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Interdisciplinary Background of Biomedical Engineering Helps Communication in Pandemic

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Abstract[1]

The global community has accelerated the spread of the virus. Medicine alone cannot solve the pandemic. Understanding information from specialists is not easy. Information is overflowing due to the progress of networks. Individuals are required to have the ability to sort huge amounts of information. How do you use information for your personal behavior? Following social campaign can lead to inconsistencies in individual behavior. The field of biomedical engineering is not limited to the fusion of medicine and engineering, but is a complex field including various fields: biology, informatics, etc. In their courses, students have the opportunity to learn pandemic-related techniques: for example, air purification techniques (clean room), and sterilization techniques (cell culture). Multi-disciplinary fields supply education to understand complex issues. They improve communication skills of students on global problems.

Keywords: *Interdisciplinary Background, Learning, Biomedical Engineering, Pandemic, Vaccine, Communication and Students.*

1. Introduction

The global society with high-speed movement of people and things causes global problems (Hashimoto, 2019). A large amount of information is transmitted at high speed. We have many globalized topics: radioactive waste, a pandemic, micro plastics (and recycling), climate change (wildfires, heavy rains, typhoons, droughts, high / low temperature), cyber security (remote work), etc. Do we purchase water and air? Japan apologizes for the leak of radioactive substances to the environment after

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the tsunami on 11th March in 2011. Japan also apologizes for the posible spread of the pandemic as a result of the Olympic games in Tokyo in 2020-2021. Everyone coexists with some viruses under the control of his or her immune system (Hashimoto, 2021). The exchange of virus between persons changes the balance in each person. Olympic games are not for the exchange of virus, but for the exchange of culture. Can each athlete keep his or her best performance in the pandemic? Vaccination also can affect the sensitive preparation of each athlete. Do vaccination and testing interfere with fair competition? Can Olympic games accelerate vaccination among people? Sterilization is big issue for the medical equipment. Every object capable of holding the virus will be sterilized and safely disposed. Syringes used for infectious diseases are disposable. Waste management is important for the sustainable society. The disposable masks can lead to environmental pollution. Plastics do not decompose in a short period. They will remain in the environment for a long time. Microplastics cause a problem in the global environment. With a view of degradation, plastics are different from radioactive materials which have a half-life of radioactivity. A single country cannot solve the globalized problem. A single principle cannot solve the globalized problem.

The COVID-19 pandemic is picked as a case study for learning the multidisciplinary field of biomedical engineering. Technology helps daily life in the pandemic. Multifaceted thinking is effective for multidisciplinary learning. Statistics is effective for society, but an individual needs logic (Hashimoto, 2019). Biomedical engineering is one of the interdisciplinary fields (Linsenmeier, 2003; Linsenmeier, 2020; Hashimoto, 2016). It has many related fields. Not only engineering, but also medicine and biology. It is even related to economics, sociology, and ethics.

2. Methods

In the course of studying biomedical engineering, students answer several questions related to COVID-19. It is a disease caused by a new type of coronavirus (SARS-CoV-2). The virus has caused a pandemic. The pathology has not fully elucidated.

Several treatments have been tried. While a unique way to address each aspect of the transmisión and symptom of the disease has not be decided yet by specialists, the questions give a chance for each student to experience multifaceted thinking (Hashimoto, 2021).

2.1. Questions

(1) The effects of vaccine: “True” or “False”.

1) Proof of vaccination is more effective than a negative result of a PCR (polymerase chain reaction) test?
2) The effect of vaccine lasts?
3) Side reactions will happen?
4) Vaccines prevent aggravated infection?
5) No more transmittance of virus to your neighbors?
6) Reduced chance of infection?
7) Prevention of infection?
8) Prevention of the virus from invading a cell?
9) The vaccine causes infection?
10) Production of antibodies to the virus?

(2) Will you be vaccinated? Do you recommend the vaccine to your friend?

(3) What is the reason, if you recommend vaccination?

1) Return to normal social life.
2) Formation of herd immunity.
3) Prevention of aggravation (severe disease).

(4) What is the reason, if you do not recommend vaccination?

1) Efficacy decreases for variants.

2) Self-quarantine is available.
3) Allergic reaction.
4) Side reaction.

(5) How do you think about side reactions?

1) These are normal reactions accompanying antibody formation.
2) Refrain from vaccination due to possible side reactions.

(6) Do you agree with the vaccine passport (certification)?

1) No: Discrimination among people.
2) Yes: Prevention of new clusters of transmission.
3) Yes: Requirement for crossing the border.

(7) Will you get vaccinated COVID-19, if you have chronic illness?

1) No: Side reactions.
2) Yes: To avoid severe illness.

(8) If you are tend to have allergies, do you get vaccinated?

1) No: Side reaction including anaphylactic shock.
2) Yes: To distinguish symptoms between COVID-19 and allergy.

(9) When will you be vaccinated?

1) Yes: Early, considering inoculation period.
2) No: After collecting cases (evidence, differences in race).

(10) Select your behavior in the past two weeks to be “free of COVID-19 infection”.

1) I have been facing others in normal life, after confirmation of negative signs by a PCR test after the recovery from COVID-19.
2) I have been facing others in normal life, after receiving the vaccine against SARS-CoV-2 virus.
3) I have been facing others in normal life, taking medications to control COVID-19 symptoms.
4) Facing others in normal life, I have been checking for the negative signs of COVID-19 infection by a PCR test every day.
5) I have been managing my own health by measuring body temperature without facing others.
6) Facing others in normal life, I have been paying attention to disinfection: masks, and distancing from others.
7) Asymptomatic; I have been facing others in normal life.

(11) Select three effects of everyday mask wearing on COVID-19.

1) Prevention of direct touch by your hands to your mouth (or your nose).
2) Prevention of the inflow of the virus.
3) Prevention of elevation of the body temperature.
4) Reduction of splashing of water droplets including virus that accompany sneezing.
5) Enhancement of the immune capacity by maintaining humidity in the oral cavity.
6) Prevention of the outflow of the virus.

(12) Choose three answers related to COVID-19 as a method to directly reduce your chances of infection.

1) Do not shake hands with others.
2) In a room with multiple people, refrain from the following action: talking, deep breathing, and singing a song.
3) Keep a distance from others.
4) Do not stay in a space with poor ventilation.

5) Do not eat meals, which are exposed to the space of everyone's conversation, at the buffet.
6) Do not get together with many people.
7) Disinfect the area you touch with alcohol.
8) Do not eat with bare hands without washing hands.
9) Wash your hands frequently.

(13) Choose three answers to directly reduce the probability of the movement of COVID-19 virus from yourself to others.

1) Do not touch where many persons touch.
2) Wear a mask when speaking.
3) Keep a distance from others.
4) Do not stay in a space with poor ventilation.
5) For sneezing and coughing, cover the mouth and the nose with sleeves or a handkerchief.
6) Do not enter a crowd.
7) Use alcohol to disinfect your hands, and the areas you touch.
8) Wear a mask when singing.
9) Wash your hands frequently.

2.2. Your Proposal

In relation to COVID-19, students make a report. Students select topics in relation to biomedical engineering. They discuss their own ideas quantitatively, using illustrations for explanation.

3. Results

Distributions of answers by students for each question are shown in Figures 1-13, respectively.

There are several types of vaccine: attenuated virus, DNA, m-RNA, virus vector, virus-like particle, and antibody. Formation of neutralizing antibodies is the key in vaccination. Information changed the answer of students from January to April in 2021 (Figure 1). Vaccine is different from virus. Vaccine reduces the probability for the infection to become severe. Students do not believe the long-term effectiveness of vaccine. There are individual differences. The effect might change against mutant viruses.

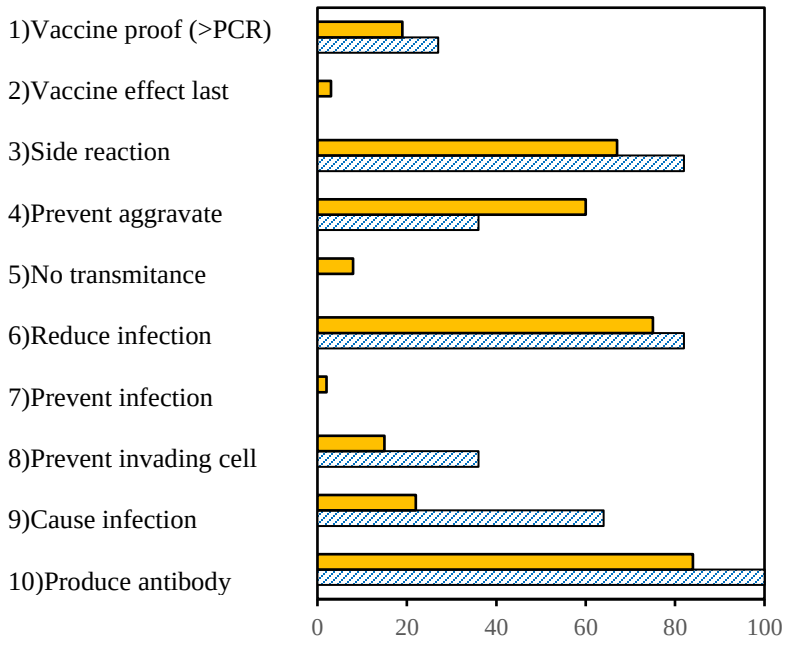

Figure 1: Effect of vaccine (%) of "True": blue striped pattern, January (number of samples n = 146); orange, April (n = 135).

Information made more students agree to get vaccinated (Figure 2b), but many students do not recommend vaccination to their friends (Figure 2c). Multifaceted thinking is helpful before making a decision: "yes", or "no". The main reason in favor of vaccination is "Not become severe after vaccination" (Figure 3). The main reason for against vaccination is "Side reaction after vaccination" (Figure 4). Vaccine is a practice. You may have a practice in a shallow pool before swimming in the sea.

Many students said they would refrain from vaccination due to side reaction (Figure 5). Side reactions are related to autoimmune reaction for antibody formation. Students are worried about social discrimination between vaccinated and unvaccinated people (Figure 6). Half of students worried about side reaction, if they have chronic illness (Figure 7). Half of students will get vaccinated to avoid severe illness.

If they tend to be allergic, many students worried about the side reaction of anaphylactic shock (Figure 8). Half of students will get vaccinated to distinguishing symptoms between COVID-19 and allergy. Half of students will be vaccinated as soon as possible, considering the vaccination reservation, vaccination interval, and the period until antibody acquisition (Figure 9). The other students prefer to be vaccinated after collection of more cases on the same race.

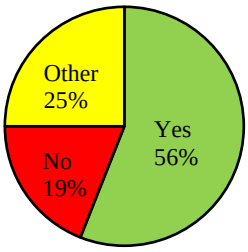

Figure 2a: Get vaccinated? January: $n = 128$.

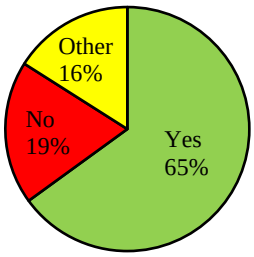

Figure 2b: Get vaccinated? April: $n = 129$.

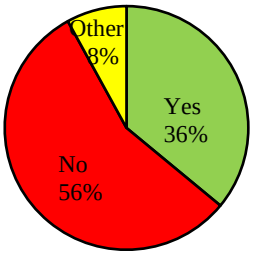

Figure 2c: Recommend vaccination to your friends? April: *n* = 129.

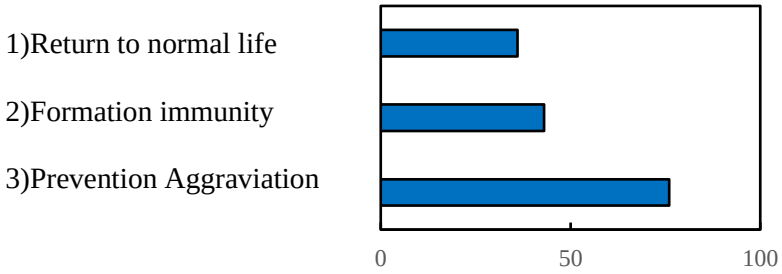

Figure 3: Reason for recommend vaccination: return to normal social life, form herd immunity, prevention of aggrevation (%): *n* = 129.

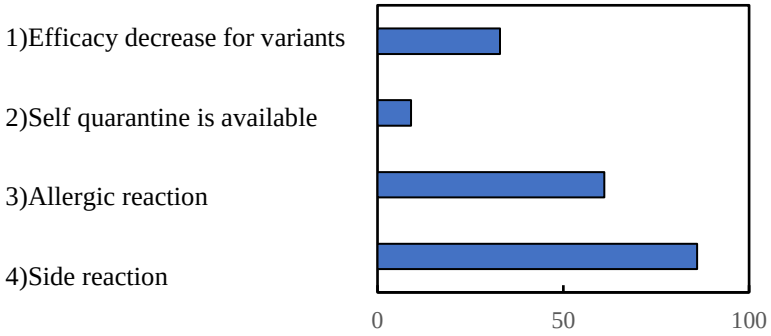

Figure 4: Reason for not recommend vaccination: efficacy decrease for variants, self-quarantine is available, allergic reaction, side reaction (%): *n* = 129.

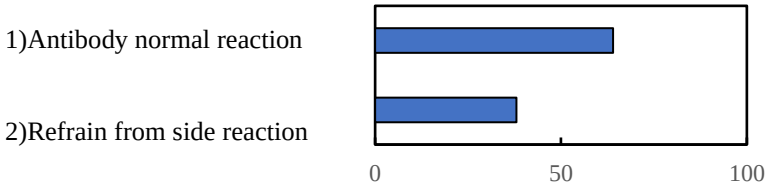

Figure 5: How do you think about side reactions: normal reactions accompanying antibody formation, refrain from vaccination due to possible side reactions (%): *n* = 129.

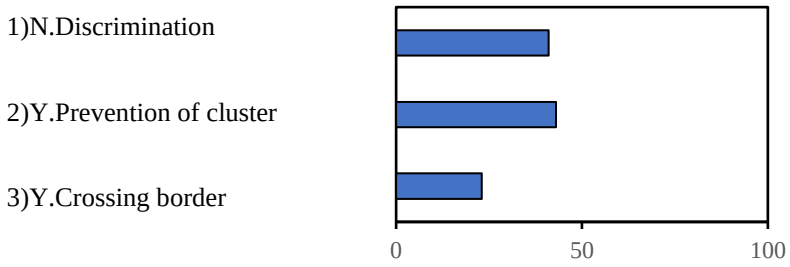

Figure 6: Vaccine passport (certification). No: discrimination among people. Yes: prevention of new clusters. Yes: requirement for crossing the border (%): *n* = 129.

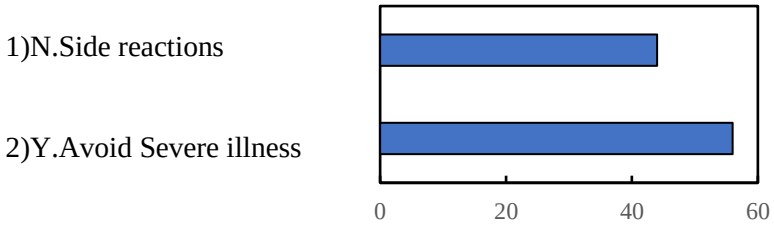

Figure 7: Vaccinated if you have chronic illness. No: side reactions. Yes: to avoid severe illness (%): *n* = 129.

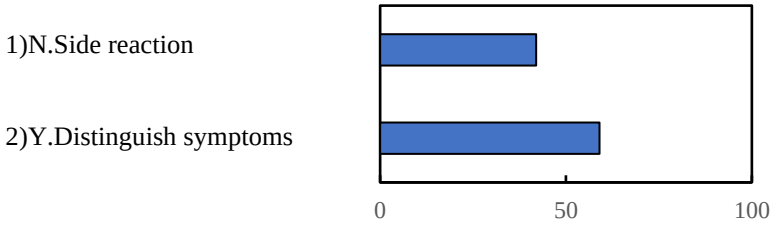

Figure 8: Allergic constitution. No: side reactions. Yes: distinguishing symptoms (%): *n* = 129.

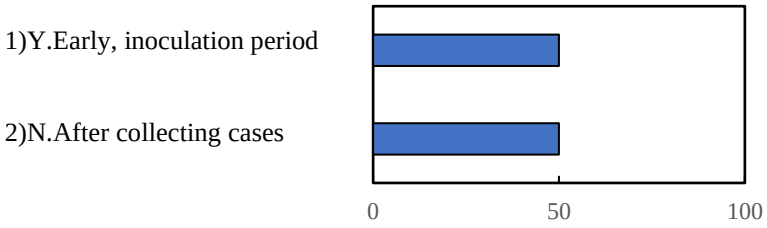

Figure 9: Timing. Yes: early, considering inoculation period. No: after collecting cases (evidence, differences in race) (%): *n* = 129.

The COVID-19 virus is transmitted from person to person. Self-quarantine blocks infection from others. The mask campaign hides the essence of the infection (Figure 10). Students tend to simply follow the mask campaign. Masks cannot stop the flow of viruses: inflows and outflows (Figure 11). The recommended logical answers are "Prevention of direct touching by your hands to the mouth (or the nose)", "Reduction of splashing of water droplets including virus that accompanies sneezing", and "Enhancement of the immune capacity by maintaining humidity in the oral cavity". Following the campaign by statistical analysis, the popular answers were "distancing" and "washing hands". The recommended logical answers are "Do not eat with bare hands", "No buffet", and "No talk" (Figure 12). Following the campaign, the popular answer was "distancing". The recommended logical answers are "Singing with a mask", "Sneezing with sleeves", and "Speaking with a mask" (Figure 13).

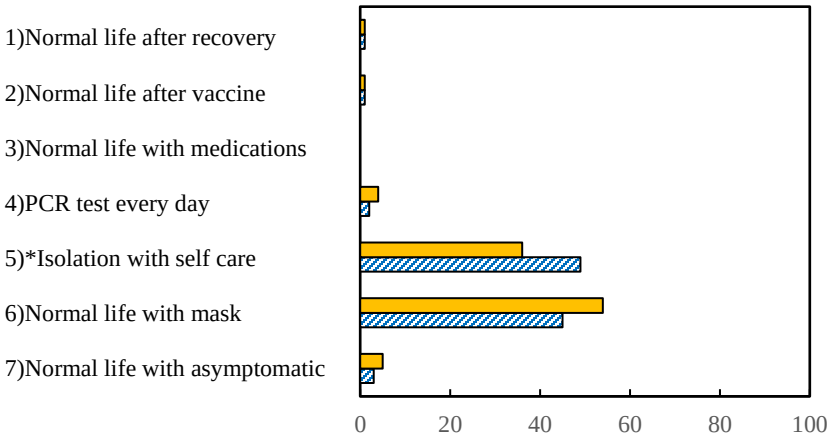

Figure 10: Select your behavior in the past two weeks to be "free of COVID-19 infection" (%): blue striped pattern, January (n = 146); orange, April (n = 135): *recommended.

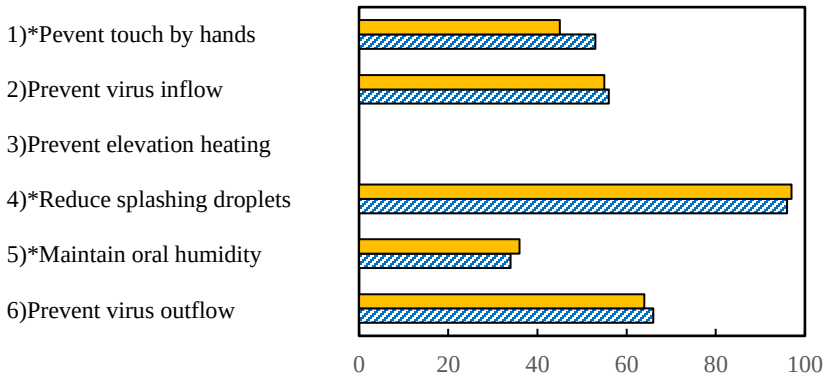

Figure 11: Select three effects of everyday-mask wearing on COVID-19 (%): blue striped pattern, January (*n* = 146); orange, April (*n* = 135): *recommended.

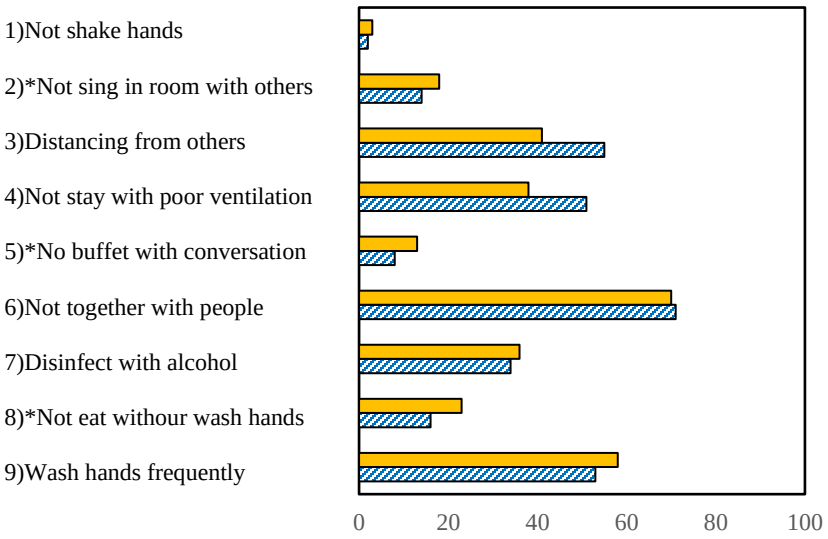

Figure 12: Choose three answers related to COVID-19 as a method to directly reduce your chances of infection (%): blue striped pattern, January (*n* = 146); orange, April (135): *recommended.

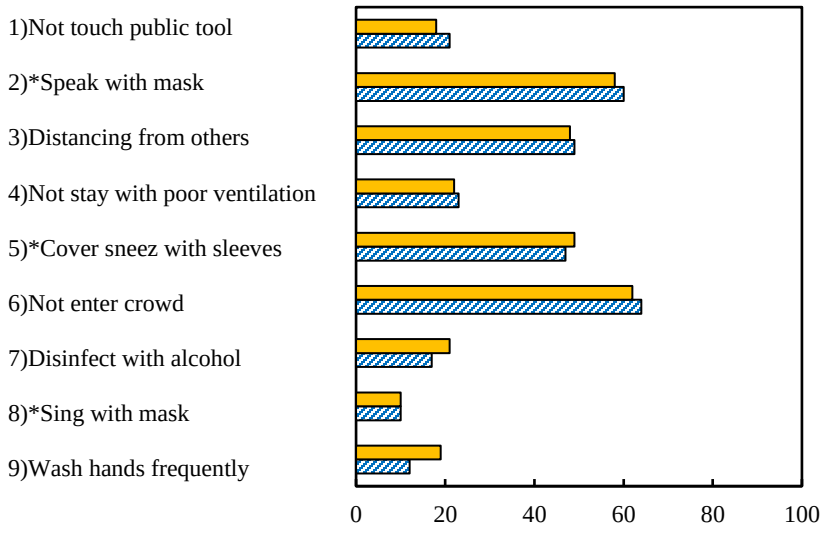

Figure 13: Choose three answers to directly reduce the probability of the movement of COVID-19 virus from yourself to others (%): blue striped pattern, January (number of samples, 146); orange, April (135): *recommended.

3.2. Your Proposal

Proposals by students change from “mask”, “distancing”, and “disinfection” to “virus sensor”, “air cleaner”, and “sensory compensation for remote communication”.

4. Discussion

Different from multiplication of virus *in vivo*, vaccine just gives information to your immune system. You can check your own immune response before infection. Severe side reaction of the vaccine may be an overreaction of your immune system, which may be related to a cytokine storm in the infection. You can prepare for timely treatment, even if you get infected in a crowd of people gathered among the room for vaccination. COVID-19 can be distinguished from other infectious diseases by the scheduled vaccination. Vaccine passports can be used to cross borders (Figure 6).

Vaccination is mandatory for patients prior to surgery. Healthcare workers are obliged to get vaccinated. Students are worried about social discrimination between vaccinated and unvaccinated people. How do we distinguish symptoms between infection by COVID-19 virus and an allergy. Additives to the vaccine could cause allergies. Do you get infected in a crowd of people gathered among the room for vaccination.

Multifaceted thinking is a good introduction for multidisciplinary learning. One-sided information does not lead everyone to cooperation. Students use a clean area for micro machining (Hashimoto, 2020a). The clean area uses a filter. The pore size of the filter controls contamination of micro particles in the space. The size of a virus is much smaller than a particle of dust. As a particle, the dimension of the virus is as large as a paticle of cigarette smoke. It will pass through a fine filter. How far do you smell cigarettes? Cigarette smoke reaches up to 25 meters away (Figure 14). Viruses also reach far. The distance of 2 meters is just a guide, considering the amount of scattered virus. When you get infected by COVID-19, chatting is similar to smoking. Do you blow cigarette smoke to your neighbors at a short distance? Once released into the space, the cigarette smoke drifts for a long time (Figure 15). It is not easy to remove by the ventilation, even after the smoker leaves the room. The next person is in danger from the smke or virus.

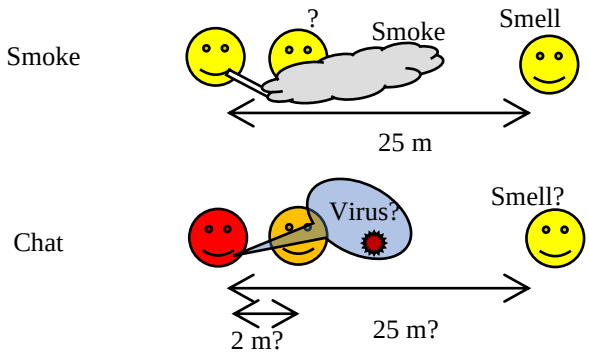

Figure 14: Smoking and chatting outside.

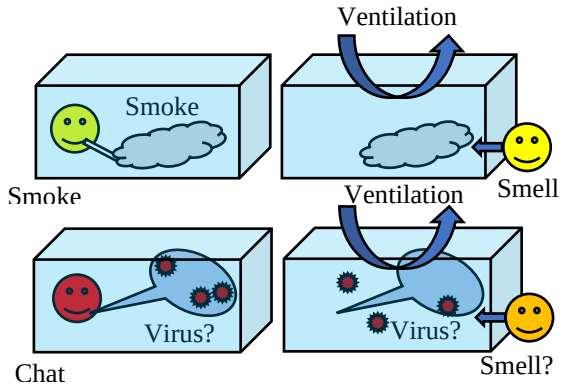

Figure 15: Smoking and chatting in an enclosed space.

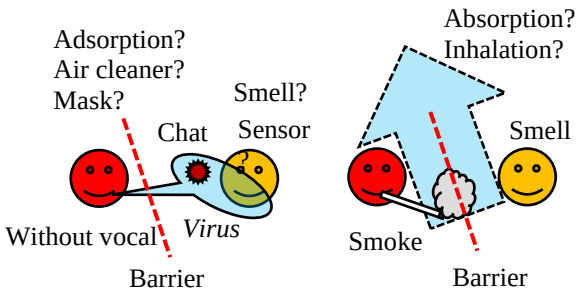

Figure 16: Barrier (shield) for chatting and smoking.

A mask is effective to reduce the amount of viruses released from a human (Figure 16). A sensitive virus detection method that can detect viruses in a short time is expected. Animals can detect the infected person with the nose. You might refrain from smoking during eating. The image of cigarette smoke will help you to stop movement of virus in everyday life.

Most campaigns designed to reduce the spread of Covid-19 are based on statistical data (Hashimoto, 2019). For society, statistical data is the basis. For individual, it is choice of two results: 0% or 100%. The author undergone reviews of doctoral theses twice: in medicine, and in engineering. Medicine emphasizes statistics based on individual specificity. Engineering emphasizes standardization based on sophisticated methodology. In 2020 in Japan, heat stroke was more dangerous than

Covid-19 in the summer. Total deaths from Covid-19 decreased. Pneumonia decreased. Suicide increased.

Both too much information and too many regulations are not good (Hashimoto, 2020b). Both refreshment and concentration are important for the long-term limitation of a pandemic. When face to face, “reduce the amount of release of virus (no vocal communication, no chatting without mask)”, and “do not inhale virus into the respiratory system (ventilation, drink water, refrain touching your face with your hand)” (Figure 16).

The aim of isolation is not to isolate people, but the virus. Not a campaign, but scientific causal relations. Separation of smokers and non-smokers? Not smokers but smoke should be separated. How do you communicate in a pandemic? Without face to face communication? The route of infection has been tracked from person to person. In some countries, GPS (Global Positioning System) of mobile phones was used to track the route. Behavioral surveys interviewed with infected individuals may not reveal the route of infection. Does privacy disturb tracking the route? Telling people that there is an “Unknown route of infection” decreases the motivation for people to act. Too much information is confusing. Try to categorize the information between yes and no. Look at things from the other side. Check not only statistics, but also logical thinking.

5. Conclusions

An interdisciplinary background supports communication on global issues. In this paper, “biomedical engineering” and “pandemic” were taken up as “interdisciplinary fields” and “global problems”, respectively. In the prevention of infectious diseases, the unknown route of infection is demoralizing. Too much information can be confusing. It is useful to classify the information as “yes” and “no”. It is important to collect information from multiple sides and look at things from the other side.

Statistical organization of information in society is not enough to convince individuals. A logical consideration of causality is important.

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