ISSN 2348-1218 (print)
International Journal of Interdisciplinary Research and Innovations ISSN 2348-1226 (online)
Vol. 9, Issue 4, pp: (1-7), Month: October - December 2021, Available at: www.researchpublish.com

A Literature Review on Technology for handling COVID-19: Infection Control

[1]Pacharada Pentrakulchai

Triamudomsuksa School

Abstract: **Due to the pandemic of Coronavirus disease, many medical workers like doctors, nurses, and others working in a risky place were infected. The safety and working conditions of those people were not safe enough to prevent them. Moreover, there were also problems about lack of preventative equipment and many healthcare workers experienced stress and pressure while working. As a result of this global pandemic, plenty of technologies were developed to help deal with the problem. This research reviewed healthcare technologies which can be utilized to prevent and control the spread of COVID-19 and can also be used to lower other problems faced by healthcare workers as well. I selected the technologies based on the efficiency proven by particular countries using them and analysed whether they can be adopted in Thailand to reduce those problems. Using technologies can boost up the safety environment in hospitals, prevent the spread of disease, reduce the number of infected workers and also provide better duty of care for patients. The stress and working time of medical professionals also decreased.**

Keywords: **Coronavirus disease, infection prevention and control, healthcare technologies.**

1. INTRODUCTION

As we all know, we had been fighting with the COVID-19 pandemic since 2019. COVID-19 or commonly known as Coronavirus disease is a contagious disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). It transmits when people breathe in air contaminated by droplets and small airborne particles. The risk of breathing these in was highest when people were in close proximity, but they could be inhaled over longer distances, particularly indoors. Transmission could also occur if splashed or sprayed with contaminated fluids, in the eyes, nose or mouth, and, rarely, via contaminated surfaces. The use of face masks or coverings had been recommended in public settings to minimize the risk of transmissions. This disease could infect a wide range of cells and systems of the body, especially the respiratory system. It was most known for affecting the upper respiratory tract (sinuses, nose, and throat) and the lower respiratory tract (windpipe and lungs). The lungs were the organs most affected by COVID-19 because the virus accessed host cells via the receptor for the enzyme angiotensin-converting enzyme 2 (ACE2), which was most abundant on the surface of type II alveolar cells of the lungs. Many countries implemented measures to reduce the spread of disease. For instance, lock down, quarantine, closing the places where people were crowded and so on [1].

Indeed,in this situation frontline workers like doctors, nurses, medical staff had to work harder and protect themselves as best as they could as this disease spread fast and easily. Moreover,they were the most risky group because they were close to the infected patients everyday and worked in a place with high probability of exposure to those viruses. According to the information from the Department of Disease Control on 12 July 2021, there were about 721,000 health care workers in Thailand and 700,000 of them (97 per cent) were vaccinated. 707 of the vaccinated group were reported infected while the other 172 healthcare workers infected had not been vaccinated yet. While the previous report on 26 January showed that 25 medical workers were infected. When comparing the lastest infected figure with the 26 January 2021, the number of medical staff rose significantly. This reflected that what we had now in terms of healthcare safety systems in hospitals was not enough to protect them [2].

Fortunately, the development of technologies had been developed in an unprecedented way. More and more innovations had been created to help mitigate the situation. Many technologies had been specially designed to help reduce the spread of Covid-19 in hospitals. Most of them were adapted from basic knowledge of some branches of science and engineering. Therefore, this research focused on the adoption of these technologies of how they could be used to help prevent and control infection so that they had lower risk of infecting Covid-19 and the number of infected medical workers decreased or disappeared as a consequence.

2. INFECTION PREVENTION & CONTROL CONCEPT

According to the World Health Organization, these were new guidelines on core components of infection prevention and control (IPC). IPC behaviors included hand hygiene,putting on personal protective equipment, and following safe remove methods of PPE. By conforming to the IPC concept, medical workers were able to perform better treatment. The risk of being infected was lessened as it helped in preventing current and future threats from infectious diseases between patients and medical personnel.It was believed to help improve the overall quality of health care delivery as well. [3] [4]

3. HEALTHCARE PROBLEMS IN THAILAND

Many countries had an infection and prevention control problem. The number of infected people still rose up. The prevention methods being done like taking temperature before coming in the hospitals, washing hands with alcohol-based water were not enough.There were also several problems in Thailand, resulting from not addressing infection prevention and control (IPC) to the standard level. According to information from the Department of Disease Control, 880 Thai medical professionals had been infected COVID-19. 54% of those were nurses and nurse assistants. Most were aged between 20-29, followed by the age of 30-39. 19.7% of those had not been vaccinated.Another problem is people working in such a risky place like the hospital had a lot of stress and concern not only about the patients but also their health. Moreover, they were working so hard and barely had time to rest. Furthermore,there was a lack of critical equipment and supplies needed in protection and treatment like PPE, breathing filter, patient isolation room,etc. COVID-19, infected waste had substantially increased and the solution to deal with this problem was not taken into action enough. Without addressing the problem, it would have a difficulty in terms of working process of doctors and would prolong the period of COVID-19 period.[5] [6]

4. WHY TECHNOLOGY FOR INFECTION PREVENTION AND CONTROL IS NEEDED FOR THE SAKE OF THE PANDEMIC?

As the duty of doctors and nurses was to take care of patients, risk of being infected was high. Strictly conforming to infection and prevention core and continuously developing those core would lay a path to provide those workers a lower risk and help reduce the spread of viruses from patients. Thus,healthcare technologies should be taken as it would significantly help abate such problems faster.Moreover, those technologies could lessen work of medical staff ,relieve stress in healthcare workers, help the situation come back to normal faster, and level up healthcare standards in hospitals.[7] [8]

Nowadays,COVID-dealing technologies being developed mainly focus on these solutions include how to eliminate the viruses which are floated in the air ,how to curb the spread of disease from patients to others ,how to reduce the number of direct patient visits, and how to alleviate shortages of much-needed medical supplies.

5. TECHNOLOGIES THAT CAN HELP COPE WITH COVID-19

1. Transportation Unit

It was important to assure that when delivering patients with respiratory diseases,the pathogens from patients would not proliferate to outside. Supposing that the transportation process was not accurately done. Workers and people nearby would be exposed to the disease-causing pathogens. Thus, this technology was invented to make sure that this transportation process would not do harm to anyone and could protect the spread of pathogens.This was a single-patient isolation and transport unit, which was developed in providing advanced treatment and transportation of patients with highly infectious diseases.It applied the knowledge of negative pressure.

Principle of negative pressure

First thing to know was air flows from high to low pressure. If air pressure in a patient's unit is adjusted to have negative or low pressure than outside ,the contaminated air will not flow outside which has higher pressure. As a result, the air from infected patients would not spread to others.[9] [10] [11]

Advantages

This transportation unit technology helped avoid cross contamination of air-borne diseases during patient transportation. This allowed medical staff to provide care in close proximity without fear of contamination and also provide safe access to the patient. This technology could be adopted to various vehicles such as helicopters,ambulances, etc.

Disadvantages

In Thailand, there were not enough manufacturing companies. SCG and PTTEP are examples of companies supporting this healthcare technology. It also required supporting costs in order to use it in the healthcare system.

How can the following technology help address the problems in Thailand?

Medical workers were able to touch patient's bodies without exposing to the viruses.They were able to do their job safely and more productive.Furthermore, they felt more relieved due to the capacity of taking patients without risking getting infected during patient transportation.As a consequence,there was lower risk of being infected.

2. Room-disinfection Robot

In the area where infected patients were treated, there might have viruses contaminated in the air. As a result, whoever breathing air or living in such an environment like doctors,nurses, cleaners,and so on had borne the brunt of being infected. Thus, room-disinfection robots were devised to solve the problem using the UV light.

In China the COVID-19 pandemic had stimulated the production of ultraviolet (UV)-disinfection robots. Disinfection robots seemed attractive to hospital management as they reduce the chance of hospital staff being in a risk environment. These robots applied the use of Ultraviolet radiation which had the shortest wavelength, and therefore highest energy; they were capable of killing bacteria and viruses, also called pathogens. It was highly effective at decontamination because it destroyed the molecular bonds that held together the DNA of viruses and bacteria which had developed a stronger resistance to antibiotics. [12] [13]

Principle of UV and disinfection of microorganisms

UV was effective at wavelengths from 200 nm to 300 nm. Microorganisms such as viruses, bacteria, yeasts and fungi are rendered harmless within seconds by UV radiation. It destroyed the structure of nucleic acid inside those cells. Moreover, the microorganisms can not become resistant to UV radiation.

Study from Fraunhofer Institute for Building Physics (IBP) showed that UV-C light was highly effective against corona viruses. It could reduce airborne viruses up to 99 percent. Virus load dropped massively, even if a person directly emitted viruses and it also destroyed virus mutations.

Advantages

UV was environmentally friendly and worked both quick and safe. It was also easy to use and maintain. Utilizing this robot would reduce the need for chemical elimination which could cause subsequent effects. Using this technology reduced wastage of cleaning equipment in hospitals which helped decrease cost in hospitals.

Disadvantages

In order to work to the fullest extent,UV light needed the right amount of energy.UV light did not delete pathogens, but it only "broke"their structure. Furthermore, When this technology was carried out, it could not involve humans in that disinfecting area due to the effect of UVC to human's eyes and tissues.

How can the following technology help address the problems in Thailand?

The number of those working on cleaning did not have to put themselves in a high risk place.Workers had more time to rest.This resulted in improving their working condition and made them feel more relieved when working.Moreover, standard of sanitation and safety in hospitals was leveled up.

3. Humanoid Robots

In some hospitals, some of the hospital staff had to deliver food and give patients medicine by themselves which was hazardous for them due to being exposed to corona viruses from patients.Healthcare technology that could copy or do certain works like humans instead of these people would be a good solution.

Nowadays, many countries have developed robots to help tackle Covid. For example, Robo-doctor Elf from India, Pinto robot from Thailand, the TIAGo robot ,and the Pepper robot . These robots could do many functions like humans. The Elf could do face-to-face talking between doctors and patients by not meeting in person. Moreover,they could boost the good

mood of patients by dancing, singing, or even showing them movies as well as the Peppers. The Pinto could deliver food or medical supplies instead of medical staff which help maintain distance from infected patients.The TIAGo could be transformed into a delivery robot and could be used as an Autonomous Disinfection Robot. Furthermore,it also tracked the person's temperature and sent the data to their doctor. [14] [15] [16]

Advantages

It helped reduce time directly facing patients, lowering the risk as a consequence.Patients could talk to doctors and receive care like being face-to-face. This robot could lighten the load of hospital maids and nurses who have to deliver food and provide medical supplies for patients.

Disadvantages

It needed to develop functions of robots continuously and required supporting costs.

How can the following technology help address the problems in Thailand?

It addressed overload jobs of healthcare workers as it reduced jobs of healthcare workers and decreased the number of infected workers as they did not have to deliver medical supplies by themselves.

4. Telehealth and Remote Patient Monitoring

Remote patient monitoring refers to the use of a specific technology to facilitate interaction between clinicians and patients at home, telehealth is a broader term that refers to the entire industry, methodology and technologies that enable that type of healthcare. Alternative technologies, conducive to self quarantine, could therefore offer an essential link between patients and clinicians, circumventing the need to travel to overburdened hospitals. Given the high transmission rates of the disease, especially within hospitals, telehealth technologies can be a cost-effective means to slow the spread of the virus and to lessen the pressure on hospital capacity by operating as a possible filter, keeping those with moderate symptoms at home while routing more severe cases to hospitals.

Telehealth technologies allow patients to be seen and diagnosed remotely by doctors via an audiovisual, realtime, two-way interactive communication system. This includes video 'visits' through webcam-enabled computers, tablets, and smartphones, chatbots and automated algorithms. Remote delivery of clinical care services with audio-visual conferencing technology offers several crucial advantages. First, it allows hospitals to be kept clear for confirmed cases; second it reduces virus transmission rates, as there is no risk of being exposed to the pathogen; and third, since it is available anytime, it can handle more patients than in-person care. [17]

Advantages

Medical staff did not have to walk around when monitoring patients and this telehealth technology couldCan be used at home in case of home isolation and used in hospitals to reduce risk of doctors and nurses. Patients still received thorough care.

Disadvantages

Its functions of work are required to be continuously developed and it might not be able to perform certain duties ,for example measuring blood pressure and concentration of blood oxygen.

How can the following technology help address the problems in Thailand?

Medical workers were able to touch patient's bodies without exposing themselves to the viruses and do their job safely and more productively. Risk of being infected due to being directly close to patients was lessened. Doctors could take care of their patients without worrying that the patients will not receive enough care.

5. Three-dimensional printing

Along with the COVID-19 pandemic, urgent needs for medical and specialized products, especially personal protective equipment, had been overwhelming.manufacturers referred to additive manufacturing or 3D printing to fill the gap and increase the production line of medical devices.The 3D printed devices were categorized based on their functionality into prevention, treatment and diagnosis devices. There was a need for factories to manufacture and these 'art-to-part' factories could be co-located at hospitals and transportation hubs to quickly serve the needs of the medical profession. 3D

printing had redeployed its capabilities in the crucible of COVID-19 responses, demonstrating its competitive advantage in this emergency situation. [13] [18] [19]

The examples of personal protective equipment (PPE) produced by 3-D printing included face shield, face mask, respirators, metal respirator filters, and ventilator. [20]

Advantages

This printing helped deal with the lack of preventative equipment problems as it offered plenty of spare equipment. It also played a role in helping provide better working conditions in hospitals.Doctors and nurses could do their duties of care more productively.

Disadvantages

It required engineering skills and expertises to design and model the computer-aided design files. After printing equipment,there was the on-going maintenance including cleaning, calibration and replacement of consumables as well as disposable accessories. It also had high manufacturing costs and needed a lot of production time.

How can the following technology help address the problems in Thailand?

Hospitals would have more spare preventative equipment and there would be distribution of equipment to the local areas. This results in the equity of access to healthcare. Moreover,healthcare workers were able to use effective and standard equipment to protect themselves. In terms of cost,it could lower the cost of importing such products from other foreign countries.

6. Thermal energy and waste management

How to manage with infectious wastes was considered as one of the important infection prevention and control (IPC) problems to solve during the pandemic. As there were more and more wastes everyday, healthcare technology regarding waste management was necessary. This would stop the subsequent spread of diseases and make the environment free from harm.

When evaluating waste treatment technologies for healthcare waste, the ability to destroy pathogens was a key factor. Microbial inactivation efficacy referred to the capability of a treatment technology for eliminating or substantially decreasing the potential of infectious waste to transmit disease. The examples were given below.

Microwave treatment -a technology utilizing a moist low-heat thermal process. In microwave systems, disinfection occurs through the action of moist heat (hot water and steam generated by the microwave energy).

ETD or electro-thermal deactivation-employing low frequency radio waves at 64 MHz to generate a high strength electrical field which causes medical waste to heat up thereby destroying pathogens.

A frictional heat treatment system-using both moist heat and dry heat thermal processes. The frictional heating system uses a high speed shredder to generate heat, converting moisture in the waste into steam. After all the fluids have evaporated, the waste is further heated to above 135°C up to 150°C for several minutes. These technologies achieved a high volume reduction of about 80% and a mass reduction of 25-30%.

Dry heat technologyI-using hot air, with no addition of water or steam, and operates below combustion temperatures. In dry heat systems, the waste is heated by conduction, convection, and/or thermal radiation using infrared or resistance heaters. As of this writing, commercial dry heat technologies were small-scale units. One dry heat technology did not reduce volume but another could achieve 75-80% reduction. [21]

Advantages

We could achieve a high volume reduction.Protein structures in pathogens were completely destroyed.This process has to be conducted within human’s control.

Disadvantages

High cost and heat energy were needed. A frictional heat treatment system had to be conducted at high temperature.Some technologies could work only in particular conditions.

How can the following technology help address the problems in Thailand?

Cleaners in hospitals did not have to get contact with infectious waste. Covid-19 viruses could not do any harm to doctors or those working in hospitals anymore because its protein structure was damaged. It had an important role in boosting the standard of sanitation and safety in hospitals, making the working environment safer.

7. Chlorine-based Chemical Waste Disinfection Systems

Chemical disinfection had been used for treating liquid waste such as blood, urine, stools or hospital sewage. Infectious healthcare wastes, including microbiological cultures and sharps, had also been disinfected chemically but using the proper concentration and ensuring contact of the disinfectant with contaminated surfaces were important.

The effectiveness of chlorine and chlorine compounds such as sodium hypochlorite had long been established.Chlorine dioxide, an alternative to hypochlorite, is also a recognized broad-spectrum disinfectant. It has been shown to inactivate bacteria, viruses such as HIV and poliovirus, protozoa, fungi, and algae. [21]

Advantages

When using this, we could control the level of chlorine concentration . The chlorine compounds were proved to effectively kill pathogenic microorganisms. Moreover, this process of waste infection took less time.

Disadvantages

There was some fear of residual chemicals from a chlorine compound. Its compound might release volatilized chemicals from treated waste.

How can the following technology help address the problems in Thailand?

This technology could decrease the number of viruses that contaminate in the waste or the air,boost standard of sanitation and safety in hospitals, and provide doctors and nurses better working areas.

6. CONCLUSION

Infection prevention and control technologies to cope with Covid-19 mainly reduced the spread of disease from patients to others via contaminated air ,lessened the time of directly facing each other between infected patients and medical workers, eliminated the viruses in the working place , did certain jobs like delivering food and medical supplies instead of hospital workers, provided essential equipment for prevention, and also managed infectious wastes. Although there were many positive effects of utilizing these healthcare technologies, there was no serious adoption due to business reasons. That is, when producing one of these technologies in a small number, the cost was high and might not be worth doing.

REFERENCES

[1] Center for Disease Control and Prevention. How COVID-19 Spreads. [cited on 2021 Sep 19]. Available from: https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/how-covid-spreads.html

[2] Thairath Online. Today's cumulative vaccine total is 13.2 million doses, reveals the number of medical personnel infected with coronavirus. [cited on 2021 July 14]. Available from: https://www.thairath.co.th/news/local/2140522

[3] World Health Organization. Infection prevention and control. [cited on 2021 July 14]. Available from: https://www.who.int/teams/integrated-health-services/infection-prevention-control

[4] Health Europa. Infection prevention and control during COVID-19. [cited on August 2]. Available from:https:// www.healtheuropa.eu/infection-prevention-and-control-during-covid-19/106436/

[5] Thaipost. Ministry of Public Health reveals information on medical personnel infected with COVID after receiving vaccination. [cited on 2021 July 14]. Available from:https://www.thaipost.net/main/detail/109363

[6] BBC news. Covid-19: Doctors at Field Hospital with working on the day when the bed occupancy rate is full. [cited on 2021 July 15]. Available from:https://www.bbc.com/thai/thailand-57894290

[7] Covington Digital Health. The Potential Benefits of Digital Health Technology in Managing COVID-19. [cited on 2021 July 20]. Available from:https://www.covingtondigitalhealth.com/2020/03/the-potential-benefits-of-digital-health-technology-in-managing-covid-19/

[8] Wu He, Zuopeng (Justin) Zhang and Wenzhuo Lia. Information technology solutions, challenges, and suggestions for tackling the COVID-19 pandemic. Int J Inf Manage. 2021 Apr; 57: 10228. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7724285/

[9] EPi GUARD. EpiShuttle. [cited on 2021 July 21]. Available from: https://epiguard.com/products/

[10] SCG. Behind the scenes of "Innovation to prevent Covid-19", a weapon to protect doctors-nurses Help alleviate the Covid-19 crisis in Thailand. [cited on 2021 July 21]. Available from: https://www.scg.com/innovation/anti-covid19-innovation-behide-the-scenes/

[11] Euronews.next. Podastic! The ICU device safely transporting COVID-19 patients. [cited on 2021 July 21]. Available from: https://www.euronews.com/next/2020/06/01/podastic-the-icu-device-safely-transporting-covid-19-patients

[12] Zuiveringstechnieken.nl. UV Disinfection: 7 Most Important Things You Need To Know. [cited on 2021 August 1]. Available from: https://www.zuiveringstechnieken.nl/uv-disinfection

[13] American Society of Mechanical Engineers. Engineering Innovations to fight COVID-19. [cited on July 18]. Available from: https://youtu.be/l7w_PCCziTQ

[14] Great Big Story. How Robots Are Preventing the Spread of COVID-19 in India. [cited on July 23]. Available from: https://youtu.be/A612BKSGxng

[15] EHL Faculty. The clever use of robots during Covid-19. [cited on 2021 July 23]. Available from: https://hospitality insights.ehl.edu/robots-during-covid-19

[16] PR THai Government. Pinto Robot to assist healthcare professionals in battle against COVID-19. [cited on July 23]. Available from: https://www.facebook.com/thailandprd/videos/pinto-robot-to-assist-healthcare-professionals-in-battle-against-covid-19/3131345010223570/?extid=SEO----

[17] Care innovations. What Is Telehealth? What Is Remote Patient Monitoring? How Are They Different? [cited on August 1]. Available from: https://news.careinnovations.com/blog/what-is-telehealth-what-is-remote-patient-monitoring-how-are-they-different

[18] Mihalis Kritikos. Ten technologies to fight coronavirus. April 2020. Available from: https://www.europarl.europa.eu/RegData/etudes/IDAN/2020/641543/EPRS_IDA(2020)641543_EN.pdf

[19] Future Medicine. The role of 3D printing in the fight against COVID-19 outbreak. [cited on August 10]. Available from: https://www.futuremedicine.com/doi/10.2217/3dp-2020-0028

[20] Nature reviews materials. Applications of 3D printing in the fight against COVID-19. [cited on 2021 August 8]. Available from: https://www.nature.com/articles/s41578-020-00234-3/figures/1

[21] United Nation Environment Programme. Compendium of Technologies for Treatment / Destruction of Healthcare Waste. [cited on 2021 Sep 19]. Available from: https://wedocs.unep.org/bitstream/handle/20.500.11822/8628/IETC_Compendium_Technologies_Treatment_Destruction_Healthcare_Waste.pdf?sequence=3&isAllowed=y