A Narrative Review on the Role and Safety Challenges of Frontline Medical Staff and Emerging Technologies during COVID-19 Pandemic

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Abstract

The coronavirus 2019 (COVID-19) pandemic is rapidly spreading worldwide, with the increasing confirmed positive cases and the mortality rate. Moreover, frontline medical staff fighting with the COVID-19 infection are being infected. This study presents an overview of the emerging literature on the role and safety of frontline medical staff and the use of technology to control the COVID-19 pandemic. This study conducted a rapid review of studies by following the PRISMA guidelines. Twenty articles were selected for this review paper from three popular and accessible data repositories. The majority of chosen studies were focused on the discussion of COVID-19 regarding China, Singapore, Italy, and USA countries. A previously proposed framework was used to synthesize the findings of this study. Results showed the role and challenges of medical staff during COVID-19 pandemic. Eleven major technologies have been identified in this paper. It is concluded that frontline medical staff and technology help prevent and detect the COVID-19 infection.

Keywords: Frontline medical staff, rapid review, psychological effects, digital technology.

1. Introduction

The first case of a novel coronavirus (COVID-19) was detected in Wuhan, Hubei province of China. After that, the rapid outbreak of the COVID-19 pandemic occurred in more than 203 locations throughout the world (Li et al., 2020). Previously, it was designated as 'serve acute respiratory syndrome coronavirus 2' (SARS-CoV-2). World health organization (WHO) called it as Coronavirus 2019 (COVID-19) disease. It is now known that COVID-19 causes pneumonia, respiratory infection, and even deaths in the population of adults and those persons with cardiovascular, diabetes, hypertension, respiratory disease, and malignancy (Bansal et al., 2020). Palliative care of patients and their families is aimed at avoiding them from the risks of COVID-19 worldwide. However, it has been observed that the current supply of personal protection equipment such as face masks, ventilators, intensive care units, may not be able to meet the projected demands. This nightmare scenario is being experienced throughout the world, including developed countries such as the USA, UK, France, Italy, and Spain. The number of confirmed COVID-19 infection cases are increasing rapidly. As of May 08, 3,917,999 cases were confirmed worldwide, which resulted in 270,740 deaths. China, including the countries mentioned earlier, has borne the brunt of this pandemic. Other than China, the USA, UK, Italy, France, and Spain have been mostly severed by the COVID-19 pandemic.

We reviewed the published articles on the COVID-19, and frontline medical staff alongside emerging technologies to help the health professionals and technologists to combat the current outbreak of COVID-19 pandemic.

2. Research Method

To conduct the rapid review of recently published works, we followed the research method and guidelines given in the study (Simon et al., 2020).

2.1 Design

A timely survey of the chosen papers was performed by following the PRISMA guidelines, as shown in Figure 1.

2.2 Papers exclusion/inclusion criteria

2.2.1 Exclusion Criteria

- Papers that discussed the role of the medical staff without the COVID-19 pandemic were excluded.
- Papers written in languages other than English were excluded.
- Papers with only abstracts were excluded.
- Duplicate documents were excluded.

2.2.2 Inclusion Criteria

• Research articles, cohort and intervention studies, case studies, editorial, and opinion papers published between December 1, 2019, and May 08, 2020, were included.



Figure 1: PRISMA flowchart diagram

2.3 Search Strategy

We performed a search of most popular digital data repositories (PubMed, Science Direct, and Springer) by using the keywords, 'Corona Virus,' OR 'COVID-19', OR 'Corona Virus 2019', 'role of physicians,' OR 'role of nurses,' 'Online Services,' 'digital technology services' between December 1, 2019, and present time (May 08, 2020). Titles, abstracts, and full-text papers with the discussion on the COVID-19 infection were initially chosen for this paper. We have presented search strategy and its actual application in the following Table 1.

Table 1: Search string results

Data Repository	Search string	
PubMed		
	(((((corona virus) OR COVID-19) AND role of physicians) OR role of nurses) OR safety	
	AND online services OR digital technology services [all]:	
Science Direct	(Corona virus, OR COVID-19, AND role of physicians OR role of nurses OR safety AND online services OR digital technology services)	
Springer	Corona virus, OR COVID-19, AND role of physicians OR role of nurses OR safety	
	AND online services OR digital technology services'	

Table 1 presents the used search strings over three popular data repositories. To find relevant studies pertaining to the research topic, we used search strings without involving the biased search process. A review paper suggests that only a biased selection of published studies is performed. This study involves a broad research process based on the predefined search keywords and strings.

2.4 Study Selection

One of the researchers applied search strings to the chosen data repositories. The screening of papers was performed by examining the title and abstracts by an author (MH). Whereas, colleague author IG conducted the screening of papers based on the full text of documents.

2.5 Data Extraction

A bespoke form (see Table 1) was created in the word document. Data were extracted by two colleague authors (MFP and IG). However, the quality of the included papers is not appraised due to a short time of compiling the narrative review paper.

2.6 Analysis

Narrative analysis is performed by using the framework proposed in (Downar and Seccareccia, 2010), which is focused on grouping the recommendations. Moreover, this framework is based on a model of intensive care surgery, which suggests that the plan should focus on staff, stuff, systems, and space.

3. Results and Discussion

Summaries of studies are presented in Table 2. In the following, we present the results and discussion of the reviewed studies. The first part of this section is aimed to present results and discussion with regard to the role and safety challenges of frontline medical staff and the second part presents results and discussion regarding emerging technologies and their role in COVID-19 pandemic situation.

Authors	Paper Type	Summary of Paper
Henry and Lippi	Editorial Paper	Enhanced risk of COVID-19 infection is associated with chronic Kidney
(2020)		disease (CKD).
Yang et al. (2020)	Short	Public resources including 48 dental hospitals in China during the spread
	Communication	of COVID-19 infection
Huang et al. (2020)	Editorial Paper	Protection of the frontline people such as nurses and doctors in the
		COVID-19 epidemic
Tey et al. (2020)	Research paper	Challenges of COVID-19 outbreak in Singapore
Sun et al. (2020)	Research paper	Positive and negative emotions of front line caregiving nurses
Li et al. (2020)	Research paper	Innovative strategies for clinical pharmacists to fight against COVID-
		19
Lu et al. (2020)	Research paper	Psychological effects on the frontline medical staff in China
Ivanov (2020)	Research paper	Global supply chain during the crisis and the role of emerging
		technologies
Ting et al. (2020)	Research paper	The role of digital technology to combat the COVID-19 pandemic
Lenca and Vayena	Commentary	Use of digital data to tackle the COVID-19 infection
(2020)	paper	
Wang et al. (2020)	Research paper	Big data analytics helped in proactive testing of COVID-19 infection in
		Taiwan
Singh et al. (2020)	Research paper	IoT applications to fight with COVID-19 infection
Smith et al. (2020)	Research paper	Telemedicine technology implementation to increase control on
		COVID-19 infection.
Shaw et al. (2020)	Research paper	Governance, technology, and citizen behavior during COVID-19
		pandemic in East Asian Countries
Goldschmidt et al.	Research paper	Telehealth usage for the care of children
(2020)		
Haleem et al.	Editorial paper	Big data applications in Covid-19 infection
(2020)		
Ozturk et al. (2020)	Research paper	The role AI technology coupled with radiological imaging

Table 2: Summary of the selected papers

Table 2 presents a summary of each chosen study in this review paper. The central idea presented in each chosen study is stated, along with the authors' list and paper type. As earlier mentioned in the exclusion criteria, research articles, including editorial papers, short communication, commentary papers, and research papers have been included in this paper, and we did not exclude any published works regarding the research topic.



Figure 2: Research article type

As shown in Figure 2, 13 papers (or 65%) are research papers, four papers (or 20%) are editorial papers, two papers (or 10%) are commentary papers, and one article (or 5%) is short communication paper. Publishing trends on COVID-19 since December 2019 has evidence from research papers, including original research studies, including case reports, proposed models, and review papers. In summary, the COVI-19 topic is in the initial phases because emerging literature is not totally focused on large and extended studies on COVID-19 prevention models and approaches.

3.1 Roles and safety challenges of frontline medical staff

Researchers stated that patients with 'chronic kidney disease' (CKD) have more exposure to COVID-19 infection. The clinical staff, and particularly physicians, must involve in close monitoring of patients with CKD (Henry and Lippi, 2020). The CKD seems to be more associated with the risk of severe COVID-19 disease. Therefore, CKD patients need extra care from medical staff to minimize the exposure of the virus. The role of physicians is worth mentioning because the timely detection of signs of COVID-19 infection can save the lives of suspected persons, as well as many other lives. It has been seen that people with diabetes and kidney diseases have higher chances of exposure from COVID-19.

A short communication paper highlights the provision of health services during the COVID-19 epidemic in China (Yang et al., 2020). The paper is focused on the role of professionals and online services in emergency and nonemergency situations in China. To combat the infection, the majority of the hospitals suspended the non-emergency treatment and provided only emergency services. Eventually, the role of dental physicians changed to online services, and a significant proportion (69%) of physicians offered free online services. Moreover, the penetration of technology in the prevention of COVID-19 infection went higher in the eastern part of China in contrast to the western and central regions of China. The implication of the use of dental non-emergency services might be a leading effect on the increased dental care issue in the future.

During the current outbreak of the COVID-19 pandemic, the protection of medical staff, including frontline physicians and nurses, is an important issue. Huang et al. (2020) stated that more than 3000 medical staff were infected by a coronavirus in China. Direct contact with COVID-19 infected people might be due to a high infection rate among nurses in China. As a result, several young medical staff members died. Of course, it is a challenging task to secure the lives of frontline medical staff members. Based on the safety challenges of frontline medical staff, it is suggested that protocols and guidelines need to be designed for the protection of physicians, nurses, and the rest of the medical staff who are fighting the COVID-19 disease.

Moreover, front line nurses experienced positive as well as negative psychological emotions. In a recently published work, researchers identified that caregiver nurse faced the challenges of fatigue, helplessness, and discomfort due to highly intensive work (Sun et al., 2020). Potential stress and depression are reported among the

nurses because they face the fear and concerns of patients' family members. Consequently, they show positive emotions after negative emotions have occurred. To combat the arising situation of medical staff and particularly nurses with insomnia or anxiety are highly encouraged to seek help from psychotherapists. In addition to it, they can avoid unnecessary contact, which is crucial for the prevention of COVID-19 infection cross-transmission.

In comparison with the administrative staff, medical staff unfolded more significant depression, fear, and anxiety. It has been stated that medical staff suffered the issues, as mentioned earlier, twice than the administrative staff (Lu et al., 2020). Limited studies focused on the psychological effects of COVID-19 on the medical staff. It might be due to a lesser amount of available data on the topics of COVID-19 and mental stress. Health researchers and other academia researchers are relying more on the news from different sources. Moreover, researchers are worried about close contact with the medical staff and COVID-19 patients.

So far, we have discussed the role of medical staff and their safety challenges about COVID-19 infection from the perspective of China. We include a paper that is based on the challenges of the COVID-19 outbreak in Singapore (Tey et al., 2020). Based on the history of 'severe acute respiratory syndrome coronavirus' (SARS), and H1N1 epidemics, the Singapore government was well prepared to fight with the virus. They used swift measures to break the chain of virus transmission. Since the death rate among cancer patients and diabetics' patients remained higher for COVID-19, and therefore, medical staff and cancer patients were provided maximum protection against the COVID-19 epidemic.

Other than the role and safety challenges of medical staff, we include an overview of the part of the digital technology from the published papers as follows:

3.2 Role of Digital Technology during the outbreak of COVID-19 pandemic

Big data and geographic information system (GIS) technologies played a vital role in generating the aggregated big data from multiple sources (Zhou et al., 2020). Besides, spatial tracking of death cases confirmed cases, and regional transmission of the virus and spatial segmentation of virus epidemic information are supportive in decision making and to take adequate measures in the prevailing COVID-19 situation. Geographic information system in this regard is more productive in data preparation, map production, and model construction with the appropriate route of technology. However, we still have challenges of adjusting technologies to prevent the widespread outbreak of the COVID-19 epidemic. For this, we need to propose and implement strategies that can provide extra benefits to users in controlling the transmission of the virus to different regions.

Taiwanese government integrated the health insurance database with the custom databases of the travel history of users to identify cases. This way, they created the big data analytics. Haleem et al. (2020) pointed out the immediate need for increasing the capacity of data storage of COVID-19 infection cases. The data stored can be further used to understand the means of spreading virus and research development about the virus. Due to the unavailability of ample data storage space, essential data may be lost. Therefore, big data need to be used to analyze the differences, patterns, and trends and association in the COVID-19 infection cases. Later, it can be used to propose techniques to control viral diseases similar to COVID-19 infection. QR code scanning is another addition to the use of digital technologies, which helped in the classification of travelers based on their travel history and infection risk in the past many days. More countries need to gear up to use digital technologies in fighting against the COVID-19 pandemic (Ienca & Vayena, 2020; Wang et al., 2020). The ultimate impact of the aforementioned technologies remained productive regarding the classification of travelers with low to high risk. Short message service (SMS) was sent to travelers with low risk for their fast immigration clearance, while those with high risks were asked to be quarantined at homes.

Ivanov (2020) points out the potentials in digital technologies to control the rapid increase of COVID-19 worldwide. For instance, the supply chain system during the crisis can be further improved by the innovation work on the available data. Particular focused areas among emerging technologies can be artificial intelligence (AI), data analytics, and machine learning. Although the role of each area is identified yet it is unknown how these technologies can be applied to the supply chain area in realistic manners in the epidemic situation.

Internet of things (IoT) and blockchain are other major technologies, which can be applied to tackle the clinical issues and disease in crisis time. Ting et al. (2020) explored the applications of the technologies, as mentioned above. They stated that IoT is a better platform that allows the public and private health agencies to access the data for monitoring the COVID-19 disease. In this way, it can efficiently monitor the changing situation of COVID-19 patients (Singh et al., 2020). The latter mentioned research highlights the tracking of infection of individuals. Furthermore, it

reduces the workload on the medical staff. Worldometers and center for system science and engineering are the prime examples of IoT, which are helping the health professionals to know real-time updates on COVID-19 infection and tracking the real-world map of COVID-19 infection. For modeling studies on viral activities, IoT is also making its contribution to guide policymakers in preparing them against the outbreak. WhatsApp, Facebook, and Twitter as social media platforms are playing their key role in informing the users and clarifying the uncertainties regarding the actual cases, deaths, and recovered cases around the world.

Telemedicine is aimed at expanding the opportunities for healthcare professionals to access the rural and remote areas' populations infected with COVID-19 infection (Smith et al., 2020). Telemedicine relies on technology to benefit the health professionals and target population in the prevailing situation of COVID-19 infection. Due to the increasing load on health professionals, and urgency in treating infected people, users of telemedicine are inexperienced. To overcome this lack and gap in the use of Telemedicine, Smith et al. (2020) proposed a method of implementing a telemedicine platform. They developed a toolkit along with its eight essential components. The method proposed in the latter study reduces the traveling cost of approaching the infected population with COVID-19. Moreover, it increases the number of visits to healthcare professionals.

In a recently published research, Bojdani et al. (2020) have shown that telehealth is widely being used throughout the world. Although this technology is supporting health professionals with regards to outpatient care. Health professional adapting to telehealth have faced difficulties in adjusting the web-cams services. Trained physicians work from their homes regarding telehealth, and add their increasing support to combat the COVID-19 pandemic. On the other hand, patients also face difficulties in accessing the earlier mentioned technology because their smartphones have no access to faster internet. Overall, many COVID-19 patients have been benefited by using this technology. Moreover, patients have eliminated transportation barriers. Legal constraints were faced while benefiting the children of different ages from telehealth. These legal constraints include the licensing and gaps in the insurance policy coverage (Goldschmidt 2020). Federal and State governments in the USA were asked to relax telehealth rules to support the children from rural areas and across the state lines. Therefore, COVID-19 pandemic has a paradigm shift in telehealth laws regarding insurance reimbursement.

Shaw et al. (2020) also highlighted the role of emerging technologies, including AI, big data, robotics, 5G, blockchain, and automated vehicle at the advanced phase of the technological intervention. Researchers in the research emphasized appropriate linking the medical technologies with the earlier mentioned technologies. However, the means of integrating emerging technologies with medical technology is not mentioned. Therefore, this topic must be considered for research in future works.



Figure 3: Mind map of emerging technologies

Figure 3 presents recently identified emerging technologies regarding their role in the prevailing COV-19 pandemic situation. We have identified 11 major technologies, which have been studied in the published works. At this stage, no strong relationship among the recognized technologies or with medical technology has been established. However,

the role of each technology shown in Figure 3 is discussed in relation to the COVID-19 pandemic. Therefore, the mind map, as illustrated in Figure 3, can be further extended to the applications of identified technologies. As earlier, we have elaborated on the role of each identified technology; we also require the proposals of new approaches with the recognized technologies. The desired methods can be applied to the COVID-19 pandemic to minimize or reduce its adverse impacts on human lives. Among the identified technologies, the role of AI, IOT, Telemedicine and Telehealth is obvious in comparison with the rest of technologies.



Figure 4: Top four technologies and their application

Figure 4 shows the mind map of the top four technologies, including AI, IoT, Telemedicine, and Telehealth. Much has been known about the applications of AI and IoT technologies. Therefore, researchers can easily apply to the COVID-19 pandemic situation to avert the big loss. Lack of specialized physicians is the major challenge, and the proposal of AI techniques are bridging the gap of correct diagnosis of COVID-19 disease. In this regard, the AI-based model is helping physicians to detect and classify COVI-19 patients (Ozturk et al., 2020; Ucar et al., 2020). The model is efficient in using the chest x-ray images of suspected persons with COVID-19 infection.

4. Recommendations from Literature

This section presents the recommendations from existing literature regarding the COVID-19 pandemic.

- To win the war against the COVID-19 pandemic, it is recommended that all necessary resources need to be provided to frontline medical staff just as a nation supports and encourages its soldiers during wartime (Vaishya & Vaish, 2020).
- Moreover, safety at the core of frontline medical staff and a team-based approach is recommended with some guidelines (Takhar et al., 2020). According to these guidelines, no team member is allowed to work more than one day per week in the critical situation of the COVID-19 pandemic. Rotation of staff can minimize the exposure of viral disease and also ensures the consistency in the expertise of team members across a week.
- Proper and practical training of physicians, nurses, and other medical staff is necessary in all cases, and more consideration should be given to the practice of the frontline medical staff in high-risk patients (Mahmud et al., 2020).
- Web technology is recommended, which can help in bringing visitors to the COVID-19 patient room by using iPads and thus reducing visitors' load on hospitals (Kapoor et al., 2020).
- For real information exchange between health workers, ministries, and administrative portals, interactive communication tools can be used. It can help healthcare staff working in remote areas to fight with the COVID-19 by sharing information with the higher authorities.

5. Conclusion

The role of medical staff can be negatively affected by the extreme pressure of COVID-19 patients and their families. Medical personnel, particularly frontline nurses, have both negative and positive emotions during the COVID-19 epidemic. The role of technology in the emerging viral situation has been identified in this review paper. Big data, AI, IoT, QR code scanning, social media platforms, 5G, block-chain short message service, telehealth, and telemedicine platforms were identified as key role-playing technologies in this review paper. The findings of this rapid review study further suggest proposing policies and guidelines to improve the security of frontline medical staff in future research works.

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