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Short communication

Basic strategies for risk management to minimize total damage due to COVID-19

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A R T I C L E  I N F O

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In this paper, risk management strategies to minimize total damage due to COVID-19 are proposed. Total damage includes direct and indirect damage by infection and regulation respectively. The regulation of people's activities involves trade-offs between direct and indirect damage; thus, risk management should consider them. In implementing risk management strategies, the government must engage in risk communication to change people's behavior. Furthermore, the expansion of medical capacity is also necessary for risk management. The theoretical mechanisms of how medical capacity expansion reduces optimal total damage due to COVID-19 and the optimal level of regulation is described.

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1. Introduction

COVID-19 has damaged our economy and society, and national governments worldwide have tried to mitigate these damages. For this purpose, they have adopted a policy of prohibition or self-restraint, i.e., regulation in a broad sense, of social and economic activities. However, such regulation of social and economic activities damages our economy and society in ways that differ from the direct damage to public health due to COVID-19. Therefore, governments should be concerned with not only the direct damages of COVID-19 on public health but also its indirect damages on the economy and society as a result of the regulation of social and economic activities.

In this paper, ways to minimize the long-term total damage to our society are proposed, including the direct damage to public health caused by COVID-19 and the social and economic damage caused by the regulation of social and economic activities mandated by the government for it.

2. Basis strategies to regulate people's social and economic activities

As Fig. 1 shows, the regulation of people's activities involves trade-offs between direct damage caused by the spread of infectious diseases and indirect damage caused by the stagnation of social and economic activities.

If the degree of regulation is too high, the resulting economic recession will cause greater social and economic damage including an increased number of suicides and greater poverty, which will lower the levels of well-being and health. If the degree is too low, the number of deaths and serious cases due to the spread of COVID-19 will increase.

Note the following regarding Fig. 1 with respect to extreme cases. First, if the economy and society collapse, the healthcare system will also collapse, and damage due to infection will increase. Therefore, in reality, the graph for “direct damage to people caused by infection” will increase sharply on the right, although the graph in the figure does not show this increase.

Second, if the infection spreads nationwide, antibodies against COVID-19 will spread too, minimizing damage in future outbreaks (e.g., next winter). In this sense, the graph for “direct damage to people caused by infection” could also show a sharp increase on the right.

Third, if the level of self-restraint is too low, the number of those infected and severely ill people will increase causing a “healthcare disruption” and nationwide panic. Consequently, the economy and society will spiral into chaos. Therefore, the graph for “indirect damage to people caused by self-restraint” will show a sharp increase to the left.

Hence, both extremely low and extremely high levels of regulation of activities would be inappropriate.

Fig. 2 shows how the government should decide whether to make regulations stricter or relaxed. As shown, if the current level of regulation is assumed to be less strict than the optimal level, it should be stricter. Subsequently, if the Figs. 1, 2, 3 and 4 current level of regulation is assumed to be stricter than the optimal level, it should be less strict.

Certainly, it might sometimes be difficult to find the optimal level of regulation, but this conceptual understanding would help discuss the...
kind of regulation to adopt while considering the trade-offs between the direct and indirect damage caused by the spread of infectious diseases and the stagnation of social and economic activities respectively.

First, this conceptual understanding would make us recognize that we should avoid ignoring the indirect damage even when trying to minimize the direct damage due to infectious diseases. Second, this conceptual understanding would make us consider that the option of regulation to minimize direct damages due to infectious diseases would be more valuable as their indirect damages decrease.

Therefore, this conceptual understanding promotes our attitude toward efforts to minimize total damage including direct and indirect damages due to COVID-19 and the regulation of activities to minimize infection, even though it might be sometimes be difficult to numerically find the optimal level of regulation.

3. Regulations regarding social events to minimize total damage

There are several types of regulation of social and economic activities to minimize COVID-19 infection. One of the most typical regulations is that for social events where people meet. Social events include cultural and sports events, and various types of social meetings such as working in offices, participating in classes at school, shopping in supermarkets, and so on.

To regulate social events while accounting for the trade-offs between the direct and indirect damages of COVID-19, the government should consider the differences in its level of mortality risk across age groups. As Fig. 3 shows, the mortality risk of COVID-19 differs across age groups. It is more than 20% for those who are older than 80 years, but 0.01% and 0% for those in their 20s and younger than 20 years respectively. This indicates that the direct effectiveness of the regulation of social events for younger people is lower than that for older people. Subsequently, it is difficult to confirm that the indirect damages due to the regulation of social events differ across age groups. Therefore, to minimize the total damage of COVID-19, the regulation (i.e., the prohibition or requesting of self-restraint) of participation in social events by elderly people is more effective in minimizing the damage than for all other age groups. Furthermore, it is known that in addition to elderly people, those with underlying diseases are at a greater risk of death; thus, regulations concerning them are also effective.

However, limiting regulations regarding participation in social events to elderly people and those with underlying diseases may evoke the problem of unfairness. Therefore, various types of support and/or compensation for these groups during regulation are necessary.

To minimize the total damage including direct and indirect damages due to COVID-19, the level and content of regulation of social events should depend on the content of the event. This is because some social events are less risky than others. For example, outdoor events are less risky than indoor ones, and even indoor events are less risky in well-ventilated rooms. Events providing alcohol are riskier because people tend to speak louder when drunk, which may produce droplets. Similarly, events involving singing, such as karaoke, are also riskier.

Therefore, the contents of the regulation of social events should be designed considering conditions related to the event: is it indoors/outdoors, with/without a meal, with/without alcohol, with/without singing, and the density of people.

Based on this discussion, it is expected that the total damage including the direct and indirect damages due to COVID-19 can be effectively minimized if the following examples of recommendations are implemented:

1) Prohibit the participation of the elderly and those with underlying diseases,
2) thorough ventilation (for indoor events),
3) hand sanitization at the entrance,
4) requesting that mask is worn (for cough etiquette),
5) requesting that the mouth and nose not be touched with the hands, and
6) maintaining social distance between people talking or singing (but this is not necessary if there is no talking or singing, or people are wearing masks).

Point (1) is necessary to minimize the direct damage of COVID-19. Point (2) is known to be effective in avoiding “airborne infection.” Points (3) and (5) are known to be effective in avoiding “contact infection.” Point (4) is known to be effective in reducing any kind of risk of infection. Point (6) is known to be effective in reducing infection from droplets [1].
Note that points (2), (3), (4), (5), and (6) cost less than canceling the event itself. Furthermore, point (1), prohibiting the participation of the elderly and those with underlying diseases also costs less than prohibiting the participation of all people. Point (6), maintaining social distance between people talking or singing costs less than keeping social distance between people in other situations. Therefore, it is expected that these partial regulations will effectively minimize the direct damages of COVID-19 with less indirect damages from regulation.

That said, if the rate of infection becomes so high that rapidly stopping the spread becomes essential, then all social events would need to be regulated. However, excepting this situation, people can participate in any type of social event to minimize not only social and economic damage due to the regulations but also health damage due to COVID-19, as long as partial regulations are adopted.

Furthermore, the costs of such partial regulations would differ across countries and cultures. Some nations may not feel any subjective cost in wearing masks, although others may. Some nations may talk to each other so frequently, but others may not. Therefore, sets of regulations of activities in social events should be designed while considering the subjective, social, and economic costs of these regulations in each country and culture.

4. Risk communication regarding the regulation of social events

People frequently touch their mouth or nose without being aware of their actions. People talk to each other without caring about the distance between them. Therefore, to increase awareness of regulations at social events, such as not touching the mouth or nose or requesting that social distance be maintained, the government must engage in risk communication to induce behavior change.

People may not like wearing masks or sanitizing their hands at the entrance. Elderly people would certainly not like being prohibited from participating in social events. Therefore, to implement regulations, such as prohibiting the elderly from participating and asking that participants wear masks, the government must engage in risk communication to persuade people to adhere to these rules to minimize damage.

The following is an example of risk communication by the government regarding COVID-19 and the related regulations and behavior changes, that the author exemplifies.

“A pandemic was officially declared. Now, while focusing on preventing an increase in the numbers of fatalities and severely ill people, and considering the social and economic damage caused by various measures, we consider it is necessary to take countermeasures aimed at a judicious and measured approach to the new coronavirus.

Based on this, we request that the following two policies regarding holding events be adopted as measures against the new coronavirus.

Policy 1 discourages senior citizens from participating in events.

The risk of mortality of this disease is 2.7 to 22.2% for people over the age of 60 (see Fig. 3). For the elderly, preventing infection is a priority. Therefore, we are going to ban participation in several social events by the elderly. We also request that people with chronic illnesses or living with the elderly practice self-restraint in their participation.

Contrastingly, the risk of mortality for those under 50 years is quite low, i.e., 0% to 0.6%. This level is not significantly different from the risk of seasonal flu (while the risk for those over 50 is several times the seasonal flu risk). Therefore, if you are younger than 50 and you become infected, you should emphasize rest and simultaneously, be very careful not to infect those around you, especially the elderly.

However, as Policy 2, we request that the organizers of all events minimize the risk of infection by preventing the overlapping of the conditions: “closed,” “dense,” and “conversation at short distance.” Specifically, we request that they provide sufficient ventilation, make disinfectants available, promote cough etiquette using masks, ensure self-restraint with actions that might cause splashing, and request that masks be worn.

Again, we request that the elderly, those with medical conditions, and those living with such people practice self-restraint from participating in events.

Note that these self-restraint and infection control requests will be mitigated and abolished whenever the risk of infection is reduced. Thank you for your cooperation in reducing the risk of infection.”

In designing the contents of risk communication, understanding the extent of the risk of COVID-19 is important. Currently, the mortality rate based on the confirmed cases and deaths of COVID-19 is around 2.16% [2]. However, this might be markedly overestimated. This rate was not based on a “100% survey,” but was a percentage of deaths among patients who test positive for the virus. Thus, it is likely that many people who are actually positive have not been tested.

A more accurate mortality rate can be estimated from the passengers on the cruise ship “Diamond Princess,” who were all tested. Based on the data, the rate of severe illness is 2.6% and the mortality rate is 1.0%.

However, the severity and mortality rates depend on age. The age-specific mortality rate for China, where there are data on more than 40,000 cases, was 0.5% for those under the age of 50 years, 1.3% for those in their 50s, 5.0% for those aged 60–80 years, and 14.8% for those older than 80.

Using these data, the severity and mortality rates by age group were estimated as shown in Table 2 assuming that the distribution of these rates for the “Diamond Princess” by age is equal to the distribution of mortality rates for the 44,672 cases reported in China.

From these estimates, the incidence of severe cases is less than 1 in 170 people and the number of fatal cases is less than 1 in 500 people for those under the age of 50 years. Therefore, those who should be especially careful of infection are people aged 60 years and older, who have a 10–30 times higher risk of death than those younger than 50 years. These mortality rate estimates are much lower than those observed, as shown in Fig. 3. This indicates that the reported-based mortality rate was overestimated. Thus, in the abovementioned risk communication, it is better to use the estimated rate in Table 2 than that in Fig. 3.

Another important purpose of risk communication on COVID-19 is to mitigate the risk that “persons newly infected with coronavirus” and “organizations that have infected persons” are victimized socially (in other words, we need to avoid so-called “corona-harassment”). For this purpose, it is necessary to deter “excessive anxiety about the new coronavirus” through the following risk communication.

First, we need to spread the following message as an example: “As a pandemic has been declared, the basics of coronavirus control have shifted from ‘just controlling infection’ to minimizing ‘severe cases’ and ‘deaths’ based on data. Simultaneously, it is necessary to minimize social and economic losses due to the measures taken against the new coronavirus.”

We also must explain that even with a new coronavirus infection, the current risk of serious illness is very low—about 0.6%—and the risk of death is about 0.2% if you are aged less than 50 years, as shown in Table 2. We should promote knowledge that the risk is not very high compared to the risk of seasonal flu. Note, however, that the

| Age            | Number of cases | Number of deaths | Mortality rate | Ratio of mortality rate to that of not elderly (50 or younger) |
|----------------|----------------|------------------|---------------|---------------------------------------------------------------|
| Younger than 50| 20.854         | 64               | 0.3%          | Table 1 and 2 (4 times)                                       |
| 50–60          | 10.008         | 130              | 1.3%          | (16 times)                                                   |
| 60–80          | 12.501         | 621              | 5.0%          | (48 times)                                                   |
| Older than 80  | 1.408          | 208              | 14.8%         |                                                              |
| Total          | 44.672         | 1,023            | 2.3%          |                                                              |

Data Source: Japanese Association for Infectious Diseases and Japanese Society for Infection Prevention and Control (2020) [3].
Table 2
Estimated severity and mortality rate for each age group.

| Age            | Estimated severity rate | Estimated mortality rate | Estimated severity/mortality rate | Ratio of mortality rate to that of not elderly (50 or younger) |
|----------------|-------------------------|--------------------------|----------------------------------|-------------------------------------------------------------|
|                | (a)                     | (b)                      | (a + b)                          |                                                              |
| Younger than 50| 0.6%                    | 0.2%                     | 0.8%                             |                                                              |
| 50–60          | 1.5%                    | 0.6%                     | 2.0%                             | (2 times)                                                   |
| 60–80          | 5.6%                    | 2.2%                     | 7.8%                             | (10 times)                                                  |
| Older than 80  | 16.7%                   | 6.5%                     | 23.2%                            | (28 times)                                                  |
| Total          | 2.6%                    | 1.0%                     | 3.6%                             |                                                              |

5. Expanding the capacity of medical treatment and its effects

The spread of hospital-acquired infections can dramatically increase the number of infected individuals at high risk of severe illness, and simultaneously, drastically reduce the availability of medical care. Therefore, it is necessary to take measures to avoid hospital-acquired infections.

It is necessary to increase the number of tests available to eliminate public anxiety and to control infections (especially hospital-acquired infections).

However, if the number of available tests increases, the “demand for screening for the new coronavirus” will inevitably increase, and the risk that the demand will exceed the medical supply capacity (so-called medical collapse risk) will also increase. To avoid this, measures should be taken to increase the medical supply capacity as much as possible, while simultaneously prioritizing those at higher risk of severe illness due to the new coronavirus (i.e., tests for those at lower risk are not absolutely necessary).

Those who have no symptoms or who have mild symptoms should be treated at home to prioritize the hospitalization of more seriously infected patients.

(The same should be applied to hospital beds to maximize the use of limited resources.) In medical institutions where the number of respirators is limited, it is necessary to examine the need for using these medical devices.

Similarly, to use “the resources of the institutes of local health” effectively, it is important to use “the resources of the local institutes of health” that were spent on tracking infection routes for treatment and prevention.

By expanding the capacity of medical treatment for COVID-19 in these ways, the curve representing relations between direct damage to people by infection and regulation would trend downward, as shown in Fig. 4. This is because direct damage to people by infection would be reduced as medical capacity expands. Therefore, the optimal level of regulation would decrease as medical capacity expands. As such, by expanding medical capacity, the government can reduce the level of regulation (from “b” to “a” in the figure).

The graph also indicates that optimal total damage to people between indirect damage by regulation and direct damage by infection would reduce. In the case of low and high medical capacity, the optimal total damage would be 2A and 2B respectively. Since A > B in the figure, the optimal total damage would be reduced by expanding capacity.

6. Summary and conclusion

In this paper, risk management strategies were proposed to minimize the long-term total damage to our society, which includes the direct damage to public health caused by COVID-19 and the social and economic damage caused by the regulation of social and economic activities. To implement risk management, we need appropriate risk communication from the government to the public. Furthermore, expanding medical capacity is necessary to minimize total damage due to COVID-19. Finally, I theoretically discussed how expanding medical capacity could reduce the optimal level of regulation and total damage due to COVID-19.

To implement the risk management proposed in this paper in real society, we should cautiously elaborate on the details of risk management. However, the theoretical discussion in this paper provides a basic framework for appropriate risk management policies.

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Declaration of Competing Interest

None.

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