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Seasonal Flu Impacts: Flu Science Meets Actuarial Science

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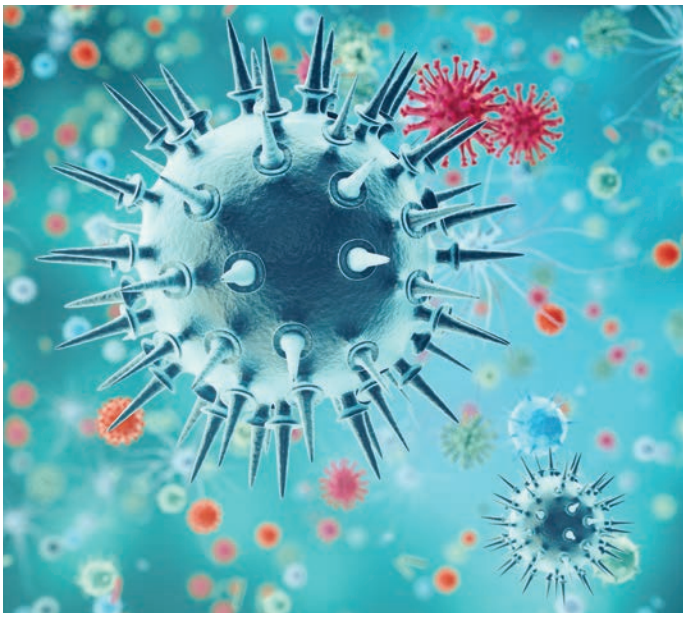

The seasonal flu comes every year with very broad (and sometimes deep) health and health care cost implications. As individuals, our interest in the flu is focused on making sure we're following recommendations around how to protect ourselves and our families from infection and what to do if we become ill. We want to be informed of the efficacy of the vaccine and virulence of the virus each year. As health care actuaries, our interest is focused on understanding its seasonal cost impacts for purposes of financial planning and projecting. We want to know if the current flu system is typical or anomalous, and if the latter, how our analyses should be adjusted to account for that variation.

I recently interviewed epidemiologist Zack Moore, M.D., MPH,[1] in order to learn more about the various types of flu viruses, the vaccine development process and vaccine efficacy. Dr. Moore is the state epidemiologist and epidemiology section chief in the Division of Public Health of the North Carolina Department of Health and Human Services. His insights were enlightening on both personal and professional levels. The remainder of this article summarizes the interview, subsequent research and key considerations for health care actuarial work.

SEASONAL FLU VIRUS OVERVIEW

There are two main types of seasonal flu viruses that infect humans: influenza A and influenza B. Influenza A infects both humans and animals and is divided into subtypes based on two proteins on the surface of the virus: the hemagglutinin (H) and neuraminidase (N) proteins. There are 18 different H proteins (H1 to H18) and 11 different N proteins (N1 to N11), and the combination of these are how we name the A subtypes. Two of these subtypes, H1N1 and H3N2, are circulating today and are known to infect humans. Influenza B is a uniquely human virus, further divided into lineages. And then, within each subtype (A) or lineage (B), there are myriad specific viral strains.[2]

Flu viruses of both types are always changing. "Antigenic drift" is when there are small changes in the genes of the virus that happen over time as it replicates. These changes are typically small enough in the short term that the immune system will still recognize and respond to the changed virus. Over time, however, the viruses become less similar, to the point that the immune system would no longer recognize the virus as something it's seen before. This type of change is why we need to get vaccinated annually (keep up with the changing viruses). "Antigenic shift" is an abrupt, more significant change in the virus that results in a new subtype to which humans have not previously been exposed or infected.[3]

Both influenza A and B undergo drift, but only A is subject to shift. For this reason, flu pandemics are always type A—the type of viral change required to get a truly new flu virus (shift) occurs at the human/animal interface. That said, illnesses resulting from B infections can be just as severe or deadly as A.[4]

FLU VACCINE DEVELOPMENT

The seasonal flu vaccine is designed to protect against three or four flu viruses (trivalent and quadrivalent, respectively). Trivalent vaccines include two A viruses and one B virus, and quadrivalent vaccines include two of both types. Because flu viruses are always changing, the viruses included in the vaccines are reviewed in preparation for each flu season.

The World Health Organization (WHO) does year-round surveillance of flu viruses worldwide. In February each year, WHO convenes a group to look at what strains are being found and make recommendations for which specific viruses to include in the vaccines for the coming season in the northern hemisphere (this initial meeting occurs in September for the southern hemisphere). WHO then comes up with a list of viruses it

recommends for vaccine inclusion. In the United States, the Food and Drug Administration (FDA) then convenes to review WHO recommendations and make a final decision for U.S. vaccine production.[5]

Production of the vaccines then begins—a process that takes at least six months and varies depending on the production technology used. Different viruses grow at different rates, and different incubators (either chicken eggs, cell cultures or insect cells) replicate the viruses at different rates. Cell-based cultures (recently approved by the FDA) can be produced faster and also lower the risk of virus mutation during growth compared to egg-based cultures.[6]

FLU VACCINE EFFICACY

There are many reasons for varying effectiveness of the seasonal flu vaccine. The following occurrences can lower vaccine effectiveness:

1. A change in the circulating virus versus what was included in the vaccine (i.e., a specific virus is recommended for vaccine inclusion based on what was circulating in January/February, but by September/October, there is a change in the predominant strain).

2. A mutation in the vaccine virus during incubation. Even small genetic changes in the virus can have a significant impact on vaccine effectiveness.

3. A new virus emerges altogether (i.e., pandemic).

Note that H3N2 subtypes are more prone than H1N1 to changes—both in the circulating virus itself and during the egg incubation process (see previous points 1–2). In general, if H3N2 is the predominant strain circulating during flu season, we can expect efficacy to be lower than if an H1N1 or type B virus is predominant.[7]

Also note that U.S. flu vaccine effectiveness data isn't available until February from the Centers for Disease Control and Prevention (CDC). While there will be information on which strains are predominant, which can be early indicators of vaccine efficacy, no one can speak to the seasonal vaccine's true effectiveness in the U.S. until the CDC publishes its data.[8]

The extent of flu impact is not always obvious because there are so many health aftereffects of the flu, which can be difficult to estimate.

ACTUARIAL IMPLICATIONS OF THE FLU

Health care actuarial work takes many specific forms, but much of it broadly boils down to understanding, accounting for and predicting health care costs. The flu fits into these functions in that it reliably brings increased costs every flu season, but to an unknown and ever-changing degree—both overall and across populations. Payers need to understand both historical flu patterns and expected future flu experience for many purposes. Some specific examples of how flu intelligence gets incorporated into actuarial work include:

- **Incurred but not reported (IBNR).** Depending on your IBNR modeling approach, average flu impacts may get added into reserve estimates as a part of seasonality adjustments. If an abnormally severe flu season emerges, additional intelligence on expected costs may be useful in interpreting paid claims.

- **Pricing.** Flu reporting can be important for making sure up and down flu seasons don't impact your prospective trend selections (e.g., do you need to normalize your experience period data for an abnormally high- or low-severity flu season?).

- **Trend/medical economics.** Flu is sometimes an explanation for costs emerging much differently than expected, particularly for more vulnerable populations. The extent of flu impact is not always obvious because there are so many health aftereffects of the flu, which can be difficult to estimate.

- **Budget/forecasting.** If early indicators show a severe flu season emerging, finance teams can use internal flu reporting to adjust expectations and modify budgets to account for that unexpected experience.

Actuarial or medical economics teams should have robust flu reporting to draw from in order to closely monitor seasonal flu impacts and have a good understanding as early as possible of the financial implications of the emerging flu season. This flu reporting will provide the information needed to support the actuarial functions mentioned previously. There are three key considerations in developing an effective flu reporting package.

Capture All Flu-Related Costs

From a payer perspective, the burden of the flu is largely driven by complications that develop because of the virus (e.g., bacterial pneumonia, ear infections, encephalitis) and/or worsening or flare-ups of underlying medical conditions due to

the additional stress flu puts on the body (e.g., congestive heart failure, asthma).[9] In any flu reporting, these impacts need to be considered.

Basic flu reporting should look at both medical claims (split into inpatient, outpatient, emergency room and professional) and pharmacy claims—both visits and costs—in two ways:

- **Flu-specific claims/scripts only.** This type of view becomes a proxy for total flu activity. With good historical analyses, you can develop a reasonable projection from early volume to expected seasonal activity.

- **All flu-influenced claims.** This view captures the full impact of flu on a population; as flu activity and/or severity increases, so do the impacts of chronic conditions and flu-related illnesses mentioned earlier. There are multiple ways to develop this view: You could define specific flu-correlated illnesses/conditions to review, or you could include all claims for the month in which a member had a flu claim. Ideally, you would review both as each has its gaps.

Track Emerging Claims Against History

Internal claims data should be monitored weekly, if possible, in comparison to historical flu seasons. Early in the flu season, reviewing flu scripts and professional visits may provide some indications around the impact of the season to come from a volume perspective. Hospitalizations and emergency room visits may provide some insight into the severity of the emerging flu. Additionally, though, this internal monitoring should be supported by reviewing official public health flu tracking, whether it be through CDC FluView, Canada's FluWatch, or another more local surveillance system. These reports are typically published weekly and they can provide insights beyond what you could see in claims data (e.g., predominant flu type, leading nationwide indicators, etc.).

Review Flu Impacts by Population

While no one is immune to developing flu complications (even young, healthy individuals), some populations are more vulnerable than others. Typically, small children, pregnant women, people 65 and older, and those with underlying health conditions are most vulnerable to complications. Tracking impacts of the flu by population is important for accurate projections. A severe flu season will hit Medicare, Medicaid and commercial populations much differently, for example. And within those populations, there will be significant variations for individuals with chronic conditions. Looking at seasonality of costs for these different subsets of the population will give you insights into the full impact of the flu and allow you to make more accurate projections.

The basic reporting and tracking approach described in this article arms the actuary with the ability to inform, adjust and project for the flu. Reviewing leading indicators early in the season using both internal and public data, knowing the implications of predominant flu type, knowing your specific population, and having estimates of full flu-related costs provides you with all the tools you need to put together a best estimate for the financial impacts of the flu. The most critical piece of this type of analysis is doing a robust historical analysis to create the correlations you need to develop solid projections. And, all that said, it is important to remember that the flu virus is ever-changing, and no two seasons are the same.

CONCLUSION

As common as the seasonal flu is—touching all of us at some point in some way—it is still an unpredictable and evolving virus with the potential for serious health and health care cost implications. As actuaries, it is important both to have an understanding of the nature of the flu and the flu vaccine and to have access to current and robust flu reporting to develop the most informed estimates of flu impact each year. We should make use of the public health knowledge and data available to us to improve the internal reporting we do to support our day-to-day work. ■

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ENDNOTES

1 Moore, Zack, M.D., MPH. (Feb. 22, 2018). Flu Background [Telephone interview]. Dr. Moore provided almost all of the information about the seasonal flu, its subtypes and vaccine efficacy. Additional support for his statements may be found at *www.cdc.gov*, noting particularly the citations in the other article footnotes.

2 Types of Influenza Viruses. *CDC.gov*, Sept. 27, 2017, *https://www.cdc.gov/flu/about/viruses/types.htm* (accessed July 10, 2018).

3 How the Flu Virus Can Change: "Drift" and "Shift." *CDC.gov*, Sept. 27, 2017, *https://www.cdc.gov/flu/about/viruses/change.htm* (accessed July 10, 2018).

4 *Supra*, note 1.

5 Selecting Viruses for the Seasonal Influenza Vaccine. *CDC.gov*, May 4, 2016, *https://www.cdc.gov/flu/about/season/vaccine-selection.htm* (accessed July 10, 2018).

6 How Influenza (Flu) Vaccines Are Made. *CDC.gov*, Nov. 7, 2016, *https://www.cdc.gov/flu/protect/vaccine/how-fluvaccine-made.htm* (accessed July 10, 2018).

7 Vaccine Effectiveness—How Well Does the Flu Vaccine Work? *CDC.gov*, Oct. 3, 2017, *https://www.cdc.gov/flu/about/qa/vaccineeffect.htm* (accessed July 10, 2018).

8 *Supra*, note 1.

9 Flu Symptoms & Complications. *CDC.gov*, June 5, 2018, *https://www.cdc.gov/flu/consumer/symptoms.htm* (accessed July 10, 2018).