Insignificant effect of counter measure for coronavirus infectious disease -19 in Japan

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Abstract

Background: To control COVID-19 outbreak in Japan, sports and entertainment events were canceled in Japan for two weeks from 26 February to 13 March. It has been designated as voluntary event cancellation (VEC).

Object: This study predicts the effectiveness of VEC enduring and after its implementation.

Method: We applied a simple susceptible–infected–recovery model to data of patients with symptoms in Japan during 14 January to VEC introduction and after VEC introduction to 8 March. We adjusted the reporting delay in the latest few days.

Results: Results suggest that the basic reproduction number, $R_0$, before VEC introduced as 2.29 with a 95% confidence interval (CI) was [2.19, 2.37] and the effective reproduction number, $R_e$, after VEC introduced as 1.99; its 95% CI was [1.71,2.23].

Discussion and Conclusion: No significant effect of VEC was observed.
Introduction

The initial case of COVID-19 in Japan was that of a patient returning from Wuhan, China who showed symptoms on 3 January, 2020. Subsequently, as of 13 March, 2020, 714 cases were announced, including asymptomatic or those infected at abroad in countries such as China but excluding or those infected on a large cruise ship, the Diamond Princess [1].

Sports and entertainment events were canceled in Japan for two weeks from 26 February to 13 March according to a government advisory. At the same time, it was advised that small business and private meetings be cancelled voluntarily. The policy is designated as voluntary event cancellation (VEC). Moreover, since 3 March, almost all schools have been closed to control the spread until early April. Although schoolchildren are not of pestiferous age, the policy effects remain unknown. These policies must be evaluated as soon as possible. If the effective reproduction number, $R_v$, under these measures is less than one, the outbreak can be contained. Alternatively, even given a low $R_0$ before these measures, if it was greater than one, it might prolong the outbreak. Nevertheless, one could expect to prevent some fatal cases over time by easing burdens on medical resources or developing a vaccine. The entire course of the outbreak might be altered if these measures were able to reduce infectiousness.
considerably. Therefore, evaluation of these measures must be thorough when these measures are commenced, continued, and ceased. The present study was conducted to evaluate VEC before VEC is cancelled so as to contribute government’s decision making whether VEC will be continued or ceased.

Method

We applied a simple susceptible–infected–recovery (SIR) model [2] to the data assuming an incubation period following its empirical distribution in the early stage of the outbreak in Japan. Experiences of Japanese people living in Wuhan until the outbreak provide information related to mild cases because complete laboratory surveillance was administered for them. During January 29 – February 17, 2020, 829 Japanese people returned to Japan from Wuhan. All had received a test to detect COVID-19; of them, 14 were found to be positive for COVID-19 [3]. Of those 14, 10 Japanese people had exhibited mild symptoms; the other 4 showed no symptom as of February 25. Moreover, two Japanese residents of Wuhan exhibited severe symptoms: one was confirmed as COVID-19. The other died, although no fatal case was confirmed as COVID-19 by testing. In addition, two Japanese residents of Wuhan with mild symptoms were refused re-entry to Japan even though they had not been confirmed as
infected. If one assumes that the Japanese fatal case in Wuhan and that the two rejected re-entrants were infected with COVID-19, then 2 severe cases, 12 mild cases, and 4 asymptomatic cases were found to exist among these Japanese residents of Wuhan. We therefore apply these proportions to the simulation.

Assuming that the power of infectivity among severe patients and mild patients were equal among the asymptomatic cases, half of the symptomatic cases can be assumed. This assumption about relative infectiousness among asymptomatic cases compared with symptomatic cases was also assumed in simulation studies for influenza [4–8]. We sought $R_0$ to fit the number of patients during 14 January – 28 February and to minimize the sum of absolute values of discrepancies among the reported numbers and the fitted values. Its 95% confidence interval (CI) was calculated using the 10000 iterations of bootstrapping for empirical distribution.

We used data of the community outbreak of patients with COVID-19 who showed any symptom in Japan for 14 January – 13 March, 2020. We excluded some patients who had returned from China, and who were presumed to be infected persons from the Diamond Princess. They were presumed to be not community-acquired in Japan. During this period, 544 cases with onset dates occurred.

Published information about COVID-19 patients with symptoms from the Ministry...
of Labour, Health and Welfare (MLHW), Japan was usually adversely affected with some delay caused by uncertainty during onset to visiting a doctor or in the timing of a physician’s suspicion of COVID-19. Therefore, published data of patients must be adjust at least a few days. To adjust it, we applied the following regression. We denote $X_{t-k|t}$ as the number of patients whose onset date was $t-k$ published on day $t$. The dependent variables are the degree of reporting delay, $X_{t-k-m|t} / X_{t-k-m|t-m}$, where $k > m$ in several $m$ and $k$. Here, $m$ denotes the difference of the publishing dates between the two published. Date $t$ represents the publishing date of the latest publishing. The explanatory variables were $1/k$, $1/m$, and $1/km$. The degree of reporting delay was estimated as [estimated coefficient of constant term] + [estimated coefficient of $1/k]/k$, when $m$ was sufficiently large and time had passed. Therefore, this estimated degree of reporting delay multiplied by the latest published data are expected to be predictions of the number of patients whose onset date was $t-k$. We used this adjusted number of patients in the latest few days including those after VEC was adopted. We used the published data on 2,5,6, and 9-14 March, 2020 by MLHW[1].

First, we estimated R$_0$ in Japan to fit the data of community outbreak before VEC was introduced. Then, using the adjusted data of patients, we estimated R$_v$ after VEC was adopted. We discussed about R$_v/R_0$ through its distribution. We used 5% as
significant level.

Ethical consideration

All information used in the present study were published and thus there was no ethical issue.

Results

During 14 January – 13 March in Japan, 640 community-acquired cases were identified for whom the onset date was published. Figure 1 showed the empirical distribution of incubation period among 62 cases whose exposed date and onset date were published by MHLW. Its mode and median were six days and average was 6.74 days.

Figure 2 depicts the epidemic curves published at 3, 5, 6, 9 and 10 March. From this information, we estimated the degree of reporting delay. Those results are presented in Table 1. The table shows that $1/k$, $1/m$ and $1/km$ are all significant. When $m$ is sufficiently large, the effects of $1/m$ and $1/km$ converge to zero. Therefore, the estimated degree of reporting delay consists of the term of $1/k$ and a constant term. Based on these results, we predict the degrees of reporting delay as 19.3 for $k=1$, 9.64 for $k=2$, 6.42 for
\( k=3 \), and so on.

The value of \( R_0 \) before VEC introduced was estimated as 2.29 with a 95\% CI was [2.19, 2.37] and \( R_v \) after VEC introduced as 2.03 and its 95\% CI was [1.72, 2.32]. The average and median of \( R_v/R_0 \) were 0.88 and its 95\% CI was [0.79, 1.05].

Discussion

We applied a simple SIR model including asymptomatic cases that had not been incorporated into the model to date. An earlier study [9] estimated \( R_0 \) for COVID-19 as 2.24–3.58 in Wuhan. Our \( R_0 \) obtained before VEC was similar.

Unfortunately, effectiveness of VEC was not observed even though it reduced infectiousness by 13\% in average.

Conclusion

Results demonstrated that VEC can reduce infectiousness of COVID-19 by 13\%, but not significant. However, we have to note that the obtained results were just a preliminary evaluation, and thus it is not a conclusive evaluation. VEC had been extended until March 19 on March 10. We hope that the present study contribute
government’s decision making for VEC. The present study is just the authors opinion,

but does not reflect any stance of our affiliation.

Conflict of interest

No author has any conflict of interest, financial or otherwise, to declare in relation to this study.
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Table: Estimation results of the degree of reporting delay

|                | Estimated coefficient | p-value | 95% CI          |
|----------------|-----------------------|---------|-----------------|
|                |                       |         | Lower bound     | Upper bound    |
| 1/k             | 16.9                  | .000    | 14.7            | 19.0           |
| 1/m             | 1.01                  | .025    | 0.140           | 2.05           |
| 1/(km)          | -21.8                 | .000    | -26.7           | -16.9          |
| Constant        | 0.266                 | .236    | -0.175          | 0.707          |

Note: The number of observations was 323. The coefficient of determination was 0.457.

$k$ denotes the number of days until the last reported day. $m$ denotes the difference between the publishing date in the past and the most recent publishing date. The dependent variable was the degree of reporting delay, which is defined as $\frac{X_{t-k-m}|t}{X_{t-k-m}|t-m}$, where $X_{t-k}|t$ is the number of patients whose onset date was $t-k$ published on day $t$. We used the number of patients by onset day published on 2, 5, 6, 10, 11, 12, 13 and 14 March 2020 by Ministry of Labour, Health and Welfare, Japan.
Figure 1: Epirical distribution of incubation period published by Ministry of Labour, Health and Welfare, Japan

(number of patients)

Notes: Bars indicates the number of patients by incubation period among 62 cases whose exposed date and onset date were published by Ministry of Labour, Health and Welfare, Japan.
Figure 2: Epidemic curves of COVID-19 in Japan published on 2, 6, 10, 12 and 14 March, 2020 by Ministry of Labour, Health and Welfare, Japan

(number of patients)

Note: The black bold, black thin, brieden gray, and gray bold lines respectively show epidemic curves published on 14 March, 12 March, 10 March, 6 March, and 2 March by Ministry of Labour, Health and Welfare, Japan.