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Review

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# Today's Healthcare in Discussion: Talking about "Techno-Medical" Paradigms

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**Abstract:** Healthcare sector is a truly dynamic and multidisciplinary system. Progressive practice of computational technologies in healthcare has enhanced electronic therapeutic measures in the care units. The healthcare decision-makers are accenting on the operational usage of digital technology in the system, to improve the health service by reducing human error and excessive load also by increasing possibility to attend more patients simultaneously. Sophisticated medical instruments are using advanced robotics, artificial intelligence to enhance their efficacy. Virtual treatments, self-diagnostics is increasing over time with the advancement of technical support in health. Electronic Health Records (EHR) of patients has created huge medical data (clinical information), which is undoubtedly a good resource for health professionals to take critical decisions and implement them accordingly. The aim of this article is to elucidate how technological developments are associated with clinical improvements in terms of constructing an upgraded health ecosystem. It is imperative to analyze how recent digital paradigms in health are helping to tackle regular and rare clinical challenges.

**Keywords:** healthcare; digital healthcare; healthcare technology

## Introduction

The management of the healthcare units are extremely dynamic as they must deal with multiple factors simultaneously. Data has become the most important and indispensable form of knowledge or information. Data analytics is a very important tool for analyzing the epidemiological data and assess several relevant factors regulation it (such as demographics, comorbidity, age, gender etc.). It plays an important role in the assessment of the demand-supply data. Both commercial and the clinical data are sorted out to take necessary decisions to take clinical and associative non-clinical (administrative or financial) data. Research on information technology is constantly growing in new heights, which can be applied effectively to analyze extremely large data and record these data in the form of digital information. Advanced usage of computational technology or contemporary electronic paradigms in the dome of medicine has increased in the last decade. In fact, the healthcare leaders (decision-makers and stakeholders) are accenting on the operational usage of the digital technology in the system. This helps in the generation and management of large clinical datasets but also interpreting those data in terms of applying them in an organized manner for the welfare of patient population and the care delivery system. Skilled professionals are extremely important in the data mining and data analytics. Data scientists are being employed all over the world in the healthcare systems to systematize mass data and analyze respective clinical parameters. These scientific considerations directly help the clinicians and the management to take essential strategies for the care service. It is a very critical work to analyze and assess numerous factors aligned with these mass data, which eventually helps in innovative decision-making for an efficient functioning of healthcare system. In this era of competition, the data analytics are progressing fast and effectively opening new branches in all industries including healthcare. Nowadays, several medical instruments are using advanced robotics, artificial intelligence which make the efficacy of the instrument more and thus increases the sophistication. Through this article we want to elucidate the recent paradigms of the technical applications in healthcare system.

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**Overview of Information Technology in healthcare**

Use of Information Technology (IT) is the very contemporary and advanced technical perspective which has now become an important part of the clinical system and healthcare management. In fact, use of the high-end computational techniques for the information storage, information management and information processing are an extremely important in healthcare. A healthcare system is majorly divided into two parts: one-part deals with the clinical or biomedical issues and the other part deals with the non-clinical or the administrative issues. Both parts have huge amount of data or information in regional, national, or international perspective. Clinical data from different demographic viewpoint is extremely important for the epidemiologists whereas, the health-managerial data is also important for the healthcare administration to plan strategies and do effective policymaking for the betterment of the care service in a profitable manner. Decision-making and planning are a very important part of any administration where undoubtedly health industry go through extremely critical and delicate decision-making protocols due to its complex functional pattern. In every circumstance, the clinical and the administrative data (regional, national, and global) are both essential for the decision-makers or policymakers. Information technology is important in tying-up the managerial applications in a health system along with the supply chain practices. The major influence of the stakeholders on the regulation of supply chain management along with the professional contacts between several healthcare associated services is analytical. It is however an essential point that how the stakeholders decide and determining while implementing the supply chain management connections. Implementation of supply chain management concepts to patients is very much issue of concern. In specific cases the patient himself / herself contributes as an individual entity and a co-creator directly interacts with several healthcare specialists (customer-supplier dichotomy), where supply chain management correlation becomes more complex. In disease management programmes (for multiple chronic diseases) the supply chain gets a diverse and complex for the healthcare providers in which the patient is in the centralized part (De Vries and Huijsman, 2011).

Healthcare information technology is extensively documented for playing the vital role in attaining nationwide aims of reducing the cost of healthcare while refining quality, safety, access, and equity. It can operate as the basis for removing replicated services, reducing error, and enhancing the care service to patients, by supportive essential changes in delivery models, and by offering thorough information on the procedures and consequences of the care of populations. Calculation of healthcare information technology financial effect is complex by inconsistency in the skills and their functions, and in the function of these skills, and by their communication with multiple administrations. Analyses will differ by possibility and scale. We endorse intense efforts to outline an active data model for healthcare organizations that will involve variable quantity to evaluate the impact of health information technology at the regional level and that can be combined at the national level. Work must be done to allocate costs and values to the inputs and outputs of the economic equation, in terms of various stakeholders and the many allied factors of healthcare information technology (Payne *et al.*, 2013).

The management of a hospital is indeed very crucial due to its mass amount of data. This data majorly includes clinical data, epidemiological data, health economics data, human and other resources data. The major challenge is to manage this data or knowledge in such a way that this can be useful for the management and health personnel. For the proper functioning of the hospital, this data gives enormous information to take further strategies. Nowadays, the leadership in healthcare programme is completely information based. Good healthcare units have the capability to channelize the information from the huge data in the proper operation of the system. For this reason, the healthcare industry has adopted the IT advancements in the system. Recent paradigms in the IT research have been implemented in such a way that huge data can be recorded, stored, processed, and analysed to generate technical and necessary information for the decision-makers (both clinical and administrative).

Electronic Health Records (EHR) or Electronic Medical Record (EMR) is a very important concept in healthcare industry. Electronic health records are one of the most important innovations

in clinical system. It is a matter of fact that clinical data needs to be organized and stored for the clinical data needs to be organized and stored for the clinical informatics. It is efficiently used by the data scientists who process the huge number of patients' health data which is a kind of information for both clinical stuffs and non-clinical personnel. This data helps for clinical and associated non-clinical decision-making in healthcare. AI solutions need available funding to grow more which will reduce the work pressure and will influx the big data analysis and will help in the cross-industry collaborations. In this system, the patients' health records are all electronically documented. Indeed, this is a very well-organized process to maintain huge demographic clinical data. This process is accessible to the health professionals (doctors, nurses, and the administration) and to the patients (the record belong to whom). In fact, the technique of documenting the data, in a cloud system is very essential to make a proper database or dataset. This clinical database is efficiently used by the epidemiologists and statisticians to study disease pattern, prevalence in demographic perspective. Huge data can be collected through hospitals and health centers and the health institutes and can be stored in an organized manner in cloud. In fact, researchers working in biomedicine deals with those data. Advanced computational techniques of machine learning, deep learning, artificial intelligence is being used to analyze those data to address research question. However, apart from its implementation in research and clinical decision-making, the analysis also keeps the administration updated to take necessary actions in term of the functionality of the hospital, which is not technically clinical but completely administrative and managerial. The commercial and business aspects are always taken care by the managerial personnel who broadly deals with the resource management, fund management and administrative decision- making. Information technology, like the clinical data, can also organize and analyze huge resource data, supply chain data and administrative data for the mangers to run the system smoothly and provide care facility to all.

Healthcare policymakers along with biomedical researchers and clinical personnel are reliant on information deducted from big datasets and analyse them accordingly. Big Data Analytics (BDA) is playing a crucial role in health management. BDA has become a very operative tool in healthcare industry for scrutinising mass data to apply it for the better improvement in handling healthcare systems (Galetsi *et al.*, 2020). Big Data and Predictive Analytics (BDPA) in achieving commercial value is extremely acknowledged by the researchers (Gunasekaran *et al.*, 2017). Technology Acceptance Model (TAM) is used to develop health informatics.  In the next age there are predictions to use more TAM for better healthcare organisations. Use of telemedicine is an instance of TAM which has exponentially developed in the previous years (Rahimi *et al.*, 2018).

Hospitals are multifaceted associations with complete qualities of variance in healthcare specialists. The multifarious networking, and analytical decision-making protocols are important part of the system. Knowledge or information has been an essential part of the healthcare institutes. Analysis of Knowledge Management (KM) could reorganize competence and coordinate the use of resources in an improved pathway.   Healthcare directors should endorse a knowledge environment, provide the gears for knowledge management, and accept knowledge dealers. Prospects for information distribution and co-operative effort is constantly needed (Karamitri *et al.,* 2015).

Healthcare division allows chance to incorporate KM practices to grow exponentially fast. However, knowledge management is a complicated procedure in healthcare which exercises knowledge gaining, circulation and implementation. KM must be strategic that authorizes rapid identification and allotment of relevant knowledge to applicable or appropriate agents, assortment of opinions should be covered. These theories reproduce scientific expansion in healthcare (Bordoloi and Islam, 2012). KM is a very substantial for decision-makers perspective. Case studies are being reflected to employ knowledge. In serious decision-making steps clinician applies information and knowledge proposed by the healthcare system. The major contribution of KM is to identify the prominence of knowledge resources that are vital for healthcare processes. KM should be recognized as a strategic initiative. Knowledge processing and application should always be connected to facility making. Information systems should be advanced to support the information serviceability. The focused knowledge processing should be checked by the institutes or industries and should target on facilities that clients need the most (like quality, cost-efficiency). It is beneficial to measure the

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information of healthcare professionals and implement them essentially. Knowledge resources and intelligence in the healthcare systems could result in insightful understanding of assessment making in healthcare businesses. Apart from the crucial responsibility of knowledge resources, the evolving process broadly includes on solving local problems with exact methodical assistance. Knowledge processing and information systems enables critical support system while developing a healthcare system (Myllärniemi *et al.,* 2012). Information technology plays a very important role in the knowledge management.

**Digital advancements in healthcare**

The adoption of digital technology is highlighted nowadays, which has revolutionized the healthcare industry by replacing traditional devices with advanced digital systems. There are various applications of digital technology in healthcare, such as accessing medical knowledge resources, enhancing patient care quality, and providing clinical support. Additionally, the study addresses the critical issues of privacy and security that arise from the integration of technology in healthcare, shedding light on the concerns associated with its use (Paul *et al.,* 2023).

There are integration of advanced medical technologies, disruptive innovations, and digital communication in delivering effective healthcare. They emphasize the urgency of restructuring healthcare systems to keep pace with rapid advancements in medical technology, as rising costs and a shortage of doctors pose significant challenges. There are strict regulations, resistance to change among healthcare stakeholders, and a lack of focus on cultural changes which are barriers to this transformation. The shift from a paternalistic model of medicine to a partnership between patients and professionals, facilitated by disruptive technologies has been discussed. It is also addressed that the impact of digital health on care practices and the design of studies implementing technological innovations in medicine. It is aimed to define the concept of digital health and examine its impact on the existing healthcare system and the design of studies implementing technological innovations in medical practice (Mesko *et al.,* 2017).

Artificial intelligence (AI) has become an indispensable part of clinical system and healthcare units specially in respect to the diagnostic protocol. It is now believed by researchers (majorly technical professionals involved in biomedical research) that artificial intelligence has the effective potential to enhance the efficacy of care delivery system in the health industry and disease diagnosis protocols in the same. Use of technological advancement has revolutionized the current healthcare industry to efficiently apply the computational methods to reduce human labour and error as well as serve a huge number of patient population in a comparative less amount of time. However, till date there are lack of technically skilled AI task force among clinical personnel as the adoption to technical practices are a matter of reluctance for significance number of healthcare stuffs. AI has been designed to support personalized medicine in a new effective form of healthcare that is modulated according to the need of individual patient. AI is practiced in respect to different clinical indices like age, lifestyle, gender, genetic clinical history to provide specific treatment plans accordingly. Very effectively AI is economically sustainable even in the remote geographical areas. The AI diagnostic intricacies, accuracy and speed has taken over the health industry notably. The demand for AI in healthcare is increasing, but privacy concerns restrict the utilization of real patient data. To address this, it is proposed to create synthetic datasets that accurately capture the complexities of the original data without compromising patient privacy. The approach integrates resampling, probabilistic graphical modelling, latent variable identification, and outlier analysis. By handling missingness, complex variable interactions, and sensitivity analysis, it is demonstrated that the method produces synthetic data sets that closely resemble the original data, while minimizing the risk of patient re-identification (Tucker *et al.,* 2020).

The challenges faced by healthcare providers in improving patient outcomes and controlling costs are crucial. Factors such as the growing demand for chronic disease management among an aging population, advancements in technology, and patients taking control of their health contribute to the need for digital transformation in healthcare. The digital transformation in healthcare, achieved through the integration of technologies such Internet of Things (IoT), advanced analytics, Machine

Learning (ML) and AI, is recognized as crucial in tackling these challenges. It enables improvements in diagnostics, prevention, and patient therapy, empowering caregivers to make evidence-based clinical decisions. Real-time interactions and operational intelligence enhance patient monitoring, resource utilization, and cost optimization. However, obstacles like legacy systems, data security concerns, and limited data standards adoption hinder efficient usage of health information. The goal is to create intelligent healthcare providers capable of delivering value-based healthcare and seamless patient experiences, with information technologies be scalable, secure, reliable, affordable and tailored to organizations' digitalization maturity-level (Gopal *et al.*, 2019).

It is discussed that the advancements in technology that have led to the development of innovative devices, such as smartphone-connected iECG, handheld ultrasound, and lab-on-a-chip technologies. The growing interest in mobile health (mHealth) has raised questions about the evidence supporting the widespread use of these devices. This state-of-the-art review aims to assess the existing literature on mHealth and provide a comprehensive framework for understanding the advancements in this field. The authors examine various factors, including device designs, patient engagement, clinical workflow, and device regulation, and their implications for digital health (Bhavnani *et al.*, 2016).

Medical practitioner with extensive experience explores the adoption of six transformative core competencies in modern healthcare: EHRs, communication, telemedicine, analytics, data security, and virtual point of care. These advancements have far-reaching effects on healthcare, surpassing mere economic reform as envisioned by government policies. The digital age serves as an unstoppable force that empowers healthcare, particularly through enhanced EHR functionality, real-time analytics, virtual care teams, and remote monitoring, providing a lifeline for the survival of the healthcare industry amid uncertain times (Watson *et al.*, 2016).

It is addressed by researchers that the shift from traditional organizations to digital platforms in the healthcare industry. While other industries have adopted platform ecosystems, healthcare has been slower to embrace this transformation. 1830 healthcare organizations and identifies eight new roles within the digital healthcare industry, such as information platforms, data collection technology, and blockchain-based Personal Health Records (PHR). The findings highlight how these roles impact value proposition, value capture, and value delivery in the industry (Hermes *et al.*, 2020).

It is focus on the global and local trends of digital technology implementation in the healthcare system. They utilize institutional and comparative analysis methods to conduct a comprehensive analysis and assessment of these trends. The results indicate that digital technologies contribute to protecting doctors and patients from infectious diseases and are reshaping the traditional "patient-doctor" model. The integration of digital technology and medical devices is revolutionizing healthcare, leading to improved service delivery, enhanced quality control, and reduced costs. Digital innovations will soon become essential for the functioning of healthcare systems in the era of digital transformation. Critical three-level decision-making system based on these advancements are being proposed to minimize risks and optimize healthcare outcomes (Osipov and Skryl, 2021).

The lack of comprehensive research on the practical implementation, effectiveness, challenges, and applications of Digital Transformations (DT) in healthcare is explored well. The authors conduct a systematic literature review to fill this gap, aiming to analyze the current state of DT in healthcare systems by examining its applications, benefits, opportunities, and threats. By employing a rigorous and objective methodology, the study offers transparency in data collection and results (Dionisio *et al.*, (2023).

There are five clusters of prior research in this domain: operational efficiency by healthcare providers, patient-centered approaches, organizational factors and managerial implications, workforce practices, and socio-economic aspects. The authors present a model that illustrates the interconnectedness of these clusters and how technology implementation can enhance operational efficiencies for service providers (Kraus *et al.*, 2021).

With the increasing commercialization of medical activities, the perception of physicians by the public becomes crucial, and unethical marketing strategies can negatively impact this perception. Reputation, based on various criteria, plays a significant role in determining the success of a

healthcare unit. Online reputation, influenced by reviews and comments on the internet, plays a crucial role in establishing and maintaining relationships with patients. The internet and social media provide new opportunities for healthcare marketing, allowing companies to enhance brand visibility and effective digital promotion (Radu *et al.*, 2018).

The entry of Tech Giants, including Alphabet, Amazon, Apple, IBM, and Microsoft, into the digital health and digital pharma markets has been explained extensively. By utilizing established management models and analyzing publicly available information sources, the authors uncover the underlying business models of these companies. The findings reveal that these Big Tech companies are actively addressing the needs of patients and healthcare providers, and they have developed clear value propositions, value chains, and revenue models to bring about a sustainable revolution in the healthcare and pharma industries (Schuhmacher *et al.*, 2023).

EHRs have produced gigantic medical data globally. Business Intelligence (BI) has been used to establish these health data for the development in clinical, scientific, and healthcare management. BI has become an obligatory tool for the sustenance of organizations in increasing its effectiveness and efficacy in managing information which ultimately helps in commercial decision-making. BI maturity models are accomplished to know intricate business management policies in numerous industries, which materializes due to complex rules and regulations, stakeholder relations and external requirements. It has direct application in healthcare industry by considering the key problems in health sectors with gap analysis (Brooks *et al.*, 2015).

### Conclusion in the dimension of COVID-19 pandemic

The potency of digital healthcare in improving patient care with various tools and technologies such as machine learning, mobile applications, sensors, wearables, and telehealth can enhance the traditional paradigm of clinical history, examination, diagnosis, and treatment. The COVID-19 pandemic has expedited the adoption of digital healthcare, but there are important considerations. Effective assessment and thoughtful introduction of new technologies, integration of data into care records, and ensuring appropriate clinical support are crucial. Additionally, addressing barriers and challenges, such as access to smart devices and the internet for underserved populations, is essential. The role of clinicians in advocating for patients and colleagues remains vital in embracing the future of digital healthcare (Butcher and Hussain, 2022).

Electronic health records of the COVID-19 patients helped a lot in terms of making a huge data set. This data set is undoubtedly an important for the biomedical researchers globally to depict different aspects of infectious disease outbreak. Many of the clinical instruments are found at home levels nowadays, among them few helped extensively during the pandemic. Home treatments, home remedies and assessment of the severity of the and self-diagnostics became extremely important during this time. Basic instruments, handled without any medical expertise, became predominantly available during the COVID-19 scenario. Like, pulse oximeter, to calculate the blood oxygen saturation along with the pulse rate (heart rate) became very popular, as oxygen saturation is a clinical biomarker of corona virus infection (specifically in case of delta variant). With the marketing of the rapid antigen kit for the diagnosis of the disease was also became popular in people. Doctors were making videos for the basic treatment of the infections and people during the lockdown was following those instructions (for mild and moderate infection). Use to contemporary technologies helped in this pandemic a lot, like virtual treatment for mild and moderate level infections, saved time made the home level therapeutic activities more. It was a useful step which helped the doctors to treat the several patients in less time. A huge number of people were treated with this virtual method or telemedicine. Many doctors who were directly treating the COVID-19 patients made several essential therapeutic videos and circulated it though several media to reach a greater population. This step was also very essential to get home awareness. News and printed media were also extremely proactive to deal with this type of programmed awareness strategies, which was basically initiated by the health administration and the government.  COVID-19 pandemic has created many innovative strategies in the treatment policies. Although we are more prone to use the recent technical enhancements in healthcare however, COVID-19 pandemic has insisted the common

population and the health professionals to make the technical system more "in hand" in terms of diagnostics and therapeutics.

## References

Bhavnani, S.P., Narula, J. and Sengupta, P.P., 2016. Mobile technology and the digitization of healthcare. *European heart journal*, *37*(18), pp.1428-1438.

Bordoloi, P. and Islam, N., 2012. Knowledge management practices and healthcare delivery: a contingency framework. *The Electronic Journal of Knowledge Management*, *10*(2), pp.110-120.

Brooks, P., El-Gayar, O. and Sarnikar, S., 2015. A framework for developing a domain specific business intelligence maturity model: Application to healthcare. *International Journal of Information Management*, *35*(3), pp.337-345.

Butcher, C.J. and Hussain, W., 2022. Digital healthcare: the future. *Future Healthcare Journal*, *9*(2), p.113.

De Vries, J. and Huijsman, R., 2011. Supply chain management in health services: an overview. *Supply Chain Management: An International Journal*.

Dionisio, M., de Souza Junior, S.J., Paula, F. and Pellanda, P.C., 2023. The role of digital transformation in improving the efficacy of healthcare: A systematic review. *Journal of High Technology Management Research*, *34*, p.100442.

Galetsi, P., Katsaliaki, K. and Kumar, S., 2020. Big data analytics in health sector: Theoretical framework, techniques and prospects. *International Journal of Information Management*, *50*, pp.206-216.

Gopal, G., Suter-Crazzolara, C., Toldo, L. and Eberhardt, W., 2019. Digital transformation in healthcare–architectures of present and future information technologies. *Clinical Chemistry and Laboratory Medicine (CCLM)*, *57*(3), pp.328-335.

Gunasekaran, A., Papadopoulos, T., Dubey, R., Wamba, S.F., Childe, S.J., Hazen, B. and Akter, S., 2017. Big data and predictive analytics for supply chain and organizational performance. *Journal of Business Research*, *70*, pp.308-317.

Hermes, S., Riasanow, T., Clemons, E.K., Böhm, M. and Krcmar, H., 2020. The digital transformation of the healthcare industry: exploring the rise of emerging platform ecosystems and their influence on the role of patients. *Business Research*, *13*, pp.1033-1069.

Karamitri, I., Talias, M.A. and Bellali, T., 2017. Knowledge management practices in healthcare settings: a systematic review. *The International journal of health planning and management*, *32*(1), pp.4-18.

Kraus, S., Schiavone, F., Pluzhnikova, A. and Invernizzi, A.C., 2021. Digital transformation in healthcare: Analyzing the current state-of-research. *Journal of Business Research*, *123*, pp.557-567.

Meskó, B., Drobni, Z., Bényei, É., Gergely, B. and Győrffy, Z., 2017. Digital health is a cultural transformation of traditional healthcare. *Mhealth*, *3*.

Myllärniemi, J., Laihonen, H., Karppinen, H. and Seppänen, K., 2012. Knowledge management practices in healthcare services. *Measuring Business Excellence*.

Osipov, V.S. and Skryl, T.V., 2021. Impact of digital technologies on the efficiency of healthcare delivery. In *IoT in Healthcare and Ambient Assisted Living* (pp. 243-261). Singapore: Springer Singapore.

Paul, M., Maglaras, L., Ferrag, M.A. and AlMomani, I., 2023. Digitization of healthcare sector: A study on privacy and security concerns. *ICT Express*.

Payne, T.H., Bates, D.W., Berner, E.S., Bernstam, E.V., Covvey, H.D., Frisse, M.E., Graf, T., Greenes, R.A., Hoffer, E.P., Kuperman, G. and Lehmann, H.P., 2013. Healthcare information technology and economics. *Journal of the American Medical Informatics Association*, *20*(2), pp.212-217.

Radu, M., Radu, G., Condurache, A. and Purcărea, V.L., 2018. The influence of digital media on the success of a health care unit. *Journal of medicine and life*, *11*(3), p.254.

Rahimi, B., Nadri, H., Afshar, H.L. and Timpka, T., 2018. A systematic review of the technology acceptance model in health informatics. *Applied clinical informatics*, *9*(03), pp.604-634.

Schuhmacher, A., Haefner, N., Honsberg, K., Goldhahn, J. and Gassmann, O., 2022. The dominant logic of Big Tech in healthcare and pharma. *Drug Discovery Today*, p.103457.

Tucker, A., Wang, Z., Rotalinti, Y. and Myles, P., 2020. Generating high-fidelity synthetic patient data for assessing machine learning healthcare software. *NPJ digital medicine*, *3*(1), pp.1-13.

Watson, A.R., 2016. Impact of the digital age on transforming healthcare. *Healthcare Information Management Systems: Cases, Strategies, and Solutions*, pp.219-233.