Review
Telehealth and Artificial Intelligence Insights into Healthcare during the COVID-19 Pandemic

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Abstract: Soon after the coronavirus disease 2019 pandemic was proclaimed, digital health services were widely adopted to respond to this public health emergency, including comprehensive monitoring technologies, telehealth, creative diagnostic, and therapeutic decision-making methods. The World Health Organization suggested that artificial intelligence might be a valuable way of dealing with the crisis. Artificial intelligence is an essential technology of the fourth industrial revolution that is a critical nonmedical intervention for overcoming the present global health crisis, developing next-generation pandemic preparation, and regaining resilience. While artificial intelligence has much potential, it raises fundamental privacy, transparency, and safety concerns. This study seeks to address these issues and looks forward to an intelligent healthcare future based on best practices and lessons learned by employing telehealth and artificial intelligence during the COVID-19 pandemic.

Keywords: COVID-19; healthcare; digital health; pandemic; telemedicine; artificial intelligence; telehealth

1. Introduction

The coronavirus disease (COVID-19) pandemic has affected the environment, and people’s health lifestyle globally [1,2]. Digital health offers a valuable opportunity to handle epidemics such that real-time results continuously emerge. Recent cases of Severe Acute Respiratory Syndrome (SARS), influenza A virus subtype H1N1, and Ebola Virus Disease have taught us many lessons about the usefulness of digital health in public health crises. Those lessons can also be applied to improve our reaction to the coronavirus disease 2019 (COVID-19) pandemic caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) through innovative and productive techniques [3–5]. In 1980, the Veterans Health Information Systems and Technology Architecture (VisTA) was deployed for the first time; this is considered the beginning of what is now referred to as digital medicine, leading to the first generation of the Electronic Health Record (EHR). The successful implementation of the computerized patient record system was another milestone in 2000. The VisTA user interface allows providers to analyze and edit the EHR of patients, which was the beginning of medical information technology [6].
The launch of the first iPhone in 2007 contributed to developing an ecosystem that enables real-world monitoring and clinical/research-level health data collection through mobile systems. Today’s social, mobile, computational, and cloud integration creates a society of customers immersed in technology. The third technological revolution (digital technology) has already taken place and has given rise to significant developments in the medical world, but the subsequent fourth medical revolution will have a significant impact on healthcare [7–9]. The fourth medical revolution began with technologies such as the Medical Internet of Things (MIoT), artificial intelligence (AI), advanced robots, biosensors, etc. These innovations have digitized services for the medical sector to enhance healthcare services [10–12]. Hence, the goal of the fourth medical revolution is to plan and build an intelligent healthcare system to function effectively and efficiently and create a better technology platform for virtualization, decision making, and real-time capability [13,14]. The principal promoting innovations of the fourth medical revolution are highlighted in Table 1 [15–21].

### Table 1. The principal promoting innovations for fourth medical revolution.

| Technology    | Feature                                                                                                                                 |
|---------------|----------------------------------------------------------------------------------------------------------------------------------------|
| Telemmedicine | 1. This technology is useful for ensuring social distancing during the COVID-19 pandemic.                                                 |
|               | 2. It is beneficial for medical care in rural areas to use telecommunication technologies.                                              |
| Biosensors    | 1. Biosensors can be used to distinguish signs of viral infection related to COVID-19.                                                   |
|               | 2. Useful to measure temperature and related changes in the patient’s symptoms.                                                         |
|               | 3. Perform the necessary functions as per the sensor’s design in any crisis.                                                             |
| MIoT          | 1. MIoT connects all healthcare tools and devices to the Internet to access real-time information.                                       |
|               | 2. It gives greater control of chronic conditions.                                                                                       |
| Robotics      | 1. This technology is used in the hospital to scan an infected patient.                                                                  |
|               | 2. Scan all patients, healthcare staff, and guests, with minimal risk to the doctors.                                                   |
|               | 3. Provide critical and noncritical services in remote and challenging locations.                                                       |
| Cloud storage | 1. The platform uses computers to store data in cloud storage.                                                                            |
| platform      | 2. All information is stored remotely after the care of the infected patient, which helps to achieve improved outcomes in the future.     |
| Data security | 1. Data management guarantees the security of medical data.                                                                               |
|               | 2. Improves the administration of various therapy programs.                                                                             |
|               | 3. Helpful in preserving and tracking confidential information about the transmission of this outbreak, inventory of services, medications, etc. |
| AI            | 1. AI with adequate preparation has a human-like intellect that helps anticipate, monitor, and interpret signs of COVID-19 or related diseases. |
|               | 2. It analyzes signs of cold, cough, fever, and other symptoms in patients with COVID-19.                                                |
|               | 3. Enables support for telemedicine and provides tracking for individuals and clusters.                                                   |
|               | 4. Can be built into other systems and technologies for predictive analysis and disease modeling.                                           |
|               | 5. Has implementation in the manufacture of drugs/vaccines.                                                                             |
|               | 6. Helpful to classify the mortality rate and other anomalies of disease data.                                                           |
Table 1. Cont.

| Technology                  | Feature                                                                 |
|-----------------------------|------------------------------------------------------------------------|
| Analytics of big data       | 1. The entire medical history of all patients is digitally, and anomalies are further examined. stored  
                              | 2. Rapidly recognize any signs of the given virus.                     |
| Bioactuators                | 1. Provides essential functions for the patient’s bed, operating table, and chair.  
                              | 2. Raise and lower bed according to the patient’s needs during treatment. |
| Blockchain                  | 1. Pandemic control system algorithm for COVID-19.                      |
                              | 2. Applicable during a crisis for patient track and trace and disease/infection prevention.  
                              | 3. Involves outlining in the early stages of the disease.              |
| Information technology      | 1. Provides a considerable change in information and data processing.  
                              | 2. Helps with the availability of backbone hardware and software for care. |
| Imaging technologies       | 1. Increased reality (AR)/virtual reality (VR) systems will promote learning and training in remote locations.  
                              | 2. AR/VR images can be used by a remote specialist in patients with major defects and recommended treatment.  
                              | 3. Health apps can encourage increased patient satisfaction.           |
| Additive manufacturing      | 1. Consists of 3D scanning, 3D printing, and other software design and printing.  
                              | 2. 3D scanning is helpful to construct the necessary design for a part of the patient.  
                              | 3. 3D/4D/5D printing consumes less time and money, and satisfies the scarcity of critical COVID-19 pandemic items.  
                              | 4. The optimized design could be researched, evaluated, and improved.  |
| Nanomedicine                | 1. Aid in healing infected patients’ cells with the help of protein repair.  
                              | 2. Nanoparticles the size of the novel coronavirus can be successfully used in patient care.  
                              | 3. Has the ability to cure and control infections in this ongoing scenario. |

Telehealth has a broader scope of remote healthcare services than telemedicine. Different terminologies are used to refer to telemedicine or telehealth—for instance, digital health, electronic health, mHealth (Mobile Health), teleconsultation, and tele-triage. In addition, there are some terms that mention specialties, e.g., teleneurology, telecardiology, and telepsychiatry [22]. Telemedicine has been used since the early 1960s by the military and space technology departments. Nowadays, telemedicine is available for everyone at digital stores, and mHealth apps can be used on smartphones, tablets, and computers [23]. These apps provide accessible remote communication between healthcare professionals and their patients [24].

Telemedicine has some disadvantages, such as the need for network stability, good battery life, data security, and privacy. Some critics of telemedicine argue that using these apps is unethical in terms of privacy, equity, and patients’ rights [24,25]. Additionally, mHealth apps may increase the spread of inaccurate information due to the absence of face-to-face communication. A limited number of studies have reviewed this issue, but it remains a safety concern that should be addressed [26,27]. This study investigates the role of telehealth and AI in combating the COVID-19 outbreak through identifying hotspots in digital health during COVID-19. We also report data privacy and security challenges that researchers must be aware of and explore the available tools and techniques to minimize the risks.
2. Bibliometric Analysis Methodology

2.1. Source and Search Query

The bibliometric method was based on the Clarivate Analytics online subscription database Web of Science™ (WOS) to search the literature. WOS permits a comprehensive investigation of major fields or subfields, as previously reported [28,29]. In this study, we adjusted the document type to “article,” the language to “English,” and the period from 2019 to December 2021. Field tag, “TI = Title; and AK = author keywords” were utilized in the search strategy, and the following query was used:

\[(TI \text{ = (Digital health AND COVID-19)) OR AK = (Digital health AND COVID-19)}\].

We built the bibliometric networks using VOSviewer (developed by Nees Jan van Eck and Ludo Waltman, Centre for Science and Technology Studies, Leiden University, The Netherlands) [30].

2.2. Bibliometric Maps of Co-Citations

This feature identifies multiple references that the same publication has cited. Given a total of 16,680 cited references, the minimum citation count was set to five; only 100 met the criteria and were designated for visualization (Figure 1).

![Figure 1. Co-citation map among COVID-19- and DH-related articles.](image-url)

2.3. Hotspots of Papers Related to Digital Health

Keywords related to digital health and COVID-19 were analyzed by VOSviewer and shown in Figure 2. The keyword map was designed by selecting authors and keywords mentioned at least five times. Out of 2125 keywords, 106 were selected and categorized into four clusters.
3. Results

3.1. Source and Search Query

The extracted results (468 publications) were analyzed further using VOSviewer, and the top five categories (healthcare sciences services, medical informatics, public environmental, occupational health, psychiatry, and general internal medicine) accounted for over 70% of publications.

3.2. Bibliometric Maps of Co-Citations

Regarding bibliometric maps of co-citations, four clusters were created. The first cluster (red) had 34 publications, and is focused on quantifying SARS-CoV-2, isolation, and digital contact tracing. The second cluster (green) encompassed 33 publications, and the central topic discussed was the psychological responses and digital mental health. The third cluster (blue) encompassed 24 publications and primarily investigated telemedicine for COVID-19. Digital education in COVID-19 and COVID-19 mortality statistics were the fourth cluster’s (yellow) main topics, with eight publications.

3.3. Hotspots of Papers Related to Digital Health

Concerning the hotspots analysis, cluster 1 comprised 29 keywords; its main focus was the management of community and individual healthcare through digital health, telemedicine, telehealth, and artificial intelligence. Cluster 2 consisted of 28 keywords regarding mental health issues, anxiety, and stress during COVID-19 and how to cope with them. Cluster 3 consisted of 28 keywords; its main topic was using big data in surveillance studies, including tracing apps and their privacy concerns. Cluster 4 consisted of 21 keywords related to population engagement on the internet and social media and sharing information and its validity.
Only keywords from the first cluster of the hotspots were included for further discussion. Through the third cluster in the bibliometric map of co-citations, commercial search engines, and local directories, we were able to identify telehealthcare technologies.

4. Discussion
4.1. Telemedicine, Telehealth, and Mobile Health (mHealth)

Telemedicine enables clinical services to use information technology, video imaging, and telecommunication links to deliver healthcare services at a distance. In contrast to telemedicine, which is defined as the provision of medical services at a distance by a physician, telehealth is an umbrella word that encompasses telemedicine as well as a number of nonphysician services such as telenursing and telepharmacy [31].

Telemedicine is often used for controlling chronic diseases such as cardiovascular diseases, diabetes mellitus, cancer, and mental disorders. Telemedicine might be a safe and effective alternative for older people who suffer from these diseases. It is easy for patients to follow up on their cases via mHealth apps, especially those living in rural areas [32].

Digital psychotherapy is considered one of the most successful roles of telehealth. It makes it easy for patients to communicate with their psychiatrists anytime and anywhere. Telepsychiatry costs less than regular visits to therapists. Due to the severe shortage of mental health professionals in rural areas, digital psychotherapy has developed to help people in the countryside communicate with their psychiatrists in urban areas [33]. Mobile apps could be an effective alternative to telepsychiatry services for patients. People with depression, anxiety, schizophrenia, and other mental illnesses can benefit from technology and be cared for at home using their smartphones [34].

Cancer is the leading cause of death worldwide. Most cancer patients need regular monitoring to control their health. Cancer is a chronic disease, and the patient’s family has a vital role in improving the patient’s quality of life. The family’s contribution to the patient’s care at home is essential. Palliative care programs are based on the family’s responsibility for care at home. Family members face challenges providing care at home, and telemedicine provides them with information and knowledge. Mobile apps can facilitate communication between cancer patients and their healthcare providers [35]. Table 2 presents examples of telehealth apps around the world.

| App Name               | Country  | Launch Date | Description                                                                 |
|------------------------|----------|-------------|------------------------------------------------------------------------------|
| Amwell                 | USA      | June 2006   | Amwell is a telehealth platform that offers telemedicine services for healthcare providers and their patients [36]. |
| Zocdoc                 | USA      | April 2007  | Zocdoc is a technology company that provides an online appointment scheduling platform [37]. |
| Ping An Good Doctor    | China    | April 2015  | A mobile platform for online consultations, hospital referrals, and appointments (Internet hospital) providing online healthcare services [38]. |
| Babylon                | UK       | January 2013| Babylon is a teleconsultation app that provides many services on behalf of general practice in London [39]. |
| KRY                    | Sweden   | April 2014  | KRY is a health tech company that provides consultations via smartphone instead of conventional face-to-face appointments for primary care [39]. |
| Doctor Anywhere        | Singapore| 2016        | Doctor Anywhere is a digital platform offering quick access to health services [40]. |
| Qare                   | France   | 2016        | Qare is a platform that provides medical video consultation services [41,42]. |
Table 2. Cont.

| App Name   | Country   | Launch Date | Description                                                                                                                                 |
|------------|-----------|-------------|--------------------------------------------------------------------------------------------------------------------------------------------|
| Videodoc   | Ireland   | July 2014   | VideoDoc is a healthcare and medical service that offers scaled access to online healthcare services [43,44].                               |
| Okadoc     | UAE       | 2018        | Okadoc is an online appointment booking platform to connect healthcare professionals with their patients [45].                               |
| MediQuo    | Spain     | 2017        | MediQuo is a 24/7 medical chat app for healthcare providers and their patients [41].                                                           |
| Maple      | Canada    | July 2015   | Maple is a virtual care platform. Through Maple, you can speak with doctors through text or video, receive diagnosis and prescriptions. [46].  |
| TeleClinic | Germany   | 2015        | TeleClinic is a telemedicine platform that enables simple and secure communication between healthcare providers and patients [47].            |
| SehatPedia | Indonesia | February 2019 | The Indonesian MOH launched SehatPedia App to facilitate access to healthcare providers [48].                                               |
| HERA       | Turkey    | 2018        | The HERA App is a health platform for the Syrian refugee population in Turkey. It provides services in the three most commonly spoken local languages: Arabic, Turkish, and English [49]. |
| Little Dot | Croatia   | 2006        | Little Dot is a health platform for remote video consultations from the user’s home [50].                                                     |
| Al-Sehha   | Saudi Arabia | Dec. 2017   | The Saudi Arabian MOH created the Al-Sehha mobile app. It provides e-consultations in audio and video modes for users at home [51].          |
| Practo     | India     | 2008        | Practo is a mHealth platform that provides access to a vast network of doctors and clinics in India. It connects patients with healthcare providers through calls or chats [52]. |
| Yandex Health | Russia   | November 2016 | Yandex Health is an online consultation with doctors (all specialists) [53].                                                                |
| Instant Consult | Australia | 2017       | Instant Consult connects doctors with patients instantly for online health consultations via video call [54].                                 |
| Vezeeta    | Egypt     | February 2012 | Vezeeta is a digital healthcare platform that provides teleconsultations and booking services for private clinics [55].                  |
| Udok       | South Africa | 2018    | Udok ia developed a telehealthcare system to connect medical practitioners with patients remotely [56].                                     |
| Health Connect | Nigeria | 2018        | Health Connect is a telemedicine app [57].                                                                                                 |

4.2. Telehealthcare’s Role during COVID-19 Pandemic

The importance of telemedicine has garnered more attention since the COVID-19 pandemic. Teleconsultation is a safe and effective way to diagnose, control, and treat diseases [15]. Suspected COVID-19 cases or infected patients (with mild and moderate cases) are advised to stay at home and use mobile apps to follow up with their healthcare providers. Many governments launched telehealth apps to provide online health services for citizens. The Brazilian Board of Medicine published a memorandum on 19 March 2020 to use telemedicine as an exception during the pandemic [58]. The MOH (Ministry of Health) of the Republic of Indonesia encouraged telehealth services for COVID-19 related inquiries or any other medical conditions. The MOH prompted health-tech start-ups to release mobile apps that provide digital health services [48]. In Turkey, Syrian refugees suffer from low quality of life, low socio-economic status, language challenges, and poor health conditions. Hence, telemedicine services are a cost-effective alternative for those refugees to contact healthcare practitioners in Arabic and English [49]. The Indian Space Research Organization, MOH, and Ministry of External Affairs played a significant role.
in developing telemedicine services in India. The government supports and promotes telemedicine during the COVID-19 pandemic to reduce overcrowding in hospitals and encourage social distancing. During the COVID-19 pandemic, telemedicine can also help with reducing the burden on tertiary hospitals by providing diagnosis and treatment to patients in their own location and reducing chances of the patient’s exposure due to hospital visits [52].

4.3. Artificial Intelligence in the Healthcare Sector

4.3.1. AI Types and Subgroups

The term AI was introduced to the world for the first time by McCarthy et al. in the 1950s [59]. The term AI refers to the ability of computer systems to think and take action like humans in comparable situations and predict the outcomes of these reactions. The AI-based algorithms continue to be improved by developers and scientists, taking advantage of the refinement of networks and technology infrastructures, especially in the late 1990s. AI has been classified into seven types based on functionality and technology (Table 3). AI has two related subgroups: machine learning and deep learning. AI refers to intelligent systems that think and act like humans. Machine learning refers to systems that learn things based on previous experience and provide defined data to make proper decisions, while deep learning refers to systems that can think like human brains using artificial neural networks [60].

Table 3. Functionality- and technology-based classification of AI.

| AI Type          | Properties                                                                 | Ref.  |
|------------------|-----------------------------------------------------------------------------|-------|
| **Functionality based** |                                                                                  |       |
| Reactive Machines | 1. The earliest AI type, with the most limited technological capabilities. |       |
|                  | 2. Operate without the need to have a memory base.                          |       |
|                  | 3. Mimic the human brain’s capabilities to react to many sorts of scenarios. |       |
|                  | 4. Cannot store experiences and use the results to predict future responses. | [61]  |
| Limited Memory   | 1. It merges the ability to react and learn from previous information.      |       |
|                  | 2. Has many learning algorithms; the collection of datasets helps AI systems with analyzing current situations and learning from past experiences to make decisions in the future. | [62]  |
|                  | 3. The best example of AI-limited memory systems is the fingerprint scanning machine. |       |
| Theory of Mind   | 1. It is designed to perform a broad range of analyses—of thought patterns, emotions, and belief systems. | [63]  |
|                  | 2. It will help robots better comprehend people and understand the different elements that impact their thinking. |       |
| Self-Aware       | 1. Theoretical systems remain under development.                           |       |
|                  | 2. Sophisticated systems comparable to the human mind; will have self-consciousness and be self-sufficient. | [64]  |
|                  | 3. It is still uncertain how long these AI systems will take to evolve.     |       |
Table 3. Cont.

| AI Type                          | Properties                                                                 | Ref. |
|----------------------------------|---------------------------------------------------------------------------|------|
| **Technology-based**             |                                                                           |      |
| **Artificial Narrow Intelligence (ANI)** | 1. Now, ANI is the most widely used category of AI.                       | [65] |
|                                  | 2. ANI is capable of doing one or two jobs at the same time.              |      |
|                                  | 3. It takes advantage of the training data, and experiences gained from past situations. |      |
|                                  | 4. Currently, all models of AI may be classified as a part of ANI, from fundamental methods to advanced algorithms used by computers to make decisions. |      |
|                                  | 5. ANI is considered a weak AI system because it operates within a limited set of parameters |      |
| **Artificial General Intelligence** | 1. This is linked to the Theory of Mind for functionality scientists are still working on. | [66] |
|                                  | 2. The goal is to design devices that can independently create connections throughout several domains. |      |
| **Artificial Super Intelligence (ASI)** | 1. It is designed to execute activities and make choices better than humans, who demand massive quantities of memory. | [67] |
|                                  | 2. Machines with a large amount of memory, a higher processing speed, and a faster rate of intelligent decision-making would be able to perform complicated tasks with ease and in less time. |      |
|                                  | 3. They will be able to make complex decisions impacted by various circumstances in ways they have never been able to before. |      |
|                                  | 4. It is still under development.                                         |      |

4.3.2. AI Applications

Nowadays, AI has become a useful tool for users in many different fields, including e-commerce (personalized and online shopping), navigation (GPS technology, traffic prediction), robotics (robots powered by AI), healthcare (diagnosis and prognosis of different diseases, and finding the appropriate treatment approach for each case), agriculture (identify defects and nutrient deficiencies in the soil), gaming (creating human-like interactions and predict the human behavior), automobiles (self-driving vehicles), social media (Facebook, Instagram, and Twitter), marketing (delivering targeted, personalized ads), and smartphones (facial recognition) [68].

The spatial distribution of diseases was identified and analyzed by Geospatial Artificial Intelligence (GeoAI). It was used to simulate or predict diseases and track them in research on infectious diseases. Google Flu Trends used big spatial data (weekly forecasts for various cities) from the National Climate Data Centre [69], and deep learning recurrent neural networks (RNNs) were used for predicting influenza outbreaks at provincial and city spatial scales in the USA, assisted by bioinformatics tools like docking and modulation to predict upcoming influenza subtypes that could cause a future pandemic [70]. Using an algorithm tailored to artificial neural networks, geotagged tweets from Twitter and the Centers for Disease Control and Prevention and influenza-like illness datasets were also used to forecast illness in real time [71]. These geotagged tweets focused on where the user sent the tweet from, and allowed for its geographical position to be monitored on the Twitter App. Another study used a machine learning approach to predict the epidemiology of influenza in the USA each season, integrating a predictive method of self-correction with Google Patterns relevant to influenza, cloud-based EHRs, and historical flu trends, in addition to a network-based approach that leverages spatiotemporal trends in historical influenza activity [72].

There are currently various GeoAI strategies for public health uses, and broad attempts to deploy GeoAI and location-based information in precision medicine, such as through mHealth for therapies. Future research will broaden current GeoAI technology to open up
new opportunities for research and development in the field of spatial epidemiology and public health, including modeling sites that have not already been documented in high resolution, or analytics for the creation of new spatially extensive data sources [73].

4.3.3. Artificial Intelligence’s Role in COVID-19 Prediction

In hospital emergency departments, COVID-19 patients are in a highly critical situation that requires quick interpretation of symptoms so that physicians can make appropriate decisions. AI-based models have been used to predict the danger of deterioration in COVID-19 patients using the X-ray images of their chests and based on artificial neural networks that are fundamental to the deep learning-based algorithms [74]. The AI-based model can learn from physicians’ daily reports, and the trained model used data from 3661 patients. The obtained results, which showed an accuracy of 0.786 of the area under the curve (AUC), could be vital in assisting physicians with diagnosis and reporting findings in the emergency department. Another AI-based model was designed to see how well a chest radiograph performs through scoring of the severity of COVID-19. The model was integrated with laboratory and clinical evidence to predict the outcomes of COVID-19 for infected patients [75]. The obtained results showed an accuracy of 84% and AUC = 0.82. Two radiologists evaluated the results, confirming the accuracy of the AI-based model findings, which will assist radiologists with chest radiograph reports and predicting COVID-19 patient outcomes in the future.

Moreover, a machine learning-based model has been designed to predict the risk of infection by SARS-CoV-2. The model was tested and trained using data from more than 51,500 patients who were diagnosed with COVID-19. The designed model used eight features collected from the COVID-19 patients, including age, sex, confirmed contact with an infected individual, and five clinical symptoms (cough, fever, sore throat, shortness of breath, and headache). Based on these features, the obtained results showed AUC accuracy with 95% CI: 0.892–0.905 [76]. Overall, the AI models and algorithms had a vital role during the COVID-19 pandemic, as users trust them to make proper decisions about diagnosis and infection outcomes and assist physicians throughout the reporting process of to achieve suitable and quick intervention.

4.4. Future Perspectives and Potential Challenges Facing Mobile Technologies and Data Sharing in Health and Healthcare

Technologies such as the Internet of Services provide new possibilities in the medical field, reducing operation times and risks. Technology enables better knowledge of COVID-19 infection levels. Doctors can anticipate patient outcomes following therapy. These technologies are intelligent enough to solve a variety of issues in healthcare, particularly detection, process simulation, analysis, and therapy selection. Virtual healthcare consultations will become readily available in the coming days, reducing the need for face-to-face contact. Doctors can use Internet-connected technologies to digitally monitor their patients in remote regions and address numerous ongoing issues of the COVID-19 pandemic, bringing about a new era in medicine. The monitoring systems provide for patient care in times of emergency [21].

Telemedicine has a lot of potential benefits, but also many disadvantages [21]. Telemedicine’s main drawbacks include a breakdown in the interface between health professionals and their patients, a breakdown in the relationship between health professionals, issues with the quality of health data, and organizational and bureaucratic challenges [77].

Mobile technology, cloud storage, broadband networking, and wearable devices are increasingly embraced by researchers, experts, and consumers alike, effectively removing the traditional boundaries around sensitive data. Consequently, procedures to secure this information must be implemented at the source. Healthcare professionals and academics are now operating in an Internet-enabled digital ecosystem of technologies that are loosely coupled, easy to install, and offer effective care delivery and measurement
capabilities. However, there are enormous difficulties involved in maintaining the privacy and confidentiality of individuals and their records [6].

Contextual [78] and ethical [79] issues have been raised about data sharing, including a lack of standardized privacy protections. We need ways to enhance health data exchange and connection and create consensus on data governance [80]. Comprehensive legislation like the General Data Protection Regulation in the EU has started to tackle this issue, but more tailor-made methods, such as the voluntary privacy code for mHealth apps [81], are needed. Recent ethics studies [82] also found that consumers need to consider and agree to all facets of the use of their results.

Obstacles noted for data exchanged in Africa are a lack of control as soon as the knowledge is shared; suboptimal benefits for producers or administrators of information; unreasonable advantages arising from a more advanced technological background; and technical questions related to data consistency, interoperability, and misinterpretation risks. Many of the technological challenges are known to have largely been resolved. Problems related to anxiety, risk, and insecurity in places such as Africa where data sharing may not be optimized are less recorded. Ethical implications may also be less often discussed or dealt with in these countries [78].

Official data-sharing standards are occasionally missing, unclear, or inconsistent. The balance between making data available, maintaining the privacy, and protecting public health staff’s intellectual, time, and financial contributions are not always well controlled or defined, resulting in protective policies on public health data sharing in general [83].

Public health science advocates continue to urge reform and create strategies for data sharing. However, the barriers behind the lack of data sharing have not yet been adequately discussed. This includes systems that reward research but not data publishing, a lack of funding, and job pathways that underestimate vital data processing practice. Practical problems must also be resolved: how and where can long-term data be kept, who manages access, and who pays for these services? Current guidelines on metadata must be loosened to make health information easily accessible [80].

5. Conclusions

Pandemics have proven the importance of digital health as an integrated part of public health, especially when social distancing is required or the number of patients is high enough to overwhelm a medical facility. AI can combat COVID-19; AI-assisted detection is safer, more accurate, and faster than previous methods. Protein structure prediction, therapy monitoring, awareness, social control, and digital health are all recognized applications of AI in the fight against COVID-19. Also, telehealth has the potential to play a critical role in the pandemic planning and response. It offers numerous benefits during a pandemic, such as expanding access to healthcare, reducing disease exposure for staff and patients, preserving scarce supplies of personal protective equipment, and reducing the patient demand on facilities. Still, privacy and security are major challenges for governments and policymakers to ensure the safe development and deployment of AI and telehealth for the public. Finally, the authors propose an action plan to enhance data sharing methods that will benefit all stakeholders, including data collectors, analysts, policymakers, and, eventually, the general public.

Author Contributions: D.M.E.-S., conceptualization, refining research idea, creating research design, and writing—original draft; M.A., bibliometric analysis, writing—review and editing; M.T.E., writing—original draft; A.A.A., writing—original draft; A.A., writing—review and editing; M.M.A., writing—review and editing. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.
Acknowledgments: Mohamed Abouzid and Alhassan Ali Ahmed are participants in the STER Internationalization of Doctoral Schools Program of the NAWA Polish National Agency for Academic Exchange No. PPI/STE/2020/1/00014/DEC/02. We would like to thank the anonymous reviewers for their thoughtful reading of our manuscript.

Conflicts of Interest: The authors declare no conflict of interest.

References
1. Abouzid, M.; El-Sherif, D.M.; Al Naggar, Y.; Alshehri, M.M.; Alothman, S.; El-Seedi, H.R.; Tabelasi, R.; Ibrahim, O.M.; Temraz, E.H.; Buimsaehad, A.; et al. Investigating the current environmental situation in the Middle East and North Africa (MENA) region during the third wave of COVID-19 pandemic: Urban vs. rural context. BMC Public Health 2022, 22, 177. [CrossRef] [PubMed]
2. Abouzid, M.; El-Sherif, D.M.; Ellewacy, N.K.; Dahman, N.B.H.; Okasha, S.A.; Ghozy, S.; Islam, S.M.S. Influence of COVID-19 on lifestyle behaviors in the Middle East and North Africa Region: A survey of 5896 individuals. J. Transl. Med. 2021, 19, 129. [CrossRef] [PubMed]
3. El-Sherif, D.M.; Abouzid, M.; Gaballah, M.S.; Ahmed, A.A.; Adeel, M.; Sheta, S.M. New approach in SARS-CoV-2 surveillance using biosensor technology: A review. Environ. Sci. Pollut. Res. 2021, 29, 1677–1695. [CrossRef] [PubMed]
4. Alwashmi, M.F. The Use of Digital Health in the Detection and Management of COVID-19. Int. J. Environ. Res. Public Health 2020, 17, 2906. [CrossRef]
5. Eloffy, M.G.; El-Sherif, D.M.; Elkodous, M.A.; El-Nakhas, H.S.; Sadek, R.F.; Ghorab, M.A.; Al-Anazi, A.; El-Sayyad, G.S. Proposed approaches for coronaviruses elimination from wastewater: Membrane techniques and nanotechnology solutions. Nanotechnol. Rev. 2021, 11, 1–25. [CrossRef]
6. Filkins, B.L.; Kim, J.Y.; Roberts, B.; Armstrong, W.; Miller, A.M.; Hultner, M.L.; Castillo, A.P.; Ducom, J.-C.; Topel, E.J.; Steinhubl, S.R. Privacy and security in the era of digital health: What should translational researchers know and do about it? Am. J. Transl. Res. 2016, 8, 1560–1580.
7. Manogaran, G.; Thota, C.; Lopez, D.; Sundarasekar, R. Big data security intelligence for healthcare industry 4.0. In Cybersecurity for Industry 4.0, Thomas, L., Schafer, D., Eds.; Springer Series in Advanced Manufacturing; Springer International Publishing: Cham, Switzerland, 2017; ISBN 9783319506993.
8. Pace, P.; Aloi, G.; Gravina, R.; Caliciuri, G.; Fortino, G.; Liotta, A. An Edge-Based Architecture to Support Efficient Applications for Healthcare Industry 4.0. IEEE Trans. Ind. Inform. 2018, 15, 481–489. [CrossRef]
9. Hathaliya, J.; Sharma, P.; Tanwar, S.; Gupta, R. Blockchain-Based Remote Patient Monitoring in Healthcare 4.0. In Proceedings of the 2019 IEEE 9th International Conference on Advanced Computing, IACC 2019, Tiruchirappalli, India, 13–14 December 2019; pp. 87–91.
10. Yan, H.; Da Xu, L.; Bi, Z.; Pang, Z.; Zhang, J.; Chen, Y. An emerging technology wearable wireless sensor networks with applications in human health condition monitoring. J. Manag. Anal. 2015, 2, 121–137. [CrossRef]
11. Reinhardt, I.C.; Oliveira, J.C.; Ring, D.T. Current Perspectives on the Development of Industry 4.0 in the Pharmaceutical Sector. J. Ind. Inf. Integr. 2020, 18, 100131. [CrossRef]
12. Aceto, G.; Persico, V.; Pescafo, A. Industry 4.0 and Health: Internet of Things, Big Data, and Cloud Computing for Healthcare 4.0. J. Ind. Inf. Integr. 2020, 18, 100129. [CrossRef]
13. Mavrogiorgou, A.; Kiourtis, A.; Perakis, K.; Miltiadou, D.; Pitsios, S.; Kyriazis, D. Analyzing data and data sources towards a unified approach for ensuring end-to-end data and data sources quality in healthcare 4.0. Comput. Methods Programs Biomed. 2019, 181, 104967. [CrossRef] [PubMed]
14. Suman, R.; Javaid, M.; Haleem, A.; Vaishya, R.; Bahl, S.; NANDAN, D. Sustainability of Coronavirus on Different Surfaces. J. Clin. Exp. Hepatol. 2020, 10, 386–390. [CrossRef]
15. Shen, Y.-T.; Chen, L.; Yue, W.-W.; Xu, H.-X. Digital Technology-Based Telemedicine for the COVID-19 Pandemic. Front. Med. 2021, 8, 646506. [CrossRef]
16. Bhaskar, S.; Bradley, S.; Sakhani, S.; Moguilner, S.; Chattu, V.K.; Pandya, S.; Schroeder, S.; Ray, D.; Banach, M. Designing Futuristic Telemedicine Using Artificial Intelligence and Robotics in the COVID-19 Era. Front. Public Health 2020, 8, 556789. [CrossRef] [PubMed]
17. Chatterjee, P.; Tesis, A.; Cymberknop, L.J.; Armentano, R.L. Internet of Things and Artificial Intelligence in Healthcare During COVID-19 Pandemic—A South American Perspective. Front. Public Health 2020, 8, 600213. [CrossRef] [PubMed]
18. Thueuemmler, C.; Bai, C. Health 4.0: Application of Industry 4.0 Design Principles in Future Asthma Management. In Health 4.0: How Virtualization and Big Data are Revolutionizing Healthcare; Springer: Cham, Switzerland, 2017; pp. 23–37. [CrossRef]
19. Javaid, M.; Haleem, A.; Singh, R.P.; Haq, M.I.U.; Raina, A.; Suman, R. Industry 5.0: Potential Applications in COVID-19. J. Ind. Integr. Manag. 2020, 5, 507–530. [CrossRef]
20. Qadir, J.; Majeed-U.-Rahman, M.; Rehmani, M.H.; Pathan, A.-S.K.; Imran, M.A.; Hussain, A.; Rana, R.; Luo, B. IEEE Access Special Section Editorial: Health Informatics for the Developing World. IEEE Access 2017, 5, 27818–27823. [CrossRef]
21. Haleem, A.; Javaid, M. Medical 4.0 and Its Role in Healthcare During COVID-19 Pandemic: A Review. J. Ind. Integr. Manag. 2020, 5, 531–545. [CrossRef]
22. Doraiswamy, S.; Abraham, A.; Mamtani, R.; Cheema, S. Use of Telehealth During the COVID-19 Pandemic: Scoping Review. J. Med. Internet Res. 2020, 22, e24087. [CrossRef]

23. Kernebeck, S.; Busse, T.S.; Böttcher, M.D.; Weitz, J.; Ehlers, J.; Bork, U. Impact of mobile health and medical applications on clinical practice in gastroenterology. World J. Gastroenterol. 2020, 26, 4182–4197. [CrossRef]

24. Pires, I.M.; Marques, G.; Garcia, N.M.; Flórez-Revuelta, F; Ponciano, V.; Oniani, S. A Research on the Classification and Applicability of the Mobile Health Applications. J. Pers. Med. 2020, 10, 11. [CrossRef] [PubMed]

25. Garg, V.; Brewer, J. Telemedicine Security: A Systematic Review. J. Diabetes Sci. Technol. 2011, 5, 768–777. [CrossRef] [PubMed]

26. Albrecth, U.V.; Von Jan, U. mHealth Apps and Their Risks—Taking Stock. Stud. Health Technol. Inform. 2016, 226, 225–228. [CrossRef] [PubMed]

27. Akbar, S.; Coiera, E.; Magrabi, F. Safety concerns with consumer-facing mobile health applications and their consequences: A scoping review. J. Am. Med. Inform. Assoc. 2019, 27, 330–340. [CrossRef]

28. Elgarahy, A.M.; Hammad, A.; El-Sherif, D.M.; Abouzid, M.; Gaballah, M.S.; Elwakeel, K.Z. Thermochemical conversion strategies of biomass to biofuels, techno-economic and bibliometric analysis: A conceptual review. J. Environ. Chem. Eng. 2021, 9, 106503. [CrossRef]

29. Abouzid, M.; Głowka, A.K.; Karránziewicz-Lada, M. Trend research of vitamin D receptor: Bibliometric analysis. Health Inform. J. 2021, 27. [CrossRef]

30. Van Eck, N.J.; Waltman, L. Software survey: VOSviewer, a computer program for bibliometric mapping. Scientometrics 2010, 84, 523–538. [CrossRef]

31. Weinstein, R.S.; Lopez, A.M.; Joseph, B.A.; Erps, K.A.; Holcomb, M.; Barker, G.P.; Krupinski, E.A. Telemedicine, Telehealth, and Applicability of the Mobile Health Applications That Work: Opportunities and Barriers. Am. J. Med. 2014, 127, 183–187. [CrossRef]

32. Portnoy, J.; Waller, M.; Elliott, T. Telemedicine in the Era of COVID-19. J. Allergy Clin. Immunol. Pract. 2020, 8, 1489–1491. [CrossRef]

33. Weightman, M. Digital psychotherapy as an effective and timely treatment option for depression and anxiety disorders: Implications for rural and remote practice. J. Int. Med. Res. 2020, 48, 1–7. [CrossRef]

34. Tourism, J.; Keshavan, M. COVID-19, mobile health and serious mental illness. Schizophr. Res. 2020, 218, 36–37. [CrossRef] [PubMed]

35. Adejoh, S.O.; Boele, F.; Akeju, D.; Dandadzi, A.; Nabirye, E.; Namisango, E.; Namukwaya, E.; Ebenso, B.; Nkhoma, K.; Allsop, M.J. The role, impact, and support of informal caregivers in the delivery of palliative care for patients with advanced cancer: A multi-country qualitative study. Palliat. Med. 2020, 35, 552–562. [CrossRef] [PubMed]

36. 2022 Amwell Review: Pros, Cons, Cost and More. Available online: https://www.healthline.com/health/mental-health/amwell-reviews (accessed on 8 February 2021).

37. Kurtzman, G.W.; Keshav, M.A.; Satish, N.P.; Patel, M.S. Scheduling primary care appointments online: Differences in availability based on health insurance. Healthcare 2018, 6, 186–190. [CrossRef]

38. Jiang, X.; Xie, H.; Tang, R.; Du, Y.; Li, T.; Gao, J.; Xu, X.; Jiang, S.; Zhao, T.; Zhao, W.; et al. Characteristics of Online Health Care Services from China’s Largest Online Medical Platform: Cross-sectional Survey Study. J. Med. Internet Res. 2021, 23, e25817. [CrossRef] [PubMed]

39. Saundisbury, C.; Quigley, A.; Hex, N.; Aznar, C. Private Video Consultation Services and the Future of Primary Care. J. Med. Internet Res. 2020, 22, e19415. [CrossRef]

40. Ahmed, S.; Sanghvi, K.; Yeo, D. Telemedicine takes centre stage during COVID-19 pandemic. BMJ Innov. 2020, 6, 252–254. [CrossRef]

41. Bhaskar, S.; Bradley, S.; Chattu, V.K.; Adisesha, S.; Nurtazina, A.; Kryykbayeva, S.; Sakhamuri, S.; Yaya, S.; Sunil, T.; Thomas, P.; et al. Telemedicine Across the Globe-Position Paper From the COVID-19 Pandemic Health System Resilience PROGRAM (REPROGRAM) International Consortium (Part 1). Front. Public Health 2020, 8, 556720. [CrossRef]

42. Qare—Téléconsultation Médicale en Ligne 7/7. Available online: https://www.qare.fr/ (accessed on 8 February 2021).

43. Home—Doctor Care Anywhere Ireland. Available online: https://shop.doctorcareanywhere.ie/pages/home?gclid=CjwKCAiAgbiQbHAEiwAuQ68kp12eybwGNAgzO2Ge3s8b8rdWxgIzlRbrskExQjotKCf0fWD7NRoCf70QAwD_BwE (accessed on 8 February 2021).

44. 2022 Quality Improvements for Rural and Remote Practice. Available online: https://www.qare.fr/ (accessed on 8 February 2021).

45. Rutherford, E.; Noray, R.; Hearrrain, C.; Quinlan, K.; Hegarty, A.; Ekpotu, L.; Arize, C.; Fabamwo, F.; Alrubaiyaan, A.; Bhupalan, A.; et al. Potential Benefits and Drawbacks of Virtual Clinics in General Surgery: Pilot Cross-Sectional Questionnaire Study. J. Med. Internet Res. 2020, 23, e25817. [CrossRef] [PubMed]

46. Book an Appointment with Your Doctor Online | Okadoc. Available online: https://www.okadoc.com/ (accessed on 8 February 2021).

47. Doraiswamy, S.; Abraham, A.; Mamtani, R.; Cheema, S. Use of Telehealth During the COVID-19 Pandemic: Scoping Review. J. Med. Internet Res. 2020, 22, e24087. [CrossRef]

48. Digital health and COVID-19. Bull. World Health Organ. 2020, 98, 731–732. [CrossRef]

49. Narla, N.P.; Surmeli, A.; Kivilehan, S.M. Agile Application of Digital Health Interventions during the COVID-19 Refugee Response. Ann. Glob. Health 2020, 86, 135. [CrossRef]
50. LittleDot-Stručni Medicinski Savjet za Zdravlje-Dostupno 0-24. Available online: https://littledotapp.com/hr/ (accessed on 8 February 2021).

51. Alanzi, T. A Review of Mobile Applications Available in the App and Google Play Stores Used During the COVID-19 Outbreak. J. Multidiscip. Health. 2021, 14, 45-57. [CrossRef] [PubMed]

52. Agarwal, N.; Jain, P.; Pathak, R.; Gupta, R. Telemedicine in India: A tool for transforming health care in the era of COVID-19 pandemic. J. Educ. Health Promot. 2020, 9, 190. [CrossRef] [PubMed]

53. Аналитична консултация врача-заказать вопрос доктору в Яндекс Здоровье. Available online: https://health.yandex.ru/BwE (accessed on 8 February 2021).

54. Book Online Doctor | DoctorCam | Telehealth Service. Available online: https://doctorcam.com.au/?gclid=CjwKCAiAgbiQBlHHEiwAuQ6bkl_hk1DPuD-syAaIlW8jiVyzr4m6eNRcW4A5UD1ZX0OXYy_U0QGuRoC0VEQAvD_BwE (accessed on 8 February 2021).

55. Farid, S.F. Conceptual Framework of the Impact of Health Technology on Healthcare System. Available online: https://udok.co.za/ (accessed on 8 February 2021).

56. Nigeria’s #1 Telemedicine Provider | Health Connect 24x7. Available online: https://www.healthconnect247.com/ (accessed on 8 February 2021).

57. Alanzi, T. A Review of Mobile Applications Available in the App and Google Play Stores Used During the COVID-19 Outbreak. J. Multidiscip. Health. 2021, 14, 45-57. [CrossRef] [PubMed]

58. Zhang, Y.; Balochian, S.; Agarwal, P.; Housheya, O.J. Artificial intelligence and its applications. Available online: https://littledotapp.com/hr/ (accessed on 8 February 2021).

59. Reddy, P.P. EasyChair Preprint Artificial Superintelligence: An AI That Makes Better AI’s Recursively. EasyChair Prepr. 2020, 4077, 11.

60. LeCun, Y.; Bengio, Y.; Hinton, G. Deep learning. Nature 2015, 521, 436-444. [CrossRef]

61. Boyer, J. Artificial Intelligence (AI) or Intelligence Augmentation (IA): What Is the Future? AI 2020, 1, 143–155. [CrossRef]

62. Hassani, H.; Silva, E.S.; Unger, S.; Tajmazinani, M.; Mac Feely, S. Artificial Intelligence (AI) or Intelligence Augmentation (IA): What Is the Future? AI 2020, 1, 143–155. [CrossRef]

63. Rivoltella, P.C. The third age of the media. Res. Educ. Media 2018, 10, 1–2. [CrossRef]

64. Chatila, R.; Renaudo, E.; Andries, M.; Chavez-Garcia, R.-O.; Luce-Vayrac, P.; Gottstein, R.; Alami, R.; Clodic, A.; Devin, S.; Girard, B.; et al. Toward Self-Aware Robots. Front. Robot. AI 2018, 5. [CrossRef]

65. LeCun, Y.; Bengio, Y.; Hinton, G. Deep learning. Nature 2015, 521, 436-444. [CrossRef]

66. Hassani, H.; Silva, E.S.; Unger, S.; Tajmazinani, M.; Mac Feely, S. Artificial Intelligence (AI) or Intelligence Augmentation (IA): What Is the Future? AI 2020, 1, 143–155. [CrossRef]

67. Farid, S.F. Conceptual Framework of the Impact of Health Technology on Healthcare System. Available online: https://udok.co.za/ (accessed on 8 February 2021).

68. Zhang, Y.; Balochian, S.; Agarwal, P.; Housheya, O.J. Artificial intelligence and its applications. Available online: https://littledotapp.com/hr/ (accessed on 8 February 2021).

69. Venna, S.R.; Tavanaei, A.; Gottumukkala, R.N.; Raghavan, V.V.; Maida, A.S.; Nichols, S. A Novel Data-Driven Model for Real-Time Influenza Forecasting. IEEE Access 2018, 6, 840491. [CrossRef]

70. Lu, F.S.; Hattab, M.W.; Clemente, C.L.; Biggerstaff, M.; Santillana, M. Improved state-level influenza nowcasting in the United States leveraging Internet-based data and network approaches. Nat. Commun. 2019, 10, 147. [CrossRef]

71. Ahmed, A.A.; Abouzid, M. Arbidol targeting influenza virus A Hemagglutinin; A comparative study. Biophys. Chem. 2021, 277, 106663. [CrossRef]

72. Hassani, H.; Silva, E.S.; Unger, S.; Tajmazinani, M.; Mac Feely, S. Artificial Intelligence (AI) or Intelligence Augmentation (IA): What Is the Future? AI 2020, 1, 143–155. [CrossRef]

73. Mori, A.; Cirstea, B.; Sahakian, B.J. Knowing me, knowing you: Theory of mind in AI. Psychol. Med. 2020, 50, 1057–1061. [CrossRef]

74. Rivoltella, P.C. The third age of the media. Res. Educ. Media 2018, 10, 1–2. [CrossRef]

75. Zhang, C.; Lu, Y. Study on artificial intelligence: The state of the art and future prospects. J. Ind. Inf. Integr. 2021, 23, 100224. [CrossRef]

76. Hassani, H.; Silva, E.S.; Unger, S.; Tajmazinani, M.; Mac Feely, S. Artificial Intelligence (AI) or Intelligence Augmentation (IA): What Is the Future? AI 2020, 1, 143–155. [CrossRef]

77. Reddy, P.P. EasyChair Preprint Artificial Superintelligence: An AI That Makes Better AI’s Recursively. EasyChair Prepr. 2020, 4077, 11.

78. Zhang, Y.; Balochian, S.; Agarwal, P.; Housheya, O.J. Artificial intelligence and its applications. Math. Probl. Eng. 2014, 2014, 804091. [CrossRef]

79. Hassani, H.; Silva, E.S.; Unger, S.; Tajmazinani, M.; Mac Feely, S. Artificial Intelligence (AI) or Intelligence Augmentation (IA): What Is the Future? AI 2020, 1, 143–155. [CrossRef]

80. Ahmed, A.A.; Abouzid, M. Arbidol targeting influenza virus A Hemagglutinin; A comparative study. Biophys. Chem. 2021, 277, 106663. [CrossRef]

81. Venna, S.R.; Tavanaei, A.; Gottumukkala, R.N.; Raghavan, V.V.; Maida, A.S.; Nichols, S. A Novel Data-Driven Model for Real-Time Influenza Forecasting. IEEE Access 2018, 6, 840491. [CrossRef]

82. Hassani, H.; Silva, E.S.; Unger, S.; Tajmazinani, M.; Mac Feely, S. Artificial Intelligence (AI) or Intelligence Augmentation (IA): What Is the Future? AI 2020, 1, 143–155. [CrossRef]

83. Hassani, H.; Silva, E.S.; Unger, S.; Tajmazinani, M.; Mac Feely, S. Artificial Intelligence (AI) or Intelligence Augmentation (IA): What Is the Future? AI 2020, 1, 143–155. [CrossRef]

84. Hassani, H.; Silva, E.S.; Unger, S.; Tajmazinani, M.; Mac Feely, S. Artificial Intelligence (AI) or Intelligence Augmentation (IA): What Is the Future? AI 2020, 1, 143–155. [CrossRef]

85. Hassani, H.; Silva, E.S.; Unger, S.; Tajmazinani, M.; Mac Feely, S. Artificial Intelligence (AI) or Intelligence Augmentation (IA): What Is the Future? AI 2020, 1, 143–155. [CrossRef]

86. Hassani, H.; Silva, E.S.; Unger, S.; Tajmazinani, M.; Mac Feely, S. Artificial Intelligence (AI) or Intelligence Augmentation (IA): What Is the Future? AI 2020, 1, 143–155. [CrossRef]

87. Hassani, H.; Silva, E.S.; Unger, S.; Tajmazinani, M.; Mac Feely, S. Artificial Intelligence (AI) or Intelligence Augmentation (IA): What Is the Future? AI 2020, 1, 143–155. [CrossRef]

88. Hassani, H.; Silva, E.S.; Unger, S.; Tajmazinani, M.; Mac Feely, S. Artificial Intelligence (AI) or Intelligence Augmentation (IA): What Is the Future? AI 2020, 1, 143–155. [CrossRef]

89. Hassani, H.; Silva, E.S.; Unger, S.; Tajmazinani, M.; Mac Feely, S. Artificial Intelligence (AI) or Intelligence Augmentation (IA): What Is the Future? AI 2020, 1, 143–155. [CrossRef]

90. Hassani, H.; Silva, E.S.; Unger, S.; Tajmazinani, M.; Mac Feely, S. Artificial Intelligence (AI) or Intelligence Augmentation (IA): What Is the Future? AI 2020, 1, 143–155. [CrossRef]
79. Luxton, D.D.; Kayl, R.A.; Mishkind, M.C. mHealth Data Security: The Need for HIPAA-Compliant Standardization. *Telemed. E-Health* 2012, 18, 284–288. [CrossRef]
80. Pisani, E.; AbouZahr, C. Sharing health data: Good intentions are not enough. *Bull. World Health Organ.* 2010, 88, 462–466. [CrossRef]
81. Privacy Code of Conduct on Mobile Health Apps! Shaping Europe’s Digital Future. Available online: https://ec.europa.eu/digital-single-market/en/privacy-code-conduct-mobile-health-apps (accessed on 8 February 2021).
82. Rumbold, B.; Wenham, C.; Wilson, J. Self-tests for influenza: An empirical ethics investigation. *BMC Med. Ethics* 2017, 18, 33. [CrossRef]
83. Van Panhuis, W.G.; Paul, P.; Emerson, C.; Grefenstette, J.; Wilder, R.; Herbst, A.J.; Heymann, D.; Burke, D.S. A systematic review of barriers to data sharing in public health. *BMC Public Health* 2014, 14, 1144. [CrossRef]