Mathematical modeling of COVID-19 considering heterogenous transmission and vaccination in the Republic of Korea: from the initiation to herd immunity

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ABSTRACT

Pandemic COVID-19 has caused serious economic burden and breakdown of medical system worldwide. Since the first large-scale epidemic have been occurred in Europe, various vaccines have been developed. In December 2020, AZD1222, known as the Oxford-AstraZeneca vaccine, acquired emergency-use authorization and the vaccination initiated in England. In Korea, minimizing mortality and forming a herd immunity in 2021 are set as prior objects and the first vaccination began on February 26, 2021. In this study, we discuss about effective vaccination strategy by the two different point of view, short-term and long-term. The total population is divided differently as the point of view changes. For short-term and long-term, four heterogeneous groups (healthcare worker, underage, adult, and senior) and five age groups (0-17, 18-29, 30-59, 60-74, and 75 years old or older) are considered, respectively. Maximum likelihood estimation was used to estimate the transmission rate between different groups, and the estimated transmission rate matrix was applied into the mathematical model including vaccination. For the short-term (or long-term), the model was simulated until February 25, 2021 (or most recent date) and extended by 100 days (or until December 31, 2021) with various scenarios. As results, both of short-term and long-term analysis emphasize the importance of maintaining adequate social distancing controls along with sufficient vaccine supply, in order to simultaneously and effectively achieve the mortality minimization and the formation of herd immunity in 2021.

REFERENCES

1. Johns Hopkins University; COVID-19 Dashboard by the Center for Systems Science and Engineering (CSSE),