



## Opinion

# Priority research and development areas for health crisis management including emerging infectious disease control: An expert questionnaire survey in Japan

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## Abstract

Health crisis management is becoming increasingly important worldwide, as evident by the most recent COVID-19 pandemic. To identify priority Research and Development (R&D) areas for health crisis management, an expert questionnaire survey using an online, two-round Delphi technique was conducted in Japan in 2019. The analysis results revealed that the top 3 R&D topics that experts considered important were related to infectious disease control, such as a control system for drug-resistant infections, ultra-small sensor, and drug development using alternatives to animal models. It was also revealed that not only biomedical approaches but also R&D in collaboration with IT and social science are considered important by experts. The results of this study might support developing a R&D strategy for health crisis management not only in Japan but also other countries.

## Introduction

Health crisis management is becoming increasingly important worldwide, as evident by the emergence/reemergence of infectious diseases, such as the most recent COVID-19 pandemic, and the drug-resistant bacterial infection epidemic. In Japan, health crisis management in the event of natural disasters such as frequent earthquakes and typhoons is also an important issue. Given this situation, Japan has long since addressed health crisis management through regulatory and scientific frameworks. The latter comprises various research and development programs related to national strategies including the “Science and Technology (S&T) Basic Plan” [1].

The National Institute of Science and Technology Policy/ Science and Technology Foresight Center (NISTEP/STFC) has administered large-scale expert questionnaire surveys for

more than 40 years [2], contributing to formulating the “S&T Basic Plan” to be renewed every 5 years. With the help of the survey, NISTEP/STFC has presented a wide range of future S&T strategies to address various social issues including health crisis management. For example, the survey conducted in 2014 demonstrated priority R&D areas for emerging/reemerging infectious disease control [3]. This paper introduces the outline and main results of the latest survey conducted in 2019 (the 2019 survey), focusing on health crisis management and providing information to design concrete R&D programs for management not only in Japan but also other countries.

## Materials and methods

An online, two-round Delphi technique was adopted based on our previous survey method [2]. First, ten R&D topics (see Table 1 for its definition) related to health crisis management were selected by the expert panel comprising 10 Japanese medical



doctors and researchers. Second, the “S&T Experts Network” of approximately 2,000 persons operated by NISTEP/STFC and other experts from academic societies, private companies, and so on were asked to rank the importance of each R&D topic on a 5-point scale (very high, high, neutral, low, very low), as an indicator of its characteristics (Table 1 for its definition). Data collection of the two rounds Delphi questionnaires was completed between February and June 2019.

The responses collected in the second round of the questionnaire were indexed based on the following point distribution: very high (+2), high (+1), neutral (0), low (-1), and very low (-2). For each topic, each point from “+2” to “-2” was multiplied by the number of respondents for that point and the value of each product was calculated. Finally the total value was divided by the total number of respondents for each topic. The data analysis was performed using Microsoft Excel 2016. The handling of data including personal information in this survey complied with the “NISTEP Research Activity Code of Conduct”.

## Results

The analysis results of the second round of the questionnaire are shown in Table 2. The number of respondents to each topic ranged from 124 to 157. The top 3 R&D topics that experts

considered important are as follows: a control system for drug-resistant infections (Topic 6), followed by ultra-small sensor (Topic 1), and drug development using alternatives to animal models (Topic 2). The importance scores of topics related to modelling of infectious diseases (Topic 3), prediction and evaluation of the impact of emerging infectious diseases on humans (Topic 5), countermeasures against large-scale disasters (Topic 10), and artificial blood (Topic 8) were also relatively high.

## Discussion

The top 3 R&D topics that experts considered important were related to infectious disease control, such as a control system for drug-resistant infections (Topic 6), ultra-small sensor (Topic 1), and drug development using alternatives to animal models (Topic 2). Considering the increasing number of drug-resistant infections worldwide, Topic 6 is characterized by incorporating not only medical but also social science approaches such as risk management according to the situation in different countries and regions. Topic 1 and 2 are considered to be commonly required S&T for controlling emerging infectious diseases including COVID-19. Topic 1 will accelerate biomedical engineering, as seen in the biosensor example, and Topic 2 will contribute to animal welfare by reducing the number and frequency of animal testing.

**Table 1:** Definitions of R&D topic and importance.

	Definition
R&D topic	Key S&T strategies that are considered important until 2050 in Japan from various perspectives, such as responding to future social changes, creating S&T innovation, being a common basic technology, and contributing to the progress of S&T.
Importance	Present level of the topic's importance for Japan, in order to realize a desirable society 30 years from now.

**Table 2:** R&D topics related to health crisis management and its importance scores.

R&D topics* <sup>1</sup>	Number of respondents* <sup>2</sup>	Importance* <sup>3</sup>
1. Ultralight sensors that can be used in contaminated areas—such as aircrafts—that can quickly detect infection with specific pathogens, the infectivity to other persons, and the susceptibility of uninfected people	154	1.00* <sup>4</sup>
2. Evaluation methods to determine the efficacy and side effects to develop drugs to combat infectious diseases by using the cells established from the stem cells, such as iPS cells, that can be substituted to animal models	145	0.95
3. Epidemic prediction and alert system for infectious disease epidemics by using comprehensive surveillance systems with various medical and web data	141	0.85
4. Isolation and identification technologies for unknown pathogens using a pathogen database* <sup>5</sup> .	141	0.77
5. A system that quantitatively predicts and evaluates the impacts of emerging infectious diseases on humans, including the pathogenicity and the potentiality of causing global epidemics, with comprehensive consideration of factors such as the environment, pathogens, and hosts	156	0.89
6. A system that controls the emergence and spread of drug-resistant infections by science (pharmaceuticals, etc.) and social technology (new approaches to infection control, etc.)	157	1.27
7. Mass-production technologies for neutralizing antibodies to pathogens in a rapid and inexpensive way by using plants	133	0.56
8. Blood substitutes that can be used in emergencies (multiorgan failure) and massive bleeding	135	0.86
9. Novel infection control technology targeting inter-organelle migrations in cells	133	0.37
10. Transport organization system for seriously injured people using artificial intelligence in large-scale disasters	124	0.85

\*<sup>1</sup>R&D topics refer to key S&T strategies that are considered important until 2050 in Japan from various perspectives, such as responding to future social changes, creating S&T innovation, being a common basic technology, and contributing to the progress of S&T.

\*<sup>2</sup>The number of respondents varies because the experts answered each topic voluntarily.

\*<sup>3</sup>Present level of the topic's importance for Japan, in order to realize a desirable society 30 years from now.

\*<sup>4</sup>Scores were calculated based on the following point distribution: very high (+2), high (+1), neutral (0), low (-1), and very low (-2). For each topic, each point from “+2” to “-2” was multiplied by the number of respondents for that point and the value of each product was calculated. Finally the total value was divided by the total number of respondents for each topic.

\*<sup>5</sup>Pathogen Database: A database of comprehensive genes and proteins of the pathogens of all animals including humans



On the other hand, because the importance scores of topics related to modelling of infectious diseases (Topic 3), prediction and evaluation of the impact of emerging infectious diseases on humans (Topic 5), and countermeasures against large-scale disasters (Topic 10) were relatively high, Information Technology (IT) such as big data analysis and artificial intelligence has great potential for contributing to future health crisis management.

It was also revealed that the development of artificial blood that can be used in emergency medical care (Topic 8) is considered important by experts. The current blood transfusion system using donated blood has bottlenecks regarding the risk of virus infection, storage period, cost and so on. The development of artificial blood that solves these problems is considered to be effective in improving emergency medical care.

## Conclusions

An expert questionnaire survey in Japan reveals that infectious disease control is a major aspect of health crisis management. In particular, in order to control emerging infectious diseases such as COVID-19, not only biomedical approaches but also R&D in collaboration with IT and social science are required. The results of this study might support developing a R&D strategy for health crisis management not only in Japan but also other countries.

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