Fuel Cells Bulletin
ISSN: 1464-2859

The Central Role of Health Informatics in Advancing Public Health, Nursing, Physical Therapy, and Dentistry: A Comprehensive Review

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1. Introduction to Health Informatics

Health informatics is a confluence of computer science, information science, knowledge science, medical and health sciences, nursing, physical therapy, and other disciplines (Miah et al., 2019). It encompasses diverse research efforts to acquire and manage data, convert raw healthcare data into useful information and knowledge, and bridge the gap among medical research, clinical practice, and the everyday aspects of management and related decision-making within the healthcare system. As part of the huge body of health informatics research and the related fields that are occasionally touched by this rapidly growing discipline, the initial exploration aimed to generate holistic understanding and to outline its emergent themes and reveal contemporary unsolved research topics.

Health Informatics (or medical informatics) denotes the application of technologies and telecommunication infrastructures in order to improve the decision-making processes, the quality and coordination of health and medical care (Moen & Merete Mæland Knudsen, 2013). It is not merely an individual discipline; rather importantly, it appears to be an interdisciplinary one. History, milestones, and achievements of health informatics have been condensed, along with related contextual aspects of health informatics. Review focuses on the contribution of health informatics to several medical professions. Public health is the main area within health service that deals with professional care, information, and a series of other services that are priceable, and require years of professional career or training knowledge. Data, information, and knowledge management are important in every sector, and healthcare is not an exception. In order to limit the discussion, the importance of health and medical informatics in the four presented professions is emphasized.

A stupendous advancement in modern technology, besides its impact on almost every niche of working and living, seems to have become essential in many aspects of daily life and professional activity, especially in healthcare. Advanced information systems, data management, and modern technologies govern the way in which healthcare services are provided, diagnosis and medical examination are performed, and medical records are stored and exchanged. (Wager et al., 2021)(Junaid et al.2022)(Sheikh et al.2021)

1.1. Definition and Scope

Health informatics has been one of the pivotal areas strategically positioned at the intersect of information technologies, computer sciences, social sciences, behavioural sciences, and health or medical caring practices. Health informatics has been uplifted to become a key applied research domain for conducting necessary technologies, techniques, tools, resources, interventions, and devices in order to improve data acquisition, retrieving, analysing, processing, presenting and use of information in decision-making for health or medical care. A large number of various forms of IT-powered applications, delivering platforms or devices have been established to underpin various e-health, m-health, u-health, p-health, g-health, and q-health driven services and systems. A range of health informatics software and applications were designed and constructed to

support particular health, medical, or nursing services (Miah et al., 2019). Today, health informatics, with its many disciplines, has aimed its comprehensive accomplishments at the design, modelling, installation, acceptance, and maintenance of appropriate and innovative applications and technologies that deliver health care services, information portals, treatment suggestions, and remote consultations.

Health informatics is an umbrella term and a tremendous variety of common applications, semantic structures, and infrastructures have emerged over time. Health informatics has become a pivot area powerfully dominated by countless forms of IT-powered applications, devices, and platforms, for example, e-health, m-health, t-health, u-health, p-health, g-health, and q-health driven health-related IT applications, platforms, services, and e-treatment quality control or delivery systems. Health informatics has in recent times become a tremendously significant applied research domain. Health informatics or other corresponding polymorphic labels, for example, medical informatics, is most widely defined as a multiplicity research field, or area, or domain, but an umbrella term under which both general health-science and more specialized informing/computing-axled knowledge is coordinated (Moen & Merete Mæland Knudsen, 2013). Its service itself and the corresponding profession are executed on the basis of entwining, juxtaposing, entangling, and interfacing an amalgam of disciplines, professions, and knowledges that have been separate and independently cultivated before a pregiven moment or day. Health informatics has been in point of fact, as evident from its rapid research progression and expanding application landscape, a genuinely multidisciplinary effort, area, field, or trade. The ascendancy of health informatics is increasingly dominating on account of the changing way of life, lifestyle, fitness, and disease-prone attitude throughout the global population.

1.2. Historical Development

Years ago, healthcare was provided on a family basis, with illness being treated within the community. Physicians and barbers worked in shops, mixing bleeding, tooth-pulling and curing. Hospitals were just places to get food and lodging with little care. Those who posed a threat to society were quarantined in correctional institutions and punishment was conducted in public view. Only ‘written chronicles of health and healing’ from several ancient civilisations border on first real medical records (Benoit et al., 2022). The development in the field of medical science and technology plays an important role in determining the future of a nation. However, the health of a person can be disadvantageous if not documented properly. The patient's health document in the past was in the form of the paper sheet by a handwritten text description. In modernization, the patient’s health record can be retrieved using the internet service and is managed in electronic form. The practices of maintaining patient health information and tracking treatment have become challenging in the recent complex healthcare environment. A field in the confluence of information and computer science discipline to maintain this information is called Health Informatics. Health informatics is a discipline which bridges healthcare, information and communication technologies. Ideas behind health informatics take root from late 1950s to early 1960s about involvement of automation in healthcare practices. The technological advancement led to the development of systems in healthcare industries including pharmacy, industry and diagnostic centers. Then, later work on healthcare informatics started broadly concerning the use of information systems and advancement of information technologies in healthcare domain. Milestones of healthcare informatics relates developments of the technology including: installation of various electronic messaging systems in 1971; terminological standard lemma project in 1972; attempt to store healthcare data in standard manner developed in 1974; English National Health Service enrolment of patient identified system in 1984 to 85, and first database statistical modeling system for a hospital patient developed in 1984-85 for hospital information system. Apply patient diagnosis database analysis model of around 10,000 records and stimulated research work among health care analysis since then. In 1987 Canada Scholar system based on a computer feed database records on patient contacts with physician in better healthcare service. Major healthcare provider in Australia as a “Western” database standards through guidelines, further investment with the development of electronic health record system connecting entire community health care department. Health informatics begins to take shape to the needs and society’s attention given to healthcare in the early 1990 in Nepal. The evolutionary advances of health informatics since its inception have been specifically initiated by the broad government policy to manage the healthcare sector. There are links to strategy to the national development agenda, targeted social grant that helped improve the health and health care sector. As a result, the emergence of several annual programs and hospital fairs/health policies at the national level opened a gate for the development of community-based health informatics. Subsequent developments and needs affect activities in healthcare data recording sessions, which eventually become a success intervention at the heart of community development efforts.

1.3. Importance in Healthcare Professions

Throughout professional practice in healthcare and allied health fields, health technology and its components, including informatics, are employed in various ways. The critical role of health informatics in healthcare professions, including but not

limited to public health, nursing, physical therapy, and dentistry, has been previously emphasized (Moen & Merete Mæland Knudsen, 2013). Informatics tools can enhance patient health outcomes by increasing administrative performance efficiency, improving decision-making, and promoting patient-specific care by increasing the accuracy of information and risk stratification of populations (Monea et al., 2016). Healthcare practice is generally collaborative, requiring the integration of interdisciplinary inputs (medical, demographic, social, psychological, etc.). Efficient electronic health record (EHR) integrated systems can facilitate this through the utilization of communicative and useful clinical workflows. A consistent delay in utilizing informatics for clinical workflows is noted by health professions. This implies that it is important for different disciplines to devise a judicious method to integrate EHRs and clinical workflows in the work process. This will increase efficiency and reduce the non-productive work demands that have been placed on the health care workforce. The use and necessity of informatics in healthcare work and processes and across disciplines desired to improve the efficiency and effectiveness of the healthcare system is discussed. Through the design of a theoretical framework based on these needs and based on a review of the literature, ways informatics can support proficiency in how tasks are completed in healthcare are described. Additionally, the health of the population can improve by enhancing decision-making and fostering the coordination and synthesis of various domains of health care. For initiation and maintenance of a flu epidemic intervention, interest was centered on public health-related informatics applications for early detection of symptoms within a population. (Bichel-Findlay et al.2023)

2. Applications of Health Informatics in Public Health

Empowered by the widespread adoption of EHRs, health informatics has been able to ingeniously address current and pressing healthcare challenges. Health informatics combines knowledge from the health sciences with insights from information and computer sciences. Contributions from nursing informatics, medical informatics, and clinical informatics focus predominantly on the creative use of technology to advance health outcomes and patient care.

Public health informatics, a distinct subdomain, centers on ways to optimize population health by employing myriad data-driven interventions (Gamache et al., 2018). These interventions apply the systematic and innovative use of data, information technologies, and public- or private-sector knowledge to improve health outcomes. Relative to traditional healthcare practices, public health places a unique emphasis on health promotion and disease prevention. Health informatics supports public health objectives by providing innovative tools and methodologies to collect, analyze, and process multidimensional health-related data (Moen & Merete Mæland Knudsen, 2013). As a result, unprecedented opportunities have emerged to identify and implement targeted interventions, looking beyond the traditional scope of single-individual patient interactions. Broad success hinges on interventions targeting the population, community, or society level. As such, examples of health informatics applications in public and population health are increasingly visible, ranging from the design of epidemiological surveillance systems to policy-level impactful implementation. Cumulatively, developments in health informatics have brought the practice of public health considerably nearer to the characteristics of an evidence-based science, ultimately benefiting both individuals and large, diverse communities.

2.1. Epidemiological Surveillance Systems

The cornerstone of public health informatics is epidemiological surveillance systems that continuously monitor community health events that affect the well-being of a society or population. This ongoing process involves data collection, aggregation, analysis, and dissemination of public health-relevant information or issues. Timely and effective actions are taken by decision makers to control the spread of diseases and to improve the health of a community. The need to monitor public health events on a daily basis and identify patterns in either health events triggering further epidemiological investigations emerges as an approach. Essential public health surveillance procedures stipulate a classification scheme called the case definitions of diseases/health events. Health-related information is collected using forms that require manually filling in case reports in the form of matrix-like tables. Epidemiological surveillance systems are built based on EpiProcessors in order to facilitate the integration with real-time data collection technologies and/or access to secondary databases that may contain potentially valuable public health information. Portable data entry systems include the use of mobile digital assistants, the use of centralized database systems to collect public health case reports, field data collection using mobile devices, and applying text mining technology to extract public health information. Data privacy and confidentiality rules are developed to integrate different public health agencies that might analyze and share their health information data. (Busaleh et al.2022)(Jia et al., 2023)

At the core of public health informatics is public health surveillance that permits to track and detect emerging health trends or outbreaks to promptly react and assess proper interventions. Public health surveillance is a process through which health

information data is continuously monitored and analyzed to identify and characterize public health events in the community. Public health agencies seek to improve effective strategies for early detection of diseases or health events and therefore mitigate the harmful impact on the community. Fortunately, the advent of new technologies holds the promise to increase the efficiency of public health surveillance systems. Recently, public health informatics experience has advocated that health agencies should intensify their monitoring and improve the responses by linking different integrated systems of health information and surveillance. Public health surveillance systems are responsible for collecting and analyzing many new data streams of typically large databases that contain traces of various complex interactions between individuals and their health conditions. In addition, these systems enable the utilization of new tools and techniques to perform a deeper analysis of the processed data for the early detection of health events. Developing advanced visualization techniques that will allow to gain valuable insights to analyze public health data and convey valuable health messages to those in charge of the health of the public.

2.2. Health Promotion and Disease Prevention

Public Health Informatics applies information science and technologies that "promote and protect the health of communities through education and advocacy in populations' health". One domain in Public Health Informatics is the surveillance of health events which is the use of informatics methods and strategies to detect and manage the outbreak of contagious diseases. Central to surveillance is the collection and analysis of data on diseases among populations. Public Health Informatics can have a real-time exchange of information between professionals and other agencies to prepare appropriate public health programs. For factors of healthcare and public health practice, when using electronic health record (EHR) systems in a limited number of clinical settings they can identify groups of at-risk residents. The discovery could identify at-risk populations for epidemic disease; public health could respond and flatten the curve. Specific health promotion and disease prevention methods could be tailored to those settings and populations (Gamache et al., 2018).

Modern digital technologies allow for rapid data collection, analysis and will enable public health professionals to synthesise and use big data. Data analytics is a crucial part of Public Health 3.0. Public health interventions, including community educational programs and health screenings need to be designed to target those who are in most need of the intervention. Virtual health platforms are envisioned where community settings provide devices or internet-based information tailored to the public's health needs. This can be combined with implementations of innovative models that behaviour change research has shown to be successful. There are a number of public health behaviour change models. Many of these models have digital implementations, examples, as how some informatics tools may be applied to improve community-based interventions and hence most health promotion and disease prevention activities/building communities. An important part of public health campaigns is to evaluate their effectiveness and make adaptations on the go based on the measured success or lack thereof. Real-time surveys gauging public response and understanding can be conducted with digital technology such as using two-way digital communications, web-intrusion, and outlets so public health communication efforts are adjusted where there is need.

In addition to more passive data streams there are emerging ideas in how community settings may engage with social media and use mobile technologies for public health purposes. Social media platforms can be used as an outreach and educational model for quality and up-to-date information. Efforts could be made for public health postings for its danger; an example of how social media may be used for health warning has been made. Furthermore, social media sites have standard app integrations that could provide users with up-to-date vaccination data and further information on why vaccination is crucial. Dental and public health information can also be delivered to these tech platforms for which an oral health clinic in Manchester posts information and tips on proper oral health care.

2.3. Health Information Exchange

Health information exchange (HIE) is a foundational aspect of public health informatics. HIE promising in expediting continuity of care among healthcare providers in public health (Patil & Katamneni, 2017). It curtails duplication among diagnostic tests, maximizes time efficiency among nurse practitioners in public health sectors, and furnishes informed decision making. It involves the electronic transmission of patients' medical information among healthcare providers. HIE systems vary widely, from state-regional exchange to personal health records (PHRs) (Everson, 2017). HIE systems might be based on P2P, centralized storage, or even cloud storage exchange. It might also serve as standalone middleware, unified electronic health care records (EHRs), or as a module in existing EHRs. In terminology, HIE Heightened shows an inquiry expanding in late years, whereas HIE Importance reveals a constant broad interest. Enhanced effort has been guarantee for openness in clinical

data exchange through encouragement and legislation. Than in turn provides a comprehensive public health effort, and advances in public health informatics will greatly to analyze public health issues.

The increased effort and improved instruments empower the accumulation and sharing of ex-situ public health data and help to set up to coordinate and synergize campaign montaging (HIE). The reason for the present work is to offer a review regarding the HIE Benefits of Improved Time Efficiency and Cost Savings in Nurse Practitioners sectors in the public health. This is partly to enlighten the informatics special field, which some informatics cognoscenti might have a lack of both familiarity with background in public health. In isolation, public health informatics uses are pertinent to public health workers, who might not have a greatly ground in informatics although they share a steady working familiarity with data and information. For instance, clinical data exchange, namely HIE, is mentioned as examples of setting up measure to further advance response to the 2005 Hurricane Katrina tragedy.

3. Integration of Health Informatics in Nursing Practice

As nursing practice has become increasingly dependent on the use of technology for the delivery of patient care, so has the term health informatics gained significance in the nursing profession. The prime goal of health informatics is to improve health outcomes and the overall quality of care delivery through the usage of data science and information technology (Moen & Merete Mæland Knudsen, 2013). This subsection explains further the inclusion of health informatics in contemporary nursing practice, illustrating how technology can enhance the delivery of patient care by nurses. Medical records that are stored electronically and called electronic health records (EHRs) offer a single source that is accessible to nurses across different medical institutions. With the ability to access information on past and present diagnoses, treatments, test results, and prescription data, EHRs allow nurses to gain a comprehensive picture of the patient's health and the care they have received before. This plays an important role in streamlining a nurse's workflow. Instead of chasing patient data that is scattered across charts, nurses can seamlessly navigate different patient records and timely address health issues according to the patient's record entries. In addition, patient data normally not available to nurses—such as medication lists, imaging results, and consultation reports—are accessible through EHRs. This leads to more informed medical decision making and heightened patient safety. A growing technology that has caught on during the ongoing COVID-19 pandemic is telehealth. This patient to provider communication alternative enhances medical access, especially when traditional means would be restricted. Additionally, telehealth allows patients to pose their questions or concerns without the intimidation of formal medical settings, thus enabling a more efficient patient-nurse interaction. Another valuable aspect of telehealth is its ability to monitor a person's health in real-time. Various home medical devices are now IoT-enabled. Data from these devices can be integrated with the patient's EHRs and continuously screened. Automated alerts can then be raised if unexpected changes are detected. Another form of electronically-assisted care delivery common in the nursing practice environment today relates to the use of clinical decision support systems (CDSS). CDSS is a class of tools used by healthcare providers for enhancing clinical decision making. CDSS offer a variety of relevant patient treatment options based on practice guidelines, patient data and a physician's feedback. Nurses can also use CDSS independently of healthcare providers in clinical practice for reviewing diagnoses and lab results. For evidence-based content, CDSS act by loading patient observations from a medical database or data entered by a nurse. Available specialist care guidelines on treatment are then used to map patient data into clinical recommendations, a method which empowers nurses to understand and influence the care process.

3.1. Electronic Health Records

This subsection will first focus on electronic health records (EHRs) as a foundational component of health informatics in nursing practice. It will then proceed to explore telehealth applications—the future of healthcare delivery, expanding on a new modality of providers caring for patients (telenursing) and examining the emerging role of nurses in addressing the delays of provider shortages in primary care. The significance of telehealth in advancing public health and nursing practice will be discussed.

The Implementation of Telehealth in Diverse Health Sectors: Considerations and Challenges

Electronic Health Records (EHRs) are widely recognized as the core component of health informatics in nursing practice, as they serve as electronic platforms for health care providers to securely create, store, and manage patient information digitally. EHRs collect medical data from multiple sources like laboratory, pharmacy, and radiology, and make this information available at a convenient time and location for more than one healthcare provider. The availability of patients' EHRs is also crucial for legitimate care by allowing access to the history of the treatment (Janssen et al., 2023).

3.2. Telehealth and Telemedicine

Health care is rapidly changing. Therefore, the way that nurse practitioners are trained and deliver care must adapt and innovate. For instance, one change that is occurring involves the adoption of telehealth and eHealth technologies (M Rutledge et al., 2017).

Telehealth, and its related synchronous consultative component, telemedicine, has long been touted as a way to dramatically expand access to care for those in geographically remote areas. Indeed, the growth and maturation of telecommunication technologies and distribution systems indicate that telehealth may indeed be coming of age. Health care has been late to the game in adopting this transformative approach to care, but it now seems inexorable.

Telehealth and eHealth technologies are now more than ever besides being quickly embraced by governmental legislation that is increasingly making parity changes to level the playing field for telehealth services compared to traditional delivery. Using health information technology, known as telehealth and eHealth, as part of patient care is rapidly increasing and is proven to be a fundamental component of practice in primary care. Before defining types of telehealth and eHealth, for the purpose of this section all such technology applications can be generally combined and described as Telehealth and eHealth. As telehealth and eHealth technologies are used in various forms across health care settings, so too must their use and application be a part of the education of nurse practitioners. Using and understanding telehealth and eHealth in patient care is a skill set that must be developed as part of the nurse practitioner training and education. Therefore, all trainer nurse practitioners need to attain adequate experience and functional understanding of applicable telehealth and eHealth.

3.3. Clinical Decision Support Systems

Health informatics (HI) offers innovative tools and practices to improve the public health system. HI supports the delivery of health care and other health services through information technology (IT). The new policy document, EHR or PHRs, states that "enabling individuals to access and control their own health information is a fundamental aspect of patient-centered care". This approach to HI recognizes that health records contain individual lifetime clinical experience and are the most comprehensive personal health source. Sharing personal health records in clinical settings achieves multiple benefits. The continuity of health care improves when clinicians have comprehensive information about a patient’s health history. Electronic health records contain recent and remote medical information that support the correlation between health conditions, treatments, and outcomes. Outpatient treatment, nursing, and medication in the community are the most common health services. In the United States, the population visits community-based practices an average of ten times per year. In England, Society of Information Technology Management developed the Toolkit for Health Interactive Patient Systems, a tool kit to facilitate the commissioning and procurement of health systems.

4. Utilization of Health Informatics in Physical Therapy

The physical therapy profession is discovering that health informatics has a lot of benefits to offer in patient assessment and therapy, because it expands the possibilities of outcome measurement (Batista e Siqueira et al., 2024). It is a very important fact, because keeping track of the patients' progress and the effectiveness of the therapy has been an essential part and a strong requirement of any kind of therapy. There are available various tools and innovative devices like inertial sensors, digital goniometers, 3D motion capturing systems with up to fifteen cameras, and isokinetic dynamometers, which are able to reveal and provide a great amount of previously unknown details about the patients' problems (Monea et al., 2016).

A newly discovered direction of therapy services is the so-called tele-rehabilitation; which implies that between the treatment sessions carried in clinical environment the patients have to do the exercises at home and using a computer system the physical therapist can continuously monitor the activity of the patient, guide her/him if necessary, and based on the gathered data can modify the parameters of the exercises. Furthermore, there are various available pieces of software. For example, with the exercise prescription software both the difficulty of the exercises and the parameters of the treatment plan can be set more accurately and the planned therapy can be carried out more structured, which will promote higher commitment from the patient, and the implementation of the plan will ensure a higher probability of recovering. This newly described point of view can modify the way of thinking about this profession, and hopefully, it promotes a new research direction to invent and develop new innovative devices, algorithms, and services. At present time in the United States, nationally 6,095 physical therapy practices use a degree of data analytics to their advantage compared with 3,603 dental practices. The so-called business intelligence applications can automatically extract and compile raw electronic health record data pieces into an intelligible information. This information can aid in forecasting the future effectiveness of a therapeutic decision, or it presents unseen

connections and relationships between the data pieces supporting the decision making for the treatment strategy or the selection of the appliance; e.g., types of therapeutic techniques, length of each treatment.

4.1. Outcome Measurement Tools

This subsection focuses on the implementation and necessity of utilizing outcome measurement tools specific to physical therapy. The central role of outcome measurement tools in assessing the efficacy of treatment will be discussed. Value and insight from outcome measurement tools will be displayed through highlighting the quantitative and qualitative data comparison over the course of treatment with an arthritic and elderly patient. Additionally, preference is given to standardized and validated outcome measures, and it is suggested that ease of data collection and interpretation must be considered when choosing appropriate outcome measures. Physical therapists are tasked with systematically assessing patient outcomes to evaluate the efficacy of interventions and support ongoing patient care. This component of physical therapy practice is critical for maintaining high standards of care, remaining relevant in the larger healthcare landscape, advocating for the profession, and being able to justify care to patients, providers, and insurers. Outcome measurement is a process by which outcomes that are meaningful to patients and practitioners can be measured and the results used to assist in rehabilitation decision-making (J van der Wees et al., 2024). Efforts to measure outcomes are congruent with health care reform and the broader shift in health care policy towards achieving greater value for the money that is spent. Being outcome-focused necessitates that measures of success are assessed, and thus the measurement of outcomes becomes of primary importance. With the increasing emphasis on value-based care and evidence-based practice, physical therapists must embrace outcome measurement and the prospect of its integration into daily practice. To be effective, outcome measurement requires the use of standardized and validated measures of patient outcomes. Standardized measures assess the same attributes in the same way across patients, services, or treatment settings. Validated measures accurately assess the outcome intended and are sound in their psychometric properties. A familiarity and comfort with these tools, an understanding of their interpretive value, and the time and resources necessary to administer, score, and record the results are requisite for their most effective use.

4.2. Tele-rehabilitation Services

Tele-rehabilitation services using interactive telecommunications devices have been investigated as a way to increase access to therapy services (R. Schmeler et al., 2009). Tele-rehabilitation uses technology to deliver therapeutic interventions remotely. The discussion on tele-rehabilitation explores how musculoskeletal rehabilitation is changing and evolving with technological advancements. Tele-rehabilitation services provide the means for delivering physical therapy interventions to patients in their homes. Consultation and treatment can still be performed in real-time through video sessions or through a virtual home exercise program that is monitored and progressed as needed.

This innovative approach to access therapy services provides more breathing room in the process to foster better care. The need to address facilitators and barriers to tele-rehabilitation is emphasized. A study on tele-rehabilitation intervention using clinical-based physical therapy was conducted and the experiences encountered are discussed. This model used the collaborative help of a caregiver on the patient's end to assist during a virtual therapy session and individualize a home exercise program. Efficiency, therapy dosage equivalence, the implementation of an application to improve tele-rehabilitation and investment with technology and education is emphasized. This exploration into tele-rehabilitation services in physical therapy provides a case for why outpatient physical therapy clinics should consider integrating it within their services.

The ability to receive physical therapy services through tele-rehabilitation has broadened the paradigms of traditional physical therapy models. Traditional physical therapy models consist of patients traveling to an out-patient therapy clinic for rehabilitation. "One-on-one" attention is given to the patient by a physical therapist during scheduled appointments to assist in their rehabilitation journey. Tele-rehabilitation offers flexibility for both the therapist and the patient to choose an environment they are most comfortable with, as well as a time that is most convenient. During a time where staying indoors is of the utmost importance, patients can still receive treatment through virtual platforms. Its incorporation into the treatment plan will help improve overall outcomes. The patient will feel more engaged and knowledgeable to pursue correct exercise form, progression, and goals set by the physical therapist.

4.3. Exercise Prescription Software

In physical therapy practice, the utilization of exercise prescription software could benefit patient-tailored care for the implementation of individualized exercise programs and monitoring of patient compliance and progression. These platforms could be effectively integrated with the electronic medical record system, indicating a remarkable productivity increase for

direct and remote exercise supervision through the administration of tele-rehabilitation services. Moreover, the software is continuously assessing and evaluating treatment progression via data analytics, prompting necessary physiologic adjustments to an exercise program in response to longitudinal outcome improvements, effectively increasing the therapeutic benefits conferred. Database-supported patient exercise plans ensure that practitioners tailor treatment strategies to address the patient's distinct symptoms rather than generalized recommendations, rendering clinical decisions patient-driven. Furthermore, these platforms have a clear and user-friendly interface layout that provides clinicians with quick access to intuitive menus, additional resources, video tutorials, and standardized evaluation tools. It was indicated that the use of software and accompanying equipment increases adherence as patients have easier access to instructional resources and are more likely to remain faithful to their prescribed treatment. However, merely providing access is insufficient, and considerable investment in staff training and education is necessary to maximize the utility of these resources.

Of all the available technologies, there is emerging evidence to suggest that exercise prescription software has made the largest positive impact in the field of physical therapy, leading to an increase in patient satisfaction rates through the accumulation of quantifiable progress. However, efforts to incorporate technological modalities into health practices are often hindered by certain impediments, such as a lack of software compatibility or initial user resistance. Thus, there are several efficacy, safety, and regulatory concerns associated with the utilization of these applications in daily routine. Physiotherapists will need to exercise increased care in monitoring and supervision to ensure effective and safe patient implementation. Nevertheless, it is important to recognize and understand the benefits and potential challenges of emergent technologies for their efficient and safe incorporation in routine rehabilitation practices.

5. Innovations in Dental Informatics

Innovations in dental informatics have drastically changed the way dentistry is practiced. In recent years, digital teaching and research centers have been established in multiple provinces across China to enhance learning and study progress in dental research. The long-term goal is to support the Chinese dental industry and enhance livelihood security for the Chinese people. It is essential that these new dental research and clinical centers have comprehensive computer and digital communication infrastructure. It is of academic importance to study, learn, evaluate, and enhance the Chinese progress in dental information technology and informatics.

The practice of dentistry is heavily data-focused and requires effective communication and storage of a great amount of information. Research findings and data storage in dentistry are increasingly focused towards images of high definition and complex shapes (Monea et al., 2016). The use of digital image technologies allows such images to be easily recorded and transmitted digitally, maintaining the image integrity. Common digital imaging in those dental fields includes photography, X-ray, and video. The radiographic image captured digitally enhances the ease in viewing, manipulation, and interpretation for obtaining a diagnosis and treatment planning. Additionally, in order to improve accuracy and streamline treatment, surrounding anatomical structures such as muscles or nerves are visualized. The wider acceptance of digital imaging technologies in dentistry allows for greater likelihood of having images produced in other digital formats. The dental imaging segment concern both current practice and the future development of the dental picture archiving and communication systems. Many digital imaging technologies are integrated with electronic health records (EHRs). Dental imaging retrieval technologies match patient's dental information with their stored images and display them simultaneously. capture dental images captured by operating dental equipment are stored in digital files and saved in the electronic patient record to form a unified system, effectively managing, searching, and tracking dental patient care.

5.1. Digital Imaging Technologies

Advances in digital imaging technology have revolutionized a wide range of applications in dentistry, relying on the generation of sophisticated medical images to help guide medical personnel decision-making. In dental informatics, developing complete records for an oral cavity requires not only written observations and diagnoses but also capturing and analyzing visual dental images such as radiological, intraoral camera, surgical micro-camera, and others. Digital imaging technologies have enhanced capabilities to capture and analyze dental images as well other feature of dental informatics. Unlike traditional photographic film methods, digital reproducible medical images offer numerous advantages: a significant reduction in radiation exposure, no intermediate steps for image acquisition/processing, and a negligible cost of imaging per patient; the main advantage of digital radiography is the immediate image retrieval. Another reason why dental professionals should consider taking an image with each patient and making it an integral practice within the Dental Information System (DIS) refers the ability to develop a comprehensive documentation for each patient. (Alauddin et al., 2021)(Carrillo-Perez et al.2022)

In the event of improved diagnoses or complicated treatment plans, having a full set of images asserting such measures is unambiguously beneficial. It also enhances patients' understanding of the dental professional's practice. Visual aids may be used by the dental professional to illustrate and simplify technical explanations. Additionally, an image can be inquired and e-mailed to a patient, allowing the patient to consult with a specialist, ensuring transparent information dissemination and potentially wiser health decision-making. Paradoxically, as dental imaging relies heavily on the generation of visual representations, it is severely limited in capturing only three-dimensional objects into two-dimensional images. Remote areas, where access to high-quality dental care is difficult, may greatly benefit from telemedicine applications, integrating communication technologies and medical data visualization and recording systems. Lastly, digital imaging can greatly boost dental research work. Recording precisely the same position and orientation of a patient's condyle before and after inducing anomalies is straightforward in computer representations but considerably impractical on a patient. (Monea et al., 2016)

5.2. Practice Management Software

The rapid development and constant progress of information technology have determined the implementation of computers in medical practice being nowadays function and also smooth the patient-doctor communication flow in a simplified manner. Electronic health records and computerized physician order entry are applications that will significantly improve patient safety and quality of care. Internet-based applications are very popular and useful. Use of such applications in the dental practice is not yet widespread but very practical application is possible. Automatic messages may be programmed to send to patients to remind them of upcoming appointments, follow-up appointments and treatments and this software also provides the possibility for the patients to access their personal health and treatment data online. Applications that can be used in the medical office include online scheduling, e-mail messaging, pre-registration and pre-visit preparation or patient access to personal medical records (Monea et al., 2016). The application of such systems improves the patient healthcare making entire process time efficient and error free.

Additionally, the dental informatics is defined as the application of computer and information science to the improvement of dental practice, research, education and management. It has been applied to both clinical dental practice and dental education. The dental office software applications are already on a very high peak of development. With entering some patient data new procedures are already scheduled and files ready for the use of the particular patient. The key features of such contemporary software are: very practical appointment schedule, electronic patient record, effective billing and insurance claim system and interestingly, some applications have the ability to diagnose, according to the filled data, new procedures necessary for patient treatment. After a complete tooth form filled the software gives out the information about the cost effective methods and benefits for a larger payment in the office. Since dental office work is administrative and operative at the same time, software applications and professional help in installation and setting are highly appreciable. The aim of the present study was to determine the level of computer-based methods and software applications in the daily activities of private dental practitioners. With the use of an original questionnaire, private dentists were questioned about the use of information technologies in daily practice and possible benefits.

5.3. Teledentistry Platforms

With the rapidly expanding reach of digital and telecommunication technologies, the introduction of teledentistry in the dental care sector has paved the way for healthcare delivery that was previously believed unattainable. In recent years, different mobile applications and web portals have been developed promoting easy connectivity with dentists or dental healthcare providers (Verma et al., 2019). It provides a mechanism by which interactions between dental professionals, oral healthcare providers, or patients can be received or disseminated by means of telecommunications for the sake of the patient's dental care. This means that the dentist may work remotely by delivering diagnosis, healthcare preparation, care, and/or treatment planning without first assessing the patient or the possibility of returning after initial assessment. Alternatively, after the initial oral health summary and recommendations, the patient does not require an in-person consultation with a dental surgery or a dental expert (Kanani et al., 2024).

Core dental treatment is often hampered by geographical separation where patients stay far from qualified dental practitioners or cannot afford to travel to dental clinics, or where disabled or elderly patients have mobility issues. The capability to make appointments for remote check-ups and follow-ups with dentists could significantly alleviate the effects of these barriers. In many cases, clients are intrigued by the capability of the dentists to provide immediate advice, grant permission for all steps and have the option by streaming voice, video, and images to monitor the process of the procedure. Moreover, teledentistry applications facilitate interested persons contacting dentists of a patient's choice worldwide. The fundamental idea behind this

present review is focused on how teledentistry applications affect the engagement of the patient for better oral healthcare and support the continuance of care.

A major hurdle for teledentistry applications is the absence of clear regulations and licensing approvals with respect to its operation. The concern also revolves around receiving compensation from oral healthcare service providers or dental insurers for such a service, as teledentistry services are not reported under the prevailing rules categorically. There is a recommendation in the national oral health care policy to introduce and use teledentistry applications more extensively within the traditional framework of dental practices so they may enhance and enhance conventional dental practices and not replace standard dental check-ups. It shares examples of successful implementation of this approach to showcase how patient care has been greatly enhanced using such applications.

6. Challenges and Future Directions in Health Informatics

Health Informatics has developed new categories and have been identified emerging directions of research. The paper aims to provide a comprehensive review on the central role of health informatics in advancing public health, nursing, physical therapy and dentistry. This analysis has potential in assisting insight into future health informatics projects or development. A content-topic analysis was conducted to quantitatively identify the changes in health informatics research over the past three decades. It generated a topic evolution frame that is used to shape four perspectives of future health informatics research.

4. Public Sector and Health Informatics Mining Social Media for Public Health Healthcare Behaviour Changes in Disease Outbreaks 5. Health Informatics in Healthcare Security and Privacy in Healthcare Data Sharing Effectiveness and Efficiency in Healthcare 6. Challenges and Future Directions in Health Informatics Regulatory Frameworks for Health Device Data Public Access and Reuse of Public Health Monitoring Ethical Guidelines for Social Media Public Health Collaboration of Health Practitioners and Stakeholders

6.1. Data Privacy and Security Concerns

This subsection discusses privacy and security concerns as they pertain to health informatics. The use of electronic health records and digital communications in public health, nursing, physical therapy, and dentistry poses challenges related to patient data access and privacy. A brief overview of these issues is provided; however, it is clear that vigilance is needed regarding new and novel threats.

The increased usage of electronic health records, health information exchanges, and digital communications by public health professionals has dramatically increased the potential for breaches of patient privacy. This is also true for other health professionals, such as nurses, physical therapists, and dentists. In this age of rapidly evolving and far-reaching technology, covered entities need to be more vigilant in their efforts to protect patient data. Care must be taken to ensure that patient consent has been obtained and all necessary precautions are in place when handling patient information. Healthcare professionals involved in the collection and dissemination of patient information must utilize best practices to minimize the risk of privacy breaches (D. Goldstein & D. Sarwate, 2016). Furthermore, under the HITECH Act, currently reconsideration was given by the US Department of Health and Human Services. It was worth to note those healthcare professionals relaying information are considered to be business associates and are therefore held to the same standards of patient data protection as the originating covered entity. Adequate education and training must be given by healthcare organizations to their staff to ensure the privacy and security of patient information. Fundamentally, a culture of privacy and security must be developed within healthcare organizations to ensure the professional, ethical, and legal obligation to protect patient information is maintained at all times.

6.2. Interoperability Issues

Seamless data sharing among disparate health informatics systems in healthcare is critical for comprehensive patient care and aggressive outreach by care providers. Over the past decade, the healthcare industry has promoted electronic record keeping for a wide variety of patient information. In an effort to transcribe and consolidate such patient records, health informatics (often known as health information technology, or health IT) has boosted the requirement of healthcare interoperability as designated by the United States Office of the National Coordinator for Health Information Technology. The seamless sharing of data between differing health informatics systems will dramatically improve the communication and efficiency of healthcare delivery across clinics, hospitals, and health care providers handling information originating from entirely separate entities (Helena de Mello et al., 2022). However, incompatible data encoding, structuring, and storing remain significant barriers to

achieving this vision of a unified health electronic information exchange. Section 6 is a comprehensive review of existing research regarding tackling interoperability problems in health informatics.

A surge of interest in mechanisms for the implementation of compatible data encoding, structuring, and storage among differing health informatics systems has been noted by academia and industry. Health informatics systems that create, read, and exchange patient data should conform to the health informatics standards to execute in a platform-agnostic faction, making it feasible for disparate care providers and health institutions to conduct aggregative outreach. Patient data should be securely and accurately transcribed, stored, and transacted at an extremely high frequency to ensure patient safety. Patient data, encoded in a machine-readable faction by health informatics infrastructures, may boost the availability and quality of patient care through effective care planning. However, patient data encoding, structuring, and storage may be inadequately formulated by healthcare vendors due to the application of non-standard data encodings and data storage plans.

6.3. Artificial Intelligence and Machine Learning Applications

Artificial intelligence (AI) and machine learning technologies have the potential to transform health informatics. AI algorithms can analyze and promote data-driven decision-making while machine learning allows for algorithms to iteratively learn from data. Together, these fields have the potential to process vast amounts of healthcare data and foster the development of applications in several industries of health including nursing, dental, physiotherapy, and public health. AI and machine learning-based systems can assist in the development of personalized medicine, resulting in the prediction of public health trends and aiding in the management of mass-personalized care. Predictive analytics, AI can be used to forecast the probability of a particular outcome, which can help health professionals to take a preemptive or prophylactic approach. AI-driven complex algorithms are the future of complex components to assist users. In the field of diagnostics, AI-driven applications have progressed from deciding the possibility of a medical condition, to recommending a list of treatments. Miniature inbuilt AI mode for health applications time-lapse data of health parameters can be diagnosed at the initial stage. Additionally, AI includes a risk assessment model that presents public health during the cognitive environment of the patient inhabitance connected by various medical devices and Health IT applications. While behavior advice is provided to the patient outside, such as dietary changes that improve diet plan there is behavior advice feedback on the risks during the gathering and spreading of the Covid-19 virus (Aamir et al., 2024).

Conversely, AI-powered public health developers need a strong partnership with researchers and policy decision takers. This is because the aim is to address the wants of the regions like well-being metrics, environments, and policy fuses. In public health areas, an optimization process can be organized by thinking back from the health issue to the physical fitness environment that helps well-being. For example, concerning wellbeing measurements, de-escalating vital sign measurements verify fitness, and policy decision-fuse creates a well-being, environmental improvement plan. But at present, these AI systems still have a large input of human products, such as AI professionals on the public fitness issue, ML experts on health metrics, environment and policy decisions experts that a medically equivalent AI can oversee.

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