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Interdisciplinary Background Helps Communication in Pandemic: Learning Multidisciplinary Field of Biomedical Engineering

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ABSTRACT

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 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 the courses, students have the opportunity to learn pandemic-related techniques: air purification techniques (clean room), 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

Global society with High-speed movement of people and things causes global problems [1]. A large amount of information is transmitted at high speed. We have many globalized topics: radioactive waste, pandemic, micro plastics (recycle), 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 Tsunami on 11th March in 2011. Japan also apologizes for pandemic caused by the Olympic game in Tokyo 2020-2021, which might collect virus in the world. Everyone coexists with some viruses under the control of his immune system [2]. Exchange of virus between persons changes the balance in each person. Olympic game is not for exchange of virus, but for exchange of culture. Can each athlete keep best performance in pandemic? Vaccination also can affect the sensitive preparation at each athlete. Can vaccination and testing achieve fair competition? Can Olympic game accelerate vaccination? Sterilization is big issue for the medical equipment. Every object with the virus will be sterilized and safely disposed. Syringes used for infectious disease are disposable. Waste management is important for the sustainable society. The disposable masks can lead to the environmental pollution. Plastics are not decomposed in a short term. They will remain in the environment for a long time. Microplastics cause a problem in the global environment. With a view of degradation, plastics is different from radioactive materials which have a half-life of radioactivity. Single country cannot solve the globalized problem. Single principle cannot solve the globalized problem.

COVID-19 pandemic is picked up as a case study for learning multidisciplinary field of biomedical engineering. Technology helps daily life in pandemic. Multifaceted thinking is effective for multidisciplinary learning. Statistics is effective for society, but individual needs logic [1]. Biomedical engineering is one of the interdisciplinary fields [3-5]. It has many related fields. Not only engineering, but also medicine, biology. It is even related to economics, sociology, and ethics.

2. METHODS

In the course of 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 been elucidated. Several treatments have been tried. While the unique answer to each question has not be decided yet by specialists, the questions give chance for each student to experience multifaceted thinking [2].

Questions

(1) The effects of vaccine: “True” or “False”.
   1) Vaccination proof is more effective than PCR (polymerase chain reaction) test negative proof?
   2) The effect of vaccine lasts?
   3) Side reactions will happen?
   4) Vaccines prevent aggravation after infection?
   5) No more transmittance of virus to your neighbors?
   6) Reduced chance of infection?
   7) Stop of infection?
   8) Prevention of virus from invading a cell?
   9) The vaccine makes infection?
   10) Production of antibodies to the virus?

(2) Will you be vaccinated? Do you recommend 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.

(4) What is the reason, if you do not recommend vaccination?
1) Efficacy decreases for variant.
2) Self-quarantine available.
3) Allergic reaction.
4) Side reaction.

(5) How do you think about side reactions?
1) Autoimmune reaction for 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 cluster.
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 allergic constitution, 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 the normal life, after confirmation of negative signs by a PCR test after the recovery from COVID-19.
2) I have been facing others in the normal life, after receiving the vaccine against SARS-CoV-2 virus.
3) I have been facing others in the normal life, taking medications to control COVID-19 symptoms.
4) Facing others in the 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 the normal life, I have been paying attention to disinfection: masks, and distancing from others.
7) Asymptomatic; I have been facing others in the normal life.

(11) Select three effects of everyday-masks 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 accompanied with 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 the crowd.
7) Use alcohol to disinfect your hands, and the areas you touch.
8) Wear a mask when singing.
9) Wash your hands frequently.

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

Presentation in a multidisciplinary conference
Students make presentations in the "World Multi-Conference of International Institute of Informatics and Systemics (IIIS, http://www.iiis.org/)".

3. RESULTS

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

There are several types of vaccine: attenuated virus, DNA, m-RNA, virus vector, virus-like particle, and antibody. Neutralizing antibody is the key in vaccination. Information changes the answer of students from January to April in 2021 (Fig. 1). Vaccine is different from virus. Vaccine reduces the probability to become severe. Students do not believe the long-term effectiveness of vaccine. There are individual differences. The effect might change against mutant viruses.
Information made more students agree to get vaccinated (Fig. 2b), but many students do not recommend vaccination to their friends (Fig. 2c). Multifaceted thinking is helpful before making a decision: "yes", or "no". The main reason for favor of vaccination is "Not become severe after vaccination" (Fig. 3). The main reason for against vaccination is "Side reaction after

vaccination" (Fig. 4). Vaccine is a practice. You may have a practice in a shallow pool before swimming in the sea. Many students refrain from vaccination due to side reaction (Fig. 5). Side reaction is related to autoimmune reaction for antibody formation. Students are worried about social discrimination between vaccinated and unvaccinated people (Fig. 6). Half of students worried about side reaction, if they have chronic illness (Fig. 7). Half of students will get vaccinated to avoid severe illness.

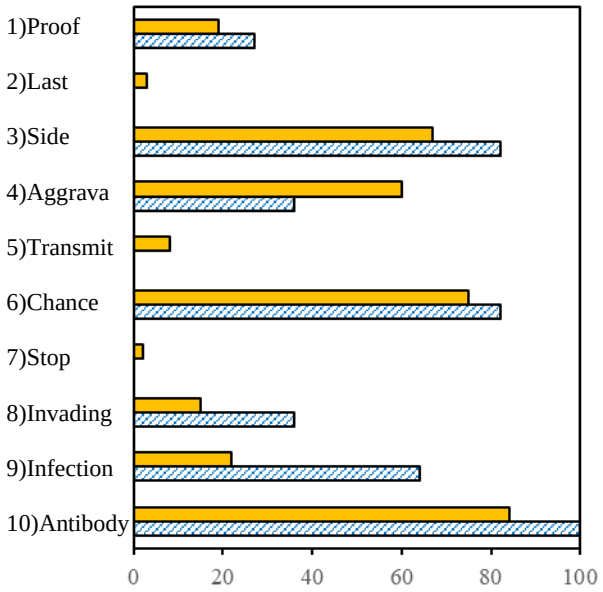

Fig. 1: Effect of vaccine: ratio (%) of "True": blue striped pattern, January (number of samples n = 146); orange, April (n = 135).

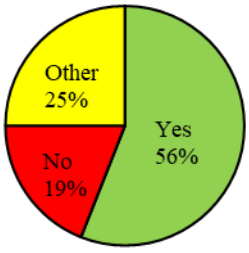

Fig. 2a: Get vaccinated? January: n = 128.

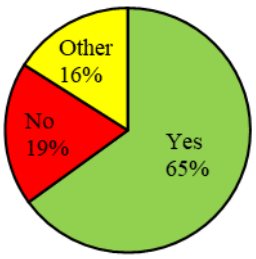

Fig. 2b: Get vaccinated? April: n = 129.

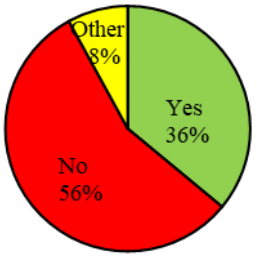

Fig. 2c: Recommend vaccination to friends? April: n = 129.

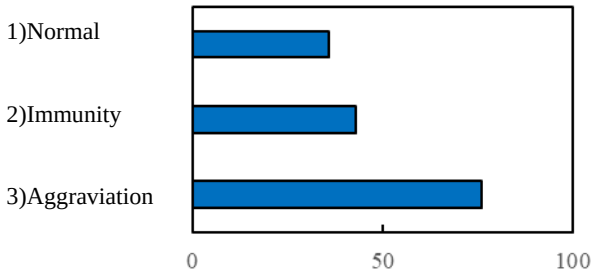

Fig. 3: Reason for "yes": Return to normal social life, Form herd immunity, Not become severe: ratio (%): n = 129.

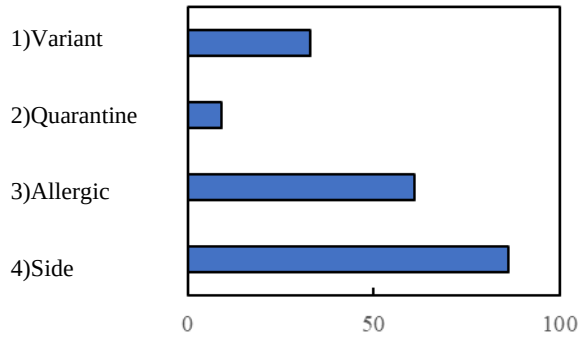

Fig. 4: Reason for "no": efficacy for variant, Self-quarantine, Allergic reaction, Side reaction: ratio (%): n = 129.

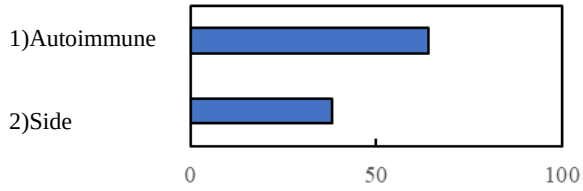

Fig. 5: Side reactions: Autoimmune reaction for antibody formation, Refrain from vaccination due to possible side reactions: ratio (%): n = 129.

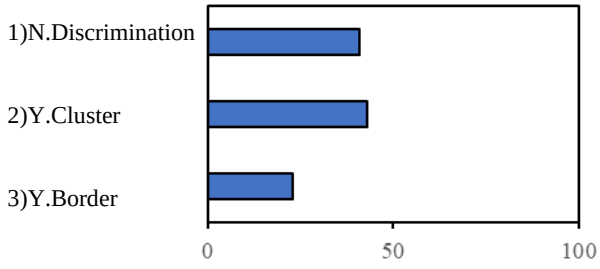

Fig. 6: Vaccine passport (certification): No: Discrimination? Yes: Prevent cluster: Yes: Cross the border: ratio (%): n = 129.

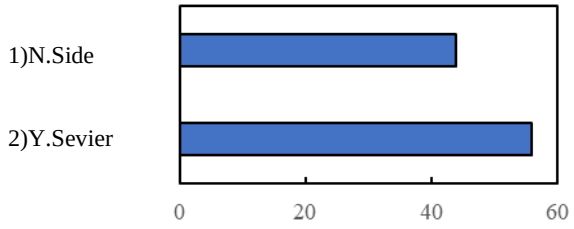

Fig. 7: Chronic illness: No: Side reactions: Yes: Severity when infected: ratio (%): *n* = 129.

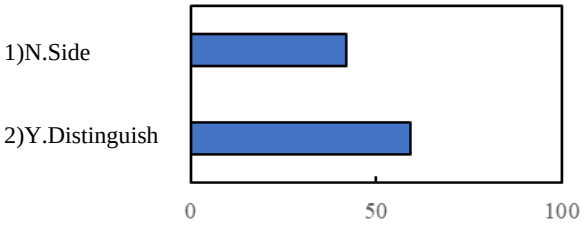

Fig. 8: Allergic constitution: Yes: distinguishing symptoms, No: Side reactions: ratio (%): *n* = 129.

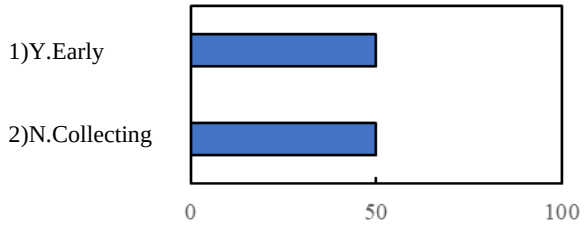

Fig. 9: Timing: Yes: early considering inoculation period, No: after collecting cases (evidence, differences in race): ratio (%): *n* = 129.

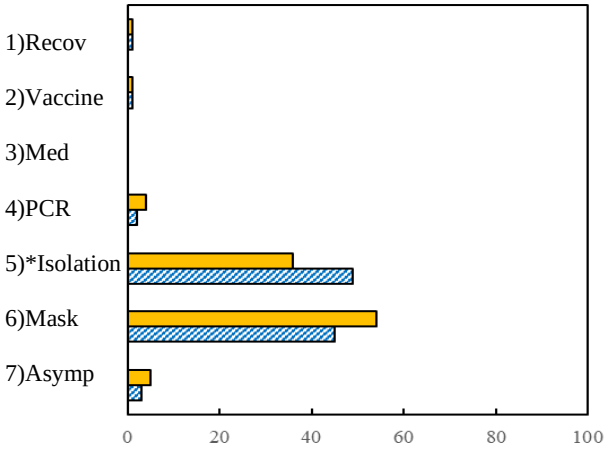

Fig. 10: Select your behavior in the past two weeks to be "free of COVID-19 infection": ratio (%): blue striped pattern, January (*n* = 146); orange, April (*n* = 135): *recommended.

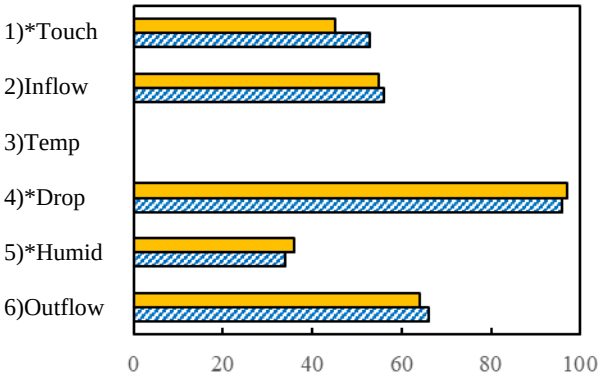

Fig. 11: Select three effects of everyday-mask on COVID-19: ratio (%): blue striped pattern, January (*n* = 146); orange, April (*n* = 135): *recommended.

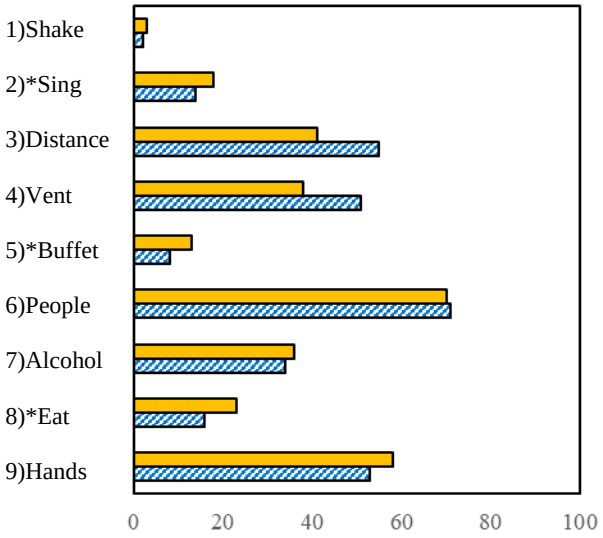

Fig. 12: Choose three answers related to COVID-19 as a method to directly reduce your chances of infection: ratio (%): blue striped pattern, January (n = 146); orange, April (135): *recommended.

If they are allergic constitution, many students worried about side reaction: anaphylactic shock (Fig. 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 (Fig. 9). The other students prefer to be vaccinated after collection of more cases on the same race.

The COVID-19 virus is transmitted from person to person. Self-quarantine blocks infection from others. The mask campaign hides the essence (Fig. 10). Students tend to simply follow the mask campaign. Masks cannot stop the flow of viruses: inflows and outflows (Fig. 11). The recommended logical answers are "Prevention of direct touch by your hands to the mouth (or the nose)", "Reduction of splashing of water droplets including virus accompanied with sneezing", and "Enhancement of the immune capacity by maintaining humidity in the oral cavity".

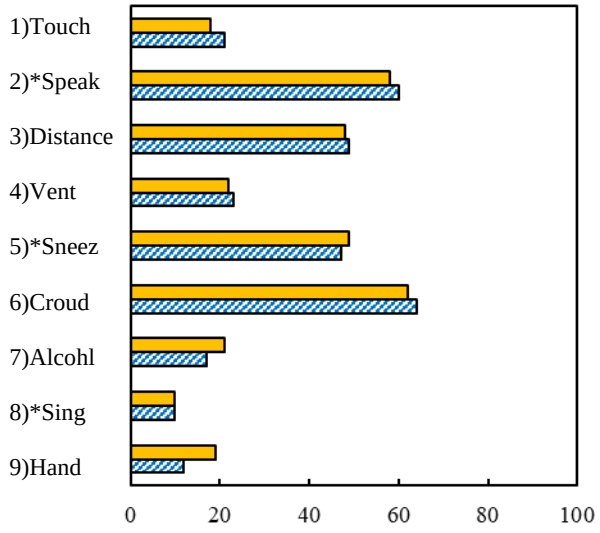

Fig. 13: Choose three answers to directly reduce the probability of the movement of COVID-19 virus from yourself to others: ratio (%): blue striped pattern, January (number of samples, 146); orange, April (135): *recommended.

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" (Fig. 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" (Fig. 13).

Your proposal

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

Presentation in multidisciplinary conference

The cumulative number of participating students from author's program in the "World Multi-Conferences of IIIS" is 96 from 2002 to 2021 spring. The topics of presentation in the summer conference in 2021 are as follows:

1) Analysis of Dielectrophoretic Movement of Cell Flowing in Micro Channel Related to Shape of Cell.
2) How Does Cell Deform during Movement in Micro Gap?
3) Can Cell Type Be Distinguished by Behavior in Shear Stress Field?
4) Does Direction of Tangential Force Field Affect Subsequent Behavior of Cells?
5) How Does Cell Change Flow Direction in Micro Groove?
6) Cell Division under Shear Stress Flow Field.
7) Basic Study on the Mechanism of Earphone Hearing Loss: Further Experiment obtaining Ear Age and Real Age.
8) Basic Study on Evaluation of Earphone Hearing Loss: Discussion of Integration of Audiograms.
9) Development of Turning Support Jig for Elderly People.
10) Construction of a Music Database for Earphone Hearing Loss Prevention and Music Therapy: Discussions on the Relationship between Beethoven's Music and His Deafness.
11) Basic Study on the Recognition of Line Thickness: Proposal of Experimental Method and Presentation of Its Results.

The annual conference of IIIS includes participants from a large number of countries: from 27 to 52. The number is rather large compared with the other international conferences on specialized fields. It is good stimulus for young students to join in the on-line meeting of the multi-disciplinary society. WMSCI (World Multi-Conference on Systemics, Cybernetics and Informatics) gives a chance for each participant to experience a multidisciplinary society and a cross-cultural society, simultaneously.

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 may be over reaction of your immune system, which may be related to cytokine storm in infection. You can prepare for timely treatment, even if you get infected in crowd of people during vaccination. COVID-19 can be distinguished from other illnesses by the scheduled vaccination. Vaccine passports can be used to cross borders (Fig. 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 allergy. Additives could cause allergy. You get infected in crowd of people during vaccination?

Multifaceted thinking is good introduction for multidisciplinary learning. One-sided information does not lead everyone to cooperation. Students use clean area for micro machining [6]. Clean area uses 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 dust. As a particle, dimension of the virus is as large as the cigarette smoke. It will pass through a fine filter. How far do you smell cigarettes? Cigarette smoke reaches up to 25 meters away (Fig. 14). Viruses also reach far. The distance of 2 meters is just a guide, considering the amount of scattered virus. When you 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 drift for a long time (Fig. 15). It is not easy to remove by the ventilation, even after leaving the room. The next person is dangerous.

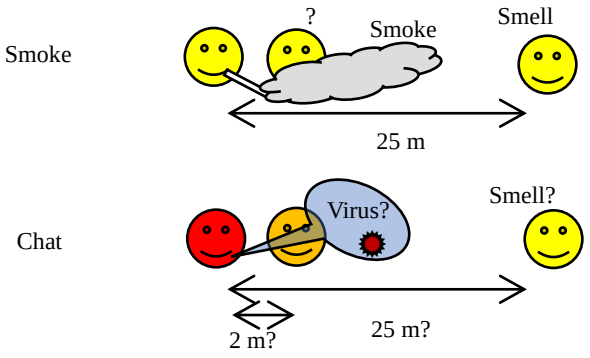

Fig. 14: Smoking and chatting outside.

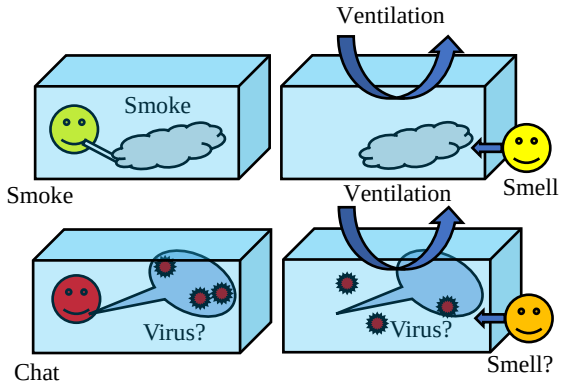

Fig. 15: Smoking and chatting in space.

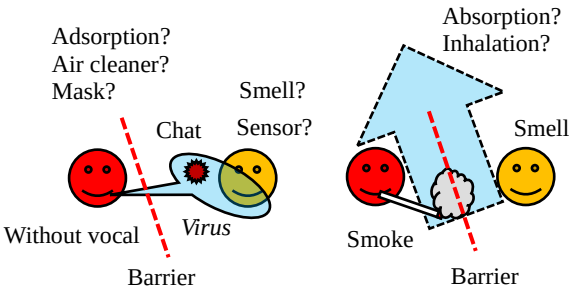

Fig. 16: Barrier (shield) for chatting and smoking.

A mask is effective to reduce the amount of viruses released from a human (Fig. 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 of campaigns are based on statistical data [1]. For society, statistical data is the basis. For individual, it is choice of two: 0% or 100%. The author experienced doctor theses twice: medicine, and 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 summer. Total death decreased. Pneumonia decreased. Suicide increased.

Both too much information and too many regulations are not good [7]. Both refreshment and concentration are important for the long-time limitation of a pandemic. When face to face, "reduce the amount of releace of virus (no vocal communication, no chat without mask)", and "do not inhale virus into the respiratory system (ventilation, drink water, refrain touching your face with your hand)" (Fig. 16).

Aim of isolation is not people, but virus. Unknown route of infection depends on privacy? Enlightenment? Not a campaign, but scientific causal relations. Separation of smokers and non-smokers? Not smokers but smoke should be separated. How do you make communication in a pandemic? "Unknown route of infection" loses motivation for actions of people. Too much information makes 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. CONCLUSION

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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