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Convergence of SaaS, AI, and Telecom in Telehealth: Transforming the future of healthcare delivery through intelligent systems

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Abstract

This paper aims at identifying and analyzing how SaaS, AI, and Telecom are changing the way healthcare is delivered by focusing on telehealth. The goal is to determine the current status of these combining technologies, identify future developments and trends in intelligent telehealth systems, and analyze the opportunities and risks associated with their implementation. Following a systematic review, relevant publications published between January 2014 and January 2024 were gathered from various databases. Finally, eight studies were included for analysis, after exclusion and inclusion criteria were applied. The findings show that SaaS, AI, and Telecom are transforming telehealth by improving the remote patient monitoring, the access to care, and the moving from the reactive to the proactive approach to health. SaaS enhances adaptable and affordable approaches, while AI infuses precise identification and reasoning. Telecom provides secure and steady communication and data transfer while facing issues regarding data security, legislation acts, and disparities in infrastructure. Overall, these research studies highlight the key possibilities of developing the application of telehealth through the integration process of these technologies.

Keywords: SaaS; Telecom in Telehealth; AI; Healthcare Delivery; Intelligent Systems

1. Introduction

Telemedicine which is a technique of providing medical care through telecommunications has become the new order in delivering medical care (1). mHealth deals with a broad category of services and implementation of technology including the teleconsultation, patients monitoring and mobile applications (2). Since telemedicine allows healthcare professionals to assess, diagnose, and treat a patient without a face-to-face meeting (3), it can be described as a convenient, rational, and appealing practice modality (4). The availability and use of Telemedicine technologies such as advanced telecommunication and connectivity solutions (1, 5), mHealth apps (6), Wearable technology systems, and innovations in Artificial Intelligence and machine learning have revolutionized healthcare (7, 8). Today's advancements have improved both the quality and availability of health care services, which have in turn made patient care more individualized and preventive in nature (9). Indeed, with the advancement of Technology, telemedicine is set for even more definitive enhancements of the methods of healthcare delivery that are patient focused as well as data-driven (10, 11).

Telemedicine is now a central concept in healthcare that has been recognized due to its necessity for innovation, integration, and patient-focused approaches (12). It highlights important and relevant concerns including the inadequately supply of health human capital with special emphasis on remote and hard-to-reach communities and the call for early medical attention among others (13). Telemedicine has been especially useful during the COVID-19 pandemic as it constitutes a way for patient exhibition and chronic disease management with reduced risks of viral

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spread (14). Telehealth has been shaped and characterized by the integration of SaaS, AI, and Telecom (15). SaaS offers easily manageable and affordable versions of applications indispensable for healthcare providers to offer telemedicine services without having to build robust tech structures (16). Telehealth or telemedicine is improved through integration with AI as it makes it possible to make informed decisions, individualized decisions, and even predictive decision making (17). Telecom guarantees the availability of telehealth services and provisions data and communication between patients and providers to make the process possible for more people (10, 15).

Thus, this article seeks to understand the blended entity of SaaS, AI, and Telecom within the paradigm of telehealth, while considering how these technologies are shaping health care. In order to advance knowledge about virtual healthcare and its capabilities in the modern world, this article attempts to present an overview of the existing situation and future development of this emerging field, which might become one of the essential avenues for the continued development of medical services around the world. One of the aims is to assess the current status of SaaS, AI, and telecom in telehealth. Other objectives include discussing potential advancements and trends in intelligent telehealth systems and assessing the benefits and challenges of their integration.

2. Methods

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) criteria were followed during the systematic review process for this study (18).

2.1. Data Strategy and keywords

For relevant research publications published between January 2014 and 2024, searches were conducted using the databases Springer Link, Elsevier, PubMed, and Google Scholar. Search terms like "convergence of technologies in healthcare," "SaaS in telehealth," "AI in telehealth," and "Telecommunications in telehealth" were among them. Boolean operators (AND, OR) were used to carefully combine these terms to generate a very focused and thorough search strategy (19).

2.2. Inclusion and Exclusion Criteria

The inclusion criteria underlined the review's dedication to comprehensiveness and accessibility. By taking into account papers released between January 2014 and January 2024, the systematic review was able to incorporate the most current and relevant research in the field. Peer-reviewed articles in English, the included studies provided information on telehealth ventures in healthcare services, illustrated the product or services of the telehealth startups, discussed the telehealth business model, highlighted telehealth entrepreneurial innovations in healthcare service delivery, and talked about commercializing telehealth convergence innovation. Excluded articles included: product or convergence information unrelated to healthcare services; detailed technical information lacking role references; lack of convergence focus or reference; lack of full-text article availability; and non-empirical research (book chapters, commentary, letters to the editor, viewpoints, and brief communications).

2.3. Screening of Articles

After obtaining the relevant articles from the databases. The full text readings, abstracts, and titles of the publications were used to evaluate them. The studies were finalized for our systematic evaluation after full-text eligibility was evaluated. The differences were settled by the team members talking things out and coming to an agreement. After extensive screening and quality assessment, eight papers were selected.

2.4. Quality Appraisal Tools

The CASP method should be used to evaluate each study's intrinsic biases and data dependability (20). These standards were essential in establishing the reliability and validity of the chosen research.

2.5. Data extraction and analysis

The information on the convergence of SaaS, AI, and telecom in telehealth was extracted and put into a spreadsheet. The study concentrated on identifying major topics, emerging technology trends, and the ways in which the convergence of these technologies would affect the provision of healthcare.

3. Results and Discussion

This section examines how SaaS, AI, and telecom convergence in telehealth are changing healthcare delivery and offers the key findings from the eight selected and collected papers (Table 1). Figure 1 shows the procedures for the systematic review, elimination, and article selection.

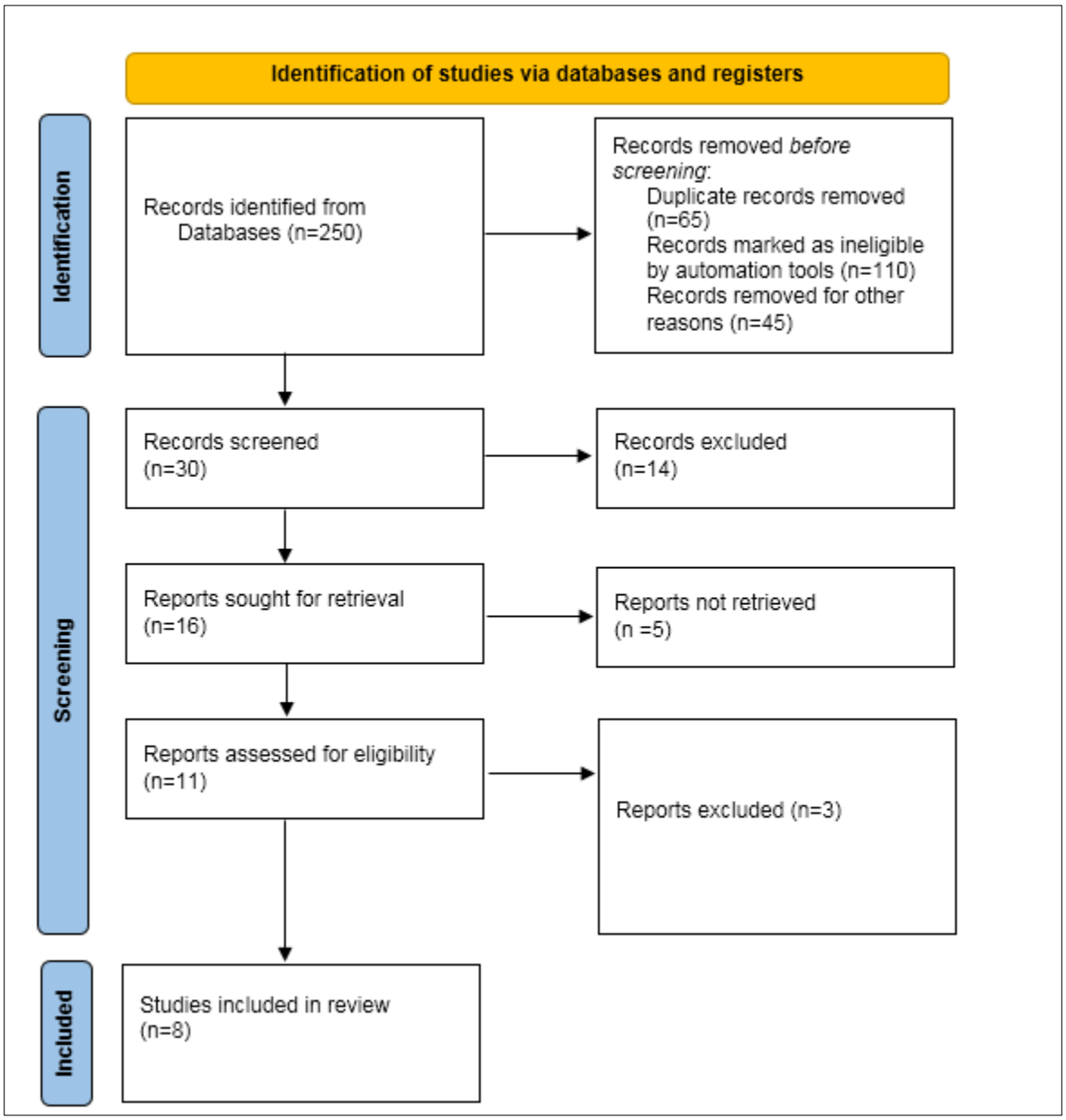

Figure 1 PRISMA Diagram

Table 1 Studies Characteristics

No.	Author and Years	Aim	Model	Key Findings
1	(Kuziemsky et al., 2019) (10)	Artificial intelligence techniques in the field of telehealth.	Health care remotely	➢ AI-enabled telehealth makes contributions to the field in the form of novel care models as well as practice development and quality improvement.
2	(Reddy et al., 2018) (11)	Realistic assessment of current AI technologies and predicted developments.	AI-enabled or AI-augmented health system	➢ AI has enormous potential to improve service quality and save costs in the delivery of healthcare. It will be employed widely in this regard.
3	(Malathi & Kavitha 2021) (12)	Cloud Computing Services in Telehealth	Cloud computing	➢ The use of clinical data exchanged via communication, starting at one location and moving to another, is known as telemedicine, and it is intended to enhance patient care.
4	(Asija & Nallusamy 2016) (13)	Software-as-a-Service (SaaS) application that aims to protect health data	Cloud computing	➢ By lowering the price of conventional software and hardware licensing arrangements, cloud computing is a significant technological enabler for offering effective services at reasonable prices.
5	(El-Rashidy et al., 2021) (14)	Utilizing Mobile Health for Remote Patient Monitoring of Chronic Conditions	Remote patient monitoring	➢ RPM can save expenses, speed up diagnostics, and enhance healthcare delivery.
6	(Abdolkhani et al., 2019) (15)	Identify the PGHD management and quality challenges	remote monitoring programs	➢ The main issues that were found to have an influence on the quality of PGHD were digital health literacy, wearable accuracy, difficulties interpreting data, and lack of PGHD linkage with electronic medical record systems.
7	(Pereira, 2020) (16)	The business model framework aids in determining the telehealth value proposition.	Mobile telehealth	➢ The VISOR framework is used to analyze telemedicine and mobile telehealth, and the results show that while nontechnological difficulties are just as important as technical ones in determining the adoption rate of telehealth, security and privacy considerations remain crucial variables.
8	(Mitropoulos et al., 2020) (17)	highlighting its advantages and resources for existing applications and services	Cloud-based services	➢ Hospitals and diagnostic centers have access to the same cloud services, cloud computing aids in the advancement of healthcare IT.

3.1. SaaS in Telehealth

Software as a service (SaaS) is a cloud computing software delivery model in which applications are hosted by third parties and run on the provider's infrastructure (12). This enables healthcare organizations to obtain and run software applications through internet browsers instead of acquiring and supporting them on local hosts or hardware systems (14). Similarly, they make payment through the subscription fees for the services under consideration. In healthcare, SaaS offers an effective means of collection, storage, and retrieval of patient records and clinical data. It helps in the practice of telemedicine through remote consultation, video calls, and virtual health appointments (15). Advantages of

SaaS when it comes to the support of telehealth include the low initial investment, its simplicity in implementation and flexibility in expanding the services offered based on patients' need (17). According to (14), SaaS has assented the ground of telehealth services and solutions due to its ability to support solutions accessible by a differential internet connection. There are numerous SaaS applications in telehealth, including EHR systems and telemedicine solutions that enable virtual consultations and monitoring (13). However, issues regarding the security of data, constraints on health care regulations and integration with the systems existing in the environment are critical concerns. SaaS also handles Electronic Health Records (EHRs) that provide dynamic patient information and treatment history (16, 17).

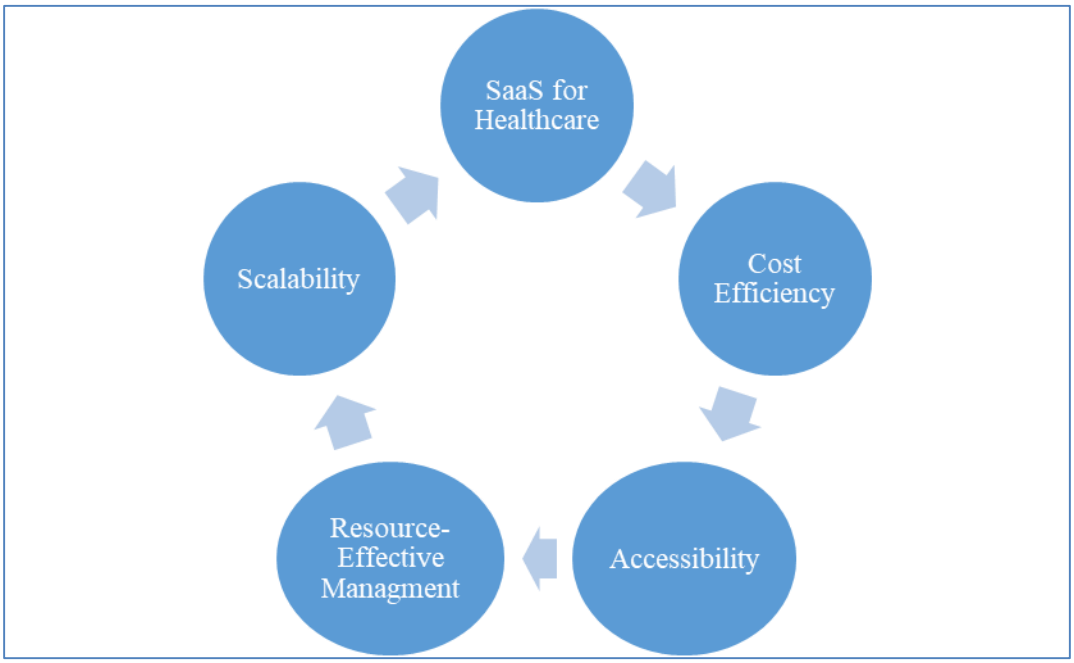

Figure 2 SaaS Program (13, 14, and 16)

Perhaps one of the most identifiable SaaS applications in telehealth is cloud based EHR where patients' data can be collected, managed, and shared electronically with utmost security (14). These systems help in the delivery of telehealth since they enable provider's physicians to store, retrieve and manage patients' record, record and schedule virtual visits (16). Another feature that SaaS has is the ability to consolidate multiple telehealth technologies, including video and audio calls, remote tracking products, and patient engagement applications, among others (17).

3.2. Remote Patient Monitoring and Management

Remote monitoring, also known as tele-monitoring, entails gathering data with the right sensor, sending it from the patient to the doctor, combining it with other data that describes the patient's condition (such as information from the electronic health record), formulating a suitable action or response, escalating the patient's care with related decision support, and storing the data (16). In addition to extending the reach of other health system ICT components, AI systems for telemonitoring rely on them. In many aspects, they may be superior to humans (10). With a basic dependence on innate reasoning that is tempered by statistical data gleaned from massive datasets using machine learning techniques, they reliably carry out their commands in a mathematical manner (12).

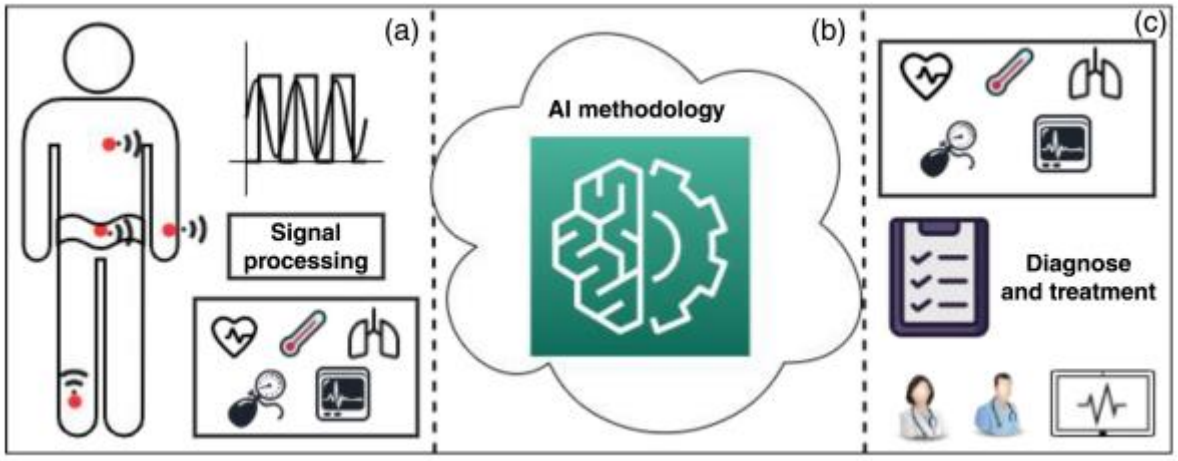

Figure 3 Patient Monitoring (16, 10)

They are able to integrate and synchronize data from other devices, such as gyroscopes, accelerometers, motion sensors, and GPS, right away (15). It is laborious to gather such additional data by hand, and integrating it into healthcare service would need education and training. Patients with chronic illnesses, such as diabetes mellitus (17), chronic obstructive pulmonary disease (COPD) (11), and chronic heart failure (13), have been studied for remote surveillance via tele-monitoring. Artificial intelligence techniques have been used to monitor and manage COPD (16). Telehealth measurement data from patients with moderate/severe COPD living at home has been used to verify the Classification and Regression Tree (CART) algorithm for the early identification of individuals at high risk of an impending exacerbation (14). Many chronic illnesses might benefit from the application of similar techniques as a real-time exacerbation event detector (10).

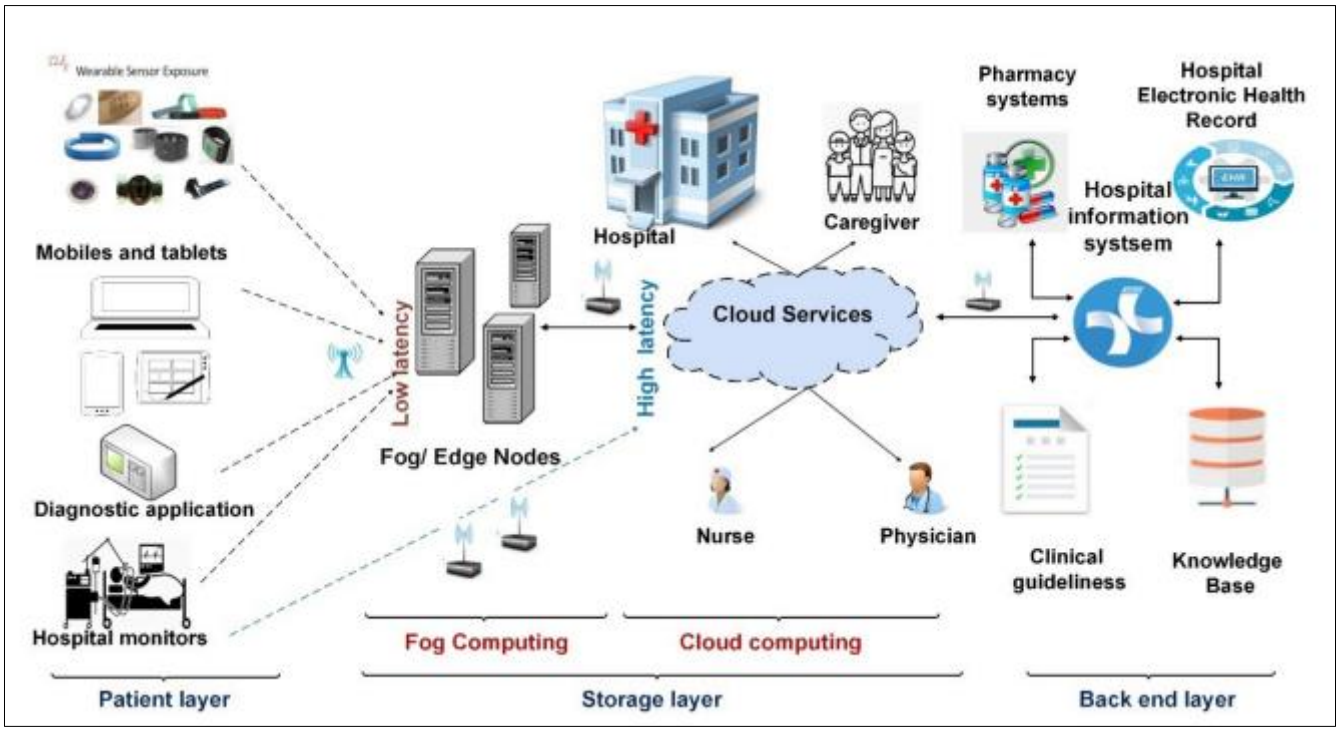

Figure 4 General architecture of Remote Patient Monitoring (15)

Table 2 Software as a Service Application

Software as a Service (SaaS)	Application Categories	Applications
	Data Analytics and Business Intelligence	Domo Sisense Geo-scatter
	Data Integration	SnapLogic Information Builders Attunity
	Team Collaboration	SBAR tools
	Project Management	Zoho Projects Trello Zapier Asana Monday Insightly Toodledo Allthings
	HRM	Omniprise HRM Triton HR Epicor HR Sage HRMS Lawson HR Ascentis Halogen Tribe HR Vista HRMS
	ERP	Evident Infor Oracle Prognosis Innovation Healthcare Supply Chain

3.3. AI in Telehealth

In telehealth, it was established that Information and Communication Technology (ICT) devices can handle misdistribution of the demand and supply of health services. AI could help in this problem by designing search algorithms that would try to match supply of care providers with demand for such care providers with required clinical skills in the surrounding area (10, 15). However, telehealth brings several operational concerns, for instance, when the telecommunication link breaks down or when the remote care clinician is not available remotely (14). AI could possibly eliminate such incidences by offering ways and means through which human or virtual interactions may take place resolving issues of timing and availability of clinicians (time taken to understand the patient's problem or taking a history) (16). Telehealth is among the important trends in the healthcare industry since AI can help with streamlining standard procedures, increasing the precision of diagnoses, and customizing treatment plans for patients (13). Other use of AI involves big data whereby large data sets will be processed to provide information that can be used in the clinical decision making. In telehealth, AI has been applied in the creation of virtual patient companions, chatbots, and decision making tools assisting in patient care and management (12).

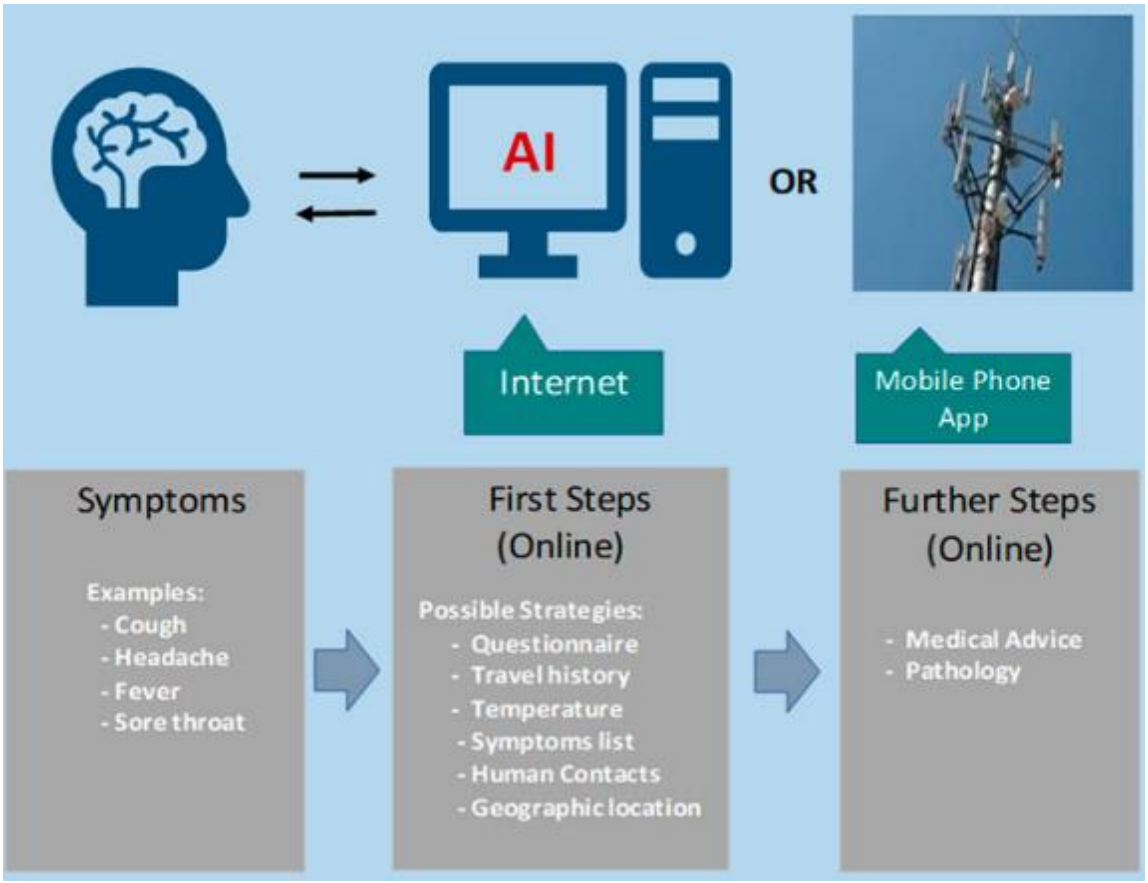

Figure 5 Designing an artificial intelligence-based tracking (11, 16)

The field of remote diagnostics is one where AI has demonstrated great potential. AI-powered devices can accurately evaluate medical pictures, including MRIs and X-rays, which eliminates the need for in-person consultations and expedites the diagnosis process (11, 15). Predictive models that may identify individuals at risk of developing chronic illnesses are also being developed using AI, opening the door to early intervention and preventative therapy (16). Artificial intelligence (AI) has the potential to streamline the process of obtaining a history by offering prompts and diagnostic hints. It may also save time for clinicians by suggesting appropriate follow-up questions based on responses (12). For instance, gastritis is probably the cause of a long-term, dull, painful ache in the upper abdomen that does not interfere with sleep. A telehealth application that includes a summary of these questions asked sequentially can be effectively deployed using mobile ICT (14). However, like all developing technologies, artificial intelligence also has limitations when it comes to its inclusion in telehealth. Such challenges as the availability of large samples to feed the programs to help make determinations, issues of privacy, and the matter of prejudice that the algorithms have (17). Also, the legal framework that has been set around the application of AI in healthcare is still placeholder, which may cause some confusion among developers as well as providers (11).

3.4. Telecom Infrastructure in Telehealth

Telecommunications is the fundamental component of telehealth since it facilitates initial contact and subsequent conversation between the patient and the physician. Telecommunication technologies such as internet connection, mobile networks, and broadband connection are vital in the provision of telehealth especially in rural regions (12). It is thereby postulated that the extension of 5G networks is going to augment the development of telehealth because these are faster and more trusted networks for high-utility applications like remote surgery and AR consultations (17). The major mobile and fixed telecom operators are at the forefront of deploying and supporting telehealth services (14). They enable the distribution of data, facilitate incorporation of telehealth solutions into the existing networks, and also have portable health solutions that enhance the coverage of such services (13). However, infrastructure disparities in ownership and access of telecoms especially in low income, rural settings may decrease the accessibility of telehealth and thus deepen healthcare inequalities (10).

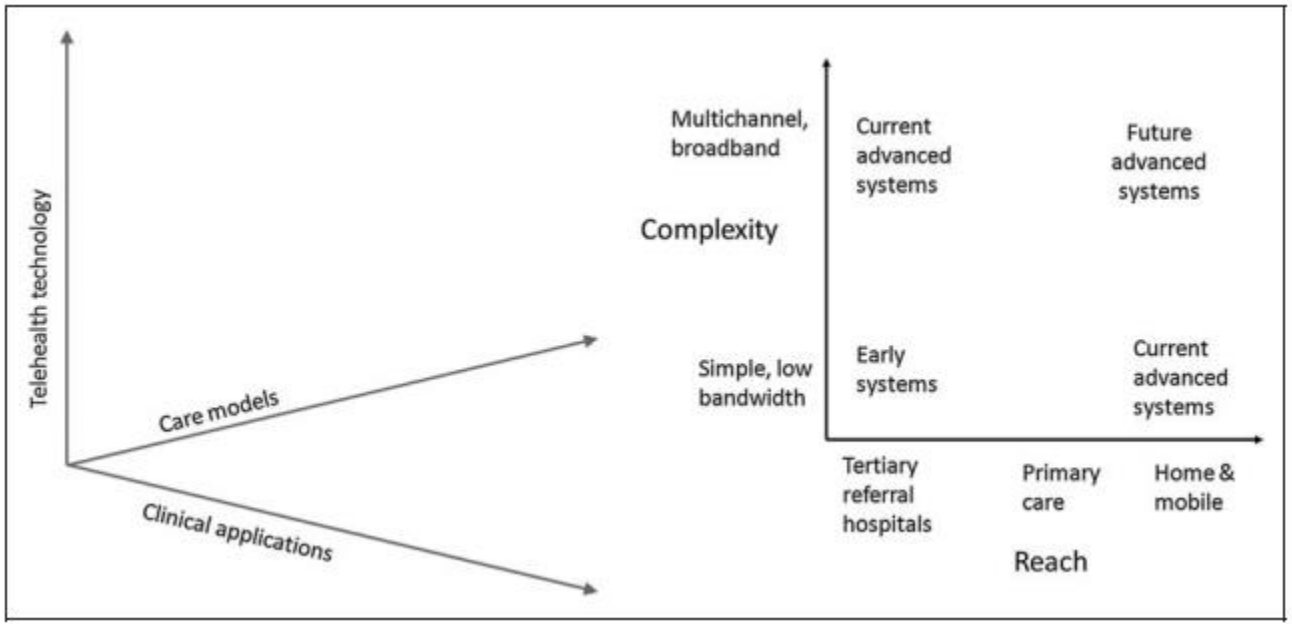

Figure 6 Telehealth development (12, 17)

3.5. Benefits of Convergence

The synergy between SaaS, AI, and Telecom in telehealth serves several benefits that are revolutionizing healthcare. The overall enhanced access to health care services is one of the most important advantages of the process (10, 14). The use of SaaS through the clouds means that patients can receive medical services regardless of where they are, eliminating geographical and mobility constraints (15). This is especially useful for those from more distant areas such as the rural regions or areas with few health centers. Furthermore, new innovations in technology such as artificial intelligence help in supporting the telehealth services as they eliminate mundane processes like scheduling, triaging patients, and documentation (12, 17). This means that healthcare providers can spend more time managing the patients' needs hence enhancing the delivery of healthcare services (13). Another important advantage is the possibility to provide individualized approach to patient treatment. AI mechanisms are capable of delineating individual approaches to treatment depending on patient's health records, genetics, and other conditions (14, 15). This makes patient outcomes better, while also increasing patient satisfaction because of the attention given to meet those specific needs (16). Moreover, the SaaS solution is considered a relatively cheap variant in contrast with the classic healthcare systems making use of on-premise settings (11, 13). Due to the decreased requirements for local IT support, minimization of in-person appointments, and the possibility to monitor patients remotely, SaaS platforms decrease operational expenses of healthcare providers. This has the result that the healthcare costs of the patients are also lowered, thus increasing the accessibility of medical services (115).

3.6. Challenges of Convergence

While there is a plethora of advantages of the integration of SaaS, AI, and Telecom in telehealth, there are also disadvantages. One of these is the issue of security and privacy of information that is collected and stored by companies and organizations (16). Cloud-based SaaS platforms and AI tools require execution and storage of enormous volumes of confidential patient information. This opens the opportunity for data breaches and unauthorized access – serious consequences affecting patient privacy and confidence (12, 14). Implementing such guidelines involves meeting various regulatory requirements including the Health Insurance Portability and Accountability Act (HIPAA) for health related applications which might also pose some challenges in international application development due to different standards in different countries (13).

A major concern is the effects of regulations in or across state lines and the meaning of product safety and reliability for consumer protection. Telehealth services face some legal frameworks that include medical license, data privacy and reimbursement (15). These regulations also largely differ depending on the state, which poses a major challenge when telehealth providers seeks to conduct operations in two or more states (10). Also, due to high innovation in Artificial intelligence and Telecom making it hard for well regulated legal frameworks to be adapted quickly which may lead to health care providers and technology inventors and developers facing legal complexities (11). The last category is the challenge of technology adoption. The implementation of SaaS, AI, and Telecom solution is beneficial in many aspects

while there is a need for acquiring new technologies and staff education on the organizational side (17). There are several barriers or factors that may slow down the adoption of these technologies which include; resistance to change, availability of resources, and the difficulty that comes with implementing new systems (13, 16).

The integration of SaaS, Artificial Intelligence and Telecom is bringing a revolutionary change in healthcare delivery as intelligent systems facilitate to deliver highly effective, easily accessible and customized healthcare services (10-17). This integration helps healthcare providers deliver highly coordinated patient care, including appointments, meetings and reviews, as well as diagnoses and other care. Telehealth is enabled through software that effectively provides the structures that enable its function as a service delivery model (21). AI improves these services through providing the data for the decision-making process, automating some processes, and providing personalized services based on the data of patients (22). Through these services, Telecom makes it possible for patients to receive any kind of service at any location in a way that promotes real-time information sharing (23). Among the most valuable advantages of such integration is the capacity to constantly and independently with patients who have chronic diseases (24). Devices such as wearables and sensors that a patient uses can be connected to SaaS platforms, where AI algorithms can then identify changes in the patient's condition (25). Telecom infrastructure makes it possible for such information to get to the health care providers as quickly as possible and there is little need for patients to visit the hospital (26).

3.7. Implications for Healthcare Providers and Policymakers

For healthcare providers especially, SaaS, AI, and Telecom represent a chance to enhance the quality and effectiveness of the care service delivery process (10, 15). However, it also calls for the adoption of new technologies, staff training, and proper mounting of compliance factors (16, 17, and 27). Telehealth has a significant future since state authorities have a crucial part in promoting the use of telecommunication networks, ensuring the safety of patients' data, and explaining the discrepancies in access to telecommunication platforms (28, 29).

4. Conclusion

SaaS, AI, and Telecom in telehealth are advancing the way patient care is being delivered with new opportunities on increasing efficiency, capacity and decreasing cost. SaaS platforms support efficient and agile telehealth services; at the same time, AI improves such services based on analysis and integration of individual data. Telecoms infrastructure guarantees these services to the patients and accessibility of communication and monitoring regardless of their location. These technologies will keep improving over the future to a point where high quality care will be provided regardless of the geographical location or the present state of the health system. This new interwoven society of healthcare and technology will present a new problem for the developers and the policymakers – that is how to strike a balance while delivering the benefits of such advancement to all members of the society.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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