Influenza Short and Medium Term Projections

June 2023

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Summary

Modelled projections in healthcare can assist in planning for demand on services. Although we know influenza (flu) is a seasonal virus and there is an expected increase in infections over the winter period, there are currently no projections for what a wave of flu in Wales could look like in the future. This paper presents methods for both short and medium term projections.

Short term projections included in this paper use data from the previous two weeks to project forward for the following two weeks. This is beneficial to see when a wave of flu is imminent and if a wave is near the peak.

Medium term projections show what could happen over the coming three month period. As these are longer term, they could show when the wave of flu is expected to increase, peak and reduce over the winter months.

For both of the projections, data for winter 2022/23 will give a better understanding of what we can expect when both flu and COVID-19 are circulating at the same time. This will provide richer data for winter 2023/24 projections though every season is different.

As with all modelled projections, the projection methods in this paper do not provide a certainty around what will happen, instead they provide an estimate of what could happen and when it might occur using data from previous points in time.

Short term projections

Background

UK Health Security Agency (UKHSA) began producing short term projections for flu in the winter 2022-23 season. The UKHSA model works by using the previous 8 weeks of data to train a generalised additive model (GAM) at the NHS England Sustainability and Transformation Partnership level (a geography level used in England where each area typically includes several local authorities) and project the anticipated rate of daily influenza patients with a positive test forward by 2 weeks. This rate and the area population catchments are used to calculate the expected number of daily influenza patients with a positive test. These are then summed nationally.

Welsh Government worked with colleagues in UKHSA to adapt the model to fit the influenza data available in Wales.

Example projections

The below projections were run on data to 5 February 2023, extracted on 7 February 2023. The model projects to 19 February 2023. The 95% confidence intervals are shown as individual cones (orange to red going back in time), with yellow cone, bound by the black lines, with the white line running through it showing the most recent week's fit. Actual data points are shown by the black dots.

The first set of projections includes the Powys Teaching Health Board area. There are no major hospitals within the boundaries of the area, so actual reported influenza admissions are very low.

Figure 1. Short term projections of Influenza admissions to 19 February 2023, Wales
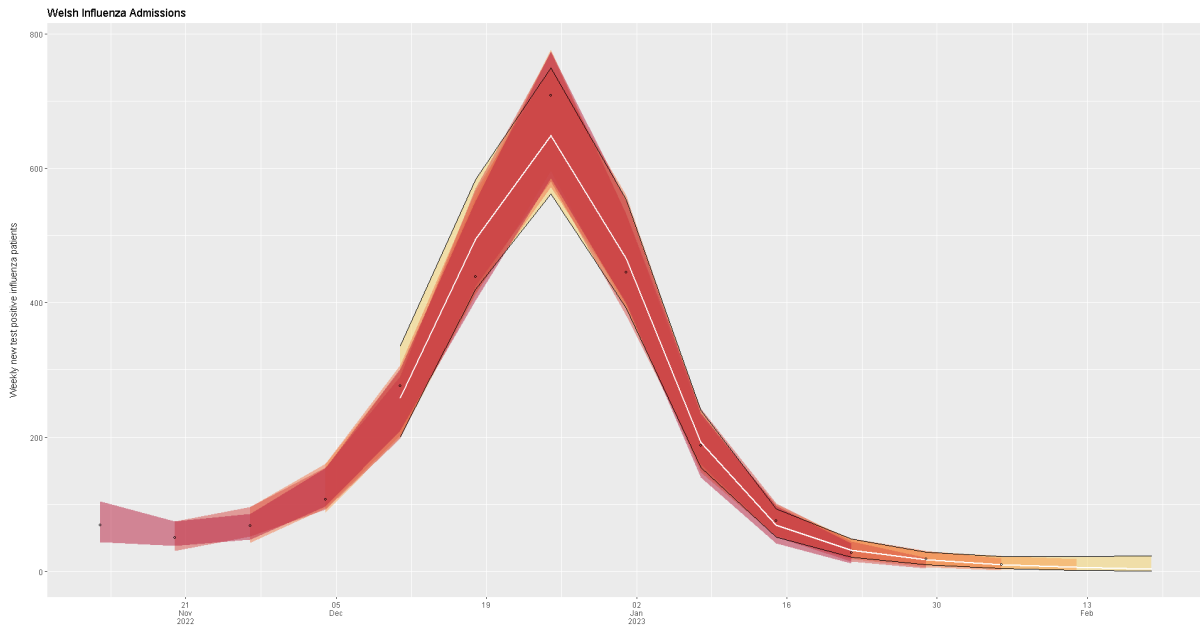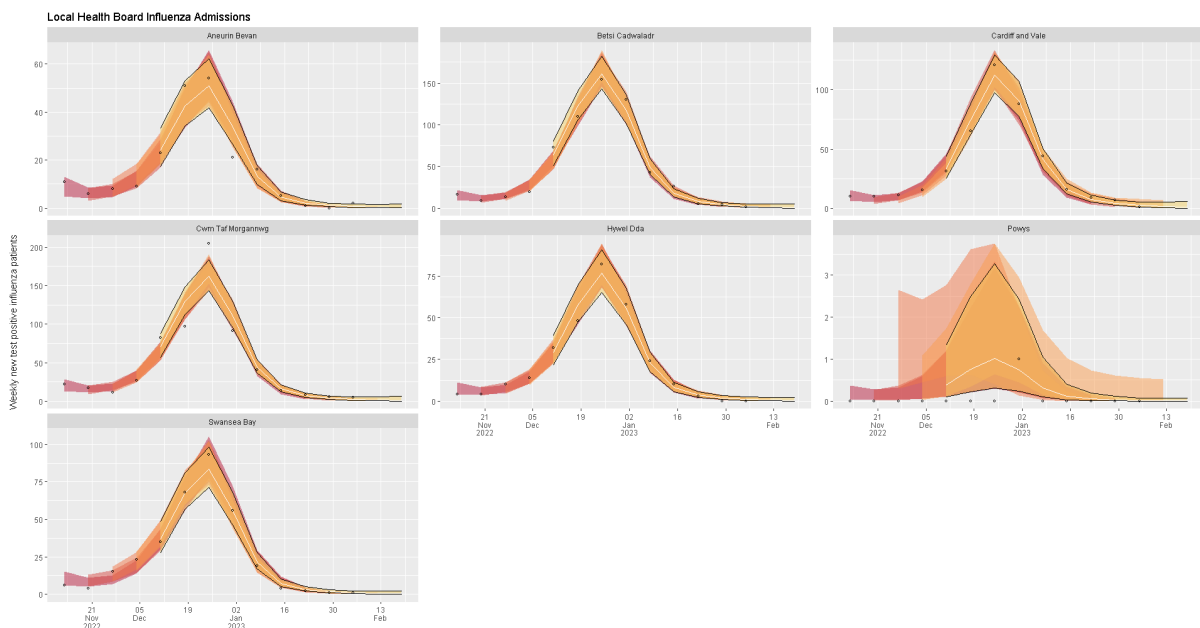

Figure 2. Short term projections of Influenza admissions to 19 February 2023, Local Health Boards

The next set of projections excludes the few admissions reported in the Powys Teaching Health Board Area.

Figure 3. Short term projections of Influenza admissions to 19 February 2023, Wales (excluding Powys Teaching Health Board)
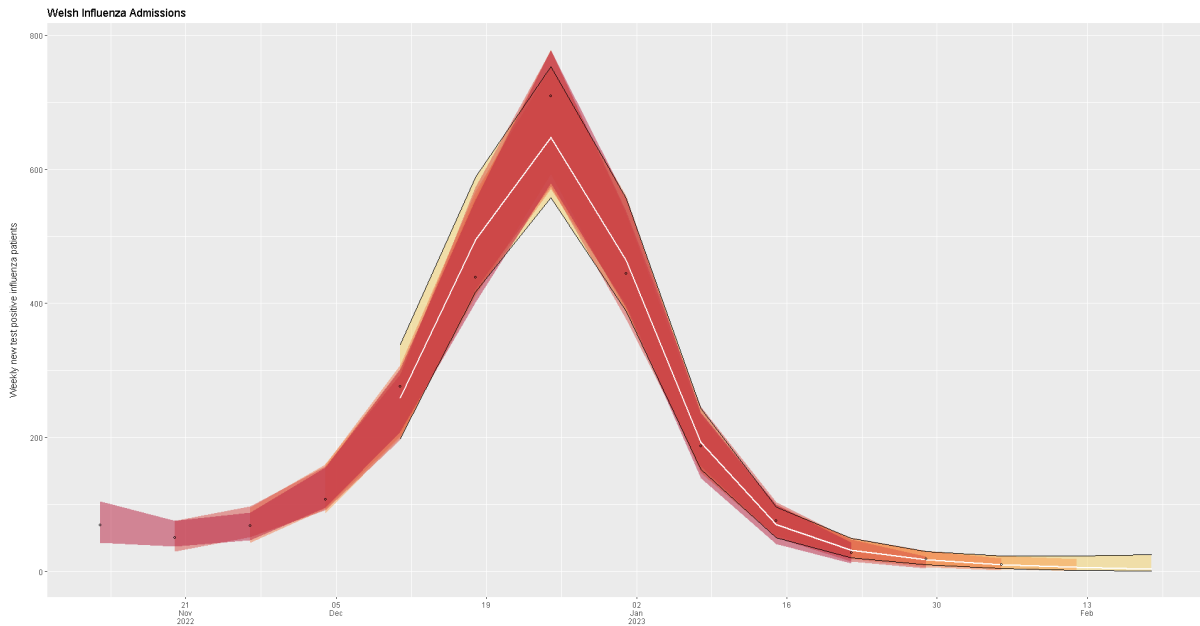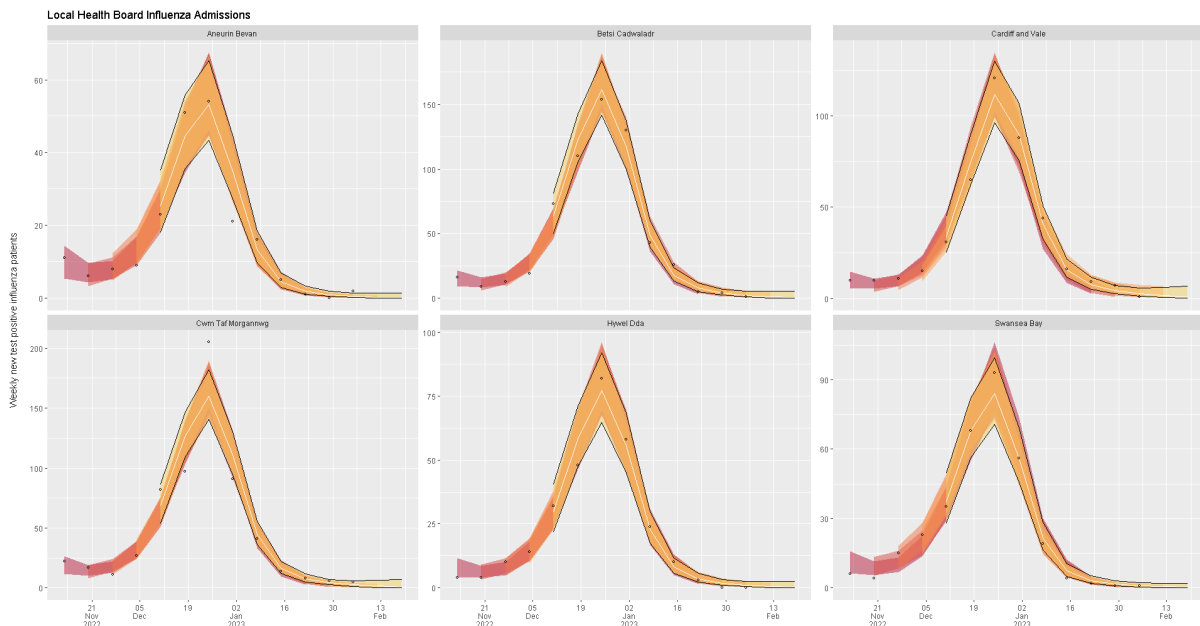

Figure 4. Short term projections of Influenza admissions to 19 February 2023, Local Health Boards (excluding Powys Teaching Health Board)

The charts show that the actual values of hospital admissions, represented by the black dots, largely fall within the 95% confidence intervals of the historic projections. The projections for Cwm Taf Morgannwg are an exception, where the actual admissions for the week ending 25 December 2022 fell above the 95% confidence intervals, and the weeks either side fell slightly below. Admissions in that week in Cwm Taf Morgannwg were particularly high, over double that of any other week.

Future Work

The model runs its projections using <u>rapid surveillance data from the Public Health Wales Health Protection ARI – Hospital Admissions dashboard</u>. It is likely that these data does not capture all the hospital admissions involving influenza, so these projections are likely to be an underestimate. The most thorough data of hospital admissions would be the PEDW data, however these data has a two month lag on it so is not suitable for use with this model. When the PEDW data that captures this winter's influenza season is available, we will compare this to the dashboard data and work out a ratio to adjust between the two datasets – an 'exchange rate'. Assuming the Public Health Wales dashboard is available in winter 2023-24, we will be able to approximate the full PEDW data from the rapid surveillance data and run the model using this, to hopefully project more accurate levels throughout the season.

The rapid data available in Wales also includes patient age bands, and whether the case is nosocomial (hospital acquired) or community acquired. Further work could be done to run projections at these levels. This could give an indication how flu spreads throughout the population, for example if an outbreak in children gradually moves through the age groups or goes to those more likely to be care-givers to children. We may also see a variation in the times when certain age groups have flu throughout the winter season.

Additionally, Public Health Wales publish the same rapid data for cases of Respiratory syncytial virus (RSV). We will look to adapt this model and run short term projections for RSV alongside influenza.

Medium term projections

Background

Currently, in Wales, medium term projections are produced for NHS pressures that arise from COVID-19. In addition to these, to assist with NHS planning, medium term projections for NHS pressures that arise from influenza (flu) will be produced. Here, hospital admissions due to flu are projected forwards based on a pattern calculated by averaging flu and pneumonia admissions from previous years. Not all pneumonia is related to flu, but it generally peaks at a similar time and so a seasonal pattern can be reinforced by including pneumonia data.

Figure 1 shows the rolling 7-day average of flu and pneumonia hospital admissions for the years 2015 to 2020, from data provided by DHWC from the Patient Episode Database for Wales (PEDW). The data shows the seasonal pattern of increasing admissions towards the December/January period, and reduced admissions during the summer months. Additionally, the latter part of 2020 experienced a reduction in admissions relative to other years, likely due to reduced social contacts due to restrictions being put in place in response to the COVID-19 pandemic.

Figure 5: Rolling 7-day average of flu and pneumonia hospital admissions for the years 2015 - 2020
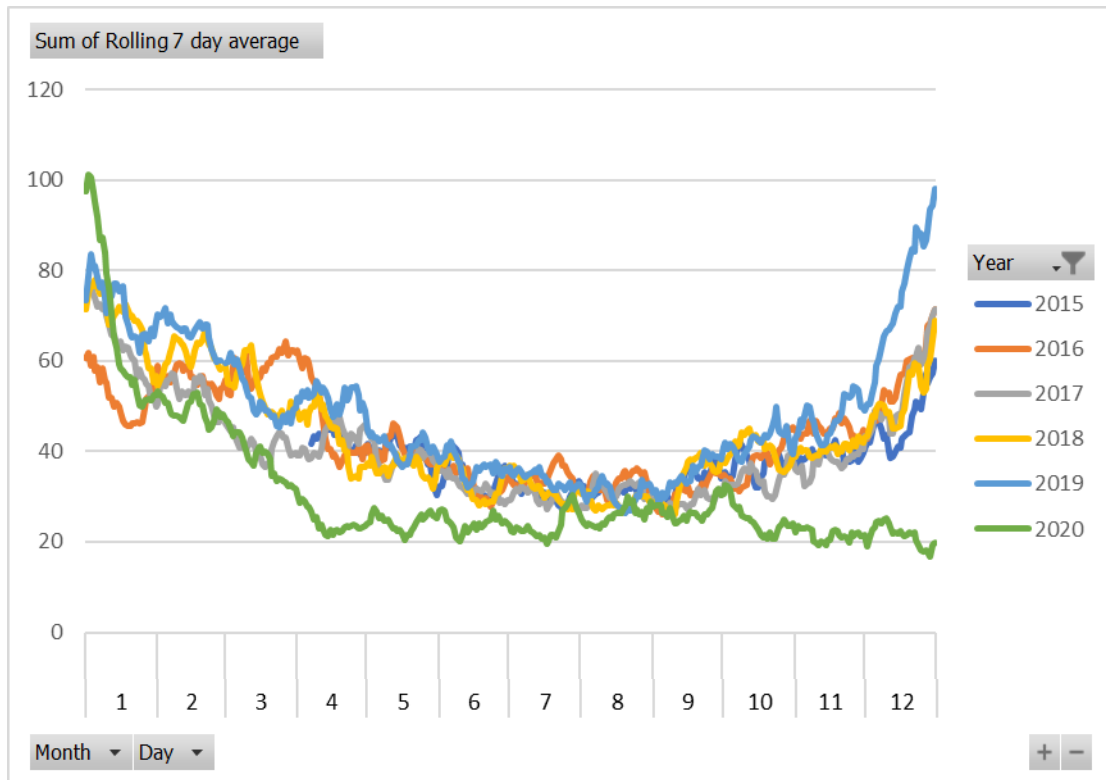

Pattern of flu and pneumonia admissions

In figure 2, the pattern of flu and pneumonia admissions was calculated based on historical data. The lightest blue line includes one year of data (2019) and the successive darker lines each include an additional year of data.

The patterns are quite close to one another, but the pattern chosen for the projection includes data from 2015 – 2019. This was judged to be the most robust of the patterns, as it includes more years' worth of data and the timing was quite similar for each season.

Data for the year 2020 was not included as the level of flu and pneumonia was severely dampened in the latter part of the year, likely due to interventions introduced in relation to COVID-19. When data becomes available for the years 2022-2023, the intention is to include those data. The data will be more reliable once it has been fully coded and quality assured.

Figure 6: Flu and Pneumonia patterns for different seasons and combinations of seasons.
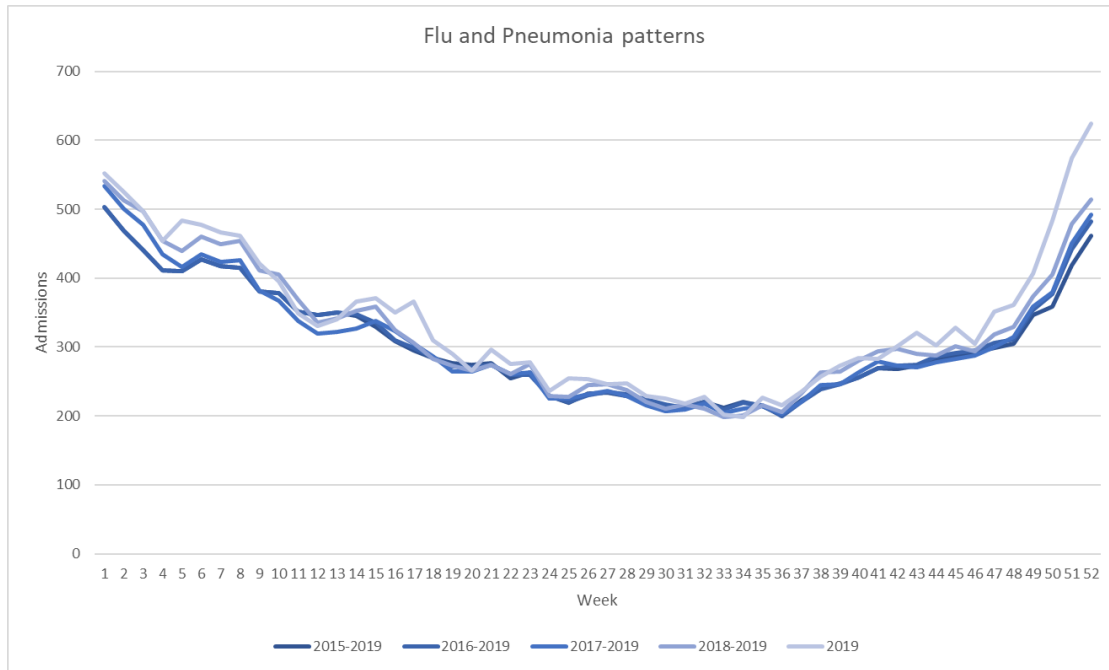
Example projections

The medium term projection is calculated using the latest available flu data provided by Public Health Wales (PHW) and projecting forwards using the pattern chosen in the previous section (that uses an average of flu and pneumonia data from the years 2015 – 2019). The pattern was scaled to the latest actual flu admissions data and the results are shown in figure 3 below (the circular points denote the latest available data with points that are likely to increase once more data is received from health boards highlighted in red, and the black line denotes the projection).

Figure 7: Flu actual admissions and projection, Wales, 2022 to 2023
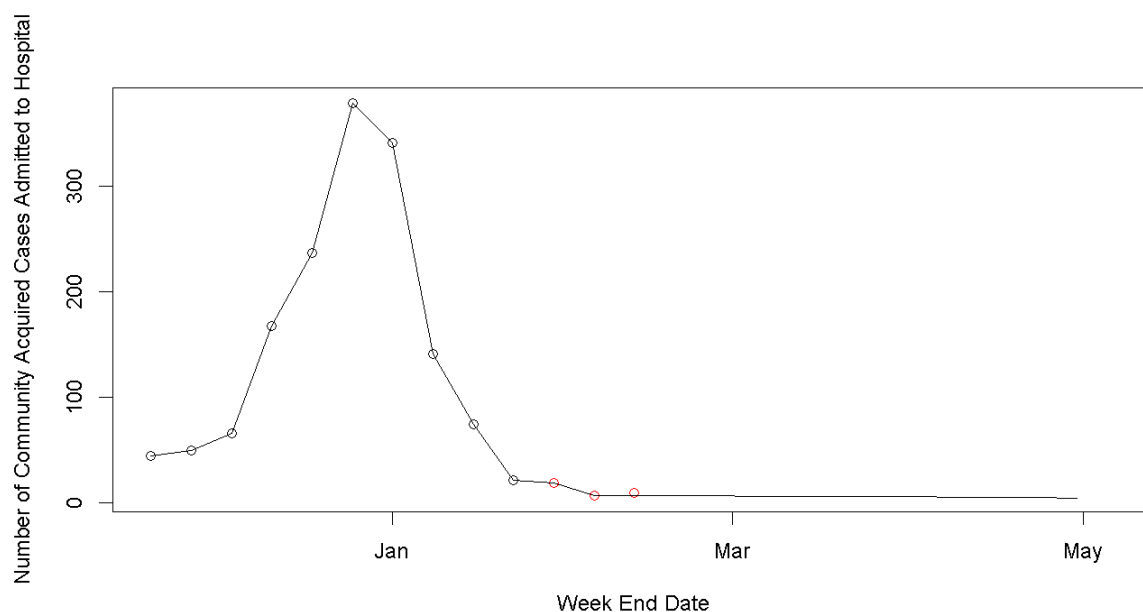
The PHW data shows the expected winter peak in hospital admissions with a steep rise in admissions in the second half of December. By January the admissions start to decrease, as they have done in previous years.

Discussion

Even though the pattern of influenza admissions was consistent over pre-pandemic years 2015-2019, the numbers of admissions decreased during pandemic years due to interventions used to manage COVID-19. It is possible that the lifting of restrictions could cause flu admissions to return to pre-pandemic levels, but it is difficult to predict the behaviour of individuals (perhaps people are still cautious of large social interactions with people who are vulnerable to hospital admission due to flu, limiting the spread of respiratory diseases). Future developments around flu vaccine match to circulating strains, more effective flu vaccines joining the market, and differences in uptake will affect admissions. These interacting factors make it more difficult to estimate what future admissions will look like based on historical data. It is important, therefore, to highlight the uncertainty when calculating these projections.

Conclusion

Once available these projection models will run using winter 2022/23 data. The medium term projections will give an additional layer to the NHS winter preparedness in Wales for 2023/24. The short term projections will give national and health board level projections for continuous monitoring as the next winter progresses.

The more recent data may indicate whether behaviours have changed amongst the population as a result of the COVID-19 pandemic. We may see less flu circulating as a result of those who are infected taking steps to avoid contact with others. Conversely, we may see levels above previous years as immunity in the population who have not had the flu vaccine due to waned immunity over the pandemic period.

There is work ongoing to compare the data available to wastewater data. There may be opportunities to incorporate these data into future iterations of these flu projection models.

These models will continue to be developed in an aim to adapted them for other seasonal viruses, such as RSV. This will give better insight into what winter viruses could peak at a similar time and the potential impact on demand.

In the longer term, a compartmental model for flu incidence and outcomes that considers factors like vaccine uptake and demographic change may be produced.