Telemedicine as Epidemic Resilience Infrastructure: A Rapid Systematic Review During COVID-19

Ankit Sharma[1*], Dr. Pavankumar Mulgund[1]

[1]The State University of New York at Buffalo School of Management

Abstract		**Original Research Article**

Purpose: The outbreak of coronavirus disease-19 (COVID-19) is a public health emergency of international concern. Telehealth is an effective option to fight the outbreak of COVID-19. The aim of this systematic review was to identify the role of telehealth services in preventing, diagnosing, treating, and controlling diseases during COVID-19 outbreak. In a World constantly challenged by the epidemics, health of every individual should be taken care of. The COVID-19 pandemic is a global crisis of historic proportions. Health providers, caregivers and working staff are most vulnerable to the infections amid widespread of any contagious disease. The minimization of human-to-human interactions to prevent exposure to the virus is paving the way for emerging technologies. Social distancing is prompting organizations to embrace video conferencing, virtual classrooms and telemedicine at an unprecedented scale. The current crop of emerging technologies is no different; they are being put to the test in fighting COVID-19. Since these technologies will generate efficiency gains, organizations may retain them beyond the crisis. The discontinuities of crises like the COVID-19 pandemic create urgent new needs and new, large healthcare customer problems to solve — a huge innovation opportunity. The coronavirus is now a global crisis, and it has impacted the healthcare system. Its advice, that patients who are not significantly ill should not go to a physician's office, clinic, or hospital. Still, patients continue to have needs, and chronic diseases must be managed. The outbreak has generated an enormous possibility related to the use of telemedicine, which offers a unique capacity for remote screening and treatment, and can be a powerful tool for reducing transmission of the disease. Telemedicine has proved to be a breakthrough technology in dealing with the crisis of the epidemics. Telemedicine delivers care to the individuals by eradicating the risks of cross-contamination of the disease to the health care providers and patients by handling many routine tasks and visits for chronic disease management over the internet. Effective coordination between the hospitals and the government can help in monitoring the spread of epidemics and controlling its spread. Telemedicine has been an effective tool in collecting clinical records to enable real time data exchange. The technology was utilized in previous epidemic outbreaks like Influenza, Ebola Virus Disease and Severe Acute Respiratory Syndrome. Similarly, it is effectively redesigning the healthcare systems in the novel Corona virus 2019 scenario. The health care industry has been evolving and incorporating remote diagnosis and assessment techniques to minimize exposure during the Corona Virus pandemic. Training and awareness regarding the platforms have helped to promote technological usage. Despite the challenges that the health industry encounters in embedding telemedicine, it has found its success due to its numerous benefits. Various reinventions have been made to the architecture of telemedicine to globally connect the people in critical situations. This has led to enhanced implementations in telemedicine activities. Effective operational plans, dedicated research and surveillance can help in utilizing the utmost benefits of the technology. Integrating the telemedicine should be encouraged by all the stakeholders in the healthcare industry. Telemedicine benefits will stretch long beyond our current coronavirus crisis. It will prevent the spread of disease now and may also solve many other "system" problems in medicine going forward. This research article discusses an overview of telemedicine; it's role in epidemics and its potential benefits which would prepare the industry that will support the World for the future outbreaks and crises situations. *Methods*: This systematic review was conducted through 42 Scientific databases and digital libraries including JMIR, JAMIA, Springer, BJA, ELSEVIER, Wiley, SAGE etc. Inclusion criteria included studies clearly defining any use of telehealth services in all aspects of health care during COVID-19 outbreak, published in in peer reviewed journals in 2020 and in English language. Two reviewers independently assessed search results, extracted data, and assessed the quality of the included studies. *Results*: Studies met the inclusion out of the 78 search results. A total of 164 full-text articles were assessed for eligibility, of which 78 were excluded based on predefined criteria, resulting in 4 studies included in the final synthesis. The included studies represented two countries (USA and India) and comprised cross-sectional and case-based research designs. Reported outcomes demonstrated reduced in-person visits, improved triage efficiency, and enhanced continuity of care during lockdown conditions. Currently, healthcare providers and patients who are self-isolating, telehealth is certainly

appropriate in minimizing the risk of COVID-19 transmission. This solution has the potential to prevent any sort of direct physical contact, provide continuous care to the community, and finally reduce morbidity and mortality in COVID-19 outbreak. ***Conclusions***: The use of telehealth improves the provision of health services. Therefore, telehealth should be an important tool in caring services while keeping patients and health providers safe during COVID-19 outbreak.

Keywords: Telemedicine; telehealth; eHealth; mHealth; Digital health; COVID-19; Coronavirus; Public health; Technology interoperability, Pandemic response; Remote patient monitoring; Public health preparedness; Tele-ICU.

1.0.INTRODUCTION

Health is an important factor for an individual. Humans can invest most of their resources to lead a healthy life. At the same time the healthcare providers extend their utmost efforts to support lives in any disastrous circumstances. The global health is at stake in harsh situations due to spread of epidemics [1]. These epidemics globally question the capabilities of the different nations in terms of healthcare, domestic, financial needs and technology. Every nation needs to be ready for an epidemic and should support their citizens with all possible facilities. The major responsibility of a nation is to build healthcare facilities that work with minimal human involvement. Reducing human involvement directly leads to reduce in spread of disease and efforts. One such healthcare system is Telemedicine technique. This technology has advanced the ways of delivering healthcare services using the information technology platform. It has surged as a revolution in the healthcare industry by reaching the remote areas. According to WHO, telemedicine is the delivery of healthcare services by using information and communication technologies for the exchange of information for diagnosis, treatment and prevention of disease. Practice cuts down one-on-on interaction between the patient and the doctor or healthcare provider and is useful when handling infectious diseases. As figure 1 illustrates, Telemedicine allows patients to be seen and diagnosed remotely by doctors via an audiovisual, real-time, two-way interactive communication system. This includes video 'visits' through webcam-enabled computers, tablets, smartphones, chatbots and automated algorithms. Both the CDC and WHO are advocating for telemedicine to monitor patients and reduce risks of them spreading the virus by traveling to hospitals.

Telemedicine is considered as a mode to combat widely spreading diseases. Telemedicine incorporates all the medical activities like consultation, diagnosis, treatment, cure and preventive measures along with generating awareness but from a distance. It provides consultation and medication when the doctor and the patient are not physically available. It permits the ill patients to receive medical advice and supportive care while minimizing their risks to come in contact with other infected patients. It also helps the incapable patients to seek medical advice with ease. The previous epidemic situations like Ebola virus disease, H7N9 influenza, severe acute respiratory syndrome and the Middle East respiratory syndrome were handled by using the e-health technologies [4]. One such pandemic is COVID-19 which requires continuous monitoring of the potential patients and the patients under observation. The patients need to be isolated from other humans to reduce the risk of transmission. This is where e-health platforms come in. They not only allow hospitals to monitor various patients, but they also reduce human contact. Another benefit is that the patient seeking medical guidance could also be helped using the e-health platform. Telemonitoring and medication can be effectively used for patients to analyze epidemiological situations. Effective implementation of Telemedicine in epidemic crisis can generate optimal solutions in investigation, control and case management by supporting the local healthcare professionals [5].

Despite the rapid global expansion of telehealth during the COVID-19 pandemic, early literature in 2020 largely consisted of commentaries, opinion articles, and descriptive reports. There remains a lack of structured synthesis evaluating how telemedicine was operationalized across diagnostic, monitoring, and treatment pathways during epidemic conditions. This review aims to systematically synthesize early empirical evidence and identify implementation patterns, challenges, and strategic implications for future epidemic preparedness.

2.0 BACKGROUND

Epidemics and disasters pose challenges to the healthcare industry. One such epidemic situation the current generation is facing is the Corona Virus Disease COVID-19. There are currently 3,566,004 confirmed cases in 212 countries and territories (Figure 2) and 248,282 people have died so far from the coronavirus COVID-19 outbreak as of Apr 29, 2020(Figure 3). World Health Organization declared it as a global pandemic on March 11, 2020. COVID-19 is a severe respiratory infirmity syndrome. It spreads due to human transmission but is suspected to have its origin from some animal infection [6]. The infected person shows feeble symptoms like dry cough, fever, headache, body ache just like acute pneumonia and rapidly worsens. The health industry across the globe is trying all possible measures to prevent and treat patients. Additionally, measures have been taken to twig possible devastating effects which is popularly known as 'flattening the

curve'. The health associations worldwide coordinate the information, communicate and issue orders and strategies to mitigate the effects of the threat. While the scientists and researchers work diligently to gather information regarding the transmission means of the disease, its clinical spectrum, diagnostics, and anticipation and curative strategies. Various uncertainties accompany the host and virus interaction as well as the pandemic evolution. In this hard time when the world is trying to overcome a global epidemic, the health care industry can be contributed by some techniques that help reduce the human interaction with the infected patients and the rest world [7]. Telemedicine has experienced a surge in this epidemic to enhance the treatment procedures by getting consultation over electronic platforms.
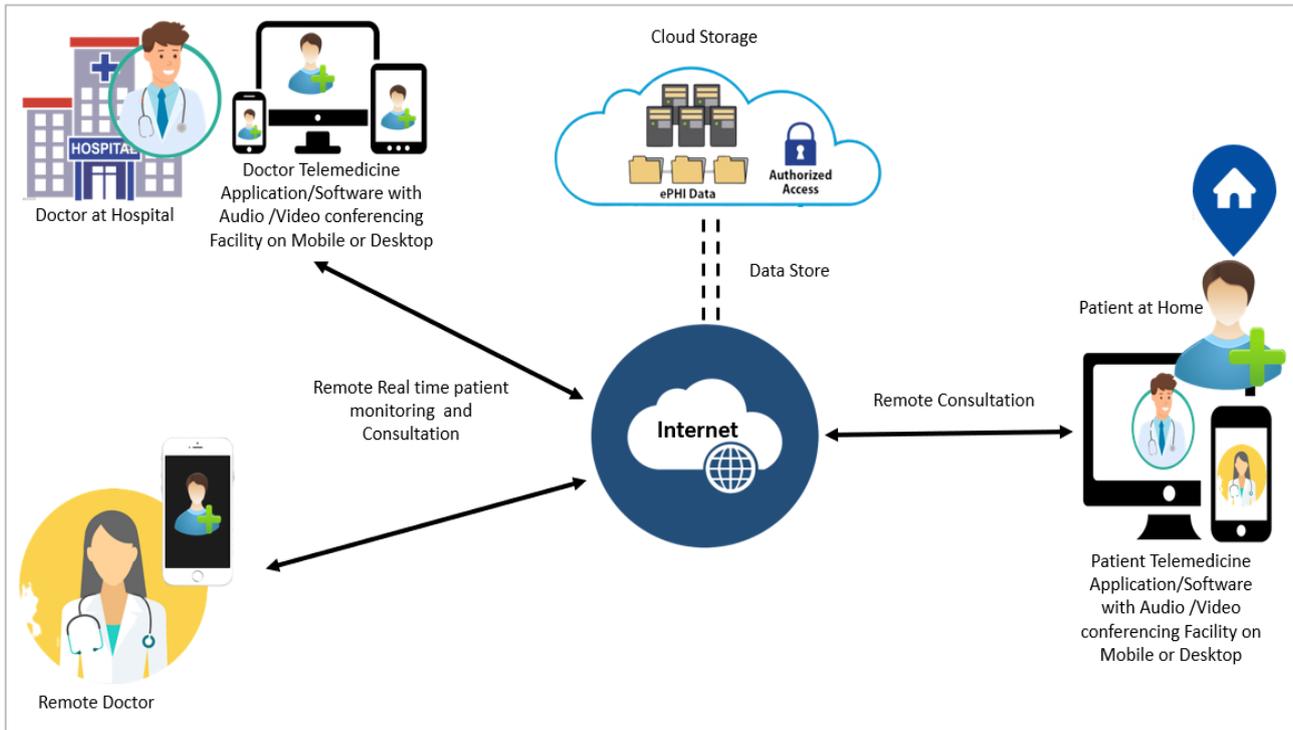

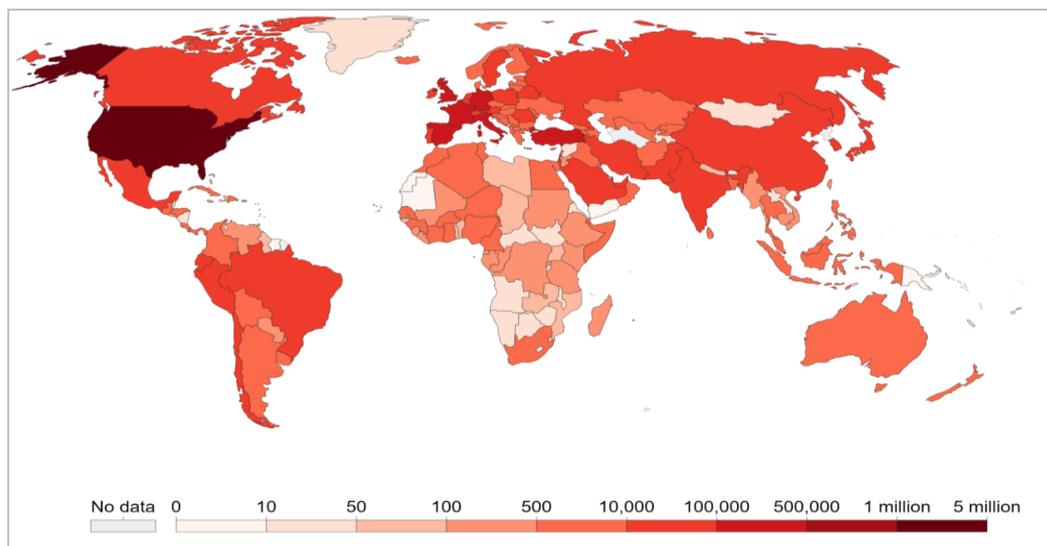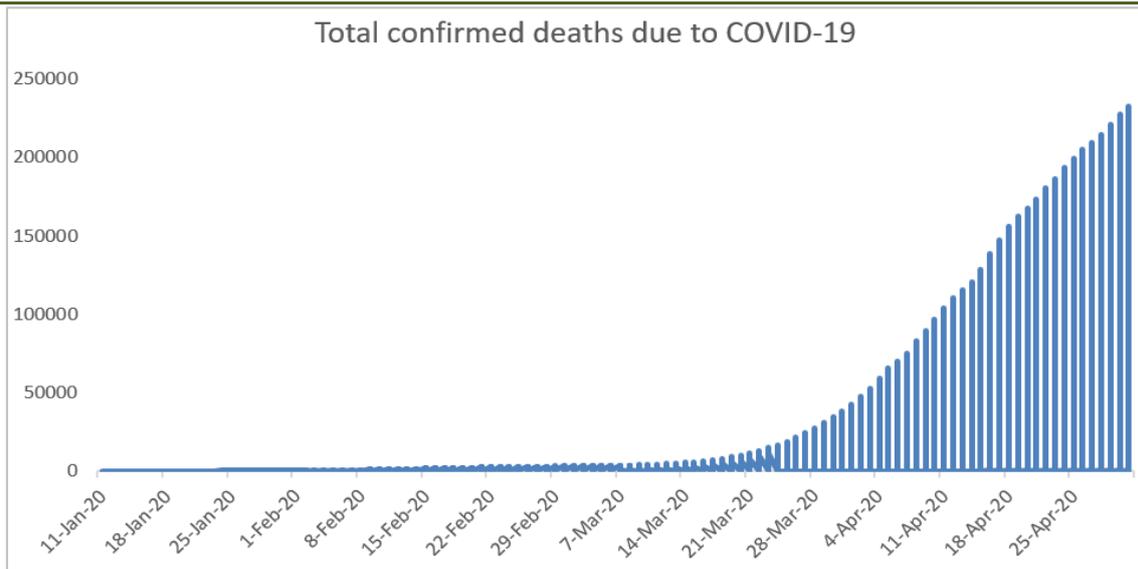**Figure 1: Basic Architecture of Telemedicine**

**Figure 2: Total confirmed COVID-19 cases, Apr 29, 2020 (Map prepared in Tableau).
Data Source: European CDC**

Figure 3: Total confirmed death due to COVID-19 cases, Apr 29, 2020 (Map prepared in Excel)
Data Source: European CDC

Telemedicine has given new insights to public health regarding the prevalence and incidence of the disease. It provides valuable information and the risk factors from remote locations. Telemedicine has played a pivotal role in real-time supervision of epidemics. It has resulted in being a tool for interventional planning, assessment of strategies and their usefulness. Telemedicine could be utilized to report, influence, and encourage citizens and organizations on healthiness, health-related concerns and acceptance of healthy routine. It can circulate information to individuals and to the population with single channels. Telemedicine can offer easy access to people living in remote areas. The platforms can promote and sustain healthy life in the community. This can be done by connecting to peers using the information exchange to supply emotional support. The telemedicine assessment implements informed decision-making by remotely examining the case. Additionally, it simplifies the procedure and communication involving healthcare providers and people about anticipation, diagnosis and managing health conditions.

3.0 Telemedicine in Past Epidemics
Treatment of extremely contagious diseases like Ebola and Influenza has been a challenge to medical science. Ebola virus disease was a contagious disease that was sourced from the infected animal mainly from the Sub-Saharan Africa during 2014-2016. It developed the epidemiological risks of the providers and seekers of the health industry [9]. While the health management system was swamped with the infected patients, the resources required to defend the healthcare workers from contamination were scarce. The workers lost their lives serving their duties. Telemedicine helped in treating the patients using the web-based channels and portals in those hard times. It also raised the number of international experts accessible at any point to give

crucial expertise and evaluation in the outbreaks. Tele-epidemiology involved various cloud-based applications as well as remote sensing data for assessments and applications. Thus, the spread of the virus between human beings could be monitored using satellite images through the vector habitats and patient population. Virtual appointments helped people maintain social distance when feeling sick. This helped in preventing the spread of viruses in the community. Using approaches such as biocontainment unit for patient care by the medical centers in US helped in mitigating the risks for treating Ebola virus patients. It also found a way to shield the heath workers from getting infected.

Severe Acute Respiratory Syndrome SARS was identified in the year 2002 and spread across 26 countries in 2003. The epidemic experienced human transmission, out of which most cases of the transmission were in the health care units. This was due to the lack of precautions and close human contact that spread the epidemic [10]. During contagious disease outbreaks, telemedicine supported distant triaging of care and generated fast accessible information that was needed to monitor the disease. The pandemics risk the lives and to minimize the contaminations the patients in serious needs should only be directed to the hospitals. Telemedicine helped in eliminating the unnecessary crowds in the hospitals and maintain the high care and attention to the needy patients. During the outbreaks of the previous epidemics the countries have explored their potential to integrate technological advancements in their health management systems. The COVID-19 has also utilized the optimum from the telemedicine industry. It helped government officials to navigate the current health management system and monitor routine care.

4.0 METHODS

Study design

This study was conducted as a rapid systematic review following PRISMA guidelines, adapted to the urgent knowledge needs arising during the early phase of the COVID-19 pandemic. Given the evolving evidence landscape and limited availability of high-quality studies during January–June 2020, methodological flexibility was applied while maintaining transparency and reproducibility.

Search Strategy and Data Sources

The study uses published studies, relevant contents and articles based on the identified topic. Databases like Scopus, PubMed, Embase, Science Direct and Web of Science were explored for the content. Titles and abstracts were searched and scrutinized for relevancy. The elementary search on April 15, 2020, identified a range of studies conducted on telehealth and its contribution in the pandemic outbreak in 2020. An improved search was conducted on April 30, 2020, to enhance the search results. Corona Virus, COVID-19, Novel Coronavirus, SARS-CoV-2, 2019-CoV, pandemic, Wuhan Virus were the key words used for the search. In addition, Telemedicine, Telehealth, Telecare, Mobile Health, mHealth, Tele-medicine, Tele-health, eHealth were the medical subheadings used to search for the studies. The Boolean operators AND, OR, NOT was used to get different search results. To get a better understanding of the search strategy a librarian was consulted. Adaptations were made accordingly in the search. For example the Google Scholar database search was conducted As follows: (COVID-19 [title/abstract] OR COVID19[title/abstract] OR Novel coronavirus OR Coronavirus [title/abstract] OR [title/abstract] OR 2019-nCoV [title/abstract] OR Wuhan coronavirus [title/abstract] OR SARS-CoV-2[title/ abstract] OR SARS2[title/abstract]) AND (Telemedicine [title/abstract] OR Tele-medicine [title/abstract] OR Telehealth [title/abstract] OR Tele-health [title/abstract] OR Telecare [title/abstract] OR Mobile health [title/abstract] OR mHealth [title/abstract] OR Electronic health [title/abstract] OR eHealth [title/abstract]).

The search engines Google and Google Scholar were explored for articles, journals, and published research. The official websites were also utilized to gather information and survey data conducted. The references from the studies were reviewed and conducted to gather additional information which was not available in the preliminary searches.

Eligibility Criteria

The studies defining the telehealth principles and procedures helped to develop a better understanding about the topic. The studies focusing on the role of telehealth in COVID-19 were included in the analyses of the study. The utilization of telehealth in diagnosis, treatment, prevention and management of COVID-19 made a strong base for the study. The selection of studies was from January 15, 2020, to June 15, 2020. The studies providing effective knowledge of utilization of telehealth in assessment of symptoms, triage of patients, consultation and training and monitoring of the clinicians were utilized for in depth knowledge and analysis. Duplicate publications, review articles, opinion articles and letters that do not coincide to the topic were excluded to refine the analyses.

Study Selection and Data Extraction

Authors performed the literature survey autonomously. They applied inclusion and exclusion criteria and screened the articles and research based on the abstracts and keywords. Later the full-text studies were studied to obtain the analysis of the eligible studies for the data extraction table. Data extraction was done from the papers and research satisfying the inclusion criteria for further review. The paper attributes like author, publication date, research design, origin country, type of telehealth, major outcomes of the study and effects of telehealth were considered for extraction procedure.

Quality assessment

The Critical Appraisal Skills Program (CASP) checklists were accorded to assess the quality of the studies included. To develop detailed understanding of ways to critically appraise various types of evidence, the CASP tools were developed. Comprised studies were classified into three categories of poor, medium, and good for scoring to assess their quality.

Evidence synthesis

The study utilizes narrative synthesis to compare and contrast the data available from the included studies. This aided in improved data synthesis. The stages of narrative synthesis are as mentioned: preliminary synthesis, exploration of inter and intra relationships of the studies and the determination of the robustness of the synthesis. The interactions and discussion among the authors helped to build consensus and conclusions for the study.

RESULTS

Search Results

The particulars on the literature examination and processes of screening are demonstrated in (Figure 4). The data deduplication in terms of search records and screening titles and abstracts of studies was conducted. A total of 164 relevant studies in full text format were selected. Later excluding the 78 articles that did not meet our inclusion criteria. Finally, study was added using reference screening (reference by reference) while, two full studies were incorporated at stage of evidence synthesis.

Characteristics of the included studies

The attributes of the included studies were verified in Table 1. The studies were published between January 15, 2020, and June 15, 2020, in various international journals. The country of origin of most studies was the USA and India. The four included research were carried out in two countries: USA (n = 2) and India (n = 2). Considering the research design two studies were cross-sectional, while two were case.

The studies aided the telehealth platforms and social media channels to endure the treatment and consultation procedures during COVID-19 pandemic. The communication channels like telephone, chat boxes, live video conferencing, serves, reports and e-mails were the major contributors to the health care industry.

Table 1: Comparative Summary of Telemedicine Applications During COVID-19 (2020 Evidence)

Study	Country	Telemedicine Type	Primary Application	Reported Outcome
Study A	USA	Video consultation	Remote triage	Reduced in-person visits
Study B	India	Teleconsultation	Chronic care follow-up	Maintained treatment continuity
Study C	USA	Tele-ICU	Critical monitoring	Reduced provider exposure
Study D	India	mHealth	Symptom tracking	Improved surveillance efficiency

Interpretation of Table 1: As summarized in Table 1, telemedicine applications during the early phase of the COVID-19 pandemic demonstrated functional diversity across healthcare delivery levels. In the United States, telemedicine was primarily utilized for video-based remote triage and Tele-ICU critical monitoring, resulting in reduced in-person clinical visits and decreased healthcare provider exposure. In India, teleconsultation platforms supported continuity of care for chronic disease patients during lockdown conditions, while mHealth-based symptom tracking systems improved surveillance efficiency and early detection capacity.

Across contexts, a consistent pattern emerges telemedicine interventions were deployed to minimize physical contact, maintain continuity of essential services, and enhance epidemiological monitoring. These findings suggest that telemedicine operated not only as a communication tool but as a structural layer within the broader epidemic response architecture.
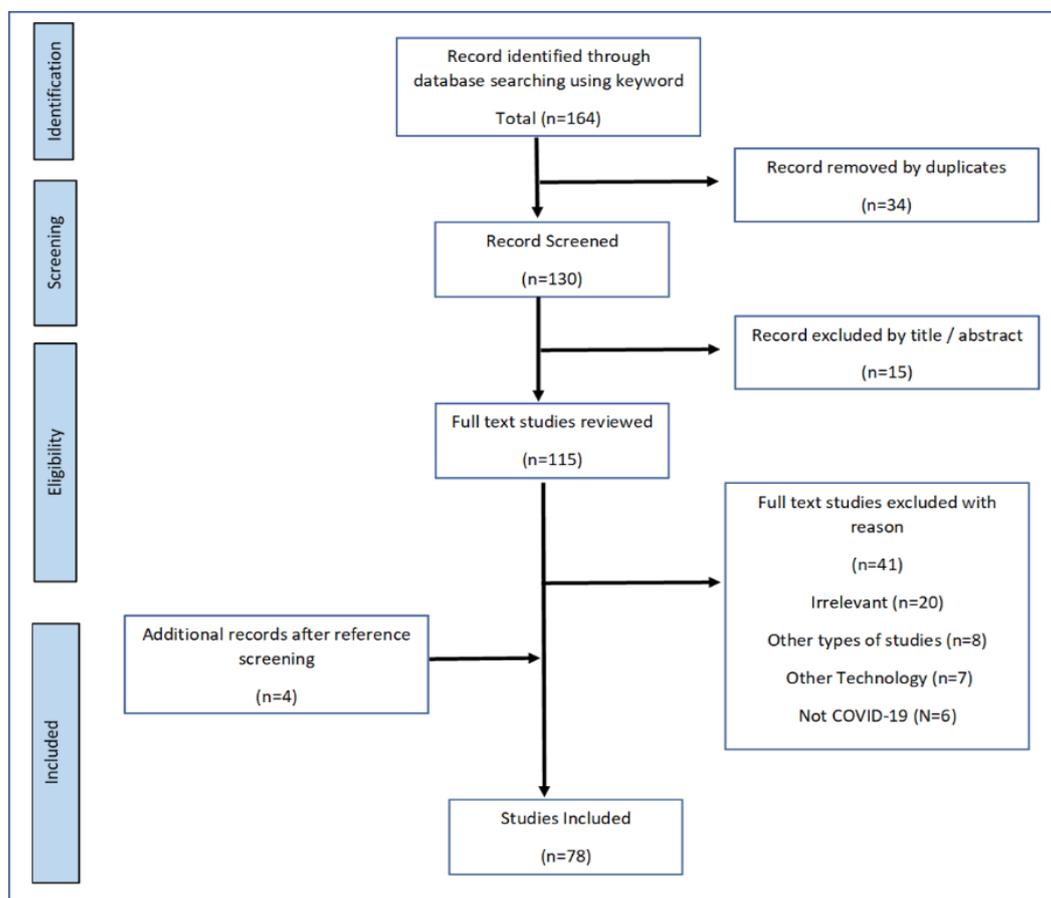

Figure 4: PRISMA flow diagram illustrating study selection

Quality Assessment

The appraisal of the four selected studies was done using the tools of CASP. A high level of quality was obtained as a result. Three out of four (75%) studies enjoyed good quality, and remaining one (25%) had medium quality. Additionally, no exclusion was experienced based on the level of quality appraisal.

Table 2: Summary of included studies in Systematic Review

Author	Research Duration	Country	Design of study	Type of Telehealth	Key outputs	Effects
Ankit et al.	1/15/2020 - 6/15/2020	India	Case Study and Cross Sectional Study	Mobile App, website, telephone, Live video conferencing, Social media platform including messaging software	1. Triage of COVID-19 infection using experts from centers from around the world 2. Faster rate in healthcare services delivery. 3. Create volunteer network coordinator. 4. Wireless remote monitoring of patients. 5. In-person evaluation, telemedicine evaluation if high-risk for infection. 6. Performing the collects, transforms, and evaluation of patients health data. 7. Telemedicine–video visits for outpatient clinic encounters. 8. Served as a portal for sharing timely information to large numbers of patients. 9. The live broadcast of the telehealth training video. 10. Can be effectively used in Rural area.	1. Provided near real-time consultation from experts located around the country and the world. 2. Minimized the risk of COVID-19 transmission during radiotherapy treatment. 3. Reduced infection risk and the risks of reduction of workforce. 4. Reduced the need for face-to-face visits. 5. Provided an opportunity to introduce telehealth in all the healthcare area. 6. Virtual care options to ensure continuity of care. 7. Provided consultation in regions with limited access to healthcare services. 8. Helped the specialist treatment team to provide primary care guidance on coronavirus.
Dr. Pavan et al.	1/15/2020 - 6/15/2020	USA	Case Study and Cross Sectional Study	Telephone, patient portal messaging, Video using HIPAA compliant platform, website	1. Providing clinicians and patients with immediate diagnosis and consultations regarding COVID-19. 2. Provide video consultations. 3. To appropriately-performed telehealth visits. 4. Use in psychological treatments. 5. contact with family, friends and colleagues. 6. Repurposing and utilizing EHR optimization team to train end users' video visit workflow. 7. Screening or treating a patient in an ambulatory care setting 8. Screening or treating a patient in an urgent care setting. 9. Facilitating electronic informed consent, digital assessment tools and virtual study visits. 10. Provide e-consultation or advice to health providers.	1. Eliminated the need to send patients to overpopulated hospitals. 2. Limited the exposure of providers to potentially infected patients. 3. Reduced exposure of patients. 4. Preserved social distancing. 5. Was Effective for managing patients with chronic conditions. 6. Reduced burden on practice resources. 7. Led to early treatment associated with better outcomes. 8. Satisfaction was higher. 9. Helped to alleviate the lack of clinical nursing teaching resources. 10. Template excuse letter for providers to recommend working from home.

Telehealth services during COVID- 19 outbreak

Critically evaluating the healthcare industry trends based on the selection of the eight included studies in the research we analysed the role of telehealth in the COVID- 19 scenario.

Telehealth has emerged as integral part of the health care industry in the pandemic outbreak. The Novel virus has made people more conscious about the health issues in their daily life. They needed some expert advice with minimal human contact to break the chain of contamination. This evolved the incorporation of technological platforms to deal with the health and social distancing issues parallelly. Telehealth is a broader spectrum that merges the health care services by utilising the communication platforms and the digital information. It allows a remote access to the health care services. It incorporates various organizations and healthcare seekers to avail the services over a virtual network. The network is comprised of local clinics, personal spaces of patients and physicians and diagnostic centres. The evolution of telehealth is attributed by the idea to decrease the transmission of the infectious disease and ensure the safety the health care providers. The virtual care facility has helped in minimising the additional burden on the health care providers. This has helped the acutely suffering and follow-up patients by getting the treatment without entering the proximity

zones of the infections. Telehealth and telemedicine have contributed to the principle of social distancing beyond the expectations. It has helped the health care industry to get in touch with all the patients and care seekers. This is made possible by transition of the healthcare industry from local to virtual platforms. It is used as a tool to monitor and undertake the medical activities like consultation, preventive measure, diagnosis, treatment and cure from a distance. The web portals, virtual appointments, remote monitoring have been useful channels for effective treatment and consultations. These techniques have also led to improved management throughout the pandemic. The success of the telehealth facilities has been accorded by the reduced mortality and modality rates. It has been a great tool to build an improved health care industry that incorporates technology and communication to treat the patients remotely with the same efficacy.

5.0. DISCUSSION
Discussion on studies in systematic review

The study focuses on critically analysing the emergence and evolution of the telehealth services during the COVID-19. It describes how the virtual health platforms have helped combat the pandemic by diagnosing, treating, consulting and controlling the disease by effectively manging the health facilities. The study highlights the scope and demand of the telehealth to support the health care industry. The critical evaluation covers the benefits and the challenges faced by the both the industry and the patients to imbibe the internet-based technologies in their health care routine.

COVID-19 has led to the added health and hygiene routines for the people. Stepping out brings people in the proximity zones which makes them prone to the infection, the people suffering with low immunity due to previous medical histories are more susceptible to the infections. COVID-19 has forced the ideology of 'Social Distancing' in people's lifestyle which refrained them to come in human contact. This was done to reduce the risks of exposure from the infected and mildly symptomatic patients. This demanded for extreme utilisation for the mobile health monitoring systems. These systems helped to control and coordinate among various remote doctors, assistants and the patients pre and post the diagnosis of the viral infections. The process followed used the existing systems to identify the risk levels of the patients by interaction and diagnostic procedures. The high-risk patients were taken under the surveillance while the mild and low symptomatic patients were prescribed and suggested follow-ups. Moreover, the people suffering from the chronic diseases who need a routine check-up and monitoring could consult the doctors through online appointments, using the techniques of self-monitoring for blood sugar level, blood pressure and sharing the clinical information with the doctor over the voice and video platforms. Telehealth with an effective network enhanced the sharing of the

medical reports, images and scans from one unit to the other. This provides comprehensive treatment plans and increased compliance to the care seekers.

Telehealth has encompassed the levels of treatment from the mild to severe patients. The providers have established remote monitoring units and Tele ICU for treating the patients in the pandemic. The units comprise of the video camera, microphones and speakers for effective communication and connecting with the doctors for treatment.

The countries have developed various virtual care platforms that remotely examine the patients by communicating over the secure audio-visual channels and applications. The practitioners prescribed the treatment using the telemedicine. China has implemented the telehealth procedures to minimise the number of infections. The key players for the effective implementation of emergency telemedicine were the National Telemedicine Center of China, ZTE, Huawei Technologies. They enhanced the treatments by setting up the equipment in the hospital networks. The increased technological advancements helped the patients in direct consultation with the doctor. The remote health care facilities added to the education, training and awareness of the pandemic by using the live interactive sessions and video streaming. It also helped people to connect to their caretakers and people whom they could not meet otherwise. The pandemic has recorded an increase in the cases of depression, anxiety and disorders caused due to the outbreak and the isolation issues. The virtual communication enabled talk therapies, meditations and calmed the stress levels and improved mental health of the patients.

The major outcomes of the study develop new insights to the health of the people regarding the COVID-19. The study highlights positive aspects and the risk factors that prevail form the treatment from the remote locations. Telehealth has played a critical part in real-time supervision of the current pandemic. It has safeguarded the healthcare providers from the possible containments that are possible by physically treating the infectious patients. The elimination of exposures from various respiratory secretions that have broken the chain of the contamination. It has resulted to be a tool of technology that emerged to diminish the infections spreading through the human contacts. It has also emerged as an ideology that has been encouraged by all the stakeholders in the health care industry, due to its effective operational plan, time conserving and improved patient surveillance. The further advancements in technology have helped the countries to monitor the spread of the virus using the image sensing of the vector habitats and suffering patient proximities.

Discussion on Utilization of Telemedicine

The use of Telemedicine can be made in different stages to fight the spread of the disease. These stages could be based on the response strategy provided by Public Health Emergency of International Concern (PHEIC). This included diagnosis, patient isolation, and indicative monitoring and health quarantine. The practice of telemedicine largely breaks down into three types of solutions, store-and-forward, remote patient monitoring, and real-time encounters (Figure 5). The isolation of population and the epidemic effects over the health care units is disturbing the follow-ups and routine care for non-COVID-19 patients. Thus, the telemedicine has scaled up and some measures utilizing the maximum from it are mentioned below.
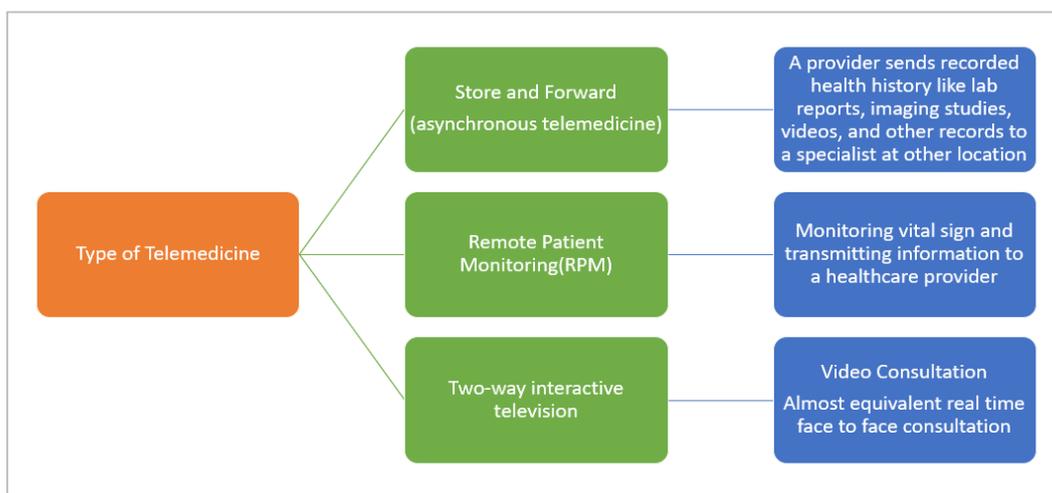

Figure 5: Type of Telemedicine

Discussion on Consultations and follow-ups

In order to fight the global epidemic governments across the globe provided free consultations during the outbreak. They enhanced the telemedicine channels to provide effective results for the patients. Additionally, the non-COVID patients have been helped by video consultations to continue their medical support from the experts. The physicians provide virtual care to senior citizens and mildly infected patients. Doctors can ask questions about the illness and observe the symptoms to prescribe medications. In critical cases doctors can assign procedures and write clinical notes. The in-house devices could be used to monitor the temperature, glucose levels, and heart rate of the patients [10]. The consultation and routine check-up can be provided to the patients from remote locations using Telemedicine. An updated framework for telemedicine during the COVID-19 pandemic has been defined in Figure 6. This framework could be applied at a large scale to improve national public health response and should be shaped on the basis of scientific evidence arising from implemented telemedicine activities.
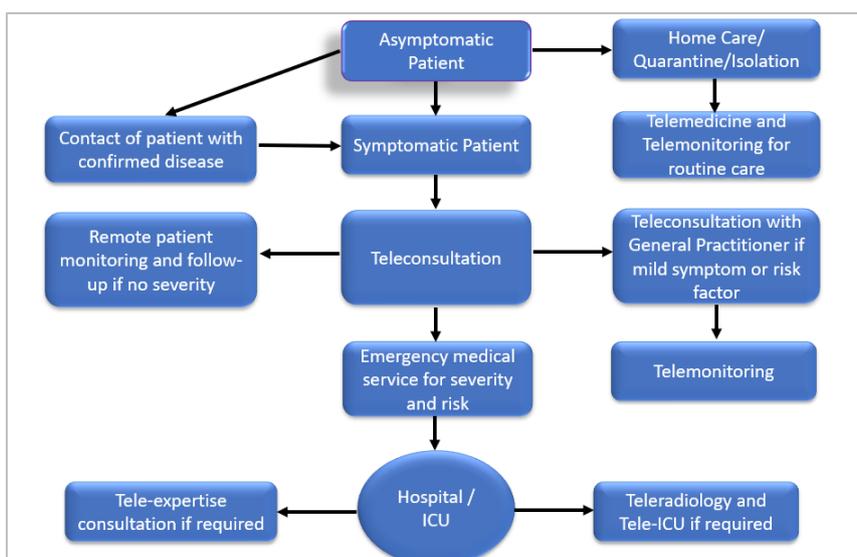

Figure 6: Conceptual framework of telemedicine for the coronavirus disease 2019 (COVID-19) pandemic

Discussion on Treatment via Telemedicine

Clinicians and patients with direct analysis and consultation regarding disease can be identified using telemedicine. The activities like wireless remote patient monitoring (Figure 7), multiple disciplinary care can be used to analyze the patient's preliminary symptoms. The experts can capture, store and process the medical records of the patients to attain real-time data exchange for the overall disease monitoring[10]. The automated facial recognition techniques and screening algorithms can be used to analyse the disease level. Telemedicine Artificial Intelligence Solution that integrates body detection, face detection and dual sensing via infrared cameras and visible light can help health care providers to swiftly identify people who have elevated body temperatures which is one of the symptoms of COVID-19. The telemedicine platforms can be used to develop awareness and knowledge about the disease. Effective use for training and education as well as using the interactive live sessions over video conferencing can help in research and development against the pandemic [10].
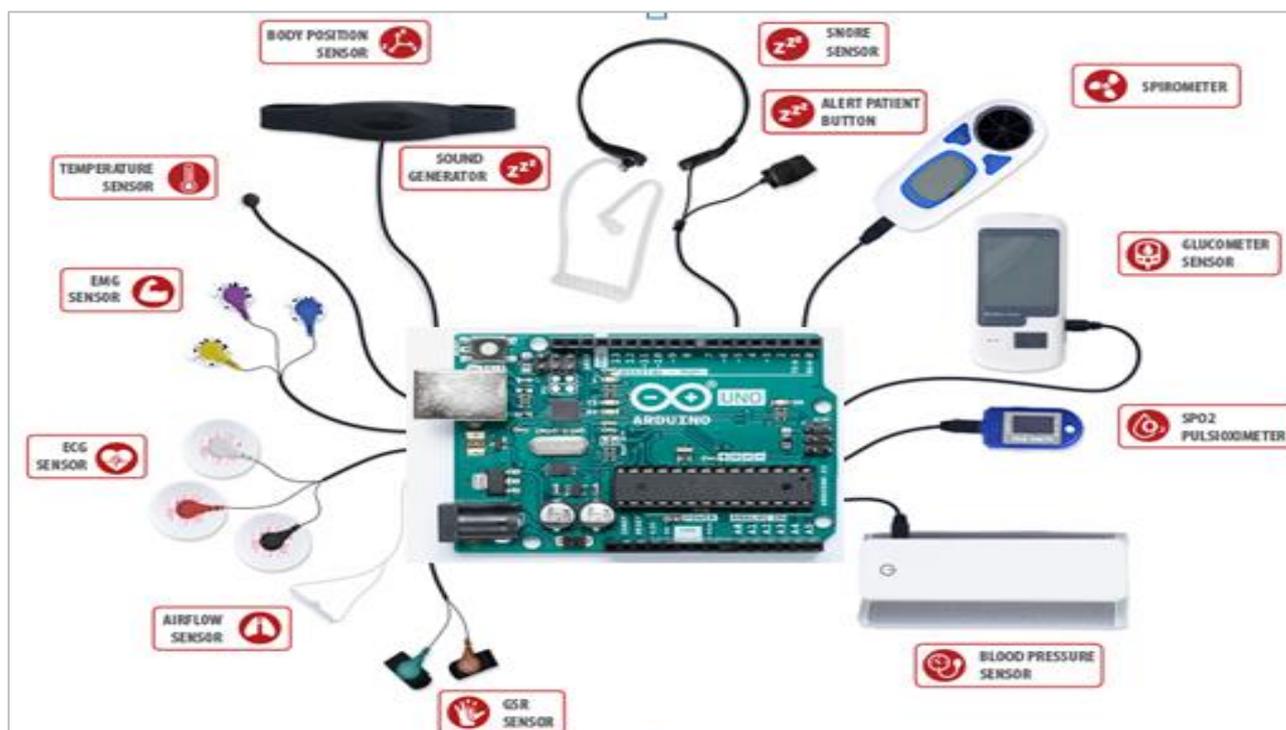

Figure 7: IOT Based Patient Remote Monitoring System

Discussion on Advanced Care for patients

The isolation wards during the pandemics can be equipped with the portable telemedicine device which efficiently gathers, transforms, and assesses the medical data for instance oxygen level, respiratory rate, blood pressure and would forward it to the health care team. This would help in facilitating the evading the direct physical contact (Figure 8). It will minimize the hazards of contact to respiratory discharges. Thus, it will prevent the potential spread of infection using hotspots to medical staff. The concept of centralized remote intensive care units which could be coordinated by command centre in closed architecture, which supports portable telemedicine at the end point at the originating site. It may have obstacles in the implementation due to the lack of the technology and workflow. But utilizing the contemporary methods with remote far-end camera control, synchronous audio-visual telecommunications, mobile telemedicine cart, and multidisciplinary nurse-driven supervision can add to the treatment procedures [11]. The plan should include a protective programmed care with proactive or reactive subject monitoring. In advanced cases full-time reporting of the remote ICU should be provided to local computers including the synchronous video, consultation, contact with medical staff to analyse the diagnostic imaging of the results from the medical evaluation [12]. The doctors and nurses get benefited from this system by observing their corresponding patients remotely without visiting in person.
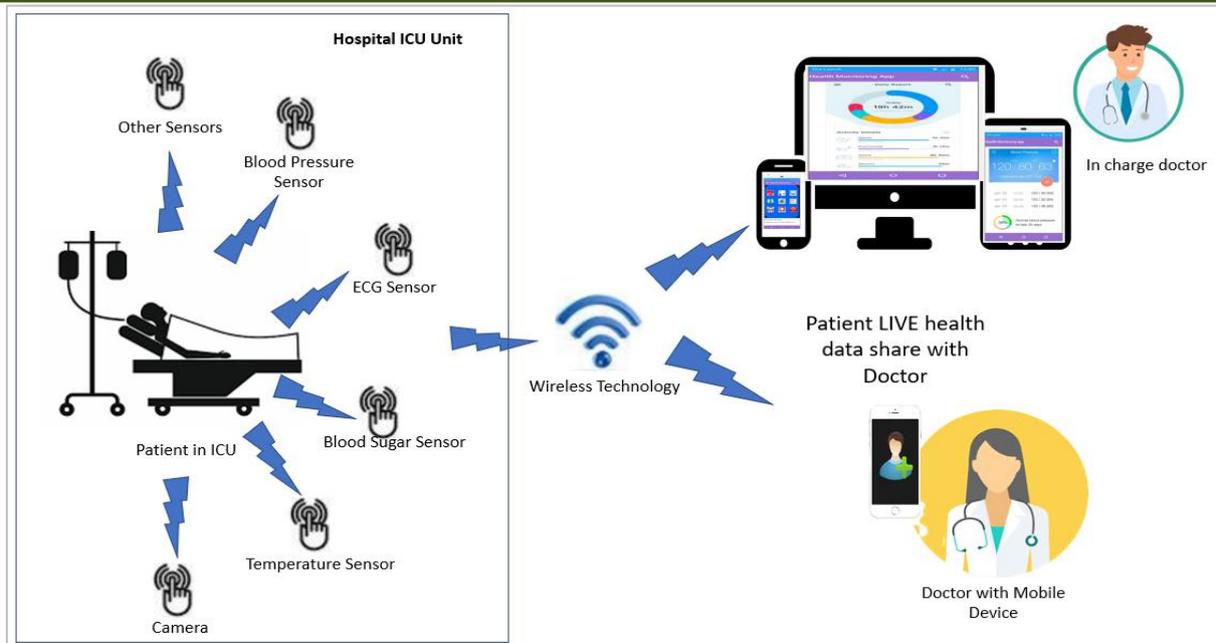
Figure 8: Remote Tele-ICU Monitoring

Discussion on Factors affecting the use of Telemedicine

Telemedicine has experienced a surge in health care; despite this it is to be used with great care [13]. There are various legal and technological implications that limit its use in industry. Some general implications correspond to the availability of high-quality internet connection for optimal exchange of information. While the one-way context provided in the asynchronous mode of communications such as Email, recordings can be only dependent on the articulation provided by the patients. This makes it difficult to analyze the problem. Additionally, visual inspection is not possible over the audio channels. Considering the security concerns and privacy breaches can obstruct the accomplishments of the achievement of motive among the citizens (Figure 9). The major limitation to telemedicine is the lack of support for it in hospitals and health care units. They face lack of hardware and technology to implement it. The increased risk of liability, lack of awareness and training are the unprecedented challenges that telemedicine is experiencing in being incorporated in the healthcare on the frontiers [14]. The success of telemedicine can be evaluated on the basis of the factors like disease diagnosis, disease treatment efficiency, cost effectiveness and customer satisfaction. Although some diseases require physical consultation, most of the diseases can be diagnosed through e-consultation. Regular check-up, consultations for acute diseases can be effectively obtained through telemedicine. The range of treatments that telemedicine can offer is small; however, all the basic infections are easily treatable through the same. Telemedicine has proven to be cost effective. The most major expense takes place while setting up its infrastructure. Thus, once the setup is established it could be utilised over longer period. Finally, the major attribute, customer satisfaction defines the extent of adoption of telemedicine by the customers. In a setting such as that of an epidemic, customer satisfaction simply relies of the patient's survival, and no real feedback is achieved. Finally, efficiency of telemedicine in the epidemics varies in terms of clinical outcomes like zero contact consultation for infectious diseases, modalities due to disease consultation14. Telemedicine can be analysed by observing the mortality, reoccurrence within a specific period of consultation. While Telemedicine can help provide much-needed care to vulnerable and hard-to-reach populations, telehealth also presents unique legal and regulatory compliance (HIPAA, GDPR, CCPA) challenges, particularly with the data protection and cybersecurity realm.
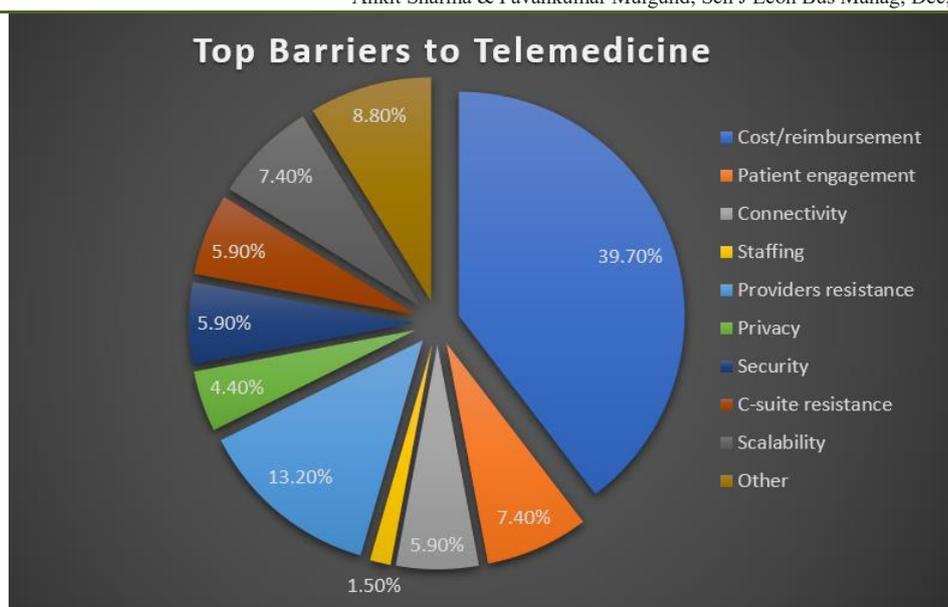
Figure 9: Top Barriers to Telemedicine
Source: HIN

Discussion on Regulatory and Policy Adaptations During COVID-19

The rapid expansion of telemedicine during the COVID-19 pandemic was facilitated by emergency regulatory relaxations across multiple countries. In the United States, temporary waivers under the Centers for Medicare & Medicaid Services (CMS) expanded reimbursement eligibility for telehealth services. Similarly, several countries revised licensing, cross-border consultation permissions, and digital prescription regulations. These regulatory adjustments reduced adoption barriers and accelerated digital transformation in healthcare delivery. Future epidemic preparedness frameworks should incorporate predefined emergency telehealth policies to ensure rapid scalability during crises.

Limitations

This study has several limitations. First, the review was conducted during the early phase of the COVID-19 pandemic when high-quality empirical studies were limited. Second, the small number of studies included restricts generalizability of findings. Third, heterogeneity in telemedicine implementation models across countries limited direct comparison of outcomes. Finally, rapidly evolving regulatory environments may influence telemedicine sustainability beyond the emergency context.

Discussion on Future Research

The further study may include the various analysis made by using the data sharing and exploration techniques to monitor the spread of the virus. The future research may focus on the implication faced in implementing and analysing the telehealth data relative to the pandemic to study the pattern, development and spread of the disease. The credibility and customer satisfactions may also be examined to ensure the success levels of the technological integration.

Theoretical Contribution

Beyond immediate pandemic response, this study contributes to digital health systems literature by conceptualizing telemedicine as an epidemic resilience infrastructure rather than merely a communication tool. The integration of AI-enabled screening, IoT-based monitoring, and tele-ICU architectures suggests a transition toward decentralized, technology-mediated healthcare ecosystems. This systems-level framing provides a foundation for future research in digital public health preparedness and intelligent health networks.

6.0. CONCLUSION

The study discusses an overview of telemedicine; it's role in epidemics and its potential benefits and barrier to its adoption. In less than a decade we've seen the likes of MERS, Ebola, Zika virus and COVID-19. The latest one has shown the importance of telemedicine and key stakeholders should embrace the technology and make it an integral part of the healthcare system. This will help work towards the digital health agenda while also preparing for an eventual emergency. In this context, telemedicine utilizes modern technology via applications and internet of things. Advanced techniques include, utilizing artificial intelligence, deep learning and automation. Telemedicine allows for consultation, disease diagnosis, vitals monitoring and disease treatment without physical contact which is tremendously helpful against infectious diseases such as that of Severe Acute Respiratory Syndrome SARS, H7N9 Influenza and Corona Virus Disease COVID-19 [15]. While legal, ethical, cybersecurity, and safety

considerations remain critical, telemedicine demonstrates substantial potential to enhance epidemic response capacity and long-term healthcare system resilience. New technology is already on its way and augmented reality, virtual medicine advances, biotech, and wearables will be integrated into this landscape to provide additional methods for the provision of care, patient monitoring, diagnosis, and treatment

Figure 10 illustrates a layered digital health response model beginning with epidemic outbreak detection and progressing through triage, remote consultation, monitoring, AI-enabled screening, tele-ICU escalation, data integration, and policy feedback adaptation. The model conceptualizes telemedicine as an epidemic resilience infrastructure.
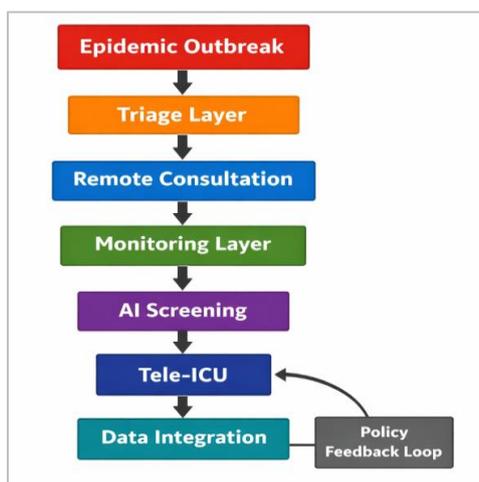

Figure 10. Epidemic Telemedicine Response Framework (2020 Model)

It is recommended that telemedicine be integrated into international and national guidelines for health preparedness and proper regulations and frameworks be defined for the same. A strategy to quickly define telemedicine frameworks and standardize triage auto questionnaire and remote patient-monitoring algorithms for any outbreaks at local, national, or global scales be implemented. It is also suggested that telemedicine as a platform be used as a communication toolkit to inform and educate the population on the recommended use of telemedicine. A data-sharing mechanism to integrate telemedicine providers' data

with epidemiological surveillance be implemented [16]. New health care models are needed during the COVID-19 pandemic. In the era of digital health technologies, the focus on new models has shifted to telehealth, mobile apps, websites and chatbots. Figure 9 describes the main stakeholders at the vanguard of the COVID emergency with significant illustrations of efficient digital health strategies that have been implemented to date at various levels. Finally, all stakeholders are encouraged to address and collaborate on effective use of telemedicine to effectively fight against infectious epidemics like COVID-19.
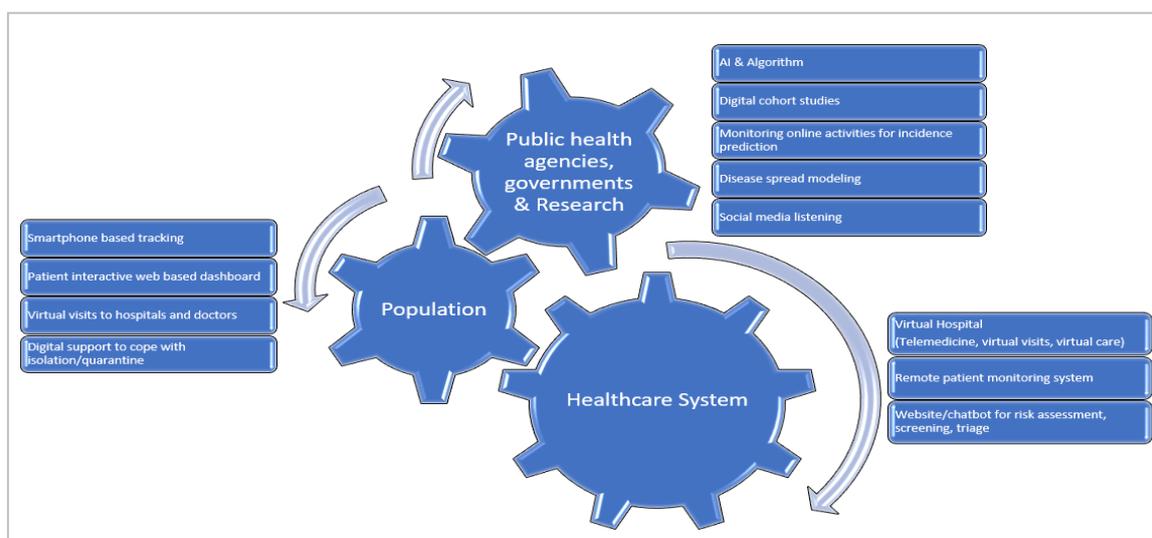

Figure 11: The COVID-19 Health ecosystem

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Datasets are available through the corresponding author upon request

Authors' Contributions

All the Authors of the paper contributed in writing the entire manuscript. They all contributed to conducting the review and reporting of findings.

REFERENCES

1. Surveillances, Vital. "The epidemiological characteristics of an outbreak of 2019 novel coronavirus diseases (COVID-19)—China, 2020." *China CDC Weekly* 2.8 (2020): 113-122.
2. Smith, Anthony C., *et al*. "Telehealth for global emergencies: Implications for coronavirus disease 2019 (COVID-19)." *Journal of Telemedicine and Telecare* (2020): 1357633X20916567.
3. Portnoy, Jay, Morgan Waller, and Tania Elliott. "Telemedicine in the Era of COVID-19." *The Journal of Allergy and Clinical Immunology: In Practice* (2020).
4. Ohannessian, Robin, Tu Anh Duong, and Anna Odone. "Global Telemedicine Implementation and Integration Within Health Systems to Fight the COVID-19 Pandemic: A Call to Action." *JMIR Public Health and Surveillance* 6.2 (2020): e18810.
5. Novel, Coronavirus Pneumonia Emergency Response Epidemiology. "The epidemiological characteristics of an outbreak of 2019 novel coronavirus diseases (COVID-19) in China." *Zhonghua liu xing bing xue za zhi= Zhonghua liuxingbingxue zazhi* 41.2 (2020): 145.
6. World Health Organization. WHO Director-General'sopening remarks at the media briefing on COVID-19 11March 2020, https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19—11-march-2020 (2020, accessed8 March 2020).
7. World Health Organization. (2020). Coronavirus disease 2019 (COVID-19): situation report, 72.
8. Zhai, Yunkai, *et al*. "From Isolation to Coordination: How Can Telemedicine Help Combat the COVID-19 Outbreak?." *medRxiv* (2020).
9. Gatherer, Derek. "The 2014 Ebola virus disease outbreak in West Africa." *Journal of General Virology* 95.8 (2014): 1619-1624.
10. Liu, Ying, *et al*. "The reproductive number of COVID-19 is higher compared to SARS coronavirus." *Journal of travel medicine* (2020).
11. Fortis, Spyridon, and Matthew R. Goede. "Structure and Design of the Tele-ICU." *Telemedicine in the ICU*. Springer, Cham, 2019. 107-128
12. Pacis, Danica Mitch M., Edwin DC Subido Jr, and Nilo T. Bugtai. "Trends in telemedicine utilizing artificial intelligence." *AIP Conference Proceedings*. Vol. 1933. No. 1. AIP Publishing LLC, 2018.
13. Chan, Kwok H., *et al*. "Detection of SARS coronavirus in patients with suspected SARS." *Emerging infectious diseases* 10.2 (2004): 294.
14. Driessen, Julia, Nicholas G. Castle, and Steven M. Handler. "Perceived benefits, barriers, and drivers of telemedicine from the perspective of skilled nursing facility administrative staff stakeholders." *Journal of Applied Gerontology* 37.1 (2018): 110-120.
15. Rockwell, K. L., and A. S. Gilroy. "Incorporating telemedicine as part of COVID-19 outbreak response systems." *The American Journal of Managed Care* 26.4 (2020): 147-148.
16. Artikis, Alexander, *et al*. "Supporting tele-health and AI-based clinical decision making with sensor data fusion and semantic interpretation: The USEFIL case study." *International workshop on artificial intelligence and NetMedicine*. 2012.
17. Jnr, Bokolo Anthony. "Use of telemedicine and virtual care for remote treatment in response to COVID-19 pandemic." Journal of Medical Systems 44.7 (2020): 1-9.
18. Monaghesh, Elham, and Alireza Hajizadeh. "The role of telehealth during COVID-19 outbreak: A systematic review based on current evidence." (2020).