Prediction and control of the impact of the onset of influenza season on the spread of COVID-19

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Abstract. The epidemic caused by the coronavirus (COVID-19) is still spreading. At the same time, the flu season in the United States is also coming. According to data released by the CDC, during the 2019 - 2020 flu season, it is estimated that 38 million flu illnesses, 0.4 million flu hospitalizations and 22000 flu deaths. A severe flu season will burden the medical system and weaken medical resources that could be provided to COVID-19 patients. Therefore, it is essential to study impacts of the flu season's arrival on the development of COVID-19 epidemic, such as the hospital bed capacity. In this paper, based on the seasonal property of flu transmission, we will use the SARIMA model to analyze and forecast the flu trend. Simultaneously, as COVID-19 is a sudden infectious disease, we will use the compartment model to predict this disease's short-term trend and study impacts of flu vaccination in different proportions on development trends of COVID-19.

Introduction

Since December 2019, the spreading of coronavirus (COVID-19) has severely affected the global world's regular order, involving all aspects of the social, economy, and healthy life. As of Oct 29, 2020, over 44 million cases have been reported, including over 11 million deaths in over 190 countries and regions [2]. According to data released by the CDC's influenza web page [1], during the 2019 - 2020 flu season, it is estimated that 38 million flu illnesses, 0.4 million flu hospitalizations, and 22000 flu deaths.

Because of the seasonal property of influenza, we use the SARIMA model [3] to study and predict the spread of this year's influenza season. Unlike influenza viruses, COVID-19 is a sudden infectious disease. There is currently no vaccine or effective treatment, but its transmission law is heterogeneous. Therefore, we use a new fractional generalized compartment model to study its transmission trend. And combined with the prediction of the spread of the influenza virus, we examined the impact of state-level influenza transmission on the treatment of the COVID-19, especially the impact on the utilization rate of hospital beds. Moreover, because we have an effective flu vaccine to prevent the spread of flu to a certain degree, we have also studied the impact of flu vaccine injection in different proportions on the utilization rate of hospital beds.

Results and discussions

The epidemic trends of COVID-19 using our model is shown in Fig.1. Moreover, it can be seen from Table 1. that compared with only 35% of the population who had given the vaccine, when 55% of the population vaccinated, the use of hospital beds could be reduced by about 1,200. These resources could have been provided to COVID-19 patients who need more beds. Therefore, expanding the scope of flu vaccination can alleviate and reduce the impact of the COVID-19.

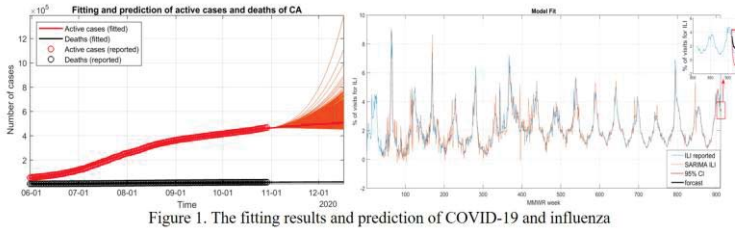

Figure 1. The fitting results and prediction of COVID-19 and influenza

ILI vaccination rate	35%	45%	55%
ILI_hosp_CA	11557 (95% CI: 1239, 21875)	10940 (95% CI: 1173,20706)	10322 (95% CI: 1107,19538)
COVID-19_hosp_CA	101652 (95% CI: 94516, 119558)		
Total_hosp_CA	113209 (95% CI: 95755, 141433)	112592 (95% CI: 95689, 140264)	111974 (95% CI: 95623, 139096)

Table 1. The hospitalization of CA

Figure 1: Welcome to the Second International Nonlinear Dynamics Conference NODYCON 2021.

References

[1] 1. CDC. National, regional, and state level outpatient illness and viral surveillance, 2020.

[2] 2. J CSSE. Coronavirus COVID-19 global cases by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University (JHU), 2020.

[3] 3. Fang-Mei Tseng, Gwo-Hshiung Tzeng, et al. A fuzzy seasonal ARIMA model for forecasting. Fuzzy Sets and Systems, 126 (3): 367-376, 2002.