Analysis of Covid-19 Data for Korean Cases
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Abstract: Recent pandemic by Covid-19 is very shocking, and appears to be more severe than any other coronavirus diseases spread throughout the world. This short report does not concern about the figures of confirmed patients, but about the mortality by Covid-19 infection for Korean cases. By analyzing the daily trend of the mortality estimated by the ratio of the number of dead to the number of the sum of recovered and dead patients, we could access the final mortality of the infection and the effect of drive-through Covid-19 testing systems adapted in Korea on the mortality.

One Sentence Summary: Data of Covid-19 infection in Korea was analyzed focusing the daily trend of the mortality estimated by the ratio of the number of dead to the number of the sum of recovered and dead patients, and the effect of drive-through Covid-19 testing systems adapted in Korea on the mortality was estimated.

As of 12.03.2020, World Health Organization (WHO) announced Covid-19 outbreak a pandemic.¹ Since the first report of infection in Wuhan, Hubei, Chine, in December 2019 the disease is spreading out throughout the world, including Rep. of Korea. Meanwhile China is reporting almost no new Covid-19 local infections and Korea seems to be managing the disease well. Many countries, such as the United States, Italy, and France, where the disease is serious, are interested in the ways of managing the disease by the Korean government, especially in drive-through Covid-19 testing systems adapted in Korea for the first time in the world (see Fig. 1). For now, this drive-through system appears to be very efficient in identifying infected persons and in isolating them from uninfected. Although it is very important to suppress or block the transmission of the disease, the mortality of the disease is of the special concern. The mortality estimated based on the rate of deaths per number of diagnosed cases is 4.1% for Wuhan.³ If the number of cases is final, the estimated mortality is accepted without no objection. However, when a country is in the middle of increasing number of cases, the mortality varies day by day, because the newly added cases include patients who would die from this disease in the future. Resultantly the mortality, e.g. for Korean cases, increases day by day eventually to the final figure. In this short report, the mortality was accessed not based on the rate of deaths per number of current diagnosed cases, but on the rate of cumulative deaths to the cumulative sum of recovered and dead patients for Korean cases, and the effect of the drive-through testing system adapted in Korea on the mortality was estimated.
**Daily progress of diagnosed cases in Korea**

Fig. 2 shows the daily progress of diagnosed cases confirmed from 19.02.2020. This figure also includes daily trends for the recovered and dead. The first case of death in Korea was reported on 20.02.2020. The number of confirmed cases increases exponentially in the first stage and then steadily after 20 days, when the number of recovered patients starts to increase apparently with respect to the number of dead. As the number of dead is far less the that of confirmed, it is hard to follow the daily trend. So the two sets of data for the recovered and dead are again shown as a function of the elapsed day in Figure 3 in a logarithmic scale. The daily progresses can be clearly seen in this figure, where we notice that the number of dead almost reaches the number of recovered at 13 or 14 days to be able to have a cross. From the next day, however, the number of recovered becomes far above the number of dead with seemingly a quantum jump. As indicated in Figure 3, at this time around drive-through Covid-19 test systems has adapted throughout the whole country. Did the application of drive-through systems a positive effect on the recovery of diagnosed persons there?
The mortality estimation based on the cumulative number recovered and dead

Usually the mortality of a disease means the rate of deaths per number of diagnosed cases. This is true for faded infections by, like middle east respiratory syndrome coronavirus (MERS-CoV) or severe acute respiratory syndrome (SARS), because we have all the final data in hand. According to a WHO report, approximately 35% of reported patients with MERS-CoV infection have died. The mortality of SARS was 11% at the end of the epidemic in June 2003. For Covid-19, we do not have final data for the total diagnosed and death cases. The mortality of Covid-19 varies by day for Korean cases, as diagnosed cases are reported every day, while the regional mortality only for Wuhan cases may be regarded as finalized. As all the diagnosed persons will eventually recover or die from the infection, the mortality estimated based on the rate of deaths per varying number of diagnosed cases in Korea would be unpractical for further analysis. Instead, we are focusing only on the figure of cumulative recovered and dead cases to analyze the effect of drive-through testing systems of Korea on the epidemics, by defining the daily varying mortality as the ratio of the cumulative number of dead to the cumulative sum of recovered and dead patients.

Figure 3. Cumulative number of cases for recovered and dead as a function of day from 19.02.2020 in a logarithmic scale.

Figure 4. Mortality in % as a function of the cumulative number of recovered + dead.
Figure 4 shows the daily varying mortality as a function of the cumulative number of recovered and dead. Five dates regarding to the adaption of drive-through testing systems in the country are given in the figure. Korea has set up drive-through systems firstly in Goyang, a small city about 16km away from Seoul, the capital city on 25.02.2020. These systems were then intensively installed nationwide on the days of 2nd to 5th of March 2020, as indicated in the figure. As is seen, the mortality goes very rapidly up to 45% on 3.03.2020 and then drastically decreases to approach asymptotically to 1.6%, the estimated one from Figure 6. Figure 5 shows an enlarged view around the turning point in Figure 4. We can see that the dates of the intensive and nationwide application of drive-through testing systems are concentrated around this turning point, suggesting a positive effect on the mortality of the infection. As our mortality is defined as the ratio of the cumulative number of dead to the cumulative sum of recovered and dead, the inclination of the curve shown in Figure 6 as the cumulative number of dead vs. the cumulative number of recovered + dead give the mortality. As shown in Figure 6, the mortality does not vary and stable from 12.03.2020 to be 1.6%. From an enlarged view of Figure 6 for the first stage of the trend, as shown in Figure 7, we can get another mortality of 56.6% up to the date on 4.03.2020. At large, there is a transition in the mortality from 56.6%
to 1.6%, the reason for which we may say the nationwide adaptation of drive-through testing systems.

Figure 7. An enlarged view of the cumulative number of dead shown in Figure 6.

**Summarizing remark**

By introducing drive-through testing system, Korea has efficiently enhanced the speed of diagnosing of Covid-19 infections. As a result, the confirmed cases has increased sharply, which caused worries domestically and abroad. However, due to these rapid and early diagnosing systems, the diagnosed persons can have more time for treatment and care. Accordingly, the mortality estimated based on the cumulative number of recovered and dead changed from 56.6% to 1.6%, the expected final mortality for now.

**References:**

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