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Impact of Modern Technology on Healthcare Quality and Data Safety

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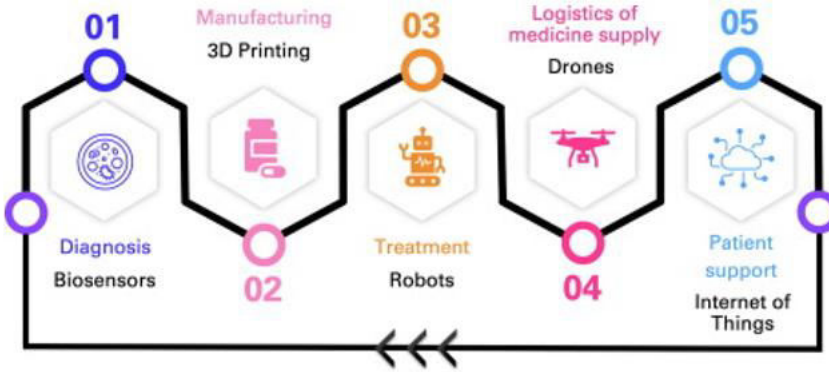
ABSTRACT

The use of information technology has become an essential part of nearly every facet of our lives, and it is increasingly becoming an important part of providing high-quality healthcare. This statement outlines the expected benefits of health information technology, the types of systems that need to be encouraged, and the barriers to its implementation. Information technology is an essential part of any successful public health operation. Every aspect of health departments' operations, from the collection of vital statistics to disease surveillance, case investigation, and public health education, is benefited by the implementation of a health IT strategy. The use of clinical information technology has the potential to improve healthcare quality, prevent medical errors, increase the efficiency of care provision, and reduce the administrative costs of healthcare. Although studies related to the impact of IT on quality are few, there have been several discussions of its effects. The patient safety literature clearly indicates that medical errors are largely the result of systems problems, including poorly designed IT. (Sheikh et al.2021)

1. Introduction

This chapter reflects on the impact of modern technology on healthcare quality and data safety. Information technologies undoubtedly bring a positive impact on medical services for both patients and doctors, who are able to implement better procedures that would otherwise have required many resources. All kinds of data, including patient history, lab test results, and doctors' daily orders, are collected and stored permanently, providing healthcare professionals with necessary information quickly. Modern IC card technology further assists doctors in identifying patients and looking up their medical records. Moreover, state-of-the-art operating systems, such as image-guided surgery, help doctors increase the accuracy of diagnosis and therapy, perform

minimally invasive therapy, and shorten recovery time for patients. On the other hand, with the evolution of modern medical information technologies, many different information systems and hardware equipped with complicated function codes increase the risk to medical information safety. In the clinical workplace, communication and connections between medical systems are necessary to implement the requirements of treatment services, but the highly effective conditions certainly increase the margin for system accidents, resulting in patient mediation. The transmission of patient privacy data from these electronic clinical systems has become a crucial problem for medical preservation, and the safety of patient privacy data is a vital proposition in the modern medical environment. The ethical parameters surrounding the residual data on these newborn screening cards are complex and confounding, inexorably resulting in a one-size-fits-all approach that allows 'deidentified' data to be widely shared or reused with varied levels of privacy protections. It remains uncertain whether the existing federal privacy framework adequately addresses lingering societal concerns associated with these public health mandates. Additionally, concerns for patient civil liberties have bred growing apprehension surrounding the development of global information systems, levels of privacy disclosures, and other private policy issues in healthcare. (Haleem et al.2022)



2. Technological Advancements in Healthcare

Over the years, humans have made tremendous advancements in science and technology. Researchers have emphasized that these advancements can transform every aspect of healthcare, providing better and highly coordinated care, preventing dangerous outcomes, ensuring precision in drugs and treatment, reducing costly expenses, and improving workforce education and training. After several decades, technological advancements have incorporated a rudimentary understanding of the resulting revolutions in healthcare, as new inventions have mostly been reacted to soon after a technology detects an amazing solution to reduce long-lasting issues in healthcare, despite offering a powerful technology that promises transformation in the health sector. Despite all these setbacks, technological elements have shown some improvement that can predict the present healthcare provision and how they are geared toward growing population needs, fostering improvement in implementing and creating the latest technologies applied in remote and urban healthcare. Over the years,

modern technology has had a vital impact on most businesses, including healthcare. Healthcare professionals have utilized these inventions to provide better treatment and therapy for patients, resulting in reduced healthcare expenses and improved residential convenience. The latest developments, such as wireless technology, mHealth applications, and technological improvements, have created a revolutionary transformation. However, in some cases, technological advancements have created workarounds that may be difficult for many practitioners to control, as the latest technological inventions, such as data methods, can protect information from attacks by unauthorized third parties while allowing care workers legitimate access. The invention of new sensors and mHealth applications is well-positioned to further improve the balance among savvy information. Innovative technologies offer healthcare professionals improved monitoring techniques and enhanced access to the necessary knowledge. (Al-Jaroodi et al., 2020)

2.1. Electronic Health Records (EHRs)

The adoption of Electronic Health Records (EHRs) instead of traditional paper records had minor effects on quality, as defined by 30-day mortality rates, and costs, regardless of whether the hospital was part of a health system. For non-system hospitals, the productivity decrease is associated with a lower probability of EHR use in larger rural hospitals. Complete EHRs are more optimal than partial ones, but this effect only materializes in later years. EHRs have reached the expected benefits with respect to length of stay when implemented in full compliance with goals, and have partially taken the expected benefits. These results imply that policy action must be better defined and adopted to ensure progress towards optimization and recognize the year in which maximum benefits are reached. Electronic Health Records (EHR) is the actual technology system used to maintain patient-level data. It is a multi-purpose, real-time shift from paper charts to standard formats, providing access to national models of personalized, risk-adjusted outcomes, quickly identifying and forecasting trends and occurrences, and increasing the visibility of in-hospital hazards and quality revelations, as well as the clarity and consistency of clinical pathways. During the realization of clinical management and continuity, increasing quality healthcare at lower costs should be achieved through EHR. For patients, hospitals, physicians, and other healthcare professionals, new healthcare service production procedures are identified with the accepted EHR. (Woldemariam & Jimma, 2023)

2.2. Telemedicine and Telehealth Services

Telemedicine is the use of medical services like telecommunication to attain the best care possible for a patient. The pandemic greatly propelled the use of telemedicine and telehealth. However, issues were brought to light by this. Data collected was shared with other third parties without the patient's explicit permission. This can bring up the ever-demanding subject of data privacy, especially given that tech companies have gained access to the data. This means that third-party companies can tamper with the data in a way that breaches the patient's data security. This issue is one that is constantly being examined. The damage that could arise from companies mismanaging health-related data is catastrophic.

Telemedicine can greatly improve data quality. Instead of doctors scribing out notes by hand, they can input data directly into medical records. The use of telemedicine increases data quality as it is recorded in a clearer transparency format. Currently, a broad spectrum of health information is being shared. This is valuable to engineers, researchers, and administrators. It includes data from traditional sources, data collected from mHealth technologies, and health data being shared from new wearables that collect data during sleep. Asthma data can even be collected from smartphones. With data under our belt from a multitude of sources, we may be able to better manage people with advanced chronic illness. Or, we may gain new insights into patterns of chronic illness that could lead to interventions that could keep people healthier in their earlier lives. The question is, who will have access to this data? Data sharing today suggests that it is not going to be the doctor alone. Platforms leverage data that is stored inside those companies, leading to improved care. (Barbosa et al.2021)

2.3. Artificial Intelligence and Machine Learning

Machine learning is the core of artificial intelligence. It intends to build models that can learn from vast amounts of data or small information inputs and later use the acquired knowledge to make data-driven predictions or decisions. Deep learning is a subcategory of machine learning and is responsible for creating an algorithm that resembles how a human brain works. AI is the science of making intelligent machines. There is a direct application of AI in interconnected medical robots, which are in high demand due to their use for infectious diseases, cardiology, healthy aging, and applicability in hospitals and other clinical services.

The most significant advantage of robots is executing actions that can carry the virus between different places. Robots have sensors that detect motion or a physical object, identify the object that might be carrying COVID-19, and use vacuum nozzles, UV lights, or heat rays to kill the virus. Furthermore, social robots resonate with patients and ease the feeling of loneliness, give hope, and decrease psychological distress, which is substantial for healing. Some robots have fluids that perform tests and return results in half the time it takes a human to do so. The devices for laparoscopy and endoscopy can spread the virus, infecting health professionals and patients. As the robots perform robot-assisted surgeries, they decrease the number of people present in the operating room, providing safety and supporting hospitals in avoiding patient delays. In cardiology, robots can hold trocars and cauteries and automate ultrasound scanning, as well as identify specific atrial regions that are significant for ablation therapy. The advantages of using robots include lower contamination, faster tests, easing patient suffering, reducing medical staff contact, and supporting remote inspection of patients, but nursing activities cannot be performed. (Korayem et al., 2021)

3. Improving Healthcare Quality with Technology

Some ways in which modern technology can improve the quality of healthcare are discussed here. Enhanced technology provides many unique ways to optimize the quality of healthcare and the delivery of medical services. Access is improved through widespread use of training and educational materials. Many different types of specially designed software support a wide range of health-related activities. Individual patients can apply self-assessment and education procedures according to their unique needs and resources. To obtain individualized counseling regarding elective surgery or treatment for various chronic conditions or episodes of illness, patients and families are directly consulting online with healthcare professionals. Software supports end-of-life discussions as well as the availability and analysis of health records. Accompanying the foregoing innovative activities is the growing production and availability of powerful information and educational materials to foster educational program development and implementation by consumers, health professional educators, and professional caregivers. Ready access to a variety of information sources, including the many interactive systems available, is helping professionals keep informed and communicate quickly to respond to the comprehensive needs of consumers for timely and pertinent information. (Karatas et al.2022)

Some systems help in the development of new kinds of care settings or allow individuals to operate more safely in a familiar home setting in which lifestyle adjustments have been made to accommodate particular needs. The approach has been to develop a model interactive system to help health professionals and other users explore both the capabilities and limitations of information-based systems intended to support chronically ill patients as they consult with trusted members of their care teams. The approach focuses on program development necessary to help dissimilar groups anticipate, examine empirical alternatives, and consider legal and ethical challenges as they develop adaptable interactive consulting systems. Aligning personal resources with commonly recognized attributes of integrated healthcare delivery and consistent with broad ethical principles, individuals are working cooperatively to

achieve high-quality biopsychosocial services. Health promotion and disease prevention programs designed by and through the consumer can meet widely shared public health goals. Major challenges remain in developing ways to support successful self-help and consumer involvement related to pre-disease, illness, and post-acute care enhancement programs. The tasks are difficult because the desired participation levels vary by individual, context, and the specific nature of the enterprise. Large gaps exist in needed information on operating parameters of interactive programs; how consumers consider and respond to alternative access modes and related cost mechanisms; trade-offs to be made to supply high levels of quality to rich and poor users alike; and whether specialized projects can be combined with other activities to interest individual or aggregated seekers of services. As the planning model is implemented and as co-developers learn by doing, their collective knowledge will expand and contribute to the next generation of interactive healthcare systems designed to help both patients and professionals carry out their future responsibilities. (Zhang et al., 2021)

3.1. Enhanced Diagnostic Capabilities

Modern technology has led to significant improvements in the field of diagnostic procedures, enabling healthcare providers to better assess patients' health. This, in turn, contributes to better diagnosis, early detection, and treatment, thereby improving patients' quality of life. New techniques and technologies have made it possible to analyze and interpret large amounts of data that are invaluable for diagnosing and treating patients. Reducing the investigation of diagnostics based on empirical tools, particularly for diseases that represent significant health problems and those that have irregular symptoms, advances can be seen as attention-grabbing. The development of medical devices that demonstrate functional analysis at the sub-molecular level is opening up new areas for diagnosing diseases that were difficult, if not inconceivable, in the recent period.

3.2. Personalized Medicine and Treatment Plans

Personalized treatment in personalized medicine is another challenge made possible by modern technologies. To deliver a precisely personalized medicine tailored to each patient, diagnostic and treatment plans are optimized using next-generation clinical sequencing data and integrated systems approaches. In short, personalized medicine tells us to switch from today's standard treatment to the concept of modifying treatment based on the patient's information and diagnosis. In the majority of instances, medicine involves the art of trying to make decisions in the absence of all knowledge. It's a general decision. As a result, making decisions for a group, or in other words, responding to the majority, is more likely. The overriding goal of personalized medicine is to transform this approach. In personalized medicine, a doctor is going to make decisions for a select group and not the majority. As a result, thanks to the availability of large data and systems approaches, doctors are effectively able to recognize and act on individual distinctions.

This customization simply personalizes care, following a patient through the treatment continuum, disabilities, and optimization of treatment strategies. The overall goal is to

find the treatment plan that will be most beneficial for each patient. Using a wide range of diagnostic tools and analytical approaches, tailoring the treatment to an individual's biology, instead of relying on a trial and error strategy that might not work, physicians can make decisions. Knowing more about an individual's genetics, with the potential for less toxic therapy and with the intention of reducing side effects, would help refine a targeted method of treatment. Outcome-based criteria for an analysis, dose, timing, or method of treatment are many of the aspects that can be altered. Correcting and avoiding factors that can cause a chronic condition or disease, and keeping the body safe and hopeful through therapies and counseling, are other steps. In comparison to the conventional, one-size-fits-all paradigm for practice, this reinforcement of personalized medical attention will significantly enhance the overall health of the community. (Deng et al.2022)

3.3. Remote Patient Monitoring

Remote patient monitoring develops dynamic care plans to continuously and automatically monitor changes in patient conditions, accounting for variability given each patient's functional age, tailoring the monitoring intensity and content to how patients feel, and delivering insights on patients' behavior and symptoms. The objective is twofold – to optimize patient satisfaction and access while providing actionable information to manage patient safety. Remote monitoring is generally more useful as the number of parameters measured increases. Some essential monitoring devices that clinicians are deploying in virtual ICU and tele-urgent care settings, besides the standard monitors, include multi-lead wearables, respiration sensors, SpO2 sensors, ECG recorders, and body temperature monitors. Implanted devices, digital ingestibles, and digital inhalers are supplied to monitor swallowing ability and inhaler use. Video consultation platforms introduce more units of measure such as respiratory rate, oxygen saturation, body temperature, and pulse rate. Generally, video and audio consultations result in lower engagement and evaluation of fewer physical parameters of patient wellness compared to interfaces with more connected sensors. (Behar et al.2020)

4. Data Security and Privacy in Healthcare

Data security refers to the integrity, confidentiality, and security of electronic health record data. It aims to protect personal information, which is included in health information reports. Obstacles to effectively guaranteeing the integrity of the patient's medical record information are the application of the traditional infrastructure and the rapid growth of technologies that allow the record to be digitized and exploited in a wide variety of ways. Privacy, on the other hand, refers to the decision that an individual makes regarding the confidentiality of health information. The traditional digital health information security system can provide an acceptable level of patient privacy. In other words, personal privacy with security offered by traditional systems and other available technologies and approaches can provide an acceptable level of privacy.

There is a new threat currently aimed at healthcare information systems, and it is called Advanced Persistent Threat. The APT is a threat that focuses on a target for a long period of time to collect health information and health research data. It infects the biomedical informatics information system and other computer systems in the medical field. The Advanced Persistent Threat generates an increasing number of new privacy and security threats by entering into more data theft and data record modification phases. The Ultimate Protection System provides enhanced protection with strong border controls for external devices and data, which depend on the protection of each node using many different techniques and the defense-in-depth concept for system components. (Yu et al.2021)

4.1. Importance of Data Security in Healthcare

All medical research and care are built on sensitive health data, but without public trust, privacy-protected health information remains unused or underutilized. The use of electronic patient records promises the development of learning healthcare systems: improving the quality of information for the delivery of optimum healthcare and reducing the futility and costs of decision-making for research, health planning, and patient care. The use of pseudonymization and privacy-enhancing technologies, together with robust security management and design, means that sensitivity and use of this information can be maintained.

The security of medical records data, including in electronic format, is essential to ensuring that the data remains usable for the purposes for which it is collected. If major data breaches involving personal data occur, the public may reject the use of their personal and genetic health data in the quest for improvements in delivery and outcomes by the national health system based on the results of science and technology. All the inhabited world wishes to make healthcare perceived benefits of potentially significant security risks. Unfortunately, there is currently no absolute security in the storage and processing of data, and it offers an acceptable balance between the two. If security imposes excessive conditions of use, the threat to security extends to that very security, with increased episodes of fraud and inadequate data reliability. Natural targeting is comprehensive, and breaches often occur, and even insiders misuse trust. Therefore, a dilemma along the experience track poses difficult challenges for the

technology delivery systems. Healthcare is absolutely essential to providing acceptable levels of quality at reduced cost while maintaining public health and informed clinical confidence in healthcare research and planning with the population. (Vimalachandran et al.2020)

4.2. Cybersecurity Threats and Vulnerabilities

Cyberattacks on health care organizations are rising and threatening personal confidentiality. Currently, there is a lack of certificate management systems, authentication mechanisms, and end-to-end encryption in telehealth systems. Cybersecurity is lacking for clinical workstations, mobile devices used in health care, and the IoT equipment to which they are connected. If a misconfiguration or vulnerability in a medical device is discovered and exploited by an attacker, there could either be a system shutdown or access to health-related information through the exploited connection. It is essential and non-negotiable that an in-depth analysis of a system's cybersecurity program is conducted to ensure protection and prevent further exploitation.

A PPS consists of all devices that are connected to the Internet and are dependent on technology, which have the potential to leak sensitive data into unknown channels. A PPS does not only contain IoT devices such as cell phones, cameras, and smartwatches, but it also consists of patient monitors, infusion pumps, and other medical devices whose purpose is to provide care. If a device is found to have a vulnerability or weakness that can cause harm or affect patient care, especially when they are interconnected, it not only becomes burdensome but also a significant concern regarding how to deal with the PPS within healthcare. The increased dependency on IoT devices and medical devices linked to a healthcare network further amplifies the potential vulnerabilities that already exist within networked systems. (Tekinerdoğan et al.2020)

4.3. Compliance with Regulations (e.g., HIPAA)

Compliance with regulations is a very important issue. One significant concern is protecting patients' private health information. It is important to note that clear legal requirements are in place. Relative to financial and other forms of private information, it is actually harder for data breach victims to recover. While a significant percentage of the total privacy violations of financial or other private data comes from being made public, this key form of violation does not occur for private health information, because the new reader would not understand most of it.

There are substantial costs of private health information data breaches. First, there are the potential fines for violations. These range from a minimum of a specified amount to a maximum of a specified amount a year, depending on the "level of neglect," which ranges from no neglect to "willful neglect not corrected." The typical case may incur hundreds of dollars per affected record, and one of the primary types of use after a data breach is medical identity theft. This is much more costly than financial data theft because the breaching party will take money from both your financial capital and your health care capital. The latter is much more valuable, but is also much harder for the new owner to use. Therefore, reported financial losses could understate the true medical identity theft losses to individual patients who are the victims of such theft.

5. Ethical Considerations in Healthcare Technology

Healthcare technology touches on the lives of everyone, from the patients depending on it to the health professionals more and more reliant on it. But the ethical and social considerations of this technology are often overlooked or considered after it has been introduced. Too often, healthcare technology is presented to users, be they health professionals, patients, or caregivers, as a benign choice, while the choices of how and why to use it are translated into technology. The agenda for healthcare technology should be set by users and those making the ethical and social policy surrounding it. The ethical policy should go hand in hand with the technologies, aiming to provide the population with the truly wanted relevant benefits, for example, using the internet for more inclusive healthcare systems focused around patients' specific needs. This helps society tackle real health problems while concentrating less on internet technology's political-economic benefits as an end in themselves. This chapter considers some of the generic issues debated in emerging and future healthcare technology and debates whether various stakeholders' needs are truly being considered. The chapter focuses on the impact of ICT upon healthcare systems, where developments are being driven by IT innovation rather than patient and care-requiring needs. Many are embracing the benefits of IT in healthcare, which include cutting costs, effectiveness, productivity, increased efficiency, higher quality, improved healthcare, improved overall lifestyle, well-being, and privacy. The communications ramifications of internet technology have become key influencing decision-makers. The above list of advantages does and has still influenced many key influential healthcare policies. (Attaran, 2022)

5.1. Ensuring Patient Consent and Data Ownership

But not only are data privacy laws on the radar, regulation around consent will need to evolve. We've all been in the situation as patients where we are required to sign a paper bequeathing the right of use to our DNA sample or any tissue or bodily fluid taken from our own body that becomes the property of the hospital or institute collecting them. Our own data is taken away from us without our consent or knowledge. Big tech companies are building digital health platforms and medical evaluation tools, and it will be our personal health data that is of great value. It won't only be technology innovators collecting this data but large companies where the wealth is typically held by the investor, not the consumer. Various regions and states already have legislative restrictions on what tech companies can do with their ingested personal health data. However, ensuring a level data and technology playing field will be important to build and maintain robust technology applications. (Hsu et al.2021)

5.2. Equitable Access to Healthcare Technologies

Equitable access is the level of healthcare services that are provided and distributed at the rate of the population’s demand and at the right time for everyone and without discrimination. It is a basic human right process, but is available to everyone outside of international human rights law. Equal access to safe and effective technology is difficult to achieve in practice, especially in developing countries and rural areas. The methods of providing healthcare technologies that are ecologically sustainable and facilitated by the effects of globalization and applications of social media are usually

mentioned as ways to reach equal access to health technologies. It is important to use e-health systems in structuring all main healthcare service access areas such as pre-diagnosis, prevention, intervention, counseling, monitoring, and follow-up, whether confidentially and securely, independent of personal, geographical, and organizational factors. In any telehealth system operated on different platforms or any mobile application for disease monitoring and counseling, technological development should be carried out in a transparent and observable way, especially in the protection of privacy.

The systems are required to be valuable, reliable, secure, and to perform successfully. Detailed regulations for filing a security review in relation to telehealth applications should be established. Furthermore, strong policy decisions must be made, and a special public health capacity must be developed from within the national government. Although e-health systems are very effective tools to reach all people and neighborhoods, countries and regions, it is also a pathway to a new unequal social dependency on technology. Thus, standard e-health technologies are not sufficient to build clear, comprehensive, and easy access to healthcare technologies. Public health administration should undertake both national and international responsibilities in the field of public health to operate in areas of telemedicine and e-health. It is important to provide global public belief in the implementation of the most valuable, reliable, and safe e-health technology and also to guide its technical applications to strategic goals. In this direction, it is proposed to provide standardization of telemedicine and e-health technologies with the cooperation of regional and international standard organizations. (Jonsson et al.2023)

5.3. Avoiding Bias in AI Algorithms

Here are some methods for avoiding bias in AI algorithms:

Start with transparency: An AI algorithm is only useful if its developers articulate its objective, adopt proper criteria, and demonstrate that it is a fair and impartial tool. To ensure transparency, AI model developers should describe how they train the algorithm, the method they used to select training data, how they selected the criteria for testing the algorithm's accuracy, how the algorithm was tested, and what data sources were used.

Query data for bias: It is important to find and address bias in the data used to train AI algorithms. Visualizations help to create a visual comparison of differences between groups, but sometimes patterns only emerge after data is stratified into even smaller units. Another technique to check data for bias is to examine whether the performance of an algorithm differs among subgroups.

Eliminate bias in the underlying data: It is important to select a representative, unbiased, and balanced data set to train AI models so that the data mirrors the population the AI will serve. If the training data covers a limited or distorted range of data that the system will encounter after it is deployed, then the system will perform inaccurately. If a lack of diversity exists in the training data, an AI model will share this bias and can impart the bias in its medical decision-making capabilities as well.

Final note to developers: They must ensure that the data used to train the algorithm is backed by evidence supporting the elements of the criteria used to evaluate the AI. Such an evaluation can help ensure the AI tools are clinically sound as well as reduce bias where it presents. All AI models and their major inputs should be carefully validated with attention given to subgroups because this process may highlight these areas of bias. Preventative action should be taken when bias is detected. Such inquiries will provide human oversight when the AI is clinically integrated.

6. Challenges and Limitations of Technology in Healthcare

While modern technology has revolutionized the healthcare domain in multiple ways that enhance healthcare quality, it doesn't come without embedded challenges and limitations. Due to the incorporation of a wide variety of healthcare devices, the existing standards and guidelines of the medical device industry act as both a facilitator and a barrier. While the penetration of wireless networks seems to be a boon as it interconnects healthcare infrastructure, network errors due to increasing data demand and security hazards could pose great trouble for the healthcare environment. Integration among wireless health devices would alleviate the gap between specialist devices, resulting in personalized healthcare through various aspects. It is a matter of concern how such health devices interact within the body, as implantation or wearable features are posed among health devices. Also, as these devices become more prevalent and forward-looking, concerns arise regarding data validity and information reliability. (Qadri et al.2020)

Another challenge is data interoperability, which obstructs information exchange to achieve a seamless, integrated wireless health ecosystem from various platforms. Data partnering also makes the wireless health area surpass the technology level of everyone working in it. Security has been a critical issue for the majority of wireless systems in the healthcare environment. Costs of implementation, cost-effectiveness, and actual return on investment are other challenges to be addressed. One main challenge is the Health Industry Continuum, which emphasizes the information continuum of continuum-based concepts that discuss integrated care across settings to provide patients with a better care experience, improve the health of the population, and help reduce the cost of healthcare.

6.1. Integration and Interoperability Issues

This section offers an overview of the impact of digital technology on the U.S. health sector, with a focus on access, engagement, and clinical outcomes. As technological advances continue to leverage significant improvements in both access and outcomes, they also create a wealth of new challenges such as data capture, access, and ownership; care coordination; and overall system efficiency. Furthermore, many senior health consumers, particularly those who report high health care spending or poor health status, face challenges accessing or getting the help they need using available digital tools. Participants at the convening also noted that technology solutions should create value, not impose additional new costs. Addressing the digital divide in health care will remain a priority if the adoption of health technology innovations is to truly improve the health of the nation.

While standalone offerings, such as stand-alone apps or electronic health records, can be valuable, events co-chairs emphasized that the utility of such tools is limited by current constraints to data usage, such as being spread across multiple sites and being owned by multiple organizations. A higher priority should be placed on innovative solutions that fully integrate and operationalize new technologies into care at the point of delivery. Relevant technology should be applied at the right time for all patients and families to ensure benefits are widely shared. Furthermore, technology often introduces value through system-level innovations that optimize the processes of care delivery, which may not necessarily be reflected in visible interface features. As a result, several important technology-driven trends are best identified through measures of relative system efficiency. (Sarwar et al.2022)

6.2. Cost and Resource Constraints

Several factors contribute to a site's ability to invest in vertical technology development. Funding and procurement procedures are classically pointed to blame. Long and bureaucratic procurement procedures, as well as suffocating regulatory restrictions, all contribute to delaying or even canceling important innovation. Engaging hospital and technical staff in different departments and locations can be a significant challenge. These challenges are magnified in multi-country programs. Legal, cultural, or even political differences among participating nations can add time and cost to an already laborious process. Competition between diverse programs or objectives for investment capital, with the help of hospital sponsors, brings its own problems. Funding levels can dictate what is realistic. Low-budget initiatives that are implemented can take longer to come to scale or may never be able to attain real, sustained impact. Lack of expertise on how applications of innovation will influence direct processes of patient care or other hospital functions can also deter good projects. This is a significant disincentive to hospital managers investing in major technical advances. (El Bizri, 2021)

In conclusion, scarce resources and the governance that exists to allocate them can lead to the selection of cost over innovation in budget-setting committees. Clinical patient safety, quality, service, usability, security, compliance, control of infections, emergency preparedness, layout, and capacity administration are all immediate central areas of emphasis. These investment decisions can be particularly limiting when looking at an entire group of hospitals, regional or national, where authoritative direct control is complicated by the dissimilarities of needs and objectives for individual facilities. Careful thought and policy need to be applied to make technology improvement programs beneficial and fruitful.

6.3. Digital Divide and Access Disparities

In the context of socioeconomics, the digital divide refers to the gap between more and less affluent individuals in their possession of or understanding of information technologies. It includes a knowledge gap across different strata of society and the lack of infrastructure, such as broadband and associated digital connectivity tools. Barriers to internet access for certain segments of the United States include the cost of a computer, broadband, and other electronic devices. Other challenges to internet access include the perceived need for digital skill sets to make internet use meaningful.

Indeed, the proportion of adults without any internet access is steadily showing a decline. The divide often occurs along age and income lines: nearly 8 in 10 adults with annual household incomes exceeding $100,000 currently use the internet, but that share falls to 44% for adults with annual household incomes between $30,000 and $49,999 and to one quarter of those earning less. (Aissaoui)

In rural areas, a home internet subscription is less common than in urban or suburban areas, with rural non-users saying the internet is not relevant to their lives. These concerns cause them not to miss it. Furthermore, the cost of subscriptions is more challenging for some rural residents. Those residents sometimes feel that going online could be unsafe. The rising cost of internet service is associated partly with the declining ownership of computers and partly with the perceived lack of relevance of the internet. Among rural adults lacking broadband, a third claim slow speed as the most significant deterrent. There is also a fear of inadequate computer skills hampering internet usage. This finding may signify the inhibiting role of knowledge and experience in shaping user behavior with technology access, and it is broadly applicable to virtually all entities relevant to healthcare and other information and communication technology services. Data on digital disparities, which affect everyone but especially vulnerable groups, indicates a need for more targeted IT policies and specific assistance programs for them.

7. Future Trends and Innovations in Healthcare Technology

In the future, healthcare technology may include the development of intelligent and advanced robots that will be able to assist healthcare professionals efficiently. The development of mobile and wireless monitoring systems will enable patients to take care of themselves with minimal assistance from others. Networked radio frequency identification and embedded sensor technology will be used to secure data. The development of personalized medicine, such that the drug, dosage, and treatment are patient-specific, will gain importance. This will be possible with the help of the patient distant inheritance database, which will enable the generation of proper patient genome sequences, helping the physician make the correct decision. Frequent advancements in next-generation microarray lab-on-a-chip techniques will facilitate rapid and efficient gene sequencing and genotyping.

The development of the EMR system, which includes a MicroClinic that merges an EMR and genetic data to create a unique, actionable, proactive data product, has high potential in creating advances in personalized medicine. The use of 3D near-infrared scanning technology for heart failure patients may have multiple health benefits, such as approximately half to two-thirds the number of bacteria present, may reduce the risk of stroke by as much as 46%, and may reduce the risk of endocarditis. It is a very promising approach to reduce healthcare costs and improve health outcomes. Head-mounted displays for emergency medical services allow the doctor in the hospital to command and interact with various entities in the ambulance, and the data received from the ambulance is accessible to the doctor in real-time, enabling them to view the patient's condition and undertake appropriate action. With such technological

advances, the healthcare system will see dramatic improvements in survival rates and long-term morbidity. (Ye et al.2024)

7.1. Internet of Medical Things (IoMT)

The Internet of Medical Things (IoMT) is linked with e-health, improving dental service and exoskeletons, and is a versatile platform that connects various medical devices both inside and outside of the human body to the Internet. These connections provide knowledgeable patients with more control over their healthcare needs. The IoMT has already had a number of significant positive effects, including the establishment of more efficient healthcare monitoring and management, drug development, assisted living activities, patient education, help with outreach services to underserved populations, and more effective public health programs. The data collected can further be adapted for research purposes, which will be used for innovative solutions that have the potential to predetermine diseases, provide new treatments, and even provide a future of tailored or personalized medication.

The downside of this "smart" medical device revolution is the catastrophic effect it may have on patients should the data be hacked and the devices fail to work, are tampered with, or are remotely controlled by an outsider. Consequently, the introduction of the IoMT may involve the use of regulations such as de-identification, vendor security programs, and pre-market and post-market requirements to ensure data security and prevent device failures and the dangers posed should a cybercriminal sabotage the smart medical devices.

7.2. Blockchain Technology in Healthcare

As we move into a data-driven economy, it is not only the volume and speed of data that matter, but the security and privacy of data, particularly in the health sector. Blockchain is a digital ledger to record transactions or other data across a secure and decentralized network. It is still at a relatively early stage of implementation, but it holds significant value, especially in sectors such as healthcare, where the security and privacy of data are crucial. The digital revolution in the 21st century has transformed many sectors and is showing great potential for the health sector by improving healthcare quality and public health through the use of technology. Health systems around the world are struggling to cope with the number of patients and the demand for healthcare services. Blockchain technology has the potential to help solve some of the infrastructure issues that plague health enterprises across the world. The worldwide trend toward mobile technology can be harnessed to enable access to electronic health records for both remote and local medical providers. Significant potential exists for the technology pitfalls of cloud storage, data and transmission security, and the transferring of access rights and permissions for protected health information to be solved using clever blockchain manipulations. The humble blockchain can spark a new approach to infrastructure and management of the age-old problem of our health data. With a robust support system thrown into the mix, the resulting different facets of blockchain could substantially help global public health outcomes via EHR manipulation, interoperability, and information sharing among the stakeholders with no single source of failure. (Farouk et al., 2020)

7.3. Predictive Analytics and Big Data

Predictive analytics is designed to predict future events by relying on a combination of patterns within an existing data set, which includes more detailed and comprehensive real-time and life-cycle data on both security components and the health system. By applying predictive analytics to the current data set and identifying a variety of adverse events and healthcare-associated infections such as healthcare-acquired pressure ulcers and lung-associated infections, sepsis, respiratory depression, and opioid dependence, the health system will be able to respond proactively to intervene and improve EHR data by linking databases from hospital information systems with real-time technologies and by collecting potential cognitive patient-generated data that may affect the correlation and veracity of the linkage to construct a detailed record of patient visits. It entails integrating the collected data from different sources and using machine learning tools for predictive modeling to identify a variety of negative events such as healthcare-associated infections. The framework enables important clinical risk standard characteristics such as awakening, cuff false tenderness height, arrhythmia, plug aspiratory and diaphragm urine, the source of false suction, and a programmed notification of the nursing paradigm of a patient that is in the system and in time for an examination. Predictive analytics provides real-time solutions that work in the form of integrated people, processes, and technologies to address vulnerabilities frequently due to the interaction between and within the patients and the different types of critical information from their EHRs. Currently, there are no analyses that aim to evaluate EHR supplementary data for the prevention of OUA morbidity.

8. Conclusion

We reviewed some of the benefits of the use of modern technology and the digital transformation of healthcare on the improvement and safety of patients. As also discussed, there are some limitations, but we believe that reducing the many mistakes found in health units due to human factors is of fundamental importance. We felt during this revision that technology allows us to construct increasingly complex tools to support all professionals, allowing them to provide increasingly better services. A premise is that technology must serve people. Many people complain that humanization has diminished due to modern technology. Furthermore, humanization should be a topic to pay attention to because when people feel respected, understood, supported, and at ease, they achieve better agreements with health professionals, and we gain more supporters for the new digital tools. Health can increasingly be considered a new pillar of that, but in parallel, the humanization of the health sector has to be consolidated. To conclude, our aim is to draw the reader's attention to the scientific evidence of the advantages of modern data storage technology, as well as data hesitance technology. Finally, we expect to help health professionals understand when the technologies addressed here can assist in curing patients more safely, according to security parameters, cost, and related conclusions.

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