A Systematic Review:

Role of Artificial Intelligence During the COVID-19 Pandemic in the Healthcare System

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ABSTRACT

Certainty, artificial intelligence (AI) has a remarkable role in the control of the COVID-19 pandemic globally. This review article aimed to determine the outcomes/benefits associated with the use of artificial intelligence during the COVID-19 pandemic in different specialties in healthcare. Out of 144 articles, 100 publish article abstracts were reviewed using keywords artificial intelligence, intelligent health systems during COVID-19 pandemic, medical education. This review determined that artificial intelligence has a significant role in predicting the spread of disease by chasing the infected population and can prove as a powerful tool for public health professionals. There is a remarkable role of AI-assisted diagnostic features in radiology to specifically diagnose infected cases with COVID-19. AI assists in taking quicker decision making among health professionals through AI operated apps.This review highlights the need for future research which should emphasize determining the effectiveness and challenges of the use of robotics during pandemics.

KEYWORDS

INTRODUCTION

COVID-19 pandemic is a huge challenge for doctors, public health professionals, epidemiologists, and researchers to bring effective and efficient solutions worldwide. Simultaneously, it is time for digital technologists to deeply engage in bringing optimal solutions in healthcare systems for controlling this devastating pandemic. Certainly, one of the digital health tools in the form of artificial intelligence (AI) has a remarkable role in predicting, tracing, and quickly diagnosing COVID-19 patients. AI is a form of machine learning and in health care innovation AI has gained obvious visibility in different medical fields (Maddox et al., 2019).

In January 2020, the American center for disease control (CDC) reported a notification to the world health organization (WHO) about the disease flu-like outbreak in China and since then the virus appeared as a COVID-19 pandemic globally. It was observed that the Canadian health authorities AI platform (BlueDot) issued a warning four weeks before this pandemic about the pattern of spread of COVID-19. This helped the Canadian government to take precautionary measures, local isolation strategies, and prepare travel regulations/policies earlier as compared to other courtesies without such AI-assisted platforms. For epidemiologists and public health care, AI is helping to rapidly collect data all over the world and predicting the spread of disease and contact tracing (Boccaletti et al., 2020).

Indeed, the COVID-19 pandemic will be a game-changer and bring major reforms in healthcare through the embracement of AI in different aspects of patient care (Coombs, 2020; Irwin, 2020). Understanding the nature of the disease and control the spread of COVID-19, we need digital technology assistants to support healthcare professionals to avoid future pandemics (Lai et al., 2020). For radiologists, (AI) is proving as a breakthrough revolution to the diagnosis of infected patients accurately and decision making for mechanical ventilation (Ai et al., 2020; Hare et al., 2020). The role of radiologists embraces not only early detection of lung abnormality but also determine the disease severity, predict the possible bacterial co-infection and potential progression to acute respiratory distress syndrome in hospitalized patients. AI models for the chest radiographs and CT scans may ease the load of radiologists and clinicians (Kim, 2020).

Additionally, AI is helping in faster genome sequencing by virologists at infectious disease control units. The advanced AI tools are assisting to find vaccines against COVID-19 and prepare a synthetic copy of the virus and build research requirements for bio technicians. Cutting-edge AI technical support is assisting fast clinical trials and suggesting suitable drugs against COVID-19 with the prediction of side effects. For instance, the AI-based tools may predict drugs/peptides straight from the sequences of infected patients and may contribute in the direction of vaccine design against COVID-19 (Chandra Kaushik & Raj, 2020).

Intelligent Information Systems in Healthcare

In the last two decades, there are multiple groundbreaking intelligent information systems in healthcare organizations to enhance diagnostics and therapeutics in the medical field (Frick, 2020; Yuan et al., 2020). The integration of intelligence systems within the human routine experiences can assist in the quicker solution of routine hitches. For instance, the utilize the user experience as a basis for strategic planning and intelligence systems equipping at airports as assist to manage daily operations more effectively during the COVID-19 pandemic (Tuchen et al., 2020). Internet of Intelligent Things (IIoT) and AI are promising technologies to avert the quick spread of COVID-19 and to make the best use of safety measures during the pandemic (Adly et al., 2020; Ayyoubzadeh et al., 2020). Data mining algorithms through the use of AI can assist policymakers to forecast trends of outbreaks (Castillo & Melin, 2020). This prediction might support legislators and health care managers to design and assign health care resources accordingly (Rahman et al., 2020).

Besides at the national and international levels, there is a pressing need to work towards the standardization of protocols for greater smart city communication (Maserat et al., 2020). There is dire demand to upgrade the smart city technology sphere for providing more possible cooperation in the case of disasters. AI and intelligent information systems can assist to strengthen this smart city communication vision (Allam & Jones, 2020; Radanliev et al., 2020). Also, the organizations need to establish ethical standards for the utilization of intelligent information systems which is imperative for the sustainability and stabilization of tech-oriented culture (Arogyaswamy, 2020; Chesbrough, 2020).

This systematic review investigates the published research papers from January 2020 to June 2020 on the use of AI and intelligent information systems in healthcare during COVID-19. The study aims to focus on the context of research and findings of publishing papers. Moreover, this study aimed to detect the main subspecialties in which AI has been used during the COVID-19 pandemic. Consequently, the authors will identify the area in research gaps and provide recommendations for

further research on the use of AI during the pandemic in various perspectives. Finally, the authors will give recommendations to gradually embed AI in medical education and the healthcare system.

AIM OF THE STUDY

The following were the objectives that guided the researchers in the research process:

- To explore the current use of artificial intelligence and intelligent information systems in healthcare during the COVID-19 pandemic. We focused on the context of published research articles related to artificial intelligence during the COVID-19 pandemic.
- To determine the outcomes/benefits associated with the use of artificial intelligence during the COVID-19 pandemic in different specialties in healthcare.

The authors investigated the challenges that are faced when attempting to implement artificial intelligence during the COVID-19 pandemic. The study helped to identify the gaps in the use of AI in medical education and determine the prospects of AI and intelligent information systems in healthcare.

METHODS

The authors searched the PubMed, PubMed (Large set results), PubMed Central, MEDLINE, Singapore National Library. Data were collected about publications from January 2020 to June 2020. We followed PRISMA guidelines of systematic review for planning and documentation. To begin with, the following keywords were used to find published articles: Artificial intelligence, intelligent information systems in healthcare, COVID-19 Pandemic. Then we narrowed down our research to be more precise and used the following keywords Artificial intelligence, COVID-19 pandemic, healthcare, medical education. Three authors independently reviewed the article search results to select peer-reviewed, English language articles, determining the role of artificial intelligence during the COVID-19 pandemic in a different part of the word and the context of the studies in different fields of medicine.

Our study includes the original articles (Published & approved), commentaries, Editorials, and news in research Journals using the keywords Artificial intelligence, intelligent information systems in healthcare, COVID-19 pandemic, medical education. For our aim of the study, we included only those articles which aimed and mentioned the specific use of AI and intelligent information systems in healthcare during COVID-19 in different fields of healthcare. We focused on the study context and outcome of AI during the COVID-19 pandemic. As we aimed to focus on the studies which specifically used AI as assistant digital technology during COVID. Figure 1 flowchart explains the process of search study based on the inclusion criteria of keywords (Artificial intelligence, COVID-19 Pandemic, intelligent information systems in healthcare, Medical education).

RESULTS

For this review article, we found 144 articles identified published from January 2020 to June 2020 using keywords: Artificial intelligence, intelligent information systems in healthcare, COVID-19 Pandemic (45 PubMed (Large data set 98 PubMed Central 2 Singapore National University). 21 articles were excluded after title review (Clearly Irrelevant) and were not matching to initial keywords (Artificial intelligence, COVID-19 Pandemic) & 24 articles were excluded as these were duplicated. About 100 articles were selected for abstract reading and 45 articles were excluded as these did not fulfill the inclusion criteria of this study (Figure 3). These 55 studies were mentioning different types of intelligent information systems in healthcare and digital tools assisting health care professionals in

Figure 1. Flowchart of the search study based on inclusion criteria of keywords (Artificial intelligence, COVID-19 Pandemic, Healthcare, Medical education)
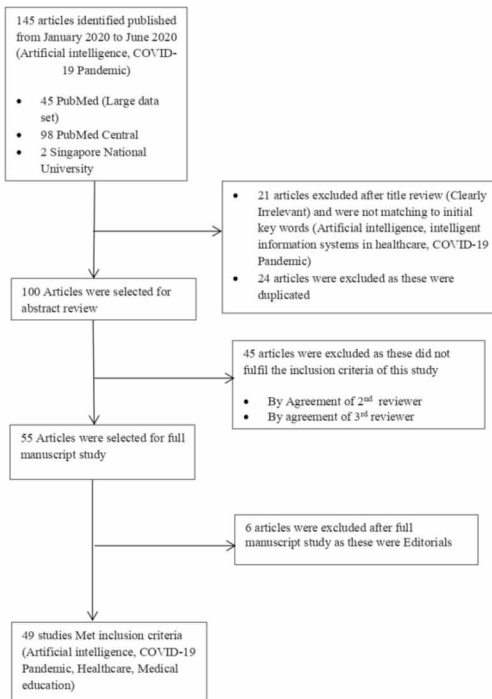
different fields. Figure 2 shows the distribution of 100 articles chosen after key words AI & COVID-19. Tables 1 and 2 show the categories and number of published articles.

For our study, 55 articles were selected for the full manuscript study. Further, 6 articles were excluded after full manuscript study as these were editorials and opinion based suggestions to prompt the use of AI in the COVID-19 crisis. Finally, 49 studies met the inclusion criteria with the aim of studies to investigate and highlight the use of artificial intelligence and intelligent information systems in healthcare during the COVID-19 Pandemic. Context, aim, and summary of the results these published articles are mentioned in Appendix A and B (Tables 3 and 4).

DISCUSSION

Currently, AI has a significant role to predict, detect the pattern, and determine the spread of the COVID-19 pandemic (Allam and Jones 2020; Ayyoubzadeh et al. 2020). Deep learning models are being applied to build predictive models for managing different aspects of the pandemic control, diagnosis of infected cases, and vaccine discovery against coronavirus (Swapnarekha et al., 2020). Integration of epidemiology database and AI data science can help scientists to control the COVID-19 pandemic efficiently (Tang et al., 2020).

Role in Public Health and Epidemiology

Currently, interactive mapping for monitoring disease spread, development of online digital monitoring dashboards instantly through AI is helping public health professionals to control the disease (McCall, 2020; Mitjà et al., 2020). AI is serving to have rapid access to data and download data on spreadsheets for the immediate development of graphs and charts for researchers and stakeholders for planning and

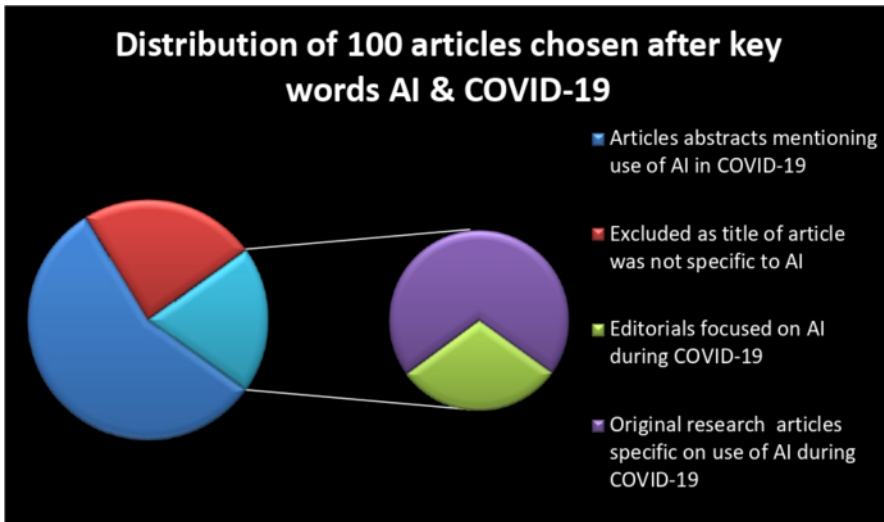**Figure 2. Distribution of 100 articles chosen after key words AI and COVID-19**

Table 1. Distribution of 76 articles chosen after the Abstract Review

No.	Category of Articles	Number of Publications
1.	Excluded as the title of articles was not specific to AI	21
2.	Articles excluded as these were duplicated	24
3.	Editorials focused on AI during COVID-19	6
4.	Original research articles aimed to determine the use of AI and intelligent information systems in healthcare, during COVID-19	49

Table 2. Percentage of articles mentioning the use of AI in different medical subspecialties (assisting in preventive, diagnostics, and therapeutics measures) during COVID-19 Pandemic

No.	Medical Speciality	Number of Published Articles	Percentage
1.	Epidemiology/Public Health innovations & digital support	31.0	40.7
2.	Diagnostic Radiology	14.0	18.4
3.	Psychology and mental health	7.0	9.2
4.	Therapeutics	7.0	9.2
5.	Infectious control	9.0	11.8
6.	Respiratory & Thoracic	6.0	7.8
7.	Cardiology	1.0	1.3
8.	Gastroenterology	1.0	1.3
	Total	76	100%

Figure 3. Presenting the distribution of published articles in different medical specialties
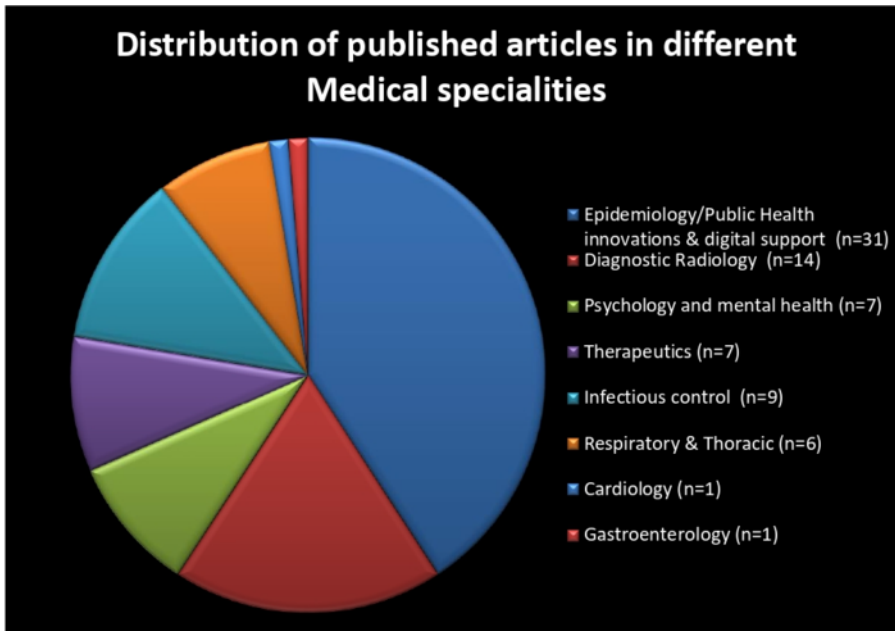
future strategies. For example, the detection of new cases, contact tracing, and daily death rates in different regions can be measured accurately and effectively. Additionally, low-cost blockchain and artificial intelligence-coupled self-testing and tracking systems for COVID-19 and reduced the related mortalities, particularly in locations with deprived access to laboratory infrastructure (Mashamba-Thompson & Crayton, 2020b).

AI tool (BlueDot) is not only collecting data from different channels like WHO, CDC, local websites, and national databases but also assisting to interpret and present the final results straight away (Santosh, 2020). Additionally, few studies determined that AI-powered temperature screening solutions using iThermo: developed by Integrated Health Information Systems (IHiS), in partnership with AI is supporting the detection of infected patients.

Role in Radiology, Imaging, and Diagnostics

AI has a significant role in diagnosis, decision-making plans, and treatment of COVID-19 cases. AI is assisting in radiology CT scans report interpretations and detection of COVID-19 through pattern and image recognition (details are mentioned in Appendix A) (Albahli, 2020; Huang et al., 2020). There is a fully automatic framework through AI tools to detect COVID-19 using chest CT can help to differentiate COVID-19 infection from other community-acquired pneumonia (Feng et al., 2020; Lightdale, 2020). Besides, high tech CT scans and several radiologic patterns of pneumonia (i.e., lobar, lobular, and interstitial) which are associated with different microorganisms can be detected effectively (Betancourt, 2019a, 2019b; L. Li et al., 2020). Several AI assistant diagnosis systems are focusing on the intelligent scanning, diagnosis, and severity estimation, to diminish the contact transmission, advance the diagnostic precision, and guide the treatment (Fan et al., 2020; Huang et al., 2020).

Role in Biomedics and Microbiology

AI tools are mean for faster detection of DNA that is helping the virologist to prepare kits for COVID-19 diagnosis (Mashamba-Thompson & Crayton, 2020a). Tools such as real-time RT–PCR assay and next-generation sequencing RT–PCR has improved the detection of patients for COVID-19 (D. Li et al., 2020). It takes less time to detect the sequencing of DNA material of virus through high technology revolution in molecular biology through AI. Now scientist does not need much time for DNA to replicate and even the single fraction of DNA content from infected patients or infected spit secretions can detect COVID-19 (Yu et al., 2020). Portable detections kits for COVID-19 are available for establishing the clinical diagnosis and screening patients (Yassine & Shah, 2020). Intelligence health system tools are helping healthcare for rapid decision making and managing the bulk of patients in a short time and reducing pressure on hospitals (Mao & Jin, 2020).

Role in Therapeutics

There is a remarkable role of AI in therapeutics and rapid vaccination development for the COVID-19 (Stebbing et al., 2020; Tárnok, 2020; Ting et al., 2020; Zhang et al., 2020). AI is assisting in fast clinical trials and suggests vaccinations. Moreover, AI is helping in faster genome sequencing to find vaccines for the COVID-19 to prepare a synthetic copy of the virus and build further research requirements for bio technicians (Alimadadi et al., 2020; Wu et al., 2020). Arvind Ramanathan, a computational biologist in Argonne's Data Science and Learning division mentions: "*By using machine learning and artificial intelligence methods to screen for drugs across multiple target proteins in the virus, we may have a better pathway to an antiviral drug*."

Role in Mental Health Diseases

Regarding the mental health issues, AI tools are bringing optimal solutions for psychiatric and mental health disorders for isolated and quarantine patients (Cosic et al., 2020; Torous & Keshavan, 2020; Wang et al., 2020; Wu et al., 2020). For example, mental health applications supported by AI (Woebot and chatbot) and mood trackers are assisting in cognitive behavioral therapy. Some AI vendors (Ginger.io) are facilitating in the wellbeing of psychiatric patients by offering automated text interactions during isolation due to the COVID-19.

RESEARCH GAPS

Technology has vastly reformed the way to detect the spread of disease since the SARS virus epidemic. Several editorials and researchers highlighted the need for academic research on the COVID-19 pandemic to plan strategies to combat such episodes in the future (Haleem et al., 2020; Yang et al., 2020). This research identified the potential areas in healthcare where AI and advanced digital technologies need to be fully embedded to control the COVID-19 pandemic. Moreover, this study instigates that intelligent technology has multiple benefits for the learning process of health professionals education during the pandemic (Chang et al., 2020). This research identified gaps in the following areas to evaluate the role of AI-assisted technology in healthcare and medical education.

Robots to Rescues Remote Patients

As the COVID-19 is a contagious disease and health care professionals and contact personals need assistance through digital tech to avoid getting infected. Robot physicians can prove a real game-changer in this pandemic. Robots are being used in America to treat patients during the COVID-19 and they allow doctors to communicate with infected patients remotely. Robots can assist the best in monitory quarantine patients to follow up the sign and symptoms without much threat to health professionals involved in inpatient care. Therefore, future research should focus to find the use of AI-assisted robotics to predict epidemics and pandemics.

Drones for Medical Aids Delivery

Further research is required to determine the impact of AI-assisted drones for medical aids, equipment, and medicines delivery can also be deployed to assist faster delivery of equipment to remote areas. Areas where physical access is difficult, how assistance through drones can optimize public health during the natural crisis.

Follow Up of Infected Patients Through AI Robotics

Future researchers should focus to determine the impact of quick post-treatment care, follow up of infected patients, contact tracing, quarantine population, and insurance payment records analysis through AI (X. Li et al., 2020). The role of telemedicine and eHealth should be evaluated during the pandemic period (Chauhan et al., 2020). Deep learning disease prediction models with intelligent robots can assist in the forecast of disease (Koppu et al., 2020).

Besides, we need studies to determine the impact and challenges during the use of AI-assisted collected data on disease control. So that health policymakers can develop strategies in collaboration with infectious control regulation authorities. Additionally, we need to investigate how AI can help in the discovery of new antiviral drugs, vaccines, and predict the efficacy and side effects of new vaccines through AI.

Evaluation of the AI-Assisted Health Apps

Many AI apps are helping to self-diagnose, self-reporting, and predicting factors for COVID-19. For example to rate the degree of COVID-19 risk in a certain location with different demographic profiles and efficient contact tracing (Sedik et al., 2020). Moreover, we need to evaluate the AI-assisted health apps for public health and how to establish the accuracy of these app's measures and prediction of health outcomes in communicable diseases (Chang et al., 2020; Sáiz-Manzanares et al., 2020).

CONCLUSION

This article explored the current use of artificial intelligence (AI) and intelligent information systems in healthcare during the COVID-19 pandemic The focus was on the context and outcomes of published research articles related to artificial intelligence during the COVID-19 pandemic. Deep learning models are being applied to build predictive models for managing different aspects of the pandemic, vaccines discovery against coronavirus. This review determined that artificial intelligence has a significant role in predicting the spread of disease by chasing the infected population and can prove as a powerful tool for public health professionals. There is a remarkable role of AI-assisted diagnostic features in radiology to specifically diagnose infected cases with COVID-19. Furthermore, AI tools are supporting in taking quicker decision making among health professionals through AI operated apps.

This review highlights that future research should emphasize determining the effectiveness and challenges of the use of AI-assisted robotics during pandemics. Especially, in the follow up of infected patients, managing mental health issues of quarantine and isolated population, delivery of health aids at contaminated areas, and so on. Additionally, it is time for medical educators and policymakers to formally embed AI in undergraduate (medical students) and postgraduate medical curriculum. Time demands to create awareness of the usefulness of AI, the application of deep learning models, and challenges linked to its utilization in different specialties in medical education.

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APPENDIX A

Table 3. Summary of 13 Articles evaluating the use of AI during COVID-19 pandemic; peer-reviewed literature from January 2020 to April 2020

No.	Study Authors and Date Reference	Title	Focus of Article	Context/ Methods	Major Findings	Conclusion
1.	Allam, Zaheer; Jones, David S. (2020) DOI: 10.3390/ healthcare8010046.	On the Coronavirus (COVID-19) Outbreak and the Smart City Network: Universal Data Sharing Standards Coupled with Artificial Intelligence (AI) to Benefit Urban Health Monitoring and Management.	Universal Data Sharing Standards Coupled with Artificial Intelligence (AI)	Highlights the need to democratize the smart city technology sphere to encourage equity and transparency amongst stakeholders, thereby Providing more possible cooperation in the case of disasters.	While thermal cameras are not sufficient on their own for the detection of pandemics -like the case of the COVID-19, the integration of artificial intelligence (AI) can provide added benefits AI can help in collaborated data sharing protocol.	Highlights the urgent need to work towards the standardization of protocols for enhanced smart city communication
2.	Arogyaswamy, Bernard (2020): DOI: 10.1007/s00146-020-00956-6.	Big tech and societal sustainability: an ethical framework	Addresses the benefits and harm wrought by the high tech giants in Information and Communication Technologies (ICTs).	Development in machine learning and artificial intelligence, the threats to individual freedoms and rights, societal cohesion and harmony, employment and economic well-being, and trust in a democracy are being ratcheted up.	Firms need to establish ethical standards, imbuing the upholders of these standards with sufficient authority, while creating a culture of morality.	Artificial intelligence (AI) based on ever-deeper neural networks can transform medical care, revolutionize transportation, enhance security using sensory recognition, provide a customized education
3.	Dadário, Andrew Maranhão Ventura; et al. (2020) DOI: 10.1148/ radiol.2020201178.	Regarding "Artificial Intelligence Distinguishes COVID-19 from Community-Acquired Pneumonia on Chest CT".	To develop a fully automatic framework to detect COVID-19 using chest CT and evaluate its performances.	Retrospective and multi-center study, a deep learning model, COVID-19 detection neural network (COVNet), was developed to extract visual features from volumetric chest CT exams for the detection of COVID-19.	Three-dimensional deep learning model, achieved high sensitivity (90% [95% CI: 83%, 94%] and high specificity of 96% [95% CI: 93%, 98%] in detecting COVID-19.	A deep learning model can accurately detect COVID-19 and differentiate it from community-acquired pneumonia.
4.	Fitzpatrick, Fidelma; Doherty, Aaron; Lacey, Gerard (2020) DOI: 10.1007/s40506-020-00216-7.	Using Artificial Intelligence in Infection Prevention	Explored the role of Artificial intelligence (AI) in infection prevention and control (IPC). benefits in epidemiology, laboratory infection diagnosis, and hand hygiene.	AI hand hygiene applications can deliver behavior change, though it requires further evaluation in different clinical settings. However, staff can become dependent on automatic reminders, and performance returns to baseline if the feedback is removed.	AI in itself will not improve IPC; this requires culture and behavior change.	Rather than focus on the AI tools themselves, the focus should be on the IPC problem that needs to be addressed with the development of strategy, goals, and processes to support this which may include AI.

Table 3. Continued

No.	Study Authors and Date Reference	Title	Focus of Article	Context/ Methods	Major Findings	Conclusion
5.	Kapoor, Aditya; Guha, Santanu; Kanti Das, Mrinal; Goswami, Kewal C.; Yadav, Rakesh (2020) DOI: 10.1016/j. ihj.2020.04.001.	Digital healthcare: The only solution for better healthcare during the COVID-19 pandemic?	Using artificial intelligence (AI) for diagnostics of COVID-19	AI-powered temperature screening solution using iThermo: Developed by Integrated Health Information Systems (IHiS), Singapore, in partnership with AI startup KroniKa. Quantitative CT image analysis of COVID-19 cases through AI-based algorithms.	The development of robust surveillance systems, telehealth, novel diagnostic and clinical decision-making tools, wider penetration of wearables for tracking of physiological parameters and development of interactive chat services for public dissemination of COVID-19 related information.	The Intelligent Evaluation System of Chest CT launched in Shanghai can not only reliably quantify the infection but also the cumulative pneumonia load by quantitative and omics analysis of image features like morphology, range, and density of the lesion. Digital health systems are well suited to provide novel solutions to this public health emergency.
6.	Li, Dasheng; Wang, Dawei; Dong, Jianping; Wang, Nana; Huang, He; Xu, Haiwang; Xia, Chen (2020a): In Korean journal of radiology 21 (4), pp. 505–508. DOI: 10.3348/kjr.2020.0146.	False-Negative Results of Real-Time Reverse-Transcriptase Polymerase Chain Reaction for Severe Acute Respiratory Syndrome Coronavirus 2: Role of Deep-Learning-Based CT Diagnosis and Insights from Two Cases.	Case Reports of COVID-19	Report two false-negative results of real-time reverse-transcriptase polymerase chain reaction (rRT-PCR) and discuss complementary approaches, such as computed tomography (CT) in combination with rRTPCR to achieve a more reliable diagnosis in clinical practice.	Artificial intelligence alarms suspected pneumonia based on a relatively large proportion of abnormalities in the lungs.	The automatic lesion segmentation on CT was also helpful to evaluate the progression of COVID-19 quantitatively. With an integrated approach of DL, CT features, and rRT-PCR results, the screening, and treatment of COVID-19 would be more effective.
7.	Li, Lin; Qin, Lixin; Xu, Zeguo; Yin, Youbing; Wang, Xin; Kong, Bin et al. (2020) DOI: 10.1148/radiol.2020200905.	Artificial Intelligence Distinguishes COVID-19 from Community-Acquired Pneumonia on Chest CT	To develop a fully automatic framework to detect COVID-19 using chest CT and evaluate its performances.	Retrospective study, 4,536 three-dimensional (3D) volumetric chest CT exams from 3,506 patients.	AI using deep learning technology has demonstrated great success in the medical imaging domain due to its high capability of feature extraction. Specifically, deep learning was applied to detect and differentiate bacterial and viral pneumonia in pediatric chest radiographs.	A deep learning model can accurately detect COVID-19 and differentiate it from community-acquired pneumonia and other lung diseases.
8.	McCall, Becky (2020a) DOI: 10.1016/S2589-7500(20)30054-6.	COVID-19 and artificial intelligence: protecting health-care workers and curbing the spread.	In The Lancet. Digital Health	News; In The Lancet. Digital Health.	The value of AI comes into play by reducing the burden on clinicians in a scenario such as the current COVID-19 outbreak.	It is still too early to tell if and to what extent AI will have an impact on the COVID-19 outbreak.

Table 3. Continued

No.	Study Authors and Date Reference	Title	Focus of Article	Context/ Methods	Major Findings	Conclusion
9.	Rao, Arni S. R. Srinivasa; Vazquez, Jose A. (2020) DOI: 10.1017/ice.2020.61.	Identification of COVID-19 Can be Quicker through Artificial Intelligence framework using a Mobile Phone-Based Survey in the Populations when Cities/Towns Are Under Quarantine.	To use machine learning algorithms to be able to improve possible case identifications of COVID-19 quicker when we use a mobile phone-based web survey.	To reduce the time to identification of a person under investigation (PUI) for the COVID-19 infection, and the rapid isolation of this individual, we propose to collect the basic travel history along with the more common manifestations using a phone-based online survey.	Thousands of data points can be collected and processed through artificial intelligence (AI) framework which can ultimately evaluate individuals that may be infected and stratify them into no-risk, minimal-risk, Moderate-risk, and high-risk of being infected with the virus.	The identification of the high-risk cases through AI & deep learning algorithms can be quarantined earlier, thus decreasing the chance of spread.
10.	Santosh, K. C. (2020b) DOI: 10.1007/s10916-020-01562-1.	AI-Driven Tools for Coronavirus Outbreak: Need for Active Learning and Cross-Population Train/Test Models on Multitudinal/ Multimodal Data.	to detect COVID-19, AI-driven tools are expected to have active learning-based cross-population train/test models that employ multitudinal and multimodal data	Discussion-based article	Artificial Intelligence (AI) promises a new paradigm in health. AI tools that are built upon Machine Learning (ML) algorithms are employed for analyzing data and decision-making processes	AI-driven tools are required to be implemented from the beginning of data collection, in parallel with the experts in the field, where active learning needs to be employed. To achieve higher confidence during the decision-making process, rather than relying on one data type, several data types are expected to be employed
11.	Yang, Zifeng; Zeng, Zhiqi; Wang, Ke; Wong, Sook-San; Liang, Wenhua; Zanin, Mark et al. (2020) DOI: 10.21037/ jtd.2020.02.64	Modified SEIR and AI prediction of the trend of the epidemic of COVID-19 in China under public health interventions	To integrate population migration data before and after January 23 and most updated COVID-19 epidemiological data into the Susceptible-Exposed-Infectious-Removed (SEIR) model to derive the epidemic curve.	The authors used artificial intelligence (AI) approach to predict the epidemic.	A five-day delay in implementation of Susceptible-Exposed-Infectious-Removed (SEIR) would have increased epidemic size in mainland China three-fold.	A dynamic SEIR model was effective in predicting the COVID-19 epidemic peaks and sizes. The implementation of control measures on January 23, 2020, was indispensable in reducing the eventual COVID-19 epidemic size.
12.	Chauhan, Vivek; Galwankar, Sagar, et al. (2020): DOI: 10.4103/JETS. JETS_32_20.	Novel Coronavirus (COVID-19): Leveraging Telemedicine to Optimize Care While Minimizing Exposures and Viral Transmission.	This Joint Position Statement represents a collective contribution of emergency and acute care experts from the World Academic Council of Emergency Medicine and the American College of Academic International Medicine Task Force on Telemedicine for COVID-19 Pandemic	Position paper	The authors highlighted that innovative TMS solutions need to be adopted and promoted worldwide to safeguard health-care workers and high-risk patient populations.	Decision-making algorithms incorporating telemedicine, designed through the utilization of artificial intelligence tools, could also be used to assist with definitive disposition of the evaluated patients by remote analysis

Table 3. Continued

No.	Study Authors and Date Reference	Title	Focus of Article	Context/ Methods	Major Findings	Conclusion
13.	Ting, Daniel Shu Wei; Carin, Lawrence; Dzau, Victor; Wong, Tien Y. (2020) DOI: 10.1038/s41591-020-0824-5.	Digital technology and COVID-19	Digital technology AI and COVID-19	Discusses that in hospitals and clinics facilitate the establishment of a highly interconnected digital ecosystem, enabling real-time data collection at scale, which could then be used by AI and deep learning systems to understand healthcare trends, model risk associations, and predict outcomes.	AI and deep learning can enhance the detection and diagnosis of COVID-19.	Digital technologies include the internet of things (IoT) with next-generation telecommunication networks (e.g., 5G)1,2; big-data analytics3; artificial intelligence (AI) that uses deep learning and blockchain technology.

APPENDIX B

Table 4. Summary of 6 Editorials recommending the use of AI during COVID-19 pandemic; peer-reviewed literature from January 2020 to April 2020

No.	Authors and Reference DOI	Title of Editorials	Focus of article	Context and Conclusion
1.	Alimadadi, Ahmad; Aryal, Sachin; et al. (2020) DOI:10.1152/physiolgenomics.00029.2020.	Artificial intelligence and machine learning to fight COVID-19.	To develop novel diagnostic approaches using machine learning algorithms.	Application of artificial intelligence and machine learning in the fight against COVID-19
2.	Hare, S.; Rodrigues, J.C.L.; Nair, A.; Jacob, J.; Upile, S.; Johnstone, A. et al. (2020) DOI: 10.1016/j.crad.2020.04.002.	The continuing evolution of COVID-19 imaging pathways in the UK: a British Society of Thoracic Imaging expert reference group update.	To validate, artificial intelligence technologies in the domains of medical image analysis and data science and the enabling of research projects in response to the COVID-19 pandemic.	The British Society of Thoracic Imaging (BSTI) collates ongoing knowledge, guidance, and developing conundrums related to COVID-19 imaging.
3.	Tang, Ningning; Huang, Guangyi; Li, Min; Xu. DOI: 10.1017/ice.2020.103.	Artificial intelligence plays an important role in containing public health emergencies.	Discusses artificial intelligence (AI) offers the potential for concerned parties to fill these gaps using big data.	An open AI-based platform, with epidemiological database integration and comprehensive coverage worldwide, will be established to maximize the benefits of AI and big data.
4.	Mashamba-Thompson, Tivani P.; Crayton, Ellen Debra (2020 DOI: 10.3390/diagnostics10040198.	Blockchain and Artificial Intelligence Technology for Novel Coronavirus Disease-19 Self-Testing	Emerging health innovations such as blockchain and artificial intelligence (AI) technology can be coupled with POC diagnostics to enable self-testing of patients in isolation as a result of exposure to COVAID-19.	Proposed community-based blockchain and artificial intelligence-coupled mobile-linked self-testing and tracking system for emerging infectious diseases. We recommend a low-cost blockchain and artificial intelligence-coupled self-testing and tracking systems for COVID-19 and other emerging infectious diseases. Prompt deployment and appropriate implementation of the proposed system have the potential to curb the transmissions of COVID-19
5.	Peng, J.; Ren, N.; Wang, M.; Zhang, G. (2020) DOI: 10.1016/j.jhin.2020.02.020.	Practical experiences and suggestions for the 'eagle-eyed observer': a novel promising role for controlling nosocomial infection in the COVID-19 outbreak	Article in press	The application of artificial intelligence in the eagle-eyed observer system might detect problems earlier and provide automatic warnings. Automatic robotic devices for diagnosis and treatment, nursing care of patients, transfer of goods, and medical waste packaging and transportation in the isolation wards may be the direction of development.

Table 4.. Continued

No.	Authors and Reference DOI	Title of Editorials	Focus of article	Context and Conclusion
6.	Kim, Hyungjin (2020): In European Radiology, pp. 1–2. DOI: 10.1007/s00330-020-06748-2.	An outbreak of novel coronavirus (COVID-19): What is the role of radiologists?	Discusses how new weapons such as AI can help in COVID-19	Artificial intelligence (AI) models for imaging studies. Given the shortage of manpower and hospital beds in China, AI models for the chest radiographs and CT scans may help alleviate the burden of radiologists and clinicians and enhance rapid triaging. Diagnostic AI models would enable prompt risk prioritization and help reduce turnaround time. Such models would be extremely useful in a mass screening setting such as the outbreak in China.

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