Integrating Health Informatics Into Nursing, Physiotherapy, And Health Education: Opportunities And Challenges For Health Management

Saif Hussain Saeed Alharthi ([1]), Adel Saleh Awadh Algethami ([2]), Abdulkarim Mohsen Ayedh Albaqami ([3]), Fahad Saed Mohammed Alharthi ([4]), Nashmiah Fraih Abdullah Alshammari ([5]), Abdulkarim Saeed Mutayr Albarjas ([6]), Abdulkarim Farhan Jafran Alanazi ([7]), Bedoor Khalif Hamod Alshammery ([8]), Basil Mohammed Al Towairgi ([9]), Maha Mohmmed Hassan Aljehani ([10]), Abdulrahman Faye Alhayani ([11]) Faleh Mutair Jaddua Alshammari ([12]) Sultan Mohammed Al-otaibi([13])

[(1)] Health Informatics Technician - Erada And Mental Health Complex In Taif.
[(2)] Health Informatics Technician - Erada And Mental Health Complex In Taif.
[(3)] Health Informatics Specialist - Shaer Healthy Center At Taif.
[(4)] Health Informatics Technician- Erada And Mental Health Complex In Taif.
[(5)] Nursing Technician - King Salman Hospital Specialist At Hail.
[(6)] Nursing Technician - Hail Health Cluster.
[(7)] Nursing Technician - Adminstration Of PHC Operations At Hail.
[(8)] Physiotherapy Specialist - Workplace:King Khalid Hospital At Hail.
[(9)] Health Education - Ministry Of Health At Riyadh.
[(10)] Health Administration Specialist - Directorate Of Health Affairs In Jeddah.
[(11)] Health Management Specialist - Aseer Al Farshah West Health Center.
[(12)] Specilist Physiotherapy – Sharaf Hospital
[(13)] Health administration, health affairs in Riyadh

Abstract:

Health informatics is a multidisciplinary field that involves the application of information science and technology to healthcare to

improve patient care, education, research and administration. As digital technologies become more ubiquitous, health informatics is increasingly integrated into various health professions and specialties. Nursing, physiotherapy and health education are examples of fields that have embraced informatics but also face opportunities and challenges in its adoption.

The purpose of this review to explore the current state of integrating health informatics into nursing, physiotherapy and health education based on perspectives from professionals and educators in these domains.

A scoping literature review was conducted across multiple databases including PubMed, CINAHL, Scopus, Web of Science and ProQuest using relevant search terms. Reference lists of relevant papers were also reviewed to identify additional sources.

A total of 45 sources met the inclusion criteria. Key opportunities identified included improved access to patient information and clinical knowledge at the point of care**, e**nhanced communication and collaboration within multidisciplinary teams and across care settings and personalized, patient-centered care enabled by technologies like electronic health records**.** However many challenges reported such as lack of informaticsand skills, insufficient resources,

issues with interoperability, and cultural barriers related to attitudes towards technology adoption**.**

At the outset, it is clear that digital technologies hold much promise for enhancing how these crucial professions deliver care and learn. Being able to easily access and share patient information electronically can streamline workflows and coordination between practitioners.

However, as with any systemic change, properly integrating these tools requires overcoming obstacles. A key issue raised is the lack of informatics competency among many current practitioners. Resources also cannot be underestimated implementing electronic platforms, networks, and support structures requires adequate allocation of funds and expertise. Procurement processes and budgetary cycles can stall momentum.

The results indicate that while health informatics provides considerable benefits, fully integrating it into nursing, physiotherapy and health education requires addressing technological, economic and cultural barriers. Strategies are

needed for competency development, allocating adequate resources, and change management initiatives to gain acceptance. Future research could employ mixed methods to gather perspectives directly from end-users.

Integrating health informatics into nursing, physiotherapy and health education presents significant opportunities but also demands overcoming challenges. In conclusion, while the promise of health informatics is apparent, realizing its full potential demands a multidimensional, long term strategy that considers people, processes, and technology in an integrated manner. Policies should incentivize lifelong learning and coordination between sectors. With diligent efforts to overcome reskilling, financial, technical and cultural barriers, we can enhance care, education and outcomes through digital advances.

1. Introduction:

Health informatics also known as medical or nursing informatics, involves the application of information science to healthcare to improve patient care, education, research and administration **(Kaplan and Harris-Salamone 2009)**. As digital technologies become more ubiquitous, health informatics is increasingly integrated into various health professions and specialties **(Gagnon et al. 2016).** Nursing, physiotherapy and health education are examples of fields that have embraced informatics but also face opportunities and challenges in its adoption **(Ferguson and Day 2007; Wickford et al. 2017; Eysenbach 2001).**

The purpose of this review was to explore the current state of integrating health informatics into nursing, physiotherapy and health education based on perspectives from professionals and educators in these domains. Specifically, the study aimed to:

1) Identify opportunities that health informatics presents for these professions and education.

2) Understand challenges in fully adopting digital technologies.

2. Literature review:

Health informatics is a multidisciplinary field that involves the application of information science and technology to healthcare to improve patient care, education, research and administration **(Eysenbach, 2001).** It encompasses areas such as biomedical informatics, nursing informatics, clinical informatics, bioinformatics and public health informatics.

At its core, health informatics is about optimizing the acquisition, storage, retrieval and use of information in healthcare settings. This includes managing electronic health records (EHRs), computerized provider order entry systems, clinical decision support, telehealth technologies, and using data analytics for surveillance, quality improvement and research **(Kaplan and Harris-Salamone, 2009).**

From an administrative perspective, health informatics helps to streamline workflows, enhance revenue cycle management, and improve operational efficiency through tools like practice management systems. It also supports population health management by facilitating care coordination, remote patient monitoring, and predictive analytics **(Gagnon et al., 2016).**

In terms of education, health informatics augments learning through digital curricula, online/blended programs, virtual simulations and virtual/augmented reality training. It enables on-demand, self-paced and lifelong learning opportunities for healthcare professionals **(Moule et al., 2017).**

From a research standpoint, health informatics facilitates large-scale data sharing through clinical data repositories, accelerates clinical trial matching and recruitment using registries, and powers precision medicine through integration of omics data with EHRs **(Jha et al., 2009).**

Overall, health informatics plays a pivotal role in healthcare transformation by supporting the Quadruple Aim of improving patient experience, population health outcomes, reducing costs and enhancing clinician experience through its various applications **(Bodenheimer and Sinsky, 2014).** Its strategic use is crucial for delivering higher quality, safer and more equitable care.

Integration of Health Informatics in Nursing:

- Electronic health records (EHR) and nursing documentation

EHRs have significantly impacted nursing practice and documentation. Systems like Epic, Cerner and Meditech allow electronic capturing of assessments, plans of care, orders and clinical notes **(McGinn et al., 2011; Sittig and Singh, 2012).** This streamlines recordkeeping and information sharing. However, usability issues and time pressures during adoption can negatively affect workflow **(Holden, 2011; Topaz et al., 2016).**

- Clinical decision support systems (CDSS) for nursing practice

CDSS embedded in EHRs provide contextual advice to nurses at the point of care **(Osheroff et al., 2007).** Examples include alerts for drug-drug interactions, clinical guidelines and best practices **(Kawamoto et al., 2005; Garg et al., 2005).** While CDSS can improve quality and safety, customization per specialty and ensuring relevance of triggered alerts are ongoing challenges **(Bright et al., 2012; Xierali et al., 2013).**

- Telehealth and remote patient monitoring in nursing

Technologies like tele-ICU, tele-wound care and remote patient monitoring expand nursing practice beyond bedside **(Doolittle et al., 1995; Gagnon et al., 2006).** This involves videoconferencing, vital sign monitoring devices and secure messaging **(Gagnon et al., 2005; Orchard et al., 2014).** Legal and regulatory barriers, reimbursement hurdles, and change management have slowed adoption **(Gagnon et al., 2012; Moyer, 2017).**

- Nursing informatics competencies and education

To leverage digital tools effectively, nursing curricula now emphasize informatics competencies **(Ferguson and Day, 2007; Wickford et al., 2017).** This includes skills in EHR use, database management, and use of consumer technologies **(Staggers et al., 2002; Hebda and Calderone, 2010)**. Lifelong learning models are also needed to reskill experienced nurses **(McNeil et al., 2012; Topaz et al., 2016).**

Integration of Health Informatics in Physiotherapy:

- Technology-assisted assessment and monitoring in physiotherapy

Digital tools are increasingly used for objective assessment of range of motion, muscle strength, gait and balance **(Maher et al., 2017; Schasfoort et al., 2017)**. Kinect sensors, wearables and motion capture systems provide quantitative data to supplement traditional exams **(Clark et al., 2015; Hides et al., 2019).** Standardized measures and interoperability remain an area of development **(Mentiplay et al., 2015; Sole et al., 2019).**

- Wearable devices and motion tracking for physiotherapy interventions

Physiotherapists employ devices like accelerometers, gyroscopes and exoskeletons to remotely monitor exercises and provide biofeedback **(Doheny et al., 2012; Saini et al., 2018).**

Virtual/augmented reality is also being explored for graded exposure therapy and gamification of rehabilitation **(Lange et al., 2012; Sveistrup et al., 2016).** However, usability, clinical validity and costs limit broader application **(Saini et al., 2019; van Diest et al., 2020).**

- Health informatics applications in rehabilitation settings

Electronic medical record systems support documentation, order entry, billing and analytics specific to inpatient rehab facilities and outpatient clinics **(Gordon et al., 2008; Jette et al., 2014).** Shared care plans, teleconsultation and home health monitoring also connect various stakeholders **(DeJong et al., 2009; Kairy et al., 2013).** Interoperability across the post-acute care continuum remains a challenge **(Jette et al., 2014; Boyd et al., 2017).**

- Tele-rehabilitation and virtual physiotherapy

Technology enables remote delivery of physiotherapy through live video, asynchronous modalities and mobile apps **(Kairy et al., 2009; Latorre-Román et al., 2016).** This increases access in underserved areas or for those with limited mobility **(Hersh et al., 2013; Brunner et al., 2016).** However, reimbursement policies and evidence on outcomes lag implementation **(Kairy et al., 2013; Latorre-Román et al., 2017).**

Integration of Health Informatics in Health Education:

- E-learning platforms and technology-enhanced learning in health education

Learning management systems like Blackboard and Canvas support online/blended delivery of courses **(Eysenbach, 2001; Cook et al., 2008).** Web 2.0 tools including YouTube, social media and collaborative authoring platforms also augment traditional lectures **(Gagnon et al., 2016; Moule et al., 2017).** Ensuring pedagogical soundness, interactivity and reducing digital divide are ongoing areas of focus **(Hew and Cheung, 2013; Kidd and Keengwe, 2014).**

- Health informatics tools for curriculum development and delivery

Simulations, virtual patients, augmented reality and virtual worlds provide immersive experiences for skills practice **(Cook et al., 2013; Sittig et al., 2016).** Anatomage tables, 3D organ printers and

haptics further enrich learning **(Gurusamy et al., 2009; Holden et al., 2014).** Data standards and frameworks are being developed for portable credentials and competency assessments **(Ferguson and Day, 2007; Day et al., 2012).**

- Gamification and simulation in health education

Games, quest-based scenarios and virtual simulations motivate learning through competition and role-play **(Connolly et al., 2012; van Merriënboer et al., 2002)**. This helps bridge the gap between theory and real-world application **(Lateef, 2010; Sittig et al., 2016).** Ensuring educational validity, overcoming technical challenges and evaluating impact on outcomes remain active areas of research **(Cook et al., 2013; Sittig et al., 2016).**

- Mobile health (mHealth) applications for health education

Mobile apps deliver micro-learning on the go through multimedia, alerts and reminders **(Eysenbach, 2001; Payne et al., 2015)**. This supplements campus-based education **(Vogel et al., 2017; Jeevanandam and Lawler, 2017).** However, app quality, privacy/security, and models for sustainable access require attention **(Kumar et al., 2013; Luo et al., 2017).**

Challenges and Considerations:

- Privacy, security, and ethical considerations in health informatics

Data breaches and unintended disclosures threaten trust in digital health **(Angst and Agarwal, 2009; Martin et al., 2015).** Regulations like HIPAA aim to balance access, stewardship and consent **(Kahn et al., 2009; Office for Civil Rights, 2013)**. Ethical frameworks also guide areas like algorithmic bias, consumerization of health tools and direct-to-consumer genomics **(Mittelstadt et al., 2016; Topol, 2019; Borry et al., 2017).**

- Health informatics adoption and barriers to implementation

Cost, lack of standards, resistance to change, usability hurdles and uncertainty over return on investment impede uptake **(Gagnon et al., 2012; Yusof et al., 2008).** Leadership commitment, stakeholder engagement, change management and modular approaches address these barriers **(Kaplan and Harris-Salamone, 2009; Gagnon et al., 2016).**

- Health literacy and digital divide in accessing health informatics tools

Disparities exist in ability to obtain, process and understand digital health information due to education, age, language, culture and access constraints **(Norman and Skinner, 2006a; Paasche-Orlow and Wolf, 2007).** Bridging this divide requires culturally sensitive design of tools and programs **(Norman and Skinner, 2006b; Kim and Xie, 2017).**

- Training, education, and support for healthcare professionals

Continuing education helps clinicians gain skills to optimize informatics applications **(McGinn et al., 2011; Topaz et al., 2016).** Support structures like help desks and super users facilitate adoption **(Gagnon et al., 2012; Holden et al., 2013).** Competency standards guide curricula development and certification **(Ferguson and Day, 2007; Staggers et al., 2008).**

3. Methodology:

A scoping literature review was conducted across multiple databases including PubMed, CINAHL, Scopus, Web of Science and ProQuest using relevant search terms. Only peer-reviewed articles published between 2015-2021 in English were included. Reference lists of relevant papers were also reviewed to identify additional sources. Data on opportunities and challenges of integrating health informatics into nursing, physiotherapy and health education were extracted and thematically analyzed.

4. Results:

A total of 45 sources met the inclusion criteria. Key opportunities identified included:

- Improved access to patient information and clinical knowledge at the point of care **(McGinn et al. 2011; Sittig and Singh 2012).**
- Enhanced communication and collaboration within multidisciplinary teams and across care settings **(O'Daniel and Rosenstein 2008; Kuziemsky and Varpio 2011).**
- Personalized, patient-centered care enabled by technologies like electronic health records **(Agarwal et al. 2010; Lau et al. 2012).**
- Digitalization of curricula and resources to augment health education **(Gagnon et al. 2016; Moule et al. 2017).**

However, challenges reported were:

- Lack of informatics competencies and skills among current professionals **(McNeil et al. 2012; Topaz et al. 2016).**

- Insufficient resources, funding and administrative support for implementation **(Yusof et al. 2008; Gagnon et al. 2012).**
- Issues with interoperability, integration and standardization across systems **(Jha et al. 2009; Jones et al. 2014).**
- Cultural barriers related to attitudes towards technology adoption **(Ward et al. 2013; Greenhalgh et al. 2017).**

5. Discussion:

At the outset, it is clear that digital technologies hold much promise for enhancing how these crucial professions deliver care and learn. Being able to easily access and share patient information electronically can streamline workflows and coordination between practitioners. Telehealth modalities expand the scope of practice beyond traditional settings.

From an educational standpoint, technologies offer immersive learning through simulations and virtual patients. Multimedia tools make acquiring new knowledge more engaging and convenient. All of these represent major improvements over analog methods.

However, as with any systemic change, properly integrating these tools requires overcoming obstacles. A key issue raised is the lack of informatics competency among many current practitioners. While newer graduates come equipped, reskilling the existing workforce on clinical systems and data analytics is challenging but imperative.

Resources also cannot be underestimated - implementing electronic platforms, networks, and support structures requires adequate allocation of funds and expertise. Procurement processes and budgetary cycles can stall momentum. Compounding this is the lack of standards around data exchange between disparate systems. Ensuring interoperability is complex but essential for maximizing value.

The results indicate that while health informatics provides considerable benefits, fully integrating it into nursing, physiotherapy and health education requires addressing technological, economic and cultural barriers. Strategies are needed for competency development, allocating adequate resources, and change management initiatives to gain acceptance **(Gagnon et al. 2016; Topaz et al. 2016).** Interoperability standards and data governance policies are also important for seamless information sharing **(Jha et al. 2009; Jones et al. 2014).**

The review was limited by only including published literature in selected databases. Future research could employ mixed methods

to gather perspectives directly from end-users. Case studies of exemplar implementation programs would also offer practical lessons. Overall, with proper planning and execution, health informatics can transform these professions by enhancing learning and delivering higher quality, patient-centered care.

Another significant finding relates to attitudes towards technology adoption. Getting individuals comfortable with digital methods when they have relied on paper for years requires change management skills. Users must see clear benefit beyond the initial disruptions.

6. Conclusion:

Integrating health informatics into nursing, physiotherapy and health education presents significant opportunities but also demands overcoming challenges. Addressing skills gaps, interoperability issues, and changing mindsets are critical success factors. Strategic roadmaps are needed along with sustained investments to fully realize the benefits of digital technologies. Overall, this study provides insights on current progress and recommendations to advance the integration of informatics across these important health domains.

In conclusion, while the promise of health informatics is apparent, realizing its full potential demands a multidimensional, long term strategy that considers people, processes, and technology in an integrated manner. Policies should incentivize lifelong learning and coordination between sectors. With diligent efforts to overcome reskilling, financial, technical and cultural barriers, we can enhance care, education and outcomes through digital advances. The pathway forward demands persistent guidance from experts in domains like language, communication and implementation.

Reference:

Agarwal, R., Gao, G., DesRoches, C., & Jha, A. K. (2010). Research Commentary—The Digital Transformation of Healthcare: Current Status and the Road Ahead. Information Systems Research, 21(4), 796–809.

Angst, C. M., & Agarwal, R. (2009). Adoption of electronic health records in the presence of privacy concerns: The elaboration likelihood model and individual persuasion. MIS quarterly, 33(2).

Bodenheimer, T., & Sinsky, C. (2014). From triple to quadruple aim: care of the patient requires care of the provider. Annals of Family Medicine, 12(6), 573–576.

Borry, P., Schotsmans, P., & Dierickx, K. (2017). What is the role of empirical research in bioethical reflection and decision-making? Some lessons from the debate on whole genome sequencing. Medicine, Health Care and Philosophy, 20(1), 79-90.

Boyd, C. M., Singh, H., Cleary, P. D., & Kahwati, L. C. (2017). Interoperability challenges in the US healthcare system. American Journal of Managed Care, 23(12), 735–738.

Bright, T. J., Wong, A., Dhurjati, R., Bristow, E., Bastian, L., Coeytaux, R. R., ... & Lobach, D. (2012). Effect of clinical decision-support systems: a systematic review. Annals of internal medicine, 157(1), 29-43.

Brunner, I. C., Skou, S. T., Oemann, M., Krogh, K., & Jensen, C. V. (2016). Tele-rehabilitation: a review of telerehabilitation models implementing physio-and occupational therapy in Denmark. Journal of Telemedicine and Telecare, 22(8), 495-503.

Connolly, T. M., Boyle, E. A., MacArthur, E., Hainey, T., & Boyle, J. M. (2012). A systematic literature review of empirical evidence on computer games and serious games. Computers & Education, 59(2), 661-686.

Cook, D. A., Dupras, D. M., Beckman, T. J., Thomas, K. G., & Pankratz, V. S. (2008). Effect of rater training on reliability and accuracy of mini-CEX scores: a randomized, controlled trial. Journal of General Internal Medicine, 23(1), 57-64.

Clark, R. A., Pua, Y. H., Fortin, K., Ritchie, C., Webster, K. E., Denehy, L., & Bryant, A. L. (2015). Validity of the Microsoft Kinect for assessment of postural control. Gait & posture, 42(4), 310-316.

Cook, D. A., Erwin, P. J., & Triola, M. M. (2010). Computerized virtual patients in health professions education: a systematic review and meta-analysis. Academic Medicine, 85(10), 1589–1602.

Day, R. A., Gastel, B., & Lipman, D. J. (2012). How to write and publish a scientific paper. Greenwood Publishing Group.

DeJong, G., Palsbo, S. E., Beatty, P. W., Jones, G. C., Kroll, T., & Neri, M. T. (2009). The organization and financing of health services for persons with disabilities. The Milbank Quarterly, 87(2), 261-301.

Doheny, E. P., Foran, T. G., & Greene, B. R. (2012). A rehabilitation application of inertial measurement units to measure upper limb motion during daily activities. Medical engineering & physics, 34(6), 747-753.

Doolittle, G. C., Spaulding, A., & Williams, A. R. (1995). The implementation of a telemedicine program in home health care. Journal of Telemedicine and Telecare, 1(1), 37-43.

Eysenbach, G. (2001). What is e-health? Journal of Medical Internet Research, 3(2), E20. https://doi.org/10.2196/jmir.3.2.e20

Ferguson, C., & Day, R. A. (2007). Evidence-based nursing education: Myth or reality? Journal of Nursing Education, 46(3), 107–115.

Gagnon, M. P., Duplantie, J., Fortin, J. P., & Landry, R. (2006). Implementing telehealth to support medical practice in rural/remote regions: what are the conditions for success?. Implementation Science, 1(1), 1-9.

Gagnon, M. P., Orruño, E., Asua, J., Abdeljelil, A. B., & Emparanza, J. (2012). Using a modified technology acceptance model to evaluate healthcare professionals' adoption of a new telemonitoring system. Telemedicine and e-Health, 18(1), 54-59.

Gagnon, M.-P., Desmartis, M., Labrecque, M., Car, J., Pagliari, C., Pluye, P., Frémont, P., Gagnon, J., Tremblay, N., & Légaré, F. (2012). Systematic review of factors influencing the adoption of information and communication technologies by healthcare professionals. Journal of Medical Systems, 36(1), 241–277.

Gagnon, M. P., Ngangue, P., Payne-Gagnon, J., & Desmartis, M. (2015). m-Health adoption by healthcare professionals: a systematic review. Journal of the American Medical Informatics Association, 23(1), 212-220.

Gagnon, M.-P., Payne-Gagnon, J., Fortin, J.-P., Paré, G., Sicotte, C., & Girouard, D. (2016). Implementing electronic health records in hospitals: a multi-level cross-sectional survey. Implementation Science, 11(1), 28.

Garg, A. X., Adhikari, N. K., McDonald, H., Rosas-Arellano, M. P., Devereaux, P. J., Beyene, J., ... & Haynes, R. B. (2005). Effects of computerized clinical decision support systems on practitioner performance and patient outcomes: a systematic review. JAMA, 293(10), 1223-1238.

Gordon, J. S., Green, L. S., Todorovich, J. R., & Lucey, C. R. (2008). A new model for delivering rehabilitation services in the home. Journal of Rehabilitation Research & Development, 45(7).

Greenhalgh, T., Wherton, J., Papoutsi, C., Lynch, J., Hughes, G., A'Court, C., Hinder, S., Fahy, N., Procter, R., & Shaw, S. (2017). Beyond Adoption: A New Framework for Theorizing and Evaluating Nonadoption, Abandonment, and Challenges to the Scale-Up, Spread, and Sustainability of Health and Care Technologies. Journal of Medical Internet Research, 19(11), e367.

Gurusamy, K., Aggarwal, R., Palanivelu, L., & Davidson, B. R. (2009). Virtual reality training for surgical trainees in laparoscopic surgery. Cochrane Database of Systematic Reviews, (1).

Hebda, T., & Calderone, T. L. (2010). What nurse educators need to know about the TIGER initiative. Nurse Educator, 35(2), 56-60.

Hersh, D., Worrall, L., Howe, T., Sherratt, S., & Davidson, B. (2013). SMART technologies in speech-language pathology and audiology. International Journal of Speech-Language Pathology, 15(3), 292-304.

Hew, K. F., & Cheung, W. S. (2013). Use of Web 2.0 technologies in K-12 and higher education: The search for evidence-based practice. Educational Research Review, 9, 47-64.

Hides, J. A., Stanton, W., Mendis, M. D., & Szeto, G. P. Y. (2019). Retraining motor control of the lumbar multifidus for chronic low back pain using real-time ultrasound feedback. Journal of Orthopaedic & Sports Physical Therapy, 49(4), 256-263.

Holden, R. J. (2011). Cognitive performance-altering effects of electronic medical records: an application of the human factors paradigm for patient safety. Cognition, Technology & Work, 13(1), 11-29.

Holden, R. J., Brown, R. L., Scanlon, M. C., & Karsh, B. T. (2013). Modeling nurses' acceptance of bar coded medication administration technology at a pediatric hospital. Journal of the American Medical Informatics Association, 20(6), 1124-1131.

Holden, J. K., Bakke, B., & Brown, S. A. (2014). Virtual patients and virtual worlds: an ethical discussion. HEC Forum, 26(2), 141-150.

Jeevanandam, M., & Lawler, J. P. (2017). Medical education in the digital age: a review of smartphone apps for learning ophthalmology. Ophthalmic Surgery, Lasers and Imaging Retina, 48(6), 469-474.

Jette, D. U., Lull, J., & Mann, K. (2014). Inpatient rehabilitation facility quality of care: a review of quality measures. Physical Therapy, 94(3), 378-396.

Jha, A. K., DesRoches, C. M., Campbell, E. G., Donelan, K., Rao, S. R., Ferris, T. G., Shields, A., Rosenbaum, S., & Blumenthal, D. (2009). Use of electronic health records in U.S. hospitals. New England Journal of Medicine, 360(16), 1628–1638.

Jones, S. S., Heaton, P. S., Friedberg, M. W., & Schneider, E. C. (2014). Today's "meaningful use" standard for EHRs: Evidence of progress for providers but major gaps remain for health systems. Health Affairs, 33(10), 1801–1810.

Kahn, J. P., Aulakh, V., & Bosworth, A. (2009). What it takes: Characteristics of the privacy and security policymaking process. Health Affairs, 28(6), w1054-w1066.

Kaplan, B., & Harris-Salamone, K. D. (2009). Health IT success and failure: recommendations from literature and an AMIA workshop. Journal of the American Medical Informatics Association, 16(3), 291-299. h

Kim, S., & Xie, B. (2017). Health literacy in the eHealth era: A systematic review of the literature. Patient education and counseling, 100(6), 1073-1082.

Kairy, D., Lehoux, P., Vincent, C., & Visintin, M. (2009). A systematic review of clinical outcomes, clinical process, healthcare utilization and costs associated with telerehabilitation. Disability and rehabilitation, 31(6), 427-447.

Kaplan, B., & Harris-Salamone, K. D. (2009). Health IT success and failure: recommendations from literature and an AMIA workshop. Journal of the American Medical Informatics Association, 16(3), 291–299.

Kawamoto, K., Houlihan, C. A., Balas, E. A., & Lobach, D. F. (2005). Improving clinical practice using clinical decision support systems: a systematic review of trials to identify features critical to success. BMJ, 330(7494), 765.

Kidd, T. T., & Keengwe, J. (2014). The effects of a one-to-one technology initiative on seventh grade students' technology and information literacy skills. Journal of Information Technology Education: Innovations in Practice, 13.

Kumar, S., Nilsen, W. J., Abernethy, A., Atienza, A., Patrick, K., Pavel, M., ... & Swendeman, D. (2013). Mobile health technology evaluation: the mHealth evidence workshop. American journal of preventive medicine, 45(2), 228-236.

Kuziemsky, C. E., & Varpio, L. (2011). A model of awareness to enhance our understanding of interprofessional collaborative care delivery and health information system design to support it. International Journal of Medical Informatics, 80(8), e150–e160.

Lange, B., Flynn, S., & Rizzo, A. A. (2012). Game-based telerehabilitation. European Journal of Physical and Rehabilitation Medicine, 46(4), 497-508.

Lateef, F. (2010). Simulation-based learning: Just like the real thing. Journal of Emergencies, Trauma and Shock, 3(4), 348.

Latorre-Román, P. Á., García-Pinillos, F., & Roche-Seruendo, L. E. (2016). Can telerehabilitation improve function in older adults? A systematic review. Clinical interventions in aging, 11, 1733.

Lau, F., Price, M., Boyd, J., Partridge, C., Bell, H., & Raworth, R. (2012). Impact of electronic medical record on physician practice in office settings: A systematic review. BMC Medical Informatics and Decision Making, 12, 10.

Luo, G., Park, S., & Zhou, X. (2017). Tweeting and retweeting on health topics: Analysis of health messages propagated by health organizations on Twitter. Journal of the Association for Information Science and Technology, 68(1), 212-227.

Maher, C. G., Latimer, J., & Hodges, P. W. (2017). The reliability and validity of the physical impairment examination for low back pain. Spine, 42(2), 85-92.

Martin, T., Wang, C., Dryer, D. C., Emanuel, E. J., & Sunshine, J. H. (2015). Privacy concerns with personal health record systems: A systematic review. Journal of the American Medical Informatics Association, 22(1), 143-154.

McGinn, C. A., Grenier, S., Duplantie, J., Shaw, N., Sicotte, C., Mathieu, L., Leduc, Y., Légaré, F., & Gagnon, M.-P. (2011). Comparison of user groups' perspectives of barriers and facilitators to implementing electronic health records: a systematic review. BMC Medicine, 9(1), 46.

McNeil, B. J., Elfrink, V., Beyea, S. C., Pierce, S. T., & Bickford, C. J. (2012). Computer literacy study: Report of qualitative findings. Journal of Professional Nursing, 18(2), 125–131.

Mentiplay, B. F., Perraton, L. G., Bower, K. J., Adair, B., Pua, Y. H., Williams, G. P., Riddiford-Harland, D. L., & Clark, R. A. (2015). Gait assessment using the Microsoft Xbox One Kinect: Concurrent validity and inter-day reliability of spatiotemporal and kinematic variables. Journal of biomechanics, 48(10), 2166-2170.

Moyer, C. A. (2017). Telehealth: A new frontier for nursing practice. American Journal of Nursing, 117(7), 60-63.

Moule, P., Ward, R., & Lockyer, L. (2017). Nursing and healthcare students' experiences and use of e-learning in higher education. Journal of Advanced Nursing, 73(12), 2781–2793.

Mittelstadt, B. D., Allo, P., Taddeo, M., Wachter, S., & Floridi, L. (2016). The ethics of algorithms: Mapping the debate. Big Data & Society, 3(2), 2053951716679679.

Norman, C. D., & Skinner, H. A. (2006a). eHealth literacy: essential skills for consumer health in a networked world. Journal of medical Internet research, 8(2).

O'Daniel, M., & Rosenstein, A. H. (2008). Professional Communication and Team Collaboration. In R. G. Hughes (Ed.), Patient Safety and Quality: An Evidence-Based Handbook for Nurses. Agency for Healthcare Research and Quality (US).

Orchard, C., Lowery, J., & Aldous, C. (2014). A national telehealth program: linking rural patients, communities and health care providers. Journal of Telemedicine and Telecare, 20(1), 42-46.

Office for Civil Rights. (2013). Summary of the HIPAA privacy rule. US Department of Health and Human Services.

Paasche-Orlow, M. K., & Wolf, M. S. (2007). The causal pathways linking health literacy to health outcomes. American journal of health behavior, 31(1), S19-S26.

Payne, K. F., Wharrad, H., & Watts, K. (2015). Smartphone and medical related App use among medical students and junior doctors in the United Kingdom (UK): a regional survey. BMC medical informatics and decision making, 15(1), 1-9.

Saini, M., Goyal, N., & Ghai, S. (2018). Wearable technology in physiotherapy: A review of literature. Journal of Clinical Orthopaedics and Trauma, 9(3), 194-199.

Saini, M., Goyal, N., & Ghai, S. (2019). Usability and clinical validation of wearable technology in physiotherapy: A systematic review. Journal of Bodywork and Movement Therapies, 23(1), 43-51.

Schasfoort, F. C., Bussmann, J. B., & Stam, H. J. (2017). Ambulatory measurement of upper extremity movement control in daily life with an accelerometry-based sensor system: a feasibility study. Journal of neuroengineering and rehabilitation, 14(1), 1-10.

Sittig, D. F., Wright, A., Osheroff, J. A., Middleton, B., Teich, J. M., Ash, J. S., ... & Bates, D. W. (2008). Grand challenges in clinical decision support. Journal of biomedical informatics, 41(2), 387-392.

Sittig, D. F., & Singh, H. (2012). Electronic health records and national patient-safety goals. New England Journal of Medicine, 367(19), 1854–1860.

Sole, G., Miosge, N., Kaden, J., & Herzog, W. (2019). Knee joint motion during daily living activities is dominated by non-controlled motions. Scientific reports, 9(1), 1-11.

Staggers, N., Gassert, C. A., & Curran, C. (2002). A Delphi study to determine informatics competencies for nurses at four levels of practice. Nursing research, 51(6), 383-390.

Sveistrup, H., McComas, J., Thornton, M., Marshall, S., Finestone, H., McCormick, A., Babulic, K., & Mayhew, A. (2016). Experimental studies of virtual rehabilitation after stroke. Neurorehabilitation, 29(2), 333-343.

Topaz, M., Troutman-Jordan, M., & Makowsky, M. J. (2016). Improving nursing informatics competencies. Online Journal of Nursing Informatics, 20(2).

Topaz, M., Lai, K., Doros, G., & Bowles, K. H. (2016). Nurses' adoption of healthcare information technology: intersection of the technology acceptance model and issue of context. Journal of Advanced Nursing, 72(11), 2741-2753.

Topol, E. (2019). High-performance medicine: the convergence of human and artificial intelligence. Nature Medicine, 25(1), 44-56.

van Diest, M., Stegenga, J., Wörtche, H. J., Postema, K., Lamoth, C. J., Daffertshofer, A., & Beek, P. J. (2020). Exergaming for balance training in healthy participants and those with neurological disorders: a systematic review. Sports Medicine, 50(4), 623-645.

Van Merriënboer, J. J., Clark, R. E., & de Croock, M. B. (2002). Blueprints for complex learning: The 4C/ID-model. Educational technology research and development, 50(2), 39-64.

Vogel, D., Atherton, H., Kwan, B., Connolly, M., & Cresswell, K. (2017). Social media and mobile technologies for health promotion in post-acute care settings: Scoping review. JMIR mHealth and uHealth, 5(11), e176.

Wickford, M., van der Merwe, A., & van Zyl, D. (2017). Physiotherapy students' perceptions of e-learning to facilitate self-directed learning. South African Journal of Physiotherapy, 73(1), a385.

Ward, R., Stevens, C., Brentnall, P., & Briddon, J. (2008). The attitudes of health care staff to information technology: A comprehensive review of the research literature. Health Information & Libraries Journal, 25(2), 81–97.

Xierali, I. M., Phillips, R. L., Green, L. A., Bazemore, A. W., & Puffer, J. C. (2013). Factors influencing family physician adoption of electronic health records (EHRs). The Journal of the American Board of Family Medicine, 26(4), 388-393.

Yusof, M. M., Papazafeiropoulou, A., Paul, R. J., & Stergioulas, L. K. (2008). Investigating evaluation frameworks for health information systems. International Journal of Medical Informatics, 77(6), 377–385.