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Digital Connecting for Health, an Open Platform Based on Data Integration and Standards to Adopt Digital and Telehealth Solutions in the Healthcare Ecosystem

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Abstract. The paper presents a collaborative approach employed to identify and examine the obstacles faced by telehealth solutions. The study involved the active participation of health start-ups, telehealth providers, and healthcare professionals delivering telehealth services. By harnessing the collective expertise and diverse perspectives of these stakeholders, the research led to develop an open platform, entitled Digital Connecting for Health, that has the potential to overcome the challenges impeding the widespread adoption and effectiveness of digital health services including telehealth in delivery of care. The developed platform shed light on various obstacles faced by telehealth solutions and provide valuable infrastructures for enhancing the implementation and efficacy of various digital health solutions, including telehealth applications, from various providers.

Keywords. Medical Record Linkage, Telehealth, Health Information Interoperability, Delivery of Health Care

1. Introduction

One of the potentials of digitalizing medical records is the ability to include telehealth applications that could help healthcare providers in a variety of patient care tasks remotely. In 2007, the World Health Organization (WHO) introduced a standardized definition for telemedicine: "The delivery of healthcare services, where distance is a critical factor, by all healthcare professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment, and prevention of disease and injuries, research and evaluation, and for the continuing education of healthcare providers, all in the interests of advancing the health of individuals and their communities" [1].

A telehealth platform integrated with an interoperable electronic medical record (EMR) system can contribute directly toward achieving better health outcomes, improved patient experience, lower costs, and improved clinician experience [2]. Despite

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promising potentials of telehealth in general, lack of interoperability renders many telehealth solutions as cumbersome stand-alone systems that cannot communicate effectively with other systems. This makes the applicability of the solution limited to local use. Interoperability enables better workflows and reduces ambiguity among systems and could be used in various areas. For example, interoperable EMRs allow the electronic sharing of patient information between different systems and healthcare providers, improving the ease with which doctors can provide care to their patients.

In this study, we aim to present the existing landscape of telehealth applications and introduce an open platform capable of integrating, standardizing, and connecting diverse digital solutions to promote the widespread adoption of care delivery. Our platform offers clinicians essential components, empowering them to create patient care flows that are interoperable and easily comprehensible.

2. Methods

We have studied literature reviews [3–5] that were conducted to identify the range of obstacles faced by telehealth solutions as well as the key issues and factors contributing to the obstacles. A diverse range of individuals with expertise in telehealth solutions and related domains were selected to ensure comprehensive representation. Health start-ups, telehealth providers, and healthcare professionals engaged in telehealth service delivery were recruited as participants.

Semi-structured interviews were conducted with experts. The interviews aimed to gather firsthand knowledge and experiences regarding the challenges faced in implementing and utilizing telehealth solutions. The interviews were recorded, transcribed, and analyzed to identify common themes and issues. Thematic analysis was conducted to identify recurring themes and obstacles in the context of telehealth solutions. The identified obstacles were further categorized and analyzed for their significance and potential impact. Each obstacle was examined in detail, and potential strategies and recommendations were formulated to address these challenges.

Based on the findings from the literature reviews and expert interviews, an ecosystem with an open framework was conceptualized and developed offering the building blocks to leverage these obstacles and support an integrated health system by bridging the gaps between telehealth solutions and electronic health records: The Digital Connect for Health (DC4H). The development of DC4H involved a collaborative effort of healthcare IT experts, software developers, and healthcare professionals.

3. Result

The results of literature studies and multi-stakeholder experts' interviews yielded a comprehensive range of obstacles faced by telehealth solutions. These obstacles included technological limitations including interoperability issues, regulatory barriers, privacy and security concerns, reimbursement policies, resistance to change, patient acceptance and engagement, and healthcare provider training and integration.

The aforementioned issues can be attributed to common factors: data integration, sharing, and digital usability and safety. The DC4H platform was created to address these requirements, establishing a connection between telehealth solutions and electronic health records. DC4H facilitates access, cleansing, integration, ingestion, and semantic

tagging of data from various clinical and operational systems, allowing any healthcare organization with any health-related solution (including telehealth solutions) to utilize the information effectively.

DC4H encompasses six pillars that collectively establish an all-encompassing platform ecosystem, to bolster an interconnected healthcare system by bridging gaps between providers, patients, and caregivers, irrespective of organizational or geographical boundaries. These pillars, described in figure 1, include integrate, ingest, index, insight, inform and intervene.

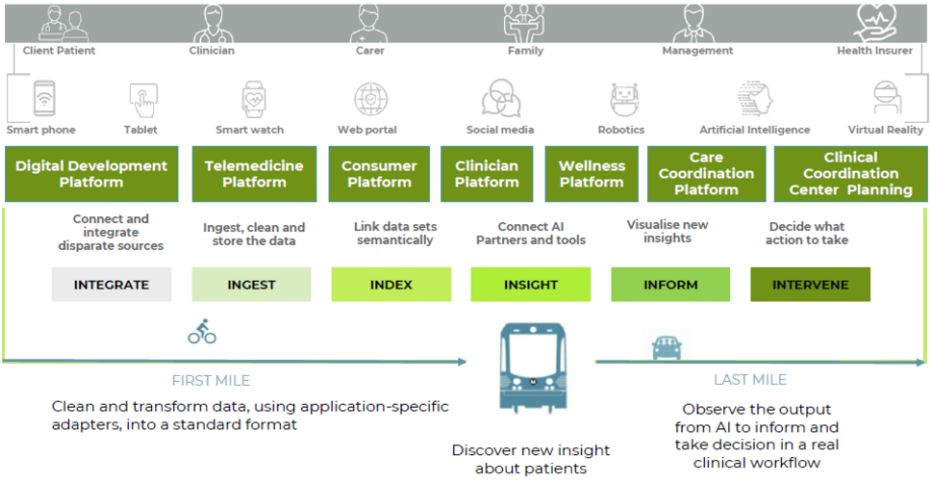

Figure 1. Six pillars of DC4H ecosystem together with some use cases in which a variety of platforms and stake holders could benefit from it with various end point solutions.

Integrate pillar. It enables the flow of complex and fragmented data across disparate applications and organizations. This makes it easier to manage high volumes of complex data with its scalable and flexible integration services.

Ingest pillar. It offers a centralized repository for storing data that has been gathered from various source systems, including provider, payer, and Internet of Things (IoT)-generated data. This data is then standardized according to industry norms. By utilizing an integrated and coordinated care record, DC4H presents a comprehensive view of the patient's clinical and administrative information. The aggregated data can be securely exchanged with internal and external systems, as well as applications like Apple Health thanks to standard data models like FHIR[6,7]. Standardized terminology sets like SNOMED-CT, ICD, and LOINC are used for mapping purposes. The aggregated data can be securely shared with other internal and external systems, plus applications such as Apple Health, by using standard FHIR APIs.

Index pillar. After storing and normalizing data into the FHIR based Clinical Data Repository, healthcare providers face the task of establishing connections between data sets through semantic linking. This process allows clinicians to ask relevant questions and extract specific information. For instance, users can easily access all data related to male patients over the age of 55 who have both chronic obstructive pulmonary disease (COPD) and hypertension. This approach tackles the persistent challenge faced by healthcare data analysts, as data is often organized and coded differently depending on its source system. For example, a hospital's electronic medical record (EMR) may utilize SNOMED-CT to encode a health condition, while a General Practitioner (GP) telehealth

system may rely on an ICD-10 code. The provision of this semantic interoperability is facilitated by our Clinical Knowledge Platform [8].

The Insight pillar. Focuses on analyzing and deriving meaningful insights from the aggregated and linked healthcare data. This involves applying advanced predictive analytics, including artificial intelligence and machine learning techniques to identify patterns, trends, and correlations within the data. These insights can be used to improve patient outcomes, enhance clinical decision-making, and optimize healthcare processes.

The Inform pillar. Involves delivering the derived insights and relevant information to healthcare providers, clinicians, and other stakeholders in a timely and actionable manner. This can be achieved through various means of visualized insights such as dashboards, reports, alerts, and notifications. By providing accurate and up-to-date information, the Inform pillar supports informed decision-making and facilitates proactive interventions.

The Intervene pillar. Involves taking action based on the insights and information provided. This pillar encompasses a range of interventions and actions aimed at improving patient health outcomes. Examples include operational and clinical decision support, personalized treatment plans, targeted interventions for high-risk patients, preventive measures, and care coordination efforts. The Intervene pillar leverages the power of data-driven insights to enable effective healthcare interventions.

4. Discussion and Conclusion

In this study, we used a collaborative approach to identify and analyze obstacles faced by telehealth solutions. The findings underscore the complex challenges hindering the widespread adoption and effectiveness of telehealth. Technological limitations, such as connectivity issues and interoperability, emerged as significant hurdles influencing the adoption and effectiveness of telehealth solutions. The Digital Connect for Health (DC4H) platform was developed, which offers an integrated and comprehensive approach to overcome these obstacles, enabling seamless data integration, standardized storage and retrieval, data linking, insights derivation, information delivery, and effective healthcare interventions.

Our approach to the use of standardized formalisms for knowledge representation as terminologies as well as the integration of semantically enriched clinical information models like FHIR resources aligns seamlessly with our prior research and development endeavors[8,9] and corroborates with the results of other studies that consider these issues as key factors for reusable systems [10].

Some limits of proposing an open platform that integrates multiple telehealth and other digital systems include variations in system functionalities. Telehealth systems may differ in their features and capabilities. The open platform must account for these variations and find ways to harmonize or bridge gaps in functionalities to offer a consistent user experience. Coordinating multiple telehealth systems from different providers requires effective governance and coordination mechanisms. Establishing clear roles, responsibilities, and communication channels among the involved parties is crucial to ensure smooth operation and address potential conflicts or issues. Another limit is assuring the user experience and usability to minimize complexity and provide a user-friendly interface, that offers intuitive navigation across different systems.

The interrelated vocabulary within the CKP [8] ensures the coherence of patient data originating from diverse medical establishments. Therefore, the patient data, residing

within sanctioned health data hosts in accordance with the regulations stipulated by respective countries, remains distinct from the DC4H ecosystem. Consequently, the patient data is not retained within the confines of the DC4H ecosystem.

Current evidence supports the effectiveness of telehealth interventions for certain conditions, but there is insufficient evidence about the impact of telehealth on utilization [11]. A quantitative assessment of the utilization of different services potentially hosted by the DC4H platform provides insights into their efficacy and areas for improvement. Telehealth functions as an integral link within the clinical pathway continuum. Clinical pathways are pivotal in ensuring optimal patient care, and their standardization has the potential to significantly improve efficiency and enhance the quality of care.

By using the DC4H platform, healthcare organizations can harness telehealth's full potential, creating an interconnected, data-driven healthcare system. This enables timely, actionable insights, supports decision-making, and facilitates the integration of AI and investigative analytics for innovative insights.

By considering the perspectives of diverse stakeholders, the developed platform provides valuable insights for policymakers, healthcare organizations, and technology developers to enhance the implementation and efficacy of telehealth solutions. Future research should focus on evaluating the effectiveness of the proposed platform and exploring additional factors influencing digital health solutions adoption and utilization.

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