations where potential virus carriers would need isolation in the hospital setting prior to formal admittance.

Supply chain risks also exist for hospitals, pharmacies and other health care providers as international shipping and delivery services play a vital role in getting pharmaceutical drugs from their manufacturing source to the site of use. The U.S. may be a key example. Research and development of new pharmaceuticals is often done within the U.S., but manufacturing is often done outside the country. High proportions of commonly used drugs such as antibiotics, ibuprofen, hydrocortisone, acetaminophen and heparin are produced outside the U.S., often in the Chinese market. Many other countries such as India, South Korea and Germany are reducing the amount of medical supplies and protective gear they export to retain supplies in their local market.

On March 18, the U.S. 1950 Defense Production Act was invoked and empowers the U.S. government to mobilize private industry to ramp up production in the name of national security if needed. Private industry, for the most part, has voluntarily stepped up to help the situation, and the need to enforce the 1950s act has not been needed. Distilleries are converting their gin, whiskey and rum production lines to the production of hand sanitizer. Auto and truck manufacturers are looking into producing ventilators. Other private businesses are looking to make face masks. However, for the first time on March 27, the power of the 1950 act was used when the U.S. president

required General Motors to accept, perform and prioritize federal contracts for ventilators deemed necessary by the health and human services secretary amid the coronavirus pandemic.

Estimates of the date or a range of dates at which the outbreak will peak have been closely followed at all governmental levels. These estimates vary based on the numerous statistical models that have been built to provide projections and the techniques the models use. The models do not provide a consensus as to when the peak will occur. White House coronavirus task force adviser Dr. Deborah Birx has mentioned these models at press briefings. Dr. Birx singled out projections by the Institute for Health Metrics and Evaluation (IMHE) at the University of Washington in Seattle, suggesting that model is close to how government experts see the situation.

The IMHE model defines the peak as the point at which there is the most demand for resources—hospital beds and ventilators—and when the most health care workers will be needed to care for coronavirus patients. Projected peaks vary by state in the model with an overall estimate of the peak for the U.S. on April 15, based on current data as of March 31.

A comparison done by the Chicago Tribune for when the virus will peak in Illinois showed a prediction of April 17 from the IMHE model versus an estimate of May 14–May 26 by another model from a group called COVID Act Now. The estimate range of the COVID Act Now model varies based on the level of compliance with stay at home measures.

REMOTE WORK

A common step implemented by many organizations around the world has been to encourage remote work environments. In this setup, employees work from a remote location outside the normal office setting, often from their own personal residence. This helps maintain physical distance and reduce the chance of spreading disease among an employee population.

While remote work is not a new concept, the volume of remote work that is expected to be implemented due to COVID-19 may greatly exceed previous expectations. Employers will be looking to maintain productivity and keep processes moving.

A mitigation to this risk is that many employers have already implemented some form of remote work, ranging from arrangements that allow employees to periodically work remotely up to full-time remote work. The previous investment of these work arrangements may be beneficial to companies in any prolonged transition for their employees.

Physical asset and information security risk also increases as remote work becomes more the norm. Organizations are often encouraged to remind staff of basic security practices, like ensuring that they do not leave company assets, documentation, confidential information or property unattended in public places and to be aware of others who may be working around them.

Some employees may feel uncomfortable if asked to work in a large corporate environment during a time of pandemic, though employers in some countries may not have an obligation to allow telecommuting unless they would be required to accommodate an employee disability. Employers in most countries generally may have the right to ask employees to work in a remote setting if they are not discriminatory in their practices or infringe on protected classes.

Complicating the remote work phenomenon for many individuals is the fact that many schools, universities and daycare facilities have been either closing or instituting “distance learning” methods. Many parents may be juggling the need to do work for their employer while also ensuring children have appropriate care or ensuring their focus

on school activities. The concern may be greatest for health care providers as they look to contend with the increasing demand of providing services.

EMPLOYMENT LAW

In many countries, employment law is being amended to adjust how paid leave will work for employees impacted by the pandemic. In the U.K., the Coronavirus Job Retention Scheme was implemented giving employers the ability to apply for grants to keep employees on the payroll if they're unable to operate or have no work for employees due to economic impacts from COVID-19. The minimum time that an employee can be furloughed is three weeks, and companies cannot rotate furloughed workers.

Effective April 1, the Families First Coronavirus Response Act was enacted in the U.S., applying to businesses based in the U.S. with fewer than 500 employees. The law ensures that employees who can't work due to symptoms associated with COVID-19 or under quarantine or isolation obligations must receive up to two weeks of paid sick leave. Additionally, if the employee is caring for a quarantined or isolated person or child due to the pandemic, up to two weeks of leave must be granted at rate equal to two-thirds of normal pay rates. The requirements are currently applicable until December 31, 2020.

An additional side effect of employment law and practices under COVID-19 stems from the dwindling capacity for commercial laboratories to process standard drug testing for employees. With the focus and allocation of space of time higher on testing new coronavirus patients, labs may be deferring on slowing down their process rates for employers testing current employees or looking to add additional hires.

INTERNET SERVICE PROVIDER AND VIRTUAL PRIVATE NETWORK CAPACITY

With the growth of remote work, many employers are looking to determine if there will be any new or different strains on ISP capacity. Remote work in large volumes across many organizations may put different pressure loads on ISPs. Organizations and their employees will be monitoring connection speeds needed for a range of work, especially if work is done using a remote desktop connection. VPN bandwidth adds to the concern, because some companies may consider advising employees to use cellular phone methods to join on conference calls as opposed to using voice-over-internet through a computer connection.

STOCKPILING

As may happen in other emergency or disaster situations, especially ones where individuals perceive that mobility and service disruptions may take place, the phenomenon of stockpiling critical goods has been seen in countries around the world. Some individuals have taken to acquiring and storing large quantities of staple goods to ensure a supply is available when needed, to have on hand over potentially long periods of isolation, or with intent to capitalize on short supply and sell goods at inflated prices. Many stores have placed purchase limitations on key products related to the outbreak to ensure a more consistent supply for their customer population. Products being stockpiled in the current environment include facemasks, toilet paper, hand sanitizer, disinfecting soap and canned goods, although shelves are being restocked. Complaints of price gouging and citations for price gouging have increased during the pandemic.

EVENT CANCELLATIONS AND RESTAURANT CLOSINGS

Many large spectator events, concerts and professional development meetings are being cancelled around the world to prevent the spread of COVID-19 among individuals in close proximity.

The world of event cancellation insurance has evolved quickly over the past few months, with some insurance providers beginning to exclude coronavirus as a triggering event. Policyholders who procured event cancellation

insurance generally before January 2020, typically would have had the ability to purchase either "all-cause" coverages, or specified coverages with options for cancellations due to infectious or communicable diseases. Beginning in early 2020, as the virus began to gain traction in China and other markets, this type of coverage began to greatly decrease in its offering. Today, many insurance companies are including specific coronavirus exclusions in newly issued event cancellation policies.

The impact of event cancelations will be noticeable in local economies that rely on spectator events, such as sports and concerts, and in particular on those individuals who work in service industries. In response, many high-profile sports celebrities and/or employers have been offering financial assistance commitments to assist those impacted by the cancellations, such as staff who work as ushers or security for large spectator venues. Some sports and entertainment companies are maintaining employee pay while their events are cancelled, or venues are closed.

To stem the spread of the virus, many jurisdictions around the world implemented measures to close restaurants, bars and nightclubs which are prone to larger gatherings and social interaction. As an example, the state of Illinois ordered all restaurants and bars to close to dine-in customers by the end of Monday March 16, with the closures lasting from March 16 through March 30. Subsequently, the governor of Illinois put into place a shelter-in-place order through April 7. The state of Ohio implemented similar orders beginning at 9 p.m. local time on Sunday, March 15. Establishments would be allowed to continue carryout and delivery services. On March 31, the governor of Illinois extended the shelter-in-place order through April 30.

INTERNATIONAL TRADE DEPENDENCY

Many manufacturing organizations around the world today are dependent on international trade and shipping systems to receive supplies, facilitate sales and distribute products. Financial services companies may be less exposed to these operational risks on a short-term basis, but longer-term events could cause risks when physical assets (such as computers, and network servers) need maintained or replaced.

ALTERNATIVE ENTERTAINMENT DISTRIBUTION

With the growing trend of reduced social interaction, but the continuing public appetite for entertainment, new methods of dissemination appear to be occurring. With the suspension of the National Basketball Association's season, some teams have taken to their fans and players continuing to "play out the season" through internet-connected game devices. Online streaming video services have increased their push into the markets with new releases or bringing forward anticipated future releases to meet the demand expected. With lower expectations anticipated for consumers gathering to watch movies in theaters, some film distributors have pushed releases to later dates or released directly to video on demand. Release schedules among major motion picture providers worldwide often are inflexible given the long-range planning and coordination that goes into film production, but there is anticipation that the industry will be careful not to layer large releases too close to each other to optimize attendance at theaters.

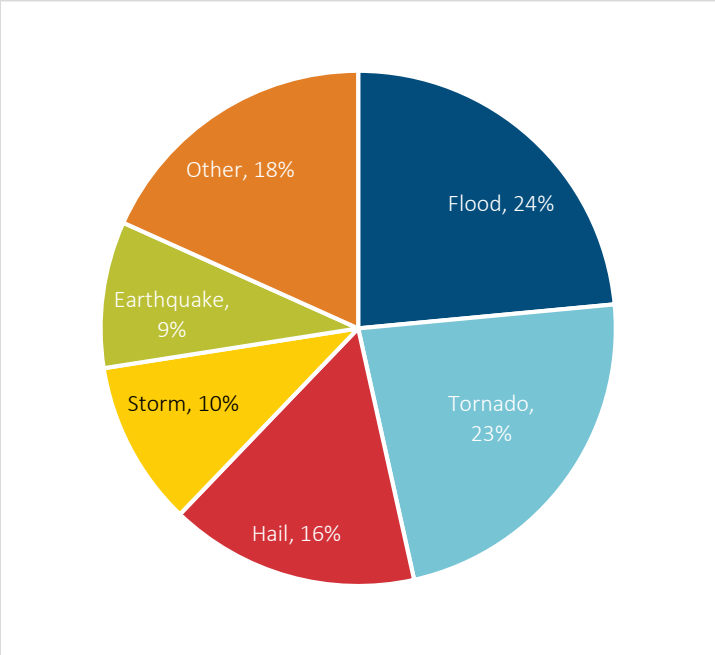
RISK OF EXTREME WEATHER AND OTHER NATURAL HAZARDS

In the weeks and months to come, the COVID-19 crisis could potentially be compounded by extreme weather events, adding an additional layer of stress to a situation that is already dire. In addition, earthquakes are an ever-present risk for the West Coast.

Extreme weather, earthquakes and wildfires caused an average of $29 billion in property damage per year in the U.S. across the period from 1980 to 2018, of which 18%—or $5 billion per year—occurred during the months of March, April and May (Figure 13).[3]

Figure 13

HISTORICAL DISTRIBUTION OF PROPERTY LOSSES BY NATURAL HAZARD DURING MARCH–MAY



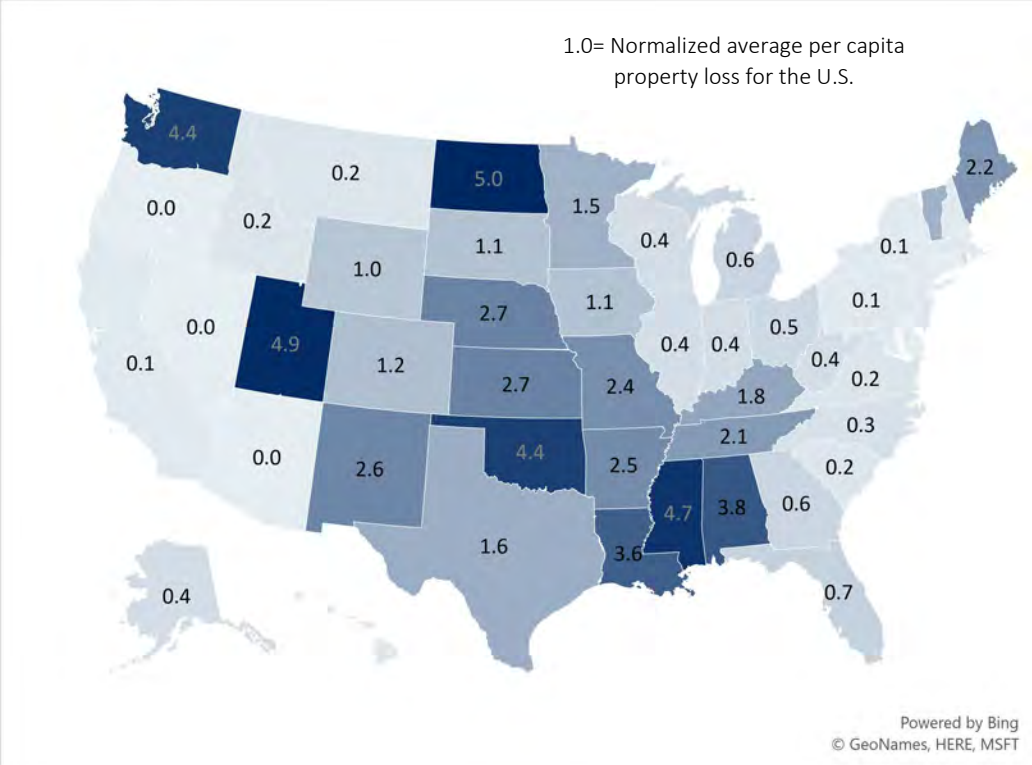
Source: authors' tabulations of SHELDUS loss data across the 1980 to 2018 period

With respect to geographic region, loss data suggest that the risk posed by natural hazards during March through May is greatest across the Great Plains and the Gulf Coast (Figure 14). Given these factors, additional strain on health care resources will vary based on geography, severity of any extreme event and previous efforts to boost preparedness for such situations.

[3] This result was computed using the Spatial Hazard Events and Losses Database (SHELDUS) for the U.S., which tracks property losses, crop losses, fatalities and injuries due to natural hazards in the U.S. SHELDUS property and crop losses are "economic" as opposed to insured. The $32 billion result includes property losses from weather events, while excluding losses from geological risks such as earthquakes and volcanoes. To account for changes in property exposure across time, losses were adjusted forward to 2018 using county-level census data for the number of residential housing units, and state-level data for the median value of a residence.

Figure 14

NORMALIZED HISTORICAL PER CAPITA PROPERTY LOSSES DUE TO NATURAL HAZARDS, FOR MARCH–MAY



Source: authors' tabulations of SHELDUS loss data across the 1980 to 2018 period. Note that a value of 2.0 indicates that a state's per capita historical losses are twice the national average, while a value of 0.5 indicates per capita losses of half the national average.

Previous SOA Research Highlights

Over the years, many committees and sections within the SOA have helped support, fund and promote research related to disease outbreaks. The following is a short highlight of key reports previously released by the SOA or highlighted at SOA professional development sessions that may be of benefit for the actuarial profession. The SOA is committed to updating these types of reports as new information emerges.

IMPACT ON THE U.S. LIFE INSURANCE INDUSTRY

The report series on "**Potential Impact of Pandemic Influenza on the U.S. Life Insurance Industry**" *https://www.soa.org/resources/research-reports/2007/research-impact-pan-influ-life-ins/* gives guidance through several reports on the potential impact of a disease outbreak on population and insured mortality in the U.S. and additionally has information on the potential impact on financial markets, corporate bond spreads, monetary policy and economic output.

Sponsored by the Committee on Life Insurance Research and the Risk Management Section's research team, Jim Toole of MBA Actuaries evaluates the financial effects of different flu pandemic scenarios on the U.S. Life Insurance industry. In addition to the research report, he has developed an accompanying spreadsheet tool for individual insurers to better understand the associated financial risks of a flu pandemic.

During this study, the Project Oversight Group conducted two Delphi studies. One study examined how excess insured mortality as a result of a flu pandemic might differ from that of the general population. The second study examined the potential economic effects of a flu pandemic. Results are presented in the following reports

Materials available include:

- Potential Impact of Pandemic Influenza on the U.S. Life Insurance Industry Report
- Pandemic Model Tool with documentation
- Study of the Effect of a Flu Pandemic on Economic Values Using the Delphi Method
- Study of the Effect of a Flu Pandemic on Insured Mortality Using the Delphi Method

COMPARISON TO CURRENT COVID-19 EVENTS

The report series included a survey, using the Delphi Method, on the impact on various economic values should the U.S. enter an influenza pandemic. Two pandemic virulence scenarios were analyzed; a moderate scenario similar in mortality severity to the 1957 H2N2 pandemic and a severe scenario similar in mortality severity to the 1918 H1N1 pandemic. The 1957 pandemic ("Moderate Scenario") produced approximately 0.7 excess deaths per 1,000 of population, and the 1918 pandemic ("Severe Scenario") produced approximately 6.5 excess deaths per 1,000.

Table 4 summarizes the survey results in comparison to current observations under the COVID-19 pandemic, using February 1, 2020 as an approximate average start of the worldwide outbreak:

Table 4
SURVEY RESULTS COMPARED TO CURRENT OBSERVATIONS

Estimated Asset Values	SOA Research Report	Current Environment, Measuring from February 1, 2020
Maximum Percentage Change in S&P 500 Index within 180 days from onset; Average response for Moderate Scenario	−11%	−25%
Maximum Percentage Change in S&P 500 Index within 180 days from onset; Average response for Severe Scenario	−24%	
Maximum Change in Aa Corporate Bond Yield within 180 days from onset; Average response for Moderate Scenario	Up 28 basis points	Up 123 basis points
Maximum Change in Aa Corporate Bond Yield within 180 days from onset; Average response for Severe Scenario	Up 35 basis points	
Maximum Change in the Federal Funds Rate within 180 days from onset; Average response for Moderate Scenario	Down 27 basis points	Down 150 basis points
Maximum Change in the Federal Funds Rate within 180 days from onset; Average response for Severe Scenario	Down 77 basis points	

IMPACT ON THE U.S. HEALTH INSURANCE INDUSTRY

The report series "Potential Impact of Pandemic Influenza on the U.S. Health Insurance Industry Report" *https://www.soa.org/resources/research-reports/2010/research-pandemic/* highlights the potential impact of an

outbreak on health care costs, including information on how costs may vary by the site of care, and the impact on operational risks to health care providers.

Sponsored by the Committee on Life Insurance Research, the Joint Risk Management Section's research team, and the Health Section, Jim Toole of MBA Actuaries evaluates the financial effects of different flu pandemic scenarios on the U.S. health Insurance industry. In addition to the research report, he has developed an accompanying spreadsheet tool for individual health insurers to better understand the associated financial risks of a flu pandemic.

This is the second paper in a two-part series examining the potential impact of pandemic influenza on the insurance industry. The first paper focused on the potential impact of pandemic influenza on the life insurance industry.

Materials available include:

- Potential Impact of Pandemic Influenza on the U.S. Health Insurance Industry Report
- Health Company Pandemic Modeling Tool and documentation

LOW AND NEGATIVE INTEREST RATE RESEARCH

- "Sustained Low Interest Rate Environment: Can It Continue? Why It Matters" *https://www.soa.org/research-reports/2014/research-2014-sustained-low-interest/*

- "Transition to a high interest rate environment: Preparing for Uncertainty" *https://www.soa.org/resources/research-reports/2015/research-2015-rising-interest-rate*

- "A Low-Growth World: Implications for the Insurance Industry and Pension Plans" *https://www.soa.org/resources/research-reports/2019/low-growth-world/*

- "Negative Interest Rates and the Insurance Industry: A Survey of Risk-Management Capabilities and Practice" *https://www.soa.org/resources/research-reports/2020/negative-interest-rates/*

References

KEY STATISTICS

World Health Organization. "Coronavirus disease (COVID-2019) Situation Reports." *https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports*

Centers for Disease Control and Prevention. "Coronavirus Disease 2019 (COVID-19)." *https://www.cdc.gov/coronavirus/2019-ncov/cases-updates/summary.html*

Centers for Disease Control and Prevention. "Coronavirus Disease 2019 (COVID-19)." *https://www.cdc.gov/coronavirus/2019-ncov/index.html*

Centers for Disease Control and Prevention. *Morbidity and Mortality Weekly Report*, Vol. 69, "Severe Outcomes Among Patients With Coronavirus Disease 2019 (COVID-19)—United States, February 12–March 16, 2020." March 18, 2020. *https://www.cdc.gov/mmwr/volumes/69/wr/pdfs/mm6912e2-H.pdf*

European Centre for Disease Prevention and Control. "Situation Update Worldwide." *https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases*

National Health Commission of the People's Republic of China. "Outbreak Notification." *https://ncov.dxy.cn/ncovh5/view/pneumonia?scene=2&clicktime=1579582238&enterid=1579582238&from=singlemessage&isappinstalled=0*

Falconer, Rebecca. (2020, March 15). "New CDC Coronavirus Guide: Cancel Large Gatherings of 50-Plus People." Axios.com. *https://www.axios.com/cdc-coronavirus-cancel-large-gatherings-a157a76c-9b3c-41d0-be63-43caa917adaa.html*

Bureau of Transportation Statistics. *https://www.transtats.bts.gov/Data_Elements.aspx?Data=5*

Centers for Disease Control and Prevention. "Lesson 3: Measures of Risk." *https://www.cdc.gov/csels/dsepd/ss1978/lesson3/section3.html*

Weixel, Nathaniel. (2020, March 6). "Coronavirus Mortality Rate Likely to Drop, Say Health Experts." The Hill. *https://thehill.com/policy/healthcare/486231-health-experts-warn-coronavirus-mortality-rate-likely-to-drop*

Doyle, Liam. (2020, March 10). "Coronavirus Named: What Does COVID-19 Stand For?" Express. *https://www.express.co.uk/life-style/health/1241302/Coronavirus-named-COVID-19-meaning-WHO-coronavirus-latest-update*

Holman, R. J., C. S. MacDonald, and P. J. Miller. (March 2020). "U.S. Population Mortality Observations-Updated With 2018 Experience." Society of Actuaries. *https://www.soa.org/resources/research-reports/2020/population-mortality-observations/*

Helathline.com. (March 2020). *https://www.healthline.com/health-news/if-you-get-the-coronavirus-what-will-it-cost-you#How-much-will-coronavirus-testing-cost?*

Aon.com (2020, March 2). "Pandemic Flu vs. 2019 Novel Coronavirus—Comparison and Context" *https://www.aon.com/getmedia/10f63fe6-9da4-4b96-9b38-c6c3acf27d01/Pandemic-Flu-VS-COVID-Comparison-And-Context-Mar-02-2020.aspx*

Chinese Center for Disease Control and Prevention. *http://www.chinacdc.cn/en/*

Centers for Disease Control and Prevention. "1918 Pandemic (H1N1 virus)." *https://www.cdc.gov/flu/pandemic-resources/1918-pandemic-h1n1.html*

Amin, Priya. (2020, March 9). "Early mortality rates for coronavirus are likely misleading, experts say." ABC News. *https://abcnews.go.com/Health/early-mortality-rates-covid-19-misleading-experts/story?id=69477312*

Ducharme, Jamie. (2019, June 20). Time. "This Past Flu Season Was the Longest in 10 Years, the CDC Says." *https://time.com/5610878/2018-2019-flu-season/*

Cigna. (2020, March 5). "Cigna Covers Cost Of Coronavirus Tests For Customers." *https://www.cigna.com/newsroom/news-releases/2020/cigna-covers-cost-of-coronavirus-tests-for-customers*

Centers for Disease Control and Prevention. "Information about Middle East Respiratory Syndrome (MERS)" *https://www.cdc.gov/coronavirus/mers/downloads/factsheet-mers_en.pdf*

McKay, Betsy. (2020, March 10). Wall Street Journal. "Coronavirus Symptoms and How to Protect Yourself: What We Know." *https://www.wsj.com/articles/what-we-know-about-the-wuhan-virus-11579716128?mod=article_inline*

Centers for Disease Control and Prevention. "Revised U.S. Surveillance Case Definition for Severe Acute Respiratory Syndrome (SARS) and Update on SARS Cases—United States and Worldwide, December 2003" *https://www.cdc.gov/mmwr/preview/mmwrhtml/mm5249a2.htm*

World Health Organization. "Middle East Respiratory Syndrome Coronavirus (MERS-CoV)" *https://www.who.int/emergencies/mers-cov/en/*

Armour, Stephanie and Thomas M. Burton. (2020, March 13). Wall Street Journal. "Trump Administration Confronts New Coronavirus Testing Woes." *https://www.wsj.com/articles/trump-administration-moves-to-speed-up-coronavirus-testing-11584117597*

Gorman, James. (2020, March 13). New York Times. "The Coronavirus, by the Numbers." *https://www.nytimes.com/2020/03/05/health/coronavirus-deaths-rates.html?utm_campaign=5aa6d9038cf2c257e2007a50&utm_content=5e67b55952551200017d7baf&utm_medium=smarpshare&utm_source=linkedin*

Larson, Jennifer. (2020, February 28.) "When Is Flu Season and Why There Is a Flu Season in the First Place." Insider.com. *https://www.insider.com/when-is-flu-season*

Centers for Disease Control and Prevention. "Human Coronavirus Types." *https://www.cdc.gov/coronavirus/types.html*

Centers for Disease Control and Prevention. "Frequently Asked Questions on COVID-19 Testing at Laboratories." *https://www.cdc.gov/coronavirus/2019-ncov/lab/testing-laboratories.html*

Kelley, Alexandra. (2020, March 12). The Hill. "UC Health Systems Launching In-House Coronavirus Testing." *https://thehill.com/changing-america/well-being/prevention-cures/487232-uc-health-systems-launching-in-house-coronavirus*

Bureau of Labor Statistics. (2020, March 6). "The Employment Situation—February 2020." *https://www.bls.gov/news.release/pdf/empsit.pdf*

Sheikh, Knvul, Derek Watkins, Jin Wu and Mika Gröndahl. (2020, February 8). New York Times. "How Bad Will the Coronavirus Outbreak Get? Here Are 6 Key Factors." *https://www.nytimes.com/interactive/2020/world/asia/china-coronavirus-contain.html*

Elliott, Helene. (2020, March 8). Los Angeles Time. "BNP Paribas Open at Indian Wells Canceled Because of Coronavirus Concerns." *https://www.latimes.com/sports/story/2020-03-08/bnp-paribas-open-at-indian-wells-canceled-because-of-coronavirus-outbreak*

Simpson, Christopher. (2020, March 10). *Bleacher Report*. "Multiple Champions League Matches to Be Behind Closed Doors Due to Coronavirus." *https://bleacherreport.com/articles/2880130-barcelona-confirm-ucl-tie-with-napoli-behind-closed-doors-due-to-coronavirus*

Elliott, Rebecca and Elizabeth Findell. (2020, March 6). Wall Street Journal. "Austin's South by Southwest Festival Canceled Due to Coronavirus." *https://www.wsj.com/articles/south-by-southwest-festival-canceled-over-coronavirus-11583530566*

Hopkins, Jared S. (2020, March 12). Wall Street Journal. "As Virus Spreads, Drugmakers Are On the Case." *https://www.wsj.com/articles/as-virus-spreads-drugmakers-are-on-the-case-11584034493*

Kuhn, Anthony. (2020, March 13). "South Korea's Drive-Through Testing For Coronavirus is Fast—And Free." NPR. *https://www.npr.org/sections/goatsandsoda/2020/03/13/815441078/south-koreas-drive-through-testing-for-coronavirus-is-fast-and-free*

Secon, Holly. (2020, March 13). Business Insider. "7 US States Are Setting Up Drive-Through Coronavirus Testing Stations. Trump Said Americans Can Expect to See More Soon." *https://www.businessinsider.com/drive-through-coronavirus-tests-states-2020-3*

Nathan-Kazis, Josh. (2020, March 4). "How Health Care Utilization Under Coronavirus Could Shake Up the Industry." Nasdaq.com. *https://www.nasdaq.com/articles/how-health-care-utilization-under-coronavirus-could-shake-up-the-industry-2020-03-04*

NYC 9/11 Health. "Physical and Mental Health". *https://www1.nyc.gov/site/911health/researchers/physical-and-mental-health.page*

Sacks, Ethan. (2020, March 16). "Social Distancing Could Have Devastating Effect on People With Depression." NBC News. *https://www.nbcnews.com/health/health-news/social-distancing-could-have-devastating-effect-people-depression-n1157871*

Fonda, Daren. (2020, March 9). "Two Companies Are Making Progress on Coronavirus Treatments. The Stocks Aren't Responding." Barron's. *https://www.barrons.com/articles/two-companies-are-making-progress-on-coronavirus-treatments-the-stocks-arent-responding-51583779661*

Romo, Vanessa and Sylvia Poggioli. (2020, March 9). "Italy Expands Quarantine Measures Nationwide To Stem Spread Of Coronavirus." NPR. *https://www.npr.org/sections/goatsandsoda/2020/03/09/813791575/italy-expands-quarantine-measures-nationwide-to-stem-spread-of-coronavirus*

Houston Chronicle. (2017, September 4). Houston Chronicle. "FEMA Extends Grace Period for Paying Flood Insurance Premiums." *https://www.houstonchronicle.com/news/houston-texas/houston/article/FEMA-extends-grace-period-for-paying-flood-12172339.php*

National Association of Insurance Commissioners. (2020, March). "NAIC Announces Special Session on COVID-19 Impact & Response".
https://content.naic.org/article/news_release_naic_announces_special_session_covid_19_impact_response.htm

Stevens, Harry. (2020, March 14). Washington Post. "Why Outbreaks Like Coronavirus Spread Exponentially, and How to 'Flatten the Curve'". *https://www.washingtonpost.com/graphics/2020/world/corona-simulator/*

Sánchez, Raúl; Ordaz, Ana; Mendoza, Sofía Pérez. (2020, March 22). "Health Reveals the Age Profile of Coronavirus Cases: 67% of the Deceased are Over 80 Years Old." Eldiario.es. *https://www.eldiario.es/sociedad/fallecidos-coronavirus-Espana-anos_0_1008599338.html*

Jaramillo, Antonia. (2020 March 23). Florida Today. "NASA Astronauts Give Tips on Handling Isolation Amid Coronavirus Outbreak."*https://www.floridatoday.com/story/tech/science/space/2020/03/23/nasa-astronauts-give-tips-handling-isolation-amid-coronavirus-outbreak/2897339001/*

Wong, Chun Han. (2020, March 24). The Wall Street Journal. "China's Hubei Province to Ease Coronavirus Lockdown This Week; Wuhan to Follow in April." *https://www.wsj.com/articles/chinas-hubei-province-to-ease-restrictions-11585029440?mod=searchresults&page=1&pos=3*

Covered California. (2020, March 21). "The Potential National Health Cost Impacts to Consumers, Employers and Insurers Due to the Coronavirus (COVID-19)." https://hbex.coveredca.com/data-research/library/COVID-19-NationalCost-Impacts03-21-20.pdf

New York Times, (2020, March 24). "Coronavirus Updates,"
https://www.nytimes.com/2020/03/24/world/coronavirus-updates-maps.html?action=click&auth=login-email&login=email&module=Spotlight&pgtype=Homepage

Kaiser Family Foundation, "The Families First Coronavirus Response Act: Summary of Key Provisions"
https://www.kff.org/global-health-policy/issue-brief/the-families-first-coronavirus-response-act-summary-of-key-provisions/

Cohen, Kelly. (2020, March 24). "Tokyo 2020 Olympics officially postponed until 2021." ESPN.
https://www.espn.com/olympics/story/_/id/28946033/tokyo-olympics-officially-postponed-2021

Hauck, Grace and Lorenzo Reyes. (2020, March 24). USA Today. "Coronavirus Lockdowns: These States Are Ordering Residents to Stay Home or Shelter in Place."
https://www.usatoday.com/story/news/nation/2020/03/21/coronavirus-lockdown-orders-shelter-place-stay-home-state-list/2891193001/

Brackett, Ron and Jan Wener Childs. (2020, March 23). "Coronavirus Updates: 15 States Have Stay at Home Orders; 'This Week, It's Going to Ge Bad,' U.S. Surgeon General Says." The Weather Channel.
https://weather.com/health/coronavirus/news/2020-03-23-coronavirus-updates-number-of-cases-lockdowns-quarantines-united

Centers for Disease Control and Prevention. (2020, March 18). *Morbidity and Mortality Weekly Report*. "Severe Outcomes Among Patients with Coronavirus Disease 2019 (COVID-19)—United States, February 12–March 16, 2020." *https://www.cdc.gov/mmwr/volumes/69/wr/pdfs/mm6912e2-H.pdf*

Fredericks, Bob. (2020, March 24). New York Post. "Pence Hopeful Anti-Malaria Drug Works for Coronavirus."
https://nypost.com/2020/03/24/pence-hopeful-anti-malaria-drug-works-for-coronavirus/

Ferguson, Neil, et al. (2020, March 16). “Impact of Non-Pharmaceutical Interventions (NPIs) to Reduce COVID-19 Mortality and Healthcare Demand.” Imperial College. *https://www.imperial.ac.uk/media/imperial-college/medicine/sph/ide/gida-fellowships/Imperial-College-COVID19-NPI-modelling-16-03-2020.pdf*

Wu, Joseph T., et al. (2020 March 19). Nature. “Estimating Clinical Severity of COVID-19 From the Transmission Dynamics in Wuhan, China.” *I*

Rochmyaningsih, Dyna (2020, March 3). “Indonesia Finally Reports Two Coronavirus Cases. Scientists Worry It Has Many More.” Science Magazine. *https://www.sciencemag.org/news/2020/03/indonesia-finally-reports-two-coronavirus-cases-scientists-worry-it-has-many-more*

Social Security Administration. Period Life Table 2016. *https://www.ssa.gov/oact/STATS/table4c6.html*

Van Beusekom, Mary. (2020, March 16). “Doctors: COVID-19 Pushing Italian ICUs Toward Collapse.” Center for Infectious Disease Research and Policy. *http://www.cidrap.umn.edu/news-perspective/2020/03/doctors-covid-19-pushing-italian-icus-toward-collapse*

Ranney, M.D., M.P.H., Megal L., et al. (2020, March 25). “Critical Supply Shortages—The Need for Ventilators and Personal Protective Equipment during the COVID-19 Pandemic.” The New England Journal of Medicine. *https://www.nejm.org/doi/full/10.1056/NEJMp2006141*

Centers for Disease Control and Prevention. (2018, May 14). “The 1918 Flu Pandemic: Why It Matters 100 Years Later.” *https://blogs.cdc.gov/publichealthmatters/2018/05/1918-flu/*

Centers for Disease Control and Prevention. (2020, April 2). “Disease Burden of Influenza.” *https://www.cdc.gov/flu/about/burden/index.html*

Chinese Center for Disease Control and Prevention. (2020, February). CCDC Weekly. “Vital Surveillances: The Epidemiological Characteristics of an Outbreak of 2019 Novel Coronavirus Diseases (COVID-19)—China, 2020.” *http://weekly.chinacdc.cn/en/article/id/e53946e2-c6c4-41e9-9a9b-fea8db1a8f51*

Instituto de Salud Carlos III. (2020, March 27). “Report on the Situation of COVID-19 in Spain.” *https://www.isciii.es/QueHacemos/Servicios/VigilanciaSaludPublicaRENAVE/EnfermedadesTransmisibles/Paginas/InformesCOVID-19.aspx*

World Health Statistics, 2019. WHO. *https://apps.who.int/iris/handle/10665/324835*

Gold, Jenny and Anna Maria Barry-Jester. (2020, March 16). Kaiser Health News. “Testing Shortages Force Extreme Shift in Strategy by Local Health Officials.” *https://www.modernhealthcare.com/safety-quality/testing-shortages-force-extreme-shift-strategy-local-health-officials*

Waldman, Anne et. al. (2020, March 17). ProPublica. “Are Hospitals Near Me Ready for Coronavirus? Here Are Nine Different Scenarios.” *https://projects.propublica.org/graphics/covid-hospitals*

Waldman, Annie. (2020, March 17). ProPublica. “Methodology: How ProPublica Mapped Hospital Capacity for Coronavirus.” *https://www.propublica.org/article/methodology-how-propublica-mapped-hospital-capacity-for-coronavirus*

Centers for Disease Control and Prevention. (2020, March 31). *Morbidity and Mortality Weekly Report*. “Preliminary Estimates of the Prevalence of Selected Underlying Health Conditions Among Patients with Coronavirus Disease

2019—United States, February 12–March 28, 2020." *https://www.cdc.gov/mmwr/volumes/69/wr/pdfs/mm6913e2-H.pdf*

NYC Health (2020, March 31). "Daily Syndromic and Case Data Update." *https://www1.nyc.gov/site/doh/covid/covid-19-data.page*

Bowden, John. (2020, March 29). The Hill. "Health Insurers Cigna, Humana Waive Out-of-Pocket Costs for Coronavirus Treatment." *https://thehill.com/policy/healthcare/490100-health-insurers-cigna-humana-waive-out-of-pocket-costs-for-coronavirus*

Economist. (2020, March 26). "Why Does Germany's Death Rate Look Better than Italy's?" *https://www.economist.com/europe/2020/03/26/why-does-germanys-death-rate-look-better-than-italys*

Institute for Health Metrics and Evaluation. (2020, March 25). "Forecasting COVID-19 Impact on Hospital Bed-Days, ICU-Days, Ventilator-Days and Deaths by U.S. State in the Next 4 Months." *http://www.healthdata.org/sites/default/files/files/research_articles/2020/covid_paper_MEDRXIV-2020-043752v1-Murray.pdf*

LaFave, Sarah. (2020, March 30). HUB. "COVID-19: Immunity and Seasonality." *https://hub.jhu.edu/2020/03/30/andrew-pekosz-immunity-seasonality/*

Wu, Katherine J. (2020, March 30). Smithsonian Magazine. "What Scientists Know About Immunity to the Novel Coronavirus." *https://www.smithsonianmag.com/science-nature/can-you-become-immune-sars-cov-2-180974532/*

ECONOMIC AND ASSET IMPACT

FederalReserve.gov. (2018, March 8). "Monetary Policy Strategies of Major Central Banks." *https://www.federalreserve.gov/monetarypolicy/monetary-policy-strategies-of-major-central-banks.htm*

Long, Heather. (2020, March 3). The Washington Post. "Fed Makes Largest Emergency Cut to Interest Rates Since the Financial Crisis." *https://www.washingtonpost.com/business/2020/03/03/economy-coronavirus-rate-cuts/*

Londoño, Ernesto, Aimee Ortiz, Nancy Coleman and Andrea Salcedo. (2020, March 16). New York Times. "Coronavirus Travel Restrictions, Across the Globe." *https://www.nytimes.com/article/coronavirus-travel-restrictions.html*

Liesman, Steve. (2020, March 15). "Federal Reserve Cuts Cate to Zero and Launches Massive $700 Billion Quantitative Easing Program. CNBC. *https://www.cnbc.com/2020/03/15/federal-reserve-cuts-rates-to-zero-and-launches-massive-700-billion-quantitative-easing-program.html*

Chavez-Dreyfuss, Gertrude. (2020, March 15). "Goldman Cuts U.S. Growth Forecast for First and Second Quarter Due to Coronavirus." Reuters. *https://www.reuters.com/article/us-healthcare-coronavirus-goldman/goldman-downgrades-u-s-growth-forecast-for-first-quarter-second-quarter-due-to-coronavirus-idUSKBN21217L*

The Economist. (2020, March 14). "Tracking the Economic Impact of COVID-19 in Real Time." *https://www.economist.com/united-states/2020/03/14/tracking-the-economic-impact-of-covid-19-in-real-time*

Schneider, Avie. (2020, March 13). "Dow Soars Nearly 2,000 Points in Rebound from Biggest Drop Since 1987." MPR News. *https://www.mprnews.org/story/2020/03/13/npr-dow-expected-to-open-up-more-than-1-100-points*

Gondo, Nancy. (2020, March 16). Investor's Business Daily. "Dow Jones Dives 3,000 Points to New Session Lows as Coronavirus Crash Continues." *https://www.investors.com/market-trend/stock-market-today/dow-jones-plunges-further-fed-rate-cut-fails-boost-confidence-coronavirus-cases-rise/*

FederalReserve.gov. (2020, March 3). "Implementation Note Issued March 3, 2020." *https://www.federalreserve.gov/newsevents/pressreleases/monetary20200303a1.htm*

Mohamed, Theron. (2020, March 9). Markets Insider. "The Entire U.S. Yield Curve Plunged Below 1% for the First Time Ever. Here's Why That's a Big Red Flag for Investors." *https://markets.businessinsider.com/news/stocks/us-treasury-yield-curve-below-1-percent-red-flag-investors-2020-3-1028975968*

YCharts.com. (2020, March 9). "Moody's Seasoned Aaa Corporate Bond Yield." *https://ycharts.com/indicators/moodys_seasoned_aaa_corporate_bond_yield*

CNBC. (2020, March 24). "Gold Futures Pop 5% Amid Extraordinary Central Bank Actions." *https://www.cnbc.com/2020/03/24/gold-markets-us-federal-reserve-coronavirus-in-focus.html*

European Central Bank. (2020, March 18). "ECB Announces €750 Billion Pandemic Emergency Purchase Programme (PEPP)." *https://www.ecb.europa.eu/press/pr/date/2020/html/ecb.pr200318_1~3949d6f266.en.html*

McCormick, Emily. (2020, March 24). "Markit U.S. PMI Reports Signals 'Steepest Downturn Since 2009 in March'." Yahoo Finance. *https://finance.yahoo.com/news/ihs-markit-march-2020-flash-us-purchasing-managers-index-134651548.html*

Muro, Mark; Maxim, Robert; and Whiton, Jacob. (2020, March 17). "The Places a COVID-19 Recession Will Likely Hit Hardest." Brookings. *https://www.brookings.edu/blog/the-avenue/2020/03/17/the-places-a-covid-19-recession-will-likely-hit-hardest/*

The Economist. (2020, March 12). "The Challenge of Addressing COVID-19's Economic Effects in Europe." *https://www.economist.com/finance-and-economics/2020/03/12/the-challenge-of-addressing-covid-19s-economic-effects-in-europe*

Werner, Erica; Kane, Paul; Bade, Rachel; and DeBonis, Mike. (2020, March 23). The Washington Post. "Senate Negotiators Cite Progress on Coronavirus Bill After Day of Drama and Rancor. *https://www.washingtonpost.com/us-policy/2020/03/23/trump-coronavirus-senate-economic-stimulus/*

Gruenwald, Paul F. (March 24, 2020). S&P Global Ratings. "Global Macroeconomic Update, March 24: A Massive Hit to World Economic Growth." *https://www.spglobal.com/ratings/en/research/articles/200324-global-macroeconomic-update-march-24-a-massive-hit-to-world-economic-growth-11402099*

Fidelity. (2020, March 19). "Bear Market Basics: With Stocks Reaching Bear Market Territory, Here's What to Think About." Fideltiy. *https://www.fidelity.com/viewpoints/market-and-economic-insights/bear-markets-the-business-cycle-explained*

Kim, Cynthia; and Roh, Joori. (2020, March 16). Reuters. "Update 2-S. Korea C. Bank Takes Policy Rate Below 1% for First Time with 50bp Cut." *https://www.reuters.com/article/health-coronavirus-cenbankbanks-southkor/update-2-s-korea-c-bank-takes-policy-rate-below-1-for-first-time-with-50bp-cut-idUSL4N2B41NW*

Sekora, Dave. (2020, March 23). Morningstar. "Corporate Bonds at Second-Widest Level in 20 Years." *https://www.morningstar.com/articles/973818/corporate-bonds-at-second-widest-level-in-20-years*

International Monetary Fund (2020, March 23). Press Release. "IMF Managing Director Kristalina Georgieva's Statement Following a G20 Ministerial Call on the Coronavirus Emergency." *https://www.imf.org/en/News/Articles/2020/03/23/pr2098-imf-managing-director-statement-following-a-g20-ministerial-call-on-the-coronavirus-emergency*

United States Department of Labor. (2020, March 26, 8:30 a.m. Eastern.) News Release. "Unemployment Insurance Weekly Claims." *https://www.dol.gov/ui/data.pdf*

United States Department of Labor. (2020, April 2, 8:30 a.m. Eastern.) News Release. "Unemployment Insurance Weekly Claims." *https://www.dol.gov/ui/data.pdf*

Bernard, Tara Siegel and Ron Lieber. (2020, March 31). New York Times. "F.A.Q. on Stimulus Checks, Unemployment and the Coronavirus Plan." *https://www.nytimes.com/article/coronavirus-stimulus-package-questions-answers.html*

Congrove, Darci. (2020, March 30). GBQ. "Coronavirus Aid, Relief, and Economic Security (CARES) Act." *https://gbq.com/coronavirus-aid-relief-and-economic-security-cares-act/*

Rubio, Marco, et al. U.S. Senate Committee on Small Business and Entrepreneurship. "Keeping American Workers Paid and Employed Act." *https://www.rubio.senate.gov/public/_cache/files/28e8263e-e7d4-4da7-a67b-077c54ba4220/9F7B494B2E355791B24536DC2162CF16.final-one-pager-keeping-american-workers-paid-and-employed-act-.pdf*

Sindreu, Jon. (2020, March 4). "Fallen Angels Test Coronavirus-stricken Bond Markets." The Wall Street Journal. *https://www.wsj.com/articles/fallen-angels-test-coronavirus-stricken-bond-markets-11583325268*

Kennedy, Simon and Michelle Jamrisko. (2020, April 2). Bloomberg. "V, L or "Nike Swoosh'? Economists Debate Shape of Global Recovery." *https://www.bloomberg.com/news/articles/2020-04-02/economists-debate-shape-of-a-global-recovery-after-coronavirus*

U.S. Department of the Treasury. "Daily Treasury Yield Curve Rates." *https://www.treasury.gov/resource-center/data-chart-center/interest-rates/Pages/TextView.aspx?data=yield*

INSURANCE INDUSTRY

Oliphant, Lee. (2020 March). MIB. "With a jump in life insurance apps…MIB Helps Its Members Respond to COVID-19."

Zinkie, Erica Cordova. (2020, March 25). "COVID-19 Relief: States Begin Extending Insurance Premium Grace Periods." OneDigital. *https://www.onedigital.com/blog/covid-19-relief-states-begin-extending-insurance-premium-grace-periods/*

Property and Casualty News. (2020, March 19). "California Prods Insurers for 60-Day Grace Period on Premium Payments." *https://insurancenewsnet.com/innarticle/california-prods-insurers-for-60-day-grace-period-on-premium-payments#.Xn5iAYhKiMo*

Bowden, John. (2020, March 29). The Hill. "Health insurers Cigna, Humana waive Out-of-Pocket Costs for Coronavirus Treatment." *https://thehill.com/policy/healthcare/490100-health-insurers-cigna-humana-waive-out-of-pocket-costs-for-coronavirus*

Hong Kong Federation of Insurers. (2020, February 28). Media Release. "Launch of Dedicated Website 'Insurance Dashboard on COVID-10' For Insurance Information on COVID-19." *https://hkfi.org.hk/#!/media-release/485*

New York State Department of Financial Services. (2020, April 1). "Information for Insurers and Providers on Coverage for Telehealth Services." *https://dfs.ny.gov/industry_guidance/coronavirus/telehealth_ins_prov_info*

Esola, Louise. (2020, March 31). Business Insurance. "Alaska Introduces Presumption Bill for Comp, Coronavirus." https://www.businessinsurance.com/article/20200331/NEWS08/912333787/Alaska-introduces-presumption-bill-for-workers-compensation-coronavirus-COVID-19

Childers, Angela. (2020, March 25). Business Insurance. "Lawmakers Introduce Comp-Related Coronavirus Bills." https://www.businessinsurance.com/article/20200325/NEWS08/912333715/Ohio-New-Jersey-lawmakers-introduce-workers-compensation-coronavirus-COVID-19-bi

Washington State Department of Labor & Industries. "Workers' Compensation Coverage and Coronavirus (COVID-19) Common Questions." https://lni.wa.gov/agency/outreach/workers-compensation-coverage-and-coronavirus-covid-19-common-questions

Terry, Karen. (2020, March). LIMRA. "The Impact of COVID-19 on Individual Life Sales and Applications."

OPERATIONAL AND EMERGING RISKS

OSF Healthcare. "Novel Coronavirus (COVID-19)." *https://www.osfhealthcare.org/covid19/*

Swanson, Ana. (2020, March). New York Times. "Coronavirus Spurs U.S. Efforts to End China's Chokehold on Drugs." *https://www.nytimes.com/2020/03/11/business/economy/coronavirus-china-trump-drugs.html*

Soo-youn, Song. (2019, May 20). "Hospital beds going up in Korea contrary to OECD's trend." Korea Biomedical Review. *http://www.koreabiomed.com/news/articleView.html?idxno=5780*

Evans, Melanie and Anna Wilde Mathews. (2020, March 12). Wall Street Journal "U.S. Hospitals Face Major Challenges as Coronavirus Spreads.". *https://www.wsj.com/articles/u-s-hospitals-face-major-challenges-as-coronavirus-spreads-11584056336*

BBC News. (2020, March 16). "Coronavirus: PM urges industry to make NHS ventilators." BBC News. *https://www.bbc.com/news/business-51896168*

Feintzeig, Rachel and Chip Cutter. (2020, March 12). Wall Street Journal "The Coronavirus and Your Job: What the Boss Can—and Can't—Make You Do.". *https://www.wsj.com/articles/the-coronavirus-and-your-job-can-my-boss-make-me-do-that-11583981316*

Watson, Kathryn. (2020, March 16). "Feds Investigating Possible Cyber Attack at HHS Amid Coronavirus Pandemic." CBS News. *https://www.cbsnews.com/news/feds-investigating-possible-cyber-attack-at-hhs-amid-coronavirus-pandemic/*

Mao, Frances. (2020, March 4). "Coronavirus Panic: Why Are People Stockpiling Toilet Paper?" BBC News. *https://www.bbc.com/news/world-australia-51731422*

Conradis, Brandon. (2020, March 15). "Illinois, Ohio Closing All Bars, Restaurants in Response to Coronavirus." The Hill. *https://thehill.com/policy/healthcare/487684-illinois-ohio-closing-all-bars-restaurants-in-response-to-coronavirus*

Centers for Disease Control and Prevention. "Get You Mass Gatherings or Large Community Events Ready." *https://www.cdc.gov/coronavirus/2019-ncov/community/large-events/mass-gatherings-ready-for-covid-19.html*

Sandler, Rachel. (2020, March 15). "CDC Guidelines: Cancel Events With 50 Or More People." Forbes. *https://www.forbes.com/sites/rachelsandler/2020/03/15/cdc-guidelines-cancel-events-with-50-or-more-people/#1e03ffc15f51*

Noel, Josh, Louisa Chu, Grace Wong and Phil Vettel. (2020, March 16). "Chicago Bar and Restaurant Owners Scramble Amid Unprecedented Closing Order to Stem COVID-19 Spread." Chicago Tribune. *https://www.chicagotribune.com/coronavirus/ct-food-covid-19-bar-restaurant-closing-illinois-reaction-20200315-mwgppfqbtvd4djj7jxupxcxhwy-story.html*

Rudolph, Max. (January 2007). "Pandemic Influenza's Impact on Health Systems." *http://rudolph-financial.com/Pandemic_articles.html*

Aon.com. (March 2020). "COVID-19 Response Site." *https://www.aon.com/event-response/coronavirus.aspx.*

Mourselas, Costas. (2020, March 6). Sentinel One. "A Peek Inside Op Risk Managers' Coronavirus Response." Risk.net *https://www.risk.net/risk-management/7491576/a-peek-inside-op-risk-managers-coronavirus-toolkit*

Gutman, Yotam. (2020, March 5). "COVID-19 Outbreak | Employees Working from Home? It's Time to Prepare." *https://www.sentinelone.com/blog/covid-19-outbreak-employees-working-from-home-its-time-to-prepare/*

Correa, Luis. (2020, March 13). "Real Life NBA Teams Using NBA 2K20 to Finish the Season." GameRant. *https://gamerant.com/nba-2k20-continue-season-phoenix-suns/*

Whiten, Sarah. (2020, March 6). "'No Time to Die' Box-Office Release Delayed for Coronavirus, But Don't Expect Other Hollywood Films to Follow." CNBC. *https://www.cnbc.com/2020/03/06/no-time-to-die-pushed-its-box-office-release-but-others-wont-follow.html*

Kheel,Rebecca. (2020, March 23). The Hill. "Navy Hospital Ship Deploying Monday to Los Angeles." *https://thehill.com/policy/defense/489020-navy-hospital-ship-deploying-monday-to-los-angeles*

Palmer, Barbara. (2020, March 23). "Convention Centers Repurposed to Hold Hospital Beds." PCMA. *https://www.pcma.org/covid-19-javits-baltimore-santa-clara-convention-centers-medical-units/*

Spielman, Fran. (2020, March 23). Chicago Sun Times. "Lightfoot forges deals with hotels, shuttered hospital to provide space for quarantined COVID-19 patients." *https://chicago.suntimes.com/coronavirus/2020/3/23/21190805/coronavirus-hotels-quarantined-patients-hospitals-ymca-homeless-metro-south-blue-island-unite-here*

Heeb, Gina. (2020, March 18). Markets Insider. "Trump Announces the U.S. Will Use a 1950s-Era Law to Ramp Up Production of Masks and Protective Gear as Coronavirus Spreads." *https://markets.businessinsider.com/news/stocks/trump-us-defense-production-act-announced-1950s-era-law-coronavirus-2020-3-1029009805*

Hernandez, David. (2020, March 18). The San Diego Union-Tribune. "Deputies Issue Eight Citations for Price Gouging Amid COVID-19 State of Emergency." *https://www.sandiegouniontribune.com/news/public-safety/story/2020-03-18/8-cited-for-price-gouging-amid-covid-19-state-of-emergency*

Levenson, Michael. (2020, March 20). Chicago Tribune. "Distilleries Race to Make Hand Sanitizer Amid Coronavirus Pandemic." *https://www.chicagotribune.com/coronavirus/sns-nyt-distilleries-race-make-hand-sanitizer-coronavirus-pandemic-20200320-7bchr2fzwvbknotgcw7owtau3u-story.html*

Krisher, Tom. (2020, March 21). Portland Press Herald. “Factories Pivot to Fight Coronavirus, But It Won’t Be Easy—or Fast.” *https://www.pressherald.com/2020/03/21/factories-pivot-to-fight-coronavirus-but-it-wont-be-easy-or-fast/*

Kageyama, Yuri. (2020, March 1). Winston-Salem Journal. “Japan Electronics Maker Sharp to Make Masks at Display Plant.” *https://www.journalnow.com/news/national/japan-electronics-maker-sharp-to-make-masks-at-display-plant/article_f46ac8a6-7141-5fe3-afbc-4ad046ef432a.html*

De Rugy, Veronique. (2020, March 22). Los Angeles Daily News. “Price Gouging Laws Make it Harder for the Market to Work.” *https://www.dailynews.com/2020/03/22/price-gouging-laws-make-it-harder-for-the-market-to-work/*

Watson, Kathryn. (2020, March 27.) CBS News. “Trump Invokes Defense Production Act to Require GM to Produce Ventilators.” *https://www.cbsnews.com/news/trump-invokes-defense-production-act-to-require-gm-to-produce-ventilators-2020-03-27/*

Mahr, Joe; Berlin, Jonathon and Schencker, Lisa. (2020 April 1). Chicago Tribune. “When Will the Coronavirus Outbreak Peak in Illinois?” *https://www.chicagotribune.com/coronavirus/ct-cb-coronavirus-when-will-illinois-peak-20200401-3c56ftr64ngqridwnuervngrma-story.html*

Alonzo-Zaldivar, Ricardo; Neergard, Lauran, and Associated Press. “White House Turns to Statistical Models for Coronavirus Forecast.” Fortune. (2020 March 31). *https://fortune.com/2020/03/31/coronavirus-predictions-white-house-covid-19-forecast/*

PREVIOUS SOA RESEARCH HIGHLIGHTS

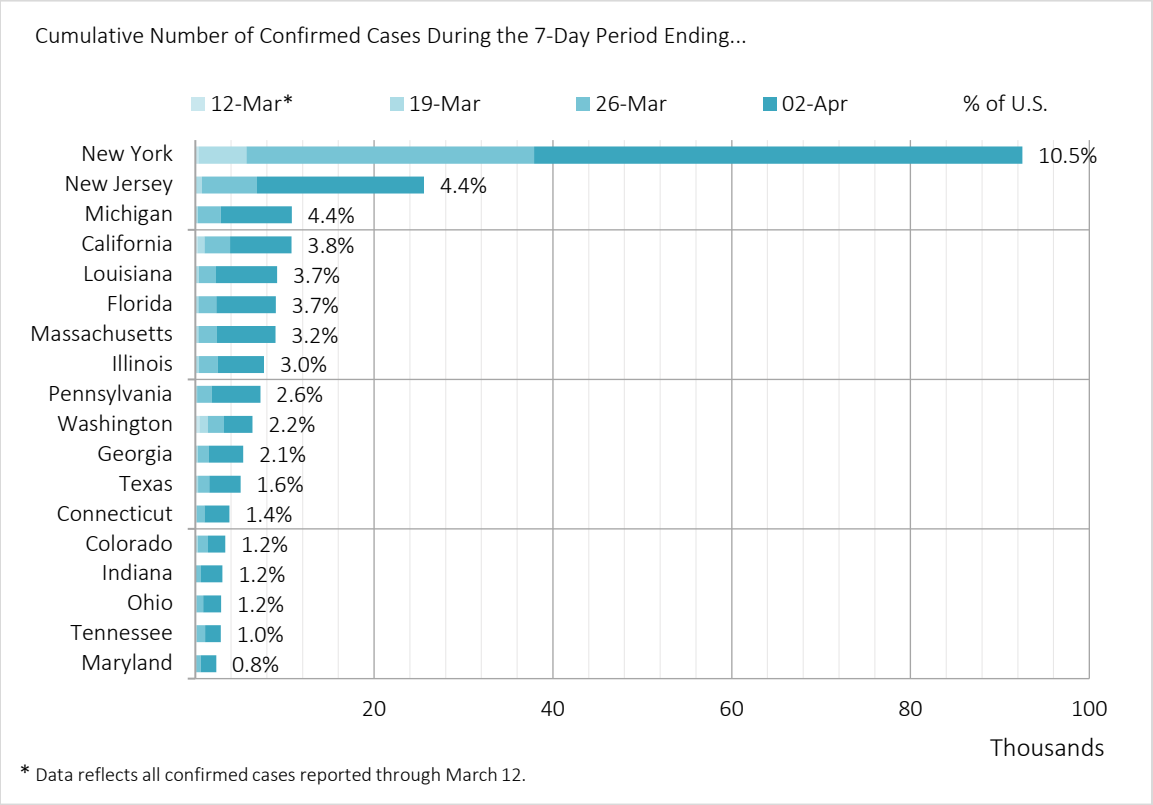
Toole, Jim. (May 2007). “Potential Impact of Pandemic Influenza on the U.S. Life Insurance Industry.” Society of Actuaries. *https://www.soa.org/resources/research-reports/2007/research-impact-pan-influ-life-ins*

Toole, Jim. (June 2010). “Potential Impact of Pandemic Influenza on the U.S. Health Insurance Industry.” Society of Actuaries. *https://www.soa.org/resources/research-reports/2010/research-pandemic/*

Appendix: Reported Cases by State

This appendix shows data by U.S. state without commentary.

CUMULATIVE COVID-19 CASES FOR STATES WITH AT LEAST 1.0% OF U.S. CASES, APRIL 2, 2020



* Data reflects all confirmed cases reported through March 12.

CUMULATIVE CONFIRMED COVID-19 CASES BY STATE, APRIL 2, 2020

State	March 12	March 19	March 26	April 2	Percent of U.S.
Alabama	0	78	517	1,233	0.8%
Alaska	0	8	56	143	0.1%
Arizona	9	45	508	1,715	0.9%
Arkansas	0	62	335	643	0.4%
California	221	1,005	3,899	10,773	6.5%
Colorado	45	277	1,430	3,342	2.1%
Connecticut	5	159	1,012	3,824	2.1%
Delaware	1	30	130	393	0.2%
District of Columbia	0	71	231	653	0.4%
Florida	30	331	2,357	9,008	4.8%
Georgia	31	287	1,525	5,348	3.0%
Hawaii	2	25	95	256	0.2%
Idaho	0	23	146	776	0.4%
Illinois	32	422	2,538	7,695	4.4%
Indiana	13	60	645	3,038	1.5%
Iowa	14	44	179	614	0.3%
Kansas	4	35	172	553	0.3%
Kentucky	10	50	247	770	0.4%
Louisiana	19	392	2,304	9,159	4.9%
Maine	1	52	155	376	0.2%
Maryland	12	107	583	2,331	1.2%
Massachusetts	107	328	2,417	8,966	4.9%
Michigan	2	259	2,845	10,791	5.7%
Minnesota	9	89	344	742	0.5%
Mississippi	1	50	485	1,177	0.7%
Missouri	2	39	520	1,857	1.0%
Montana	0	11	90	241	0.1%
Nebraska	10	29	74	246	0.1%
Nevada	10	95	420	1,463	0.8%
New Hampshire	6	42	137	316	0.2%
New Jersey	29	741	6,876	25,590	13.7%
New Mexico	5	35	113	388	0.2%
New York	327	5,704	37,877	92,506	56.0%
North Carolina	15	136	738	1,977	1.2%
North Dakota	1	19	51	159	0.1%
Ohio	5	119	868	2,901	1.6%
Oklahoma	3	44	248	881	0.5%
Oregon	24	88	316	826	0.5%
Pennsylvania	22	206	1,795	7,268	3.8%
Rhode Island	3	44	165	657	0.4%
South Carolina	7	80	424	1,554	0.8%
South Dakota	7	14	46	165	0.1%
Tennessee	18	154	1,097	2,845	1.7%
Texas	27	306	1,563	5,069	2.9%
Utah	3	62	396	1,092	0.6%
Vermont	2	22	158	338	0.2%
Virginia	12	103	466	1,706	0.9%
Washington	442	1,374	3,207	6,389	4.7%
West Virginia	0	2	52	216	0.1%
Wisconsin	8	159	728	1,748	1.1%
Wyoming	0	0	0	0	0.0%

About The Society of Actuaries

With roots dating back to 1889, the Society of Actuaries (SOA) is the world's largest actuarial professional organizations with more than 31,000 members. Through research and education, the SOA's mission is to advance actuarial knowledge and to enhance the ability of actuaries to provide expert advice and relevant solutions for financial, business and societal challenges. The SOA's vision is for actuaries to be the leading professionals in the measurement and management of risk.

The SOA supports actuaries and advances knowledge through research and education. As part of its work, the SOA seeks to inform public policy development and public understanding through research. The SOA aspires to be a trusted source of objective, data-driven research and analysis with an actuarial perspective for its members, industry, policymakers and the public. This distinct perspective comes from the SOA as an association of actuaries, who have a rigorous formal education and direct experience as practitioners as they perform applied research. The SOA also welcomes the opportunity to partner with other organizations in our work where appropriate.

The SOA has a history of working with public policymakers and regulators in developing historical experience studies and projection techniques as well as individual reports on health care, retirement and other topics. The SOA's research is intended to aid the work of policymakers and regulators and follow certain core principles:

Objectivity: The SOA's research informs and provides analysis that can be relied upon by other individuals or organizations involved in public policy discussions. The SOA does not take advocacy positions or lobby specific policy proposals.

Quality: The SOA aspires to the highest ethical and quality standards in all of its research and analysis. Our research process is overseen by experienced actuaries and nonactuaries from a range of industry sectors and organizations. A rigorous peer-review process ensures the quality and integrity of our work.

Relevance: The SOA provides timely research on public policy issues. Our research advances actuarial knowledge while providing critical insights on key policy issues, and thereby provides value to stakeholders and decision makers.

Quantification: The SOA leverages the diverse skill sets of actuaries to provide research and findings that are driven by the best available data and methods. Actuaries use detailed modeling to analyze financial risk and provide distinct insight and quantification. Further, actuarial standards require transparency and the disclosure of the assumptions and analytic approach underlying the work.

Society of Actuaries
475 N. Martingale Road, Suite 600
Schaumburg, Illinois 60173
www.SOA.org