The **digital transformation** in **nursing** education and practice

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Contents

FOREWORD

In the current landscape of public health, we find ourselves at the intersection of two powerful forces: the ever-advancing power of the digital transformation of the health sector and the critical demand for more comprehensive health services. This juncture underscores the profound impact of digital transformation on nursing, a profession within the health workforce that constitutes a core pillar within health systems in the Americas.

This publication, *The Digital Transformation in Nursing Education and Practice*, emerges as a relevant contribution in the rapidly evolving world of nursing. It stands not only as a testament to the profession's resilience, but also as a guide through the digital transformation for nursing professionals, educators, policy-makers, and stakeholders.

The convergence of public health and digital health is reshaping the landscape of patient care, administrative processes, and the very essence of health service delivery. Nurses and other health workers are essential for this transformation, and their capacity to embrace digital tools and technologies is critical to the future of health systems.

The content within this publication delves deeply into the multifaceted dimensions of this digital transformation. It covers from the importance of digital literacy in nursing practice to the integration of immersive virtual learning experiences. It addresses the adoption of electronic health records and the limitless potential of telehealth. In essence, it explores what it means to be a nurse in today's digitally driven public health environment.

The COVID-19 pandemic, an unprecedented global crisis, has unequivocally underscored the urgency of the digital transformation of the health sector. The surge in telehealth and virtual care settings became not merely a convenience but an essential lifeline, highlighting the need for nurses to rapidly adapt to new modes of health service delivery. The pandemic made it evident that the future of nursing education must encompass not only traditional clinical skills but also the ability to excel in virtual care settings and leverage emerging technologies, including artificial intelligence, the Internet of things, wearables, and data analytics, among others.

However, this digital transformation does not come without its share of challenges. It necessitates a paradigm shift in nursing education and practice, entailing changes in curricula, teaching methodologies, and the adoption of digital literacy as an essential skill, adapted to the needs of health systems based on primary health care. It calls for the collaboration of governments, universities, healthcare institutions, and the nursing community to support and nurture this transformation.

As we navigate this exciting yet challenging terrain, we must remain firm in our commitment to the ultimate goal: providing better, more efficient, and more accessible health for all. This transformation transcends technology; it is about elevating the quality of patient care, improving health outcomes, and empowering nurses to be champions in health innovation.

The journey outlined in this publication is not an isolated endeavor; it is part of a global movement toward a digitally enabled and empowered nursing workforce. We hope that the insights, perspectives, and experiences shared within these pages will not only inspire but also inform and guide all those engaged in nursing education and practice. Together, we can embrace the digital age and ensure that nursing remains not just a critical and core profession within our health systems, but a driving force in shaping the future of health care.

The digital transformation in nursing education and practice

Our heartfelt gratitude extends to the editors and all who have contributed to the realization of this publication. May it serve as a catalyst for positive change, a wellspring of knowledge, and a testament to the tenacity and adaptability of the nursing profession, especially in the face of extraordinary challenges and opportunities.

Let us embark on this digital journey with a shared vision of excellence in nursing education and practice, knowing that our collective efforts today will lay the foundation for a healthier, more connected, and digitally empowered tomorrow.

Dr. Jarbas Barbosa da Silva Jr.
Director of the Pan American Health Organization

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ABBREVIATIONS AND ACRONYMS

AI	artificial intelligence
AR	augmented reality
EHR	electronic health record
ICT	information and communication technologies
IoT	Internet of things
IT	information technology
NI	nursing informatics
VR	virtual reality

INTRODUCTION

INTRODUCTION

Digital health refers to "the cost-effective and secure use of information and communications technologies in support of health and health-related fields, including health-care services, health surveillance, health literature, and health education, knowledge and research" *(1, 2)*.

Several definitions try to delimit the scope of the area and the best use of the term digital health, which is often applied as a synonym for health informatics and eHealth. An important characteristic is that digital health connects and empowers people and populations to manage health and wellness. Thus, healthcare professionals must work together using integrated, interoperable, and digitally enabled care environments that strategically leverage digital tools, technologies, and services to transform care delivery *(3)*.

The adoption of digital health solutions has been accelerated due to the COVID-19 pandemic, proving they are key for the delivery of care at all levels of the public health system: the patient *(4)*, the community *(5)*, the care team *(6)*, the healthcare institution *(7)*, and the political and economic environment *(8)*. Digital health is an integral part of health priorities and can be beneficial when used in an ethical, equitable, and sustainable way. The comprehensive benefits of digital health include facilitating the assessment, diagnosis, and management of health problems in a safe and effective manner, thereby fostering greater equity in access to timely medical care; addressing unmet health needs; and strengthening the capacity of the whole sector to access the information needed to understand complex scenarios and make decisions, among others *(3, 9)*.

In an era defined by the United Nations Secretary-General as the Age of Digital Interdependence, the importance of digital literacy in health care, and particularly within the nursing profession, cannot be overstated. As the world becomes increasingly interconnected and reliant on digital tools and technologies, the ability to navigate, harness, and leverage these resources has become a fundamental skill for healthcare professionals. Digital literacy empowers nurses to excel in an ever-evolving healthcare landscape, enabling them to provide more efficient, effective, and patient-centered care. This publication delves into the critical intersection of digital health and nursing, emphasizing the pivotal role of digital literacy in shaping the future of healthcare delivery.

With the objective of reducing the gaps and overcoming the obstacles that arise on the path to implementation of digital health, the Pan American Health Organization/World Health Organization (PAHO/WHO) has been working consistently with Member States in the development and implementation of strategies and action plans on eHealth, Knowledge Management and Communications, Information Systems for Health, Human Resources for Health, Digital Transformation, and Data Science *(9–11)*. (See Annex.)

The COVID-19 pandemic highlighted the essential and growing demand for human resources for health, in which nurses are an important cadre. Currently the numbers of nurses and healthcare professionals are not sufficient to cover all the needs of the population. This shortage is attributed to the lack of investment in the profession, an insufficient number of nursing schools to meet demand, nursing being an unattractive profession to young students, and outmigration of nursing professionals toward urban areas or higher-income countries. Although more than a quarter of the world's nursing workforce is in the Region of the Americas, more than half of these nurses work in North America *(12)*.

The density of registered nurses in the countries of the Region of the Americas is generally low, which jeopardizes the conditions and capacity to expand access and coverage with equity and quality. A positive impact on the performance of health systems and on the lives of people, families, and communities can be achieved through more robust public policies and management, while increasing the number and qualifications of registered nurses, improving their regulation and education, and expanding both the labor market for nurses and nurses' scope of practice. The quality and competence of nursing personnel is another key issue In Latin America, where approximately 70% of the nursing workforce is composed of technologists, technicians, and aides or assistants (13).

In the Region of Americas there are about 9 million nursing professionals, of which 4.5 million are registered nurses (14). Among the greatest challenges facing the sector are the adoption of effective policies at the national and regional levels that include adequate investment to overcome the shortage of human resources, the expansion of the role of nurses, regulation, and improvement of working conditions (12). Furthermore, both adequate investment and maintenance are obviously needed to ensure a better ratio of professionals to population in the Region. Hence, considering the ratio of professionals, population aging, chronic noncommunicable diseases, and all activities and roles performed by nursing professionals, information and communication technologies (ICT) can be a fundamental resource to support care delivery. Thus, nurses should master all resources available in digital health, now and for the future, to be able to select the most adequate digital solution for each sector, type of care delivery, facility, and others.

PAHO has been working with the countries of the Region to recover and sustainably develop health systems, reducing structural vulnerabilities and expanding access, in order to address future health needs and be better prepared to respond to future crises. One of the recommendations to strengthen capacities of health service delivery networks to expand access and improve preparedness and response to public health emergencies is to adopt digital solutions to enhance access to health services, including those tools employed during the COVID-19 pandemic (15).

This digital transformation does not occur automatically but requires a culture change. Among other things, it is necessary to provide secure environments, train human resources, and promote continuous assessment of the quality of care and of the efficiency and effectiveness of interventions in all stages of the process. Some identified challenges shared by the countries of the Region include developing new competencies to allow professionals an adequate use of digital health devices, the updating of legal frameworks, data-sharing among institutions, development of revamped governance and leadership models, and adoption of a series of standards and procedures for measuring, monitoring, and continuously improving the quality of information (16).

The application of digital solutions in nursing care is wide and includes electronic health records (EHR), telehealth, social networks, and emerging and advanced technologies such as artificial intelligence (AI), the Internet of things (IoT), wearable technologies, and data analytics. Nurses, as the foundation of the healthcare system in every nation, have a broad view of the system and all departments engaged to deliver patient care and need to be involved in the selection, design, implementation, and evaluation of those technologies (17). The recent rise of telehealth care during the COVID-19 pandemic showed that formative training

experiences should include extended capabilities preparing nurses to participate in virtual healthcare delivery settings *(12)*.

Consequently, nurses must be prepared from initial undergraduate programs, have access to training and education in their workplaces, and become leaders in the technological changes in health. For this, the support of governments, universities, industry, employers, and the health sector in general is required to promote and enhance the profile of the nurse. This support is also required in order to achieve better health care for the population and to facilitate nurse-led roles in the computerization of nursing data and information – an essential profile for this digital transformation.

Nursing education has seen transformation in recent years through technology. Virtual learning experiences have increased dramatically worldwide due to the COVID-19 pandemic, exposing new opportunities and challenges for educators and students. Virtual learning can be an option for increasing access to education and opportunities for nursing students living in remote areas. In the United States of America, virtual learning is currently being explored as an alternative method for teaching didactic courses, practicing simulation, and facilitating clinical experience at both the undergraduate and graduate levels *(12)*. In Guyana the Ministry of Health is working with the opportunity to increase the number of nurses using mainly virtual learning experiences *(18)*. To build capacity for nursing and midwifery education, a regional partnership of PAHO/WHO Collaborating Centers in Latin America and the Caribbean developed three culturally congruent, sequential online educational modules for English-speaking and Spanish-speaking nurse and midwife educators, focused on (a) principles of teaching and learning, (b) instructional strategies, and (c) methods to evaluate students and courses *(19)*. The Virtual Campus for Public Health (VCPH), the educational platform of PAHO, surpassed the 2 million user mark at the end of September 2022. The majority of the participants of its courses are nurses *(20)*.

A quantitative and descriptive study collected data from the participants of virtual courses in the VCPH from January 2013 to June 2020. A total of 368 018 nurses were enrolled in the 515 virtual courses offered. The percentages of certified nurses according to the country of origin were as follows: Ecuador 64.7%, Mexico 58.3%, Honduras 52.9%, Paraguay 48.6%, Colombia 45.2%, Uruguay 42.2%, Argentina 38.0%, Chile 22.7%, Peru 21.3%, and Brazil 9.7%. Of these nurses, 83.1% were women, 75% had some degree of university education, 40% were aged 26–35, and 47.1% worked in hospitals *(21)*.

In 2022, *The Strategic Importance of National Investment in Nursing Professionals in the Region of the Americas* recommended priority areas for the nursing curricula, including utilizing digital technologies, preparing nurses to take advantage of available technological resources, and training faculty in the use of digital technology to work with students living in remote areas and in the preparation of courses in online environments *(12)*.

This publication presents the possibilities for incorporating and using technologies in the education and practices of nurses in their various contexts of activity and proposes a digital transformation of nursing as part of the increased technological advance in health care. It also contemplates regulatory and normative aspects in digital health. This digital transformation depends on a range of aspects such as investment, infrastructure, professional recognition, cultural change, educational update, and new skills and competencies. It positions the nurse as a health agent capable of transforming nursing processes for a future setting where patients will be more digitally empowered and knowledgeable on their own health status.

NURSING IN THE AGE OF DIGITAL INTERDEPENDENCE

1. NURSING IN THE AGE OF DIGITAL INTERDEPENDENCE

The healthcare ecosystem across countries has made nursing practice, management, and education more diverse and complex. While information processing has always been part of the practice and delivery of care, the use and analysis of data to generate quality information in designing nursing care plans is increasingly challenging when trying to improve population health. Nurses depend on timely access to accurate information to perform the range of their activities including patient care, administration, consulting, education, and training.

The use of ICT in nursing is not new; the concept dates back almost 200 years, to 1850, when Florence Nightingale compiled and processed data to improve sanitation through nursing and medical protocols. After that milestone, the concrete relation with information technology (IT) can be traced to 1966, when the terms nursing and computers were found in the International Nursing Index *(22)*.

According to the American Nurses Association *(23)*, nursing informatics (NI) "is the specialty that integrates nursing science with multiple information management and analytical sciences to identify, define, manage, and communicate data, information, knowledge, and wisdom in nursing practice. NI supports nurses, consumers, patients, the interprofessional healthcare team and other stakeholders in their decision-making in all roles and settings to achieve desired outcomes. This support is accomplished using information structures, information processes, and information technology."

An international survey of 272 respondents from 31 countries in Asia, Africa, the Americas, Europe, and Oceania identified actions to advance NI in the next 5–10 years. In terms of education this included: (a) integrate NI contents into all levels of nursing curricula; (b) provide continuous, practice-relevant NI education opportunities to practicing nurses and other interdisciplinary stakeholders; and (c) prepare more nurses with NI background to enrich the current teaching workforce. Practice actions included: (a) make nursing information systems a requirement for all the nurses to improve patient outcomes; (b) increase support for roles such as Chief Nursing Information Officer or other types of field informatics specialists at organizational/country levels; and (c) create better, more nursing-specific and usable information systems *(24)*.

Digital technologies are already an integral part of everyday life, and the world's population has never been more interconnected. The COVID-19 pandemic demonstrated how ICT applications can support providers, clinicians, and citizens around the Region. However, there is much more to be explored, and nurses must take leadership in driving the adoption and selecting the most adequate resources of digital health solutions *(25)*. In fact, a key recommendation of the National Academy of Medicine report entitled *The Future of Nursing 2020–2030: Charting a Path to Achieve Health Equity* states that "all public and private health care systems should incorporate nursing expertise in designing, generating, analyzing, and applying data to support social determinants of health and health equity using diverse digital platforms, artificial intelligence, and other innovative technologies" *(26)*.

Digital transformation of health care can be disruptive; however, technologies such as the IoT, remote monitoring, AI, big data analytics, blockchain, smart wearables, tools enabling data exchange and storage, and tools enabling remote data capture and the exchange of data and sharing of relevant information across the health ecosystem creating a continuum of care have
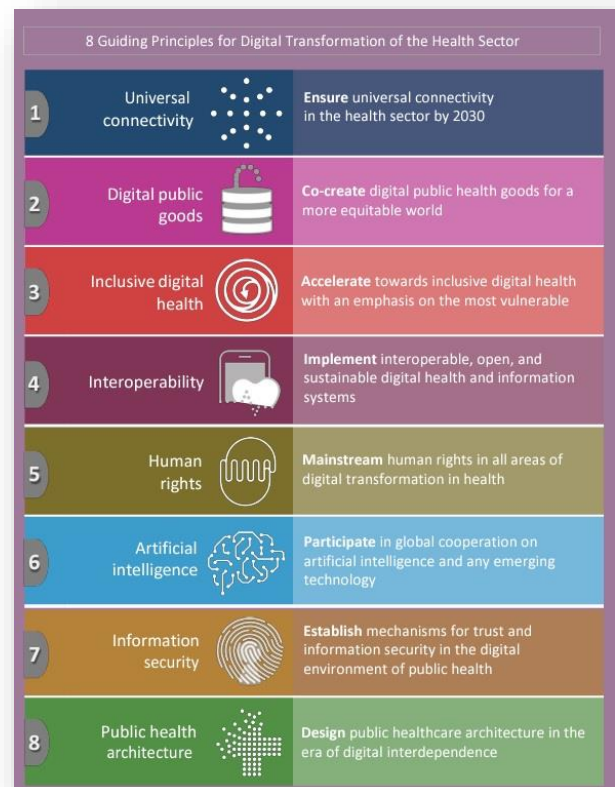
proven potential to enhance health outcomes, creating more evidence-based knowledge, skills, and competences for professionals to support health care *(3)*.

Digital solutions such as mobile applications, the Internet, social networks, AI, and telehealth are having an increasingly greater impact on nursing around the world. Those technologies are bringing new challenges in how to make use of these technological advances and create a body of evidence, so that nursing, in general, can be at the forefront of these changes. Challenges facing the health system also include expanding and improving access to and quality of health care in terms of shortages of professionals and difficulty in optimizing the existing workforce. The situation is aggravated by demographic changes and the increase of vulnerable populations. Technology can solve some problems and catalyze and enhance the progress of nursing, improving the quality of patient care and providing support for care demands *(27)*.

PAHO developed eight guiding principles for digital transformation of the health sector (see Figure 1), following eight areas of collaboration for strengthening technical cooperation in the age of digital interdependence endorsed by the United Nations *(27, 28)*:

- Universal connectivity. It is imperative to achieve universal connectivity in the health sector by 2030, addressing the needs and challenges of people, communities, and service providers, and the benefits that will accrue to governments by positioning connectivity and bandwidth as a high priority for public health interventions.

- Digital goods. There is a need to co-create digital public health goods for a more equitable world, with appropriate architecture and licensing to scale them regionally and globally in different populations and contexts, with the capacity for local adaptation.

Figure 1. Eight guiding principles for digital transformation of the health sector

Source: Pan American Health Organization. Eight Guiding Principles of Digital Transformation of the Health Sector. A Call to Pan American Action. Washington, D.C.: PAHO; 2021. Available from: https://iris.paho.org/handle/10665.2/54256

- Inclusive digital health. Digital health must be inclusive, and it is necessary to accelerate progress toward inclusive digital health, with emphasis on the most vulnerable populations, reaching not only populations in conditions of greater social, economic, geographical, or cultural vulnerability but also people and population groups that are not digitally literate.

- Interoperability. There is a need to stop seeing interoperability as an isolated IT-related term. It is a key concept for having timely open access to properly disaggregated data and the integration of national and local systems.

- **Human rights.** Mainstreaming human rights across all areas of digital transformation in health is one of the most important critical factors for success. Guaranteeing the protection of human rights in digital health requires immediate in-depth action to review legal and regulatory instruments directly or indirectly related to the health sector.

- **Artificial intelligence.** Participation in global cooperation on AI and any emerging technology should be part of public health policies. The principle of global cooperative support in AI and any emerging technology means including the individual and social dimensions in a globalized interconnected reality that is now part of the human condition.

- **Information security.** It is also imperative to protect sensitive health information, and therefore it is necessary to collaborate and co-create mechanisms for ensuring the confidentiality and security of personal information in the digital public health setting, while simultaneously promoting access and transparency in information and knowledge.

- **Public health architecture.** Public health architecture in the age of digital interdependence should be designed within the framework of a digital governance agenda. This architecture should be cross-cutting, permitting proper coordination of the different areas of governance and achieving optimization of strategic planning and management of the resources allocated to it.

The current scenario requires a transformation of nursing professionals with skills for the new and constant challenges and takes advantage of the benefits that technologies bring to care practice, research, management, and education. The COVID-19 pandemic showed how the use of telehealth (remote care) made it possible to reduce emergency room admissions or readmissions *(29)*. Nurses are important players in this modality of digital health applications allowing remote presence, care, advice, and evaluation of patients' needs. Examples in the literature demonstrate cases of telenursing for pain management, medication control, or monitoring of chronic diseases such as diabetes and hypertension, and even with the adolescent population, where this technology is widely and naturally adopted *(30)*.

As technology and science continue to advance, the nursing profession should acquire access to relevant technologies and the requisite competencies to implement the nursing process within new, technologically compatible care environments, increasing the fusion of technology and care to address fundamental and increasing challenges in daily life *(31)*.

Nursing can anticipate the impact of technology, use technological advances, and influence how technology does, can, and should impact care delivery. This anticipation involves being aware of current technological and scientific developments, and being able to explore the benefits and the impact produced on the care provided by nursing *(32)*.

Although, healthcare delivery has traditionally been focused on acute conditions, today it is necessary to design models and systems according to the current conditions of living and being healthy, convalescence, dealing with noncommunicable diseases, and having a dignified end of life. Seeing patient care as a collaboration between providers and patients around a patient's health and life conditions enables nurses to understand how to transform health care by focusing on non-visit-based care, patient engagement, and new models of care delivery *(33)*. Among all healthcare strategies being implemented by countries, ICT is a priority. As a priority to reach high quality of information for evaluation and healthcare planning, most countries must invest in affordable technology and deploy resources that enable the provision of care and expertise at a distance *(34)*. Effective responses to current and new threats require

a more holistic approach that puts information systems for health, digital health, and innovation at the center of the scene, acting as orchestrator and catalyst of responses to enable engagements and open possibilities for dealing with health emergencies by using modern tools that complement the traditional approaches *(35)*.

1.1 Transforming nursing education.

Nursing encompasses autonomous and collaborative care of individuals of all ages, families, groups and communities, sick or well, and in all settings. Nursing includes the promotion of health, prevention of illness, and the care of ill, disabled, and dying people. Advocacy, promotion of a safe environment, research, participation in shaping health policy and in patient and health systems management, and education are also key nursing roles *(36)*.

As healthcare workers, each and every activity performed by nurses is dependent on a robust education and continuous training. Education and specifically digital literacy is a long-life process that never ends, and considering the evolution of health informatics and ICT resources, education and training on digital health is an essential part of education curricula. Thus, it is necessary to establish and deploy programs in health informatics as much as consumer and patient education *(37, 38)*.

Nursing is widely considered as an art and a science underpinned by a theoretical framework of nursing. Nursing and caring are grounded in a relational understanding, unity, and connection between the professional nurse and the patient *(39)*. The art and science of nursing has long required the use of data to create information and knowledge, on which to make informed clinical decisions and to create care systems that are efficient and effective for patients, families, consumers, communities, populations, and professional care partners. Using information to determine appropriate care has been key to the nursing profession from its inception *(39)*. This concept is very well known in the

A competency is "an expected level of performance that integrates knowledge, skills, abilities, and judgment."

field of nursing, since Florence Nightingale significantly reduced death rates by improving hygiene and living standards. Nightingale gave nursing a favorable reputation and became recognized as a statistician and the founder of modern nursing *(40)*.

Globally, the healthcare system must prioritize the training and capacity-building of human resources to use computerized systems in clinical practice. Therefore, the research on ICT in Health also investigates the use and appropriation of ICT by healthcare facilities and clinicians. It is also assumed that the proper training of these professionals is an important factor for the advancement of digital health, as well as their engagement in the adoption of new devices and systems in patient care routines *(41, 42)*.

Stakeholders, academia, governments, and educational entities must support nursing professionals to acquire knowledge and generate new scientific knowledge on data analysis, virtual models of care, and in the co-design with patients of models with functionality as digital solutions, considering the differences between these solutions in countries where they are implemented. This action can be an important route for growth in the profession in the coming years *(43)*.

It is common sense that training and education programs must incorporate resources and adapt the curriculum according to the current demands of the health sector. Increasing the level of education of nurses is required to maintain the field, the research perspectives, and the education of future generations, considering that professionals and students must become independent learners prepared to face and solve different problems and situations, assuring the quality of the care delivery *(44)*.

Several initiatives define the core competencies in nursing informatics. For example, the Technology Informatics Guiding Education Reform (TIGER) initiative, now also coordinated by the Health Information and Management Systems Society (HIMSS), established a competency matrix for nurses using a collaborative approach, which ranges from basic competencies in the use of technological resources to the development of leadership in the area, including management information and strategies for use and implementation *(45)*.

It is worth mentioning the HITComp project, which is a European and North American partnership that has developed a platform containing tools and a repository that can be used to compile information on the skills and competences needed for a variety of functions, levels, and areas of health knowledge. More than 1000 competences can be classified in five domains: Direct Patient Care, Administration, Informatics, Engineering, and Research in Biomedical Informatics/Biomedicine *(46)*.

In the HITComp project, competences are associated with a specific skill level (fundamental, basic, intermediate, advanced, and specialist). Competences can also be mapped to more than 250 roles that have an impact by IT on health care at all levels and sectors. The project aimed to map skills and competences, providing access to information and knowledge to strengthen, disseminate, and exploit successful results for a qualified workforce that can work with technology resources to the best advantage and obtain the best result in global health *(47)*. In this project, a specialist is understood to be a professional who has a master's degree or doctorate in the area.

In the latest edition of the book *Informatics Education in Healthcare: Lessons Learned*, Berner and Moss *(48)* highlight that:

A competency is "an expected level of performance that integrates knowledge, skills, abilities, and judgment." First, all healthcare professionals need to acquire basic computer and information science competencies to be able to interact, not only with electronic medical records, but also with a variety of patient information and communication technologies that are increasingly a part of every aspect of healthcare. Second, every healthcare professional needs to be information literate. Finding, evaluating, and synthesizing the best evidence helps ensure that patients receive the highest level of care available from their providers. Those managing the organization and delivery of this care require current and accurate information to manage care access and organizational resources effectively and efficiently. Finally, all healthcare professionals require basic competencies related to the management and analysis of data. Development of data management competencies enables individuals and organizations to understand the need for ensuring the privacy and confidentiality of data, standardized data collection, and patient and organizational outcomes analysis.

A review using mixed methodology to verify the domains of competences in the training of medical students in the United Kingdom identified 2734 references, and after analysis and

consultation with experts, proposed a set of 50 competences in health informatics including skill level and relevance in 71 specialty program curricula. The competences were mapped to those published by the International Medical Informatics Association (IMIA), some of which are completely comprehensive and to be included in a nursing curriculum *(49)*:

- Efficient and responsible use of information processing to support health professionals in practice and decision-making.

- Structure, design, and analysis principles of the health record including notion of data quality, minimum data set, architecture, and general applications of the EHR.

- Principles of data representation and analysis using primary and secondary data sources, principles of data mining, data warehouses, and knowledge management.

- Clinical decision-making principles and diagnostic and therapeutic elaboration strategies.

- Principles of evidence-based practice.

- Methods for decision support and their application in the management of patient care, observing methods of acquisition, representation, and engineering of health knowledge, building, and using clinical protocols and guidelines for conduct.

As a suggestion, the authors emphasize that competences must have flexibility to allow for local variations, and those responsible for creating curriculum matrices need to relate to changes in the industry that may impact the activity and training of the professional. Furthermore, they show that there is a need for training in the area of health informatics, and students at all levels need to be exposed to such knowledge and be encouraged to get involved to promote the health informatics profession *(49)*.

Supporting nursing professionals to acquire and/or generate scientific knowledge includes training and education with specific competences to select and register data, understand how data can become information, apply knowledge on data analysis and virtual models of care, and participate in the selection, design, and implementation of digital solutions with patients, taking into account the differences of these solutions in the contexts and regions where they are implemented *(34)*.

Advancing leadership competencies in existing IT such as clinical decision support systems, EHRs, and mobile technologies is also essential. Emergent resources on analytics, the use of AI functionality, big data, and machine learning methods are also themes frequently explored in the literature. Thus, having a critical mass of nursing leaders who understand the intended and unintended consequences, as well as the opportunities for this type of technology, is vital to guarantee the quality and safety of professionals and patients. The growing presence and recognition of the importance of the Chief Nursing Information Officer in some healthcare services is a step in the right direction. Furthermore, providing opportunities for nurses from all specialties to contribute to the development and implementation of digital health policies, at local, regional, national, and international levels, could increase the future use of digital technologies in health *(50, 51)*.

Educational opportunities at the undergraduate and graduate levels in information, computer science, digital health, system architecture, usability design, implementation best practice, evaluation, data quality, data analysis, and other important topics may create new nursing education programs in the coming years for undergraduate, graduate, and continuous education programs. In fact, adoption of these educational opportunities will increase the nursing skills to perform actions in the scenarios where ICT is part of daily living and support healthcare delivery.

The American Association of Colleges of Nursing (AACN) identifies informatics, social media, and emerging technologies, and their impact on decision-making and quality are critical to professional practice.

Consequently, these should include interprofessional education opportunities to work with and learn from computer science, engineering, and other experts and educators; for example, professionals who understand how to use data science for knowledge translation to support practice. Nurses will also need knowledge and competences to lead the development of new patient care models enabled by digital technologies *(34)*.

Schools of nursing should work and plan to develop competencies among faculty and update their curricula to increase the use of digital technologies in all areas while incorporating new pedagogical approaches such as virtual and augmented reality, online and hybrid educational programs, and simulation-based education *(34)*.

The importance of informatics in health care is highlighted due to changes in the healthcare landscape in response to the increasing integration and use of technologies and digital health. Informatics education must be implemented from undergraduate to postgraduate levels, as well as in nursing professional development. Education at the master's level in health informatics is not yet available in many countries in the Region of the Americas. The specialty is recognized in countries such as the United States of America, and nursing informatics graduate programs have been available for the last three decades.

Although there has been much effort from schools of nursing and by professionals, there is still an evident gap in informatics competency in practicing nurses and nursing leaders. There are several reasons for this, including lack of faculty and lack of recognition of the specialty in countries that need specific legislation to approve the occupation and professional board recommendations. In addition, the lack of programs at the master's and doctoral levels represents a constraint, since without those faculties there will be a barrier to implementing continuous education, specialty programs, and including content on nursing informatics and digital health in the nursing curriculum. It is a vicious cycle where one level does not happen without the level above.

With a lack of a formal educational graduate program, nursing schools must congregate faculty who perform and develop research using ICT and establish research groups in nursing informatics. The intention then is to strengthen the field and the body of knowledge. In an international survey of nursing informatics research trends *(43)*, results show that the top five current research trends include clinical quality measures, clinical decision support systems, big data research, AI, and coordination of care and outcomes. These themes indicate a greater demand for research to evaluate the care provided with the use of technology, an increase in the use of available data for research, and discussions about the use of AI techniques in health care *(43)*.

Although there has been a considerable amount of research on informatics education and the competencies of nurses in different roles, most nursing educational programs in the Region of the Americas still do not adhere to standardized criteria for informatics education and the need to train educators – training the trainer. Therefore, there is a need to evaluate the inclusion of technologies in nursing education, preparing nurses to act in a transformed healthcare environment, where not only technologies but also intelligent systems are implemented in the clinical practice *(52)*.

The future of nursing may be influenced by how nurses decide to master and integrate new technologies. Therefore, it becomes vitally important that nurses be trained during their undergraduate education and can quickly adapt technology and integrate it into health care. Technology can help them to manage with large flows of data, apply insights that can support clinical decision-making, and improve communication at the point of care, improving safety and quality outcomes for patients in all settings *(53, 54)*.

A program in nursing informatics education should also include themes that can impact learning models and healthcare environments, the meaningful use of ICT functionalities, acquiring skills on interprofessional collaborative practice, understanding the different environments of patient care services, models to develop strategic planning, frameworks to assess patient satisfaction, and ultimately acquire knowledge to evaluate patient outcomes. The use of informatics in nursing education can support virtual teaching and learning, assessment, and analysis associated with educational outcomes, and the use of virtual books. Supervisors working in management use nursing informatics to help them with cost containment, improved workflows, decision support, budgeting tools, and cost and savings trends. It can also facilitate and support research through patient outcome assessment, evidence-based practice, standardized terminologies, and virtual knowledge bases. As nurses learn informatics, they must learn to use all information technologies effectively, recognize the benefits and limitations of these technologies, and integrate these into the way they implement these technologies.

In the era of large amounts of data, nurses' computer skills are key to safe, efficient, and quality practice. Nurses must have information and knowledge to recognize data quality, nursing data sets, and how to use data analysis resources toward better patient care outcomes *(55)*. However, as already mentioned, the preparation and training of faculty, computer infrastructure in nursing schools, Internet access, and the availability of clinical practice environments that use technology are essential.

In addition, it is suggested that the use of informatics be promoted and discussed among students and be transversal throughout the curricular plan of the schools of nursing. If appropriate, a review and update of the curriculum and the provision of opportunities to improve the capacities of teachers are highly recommended.

The COVID-19 pandemic highlighted the need and feasibility of online education programs. Although the nursing profession is essentially characterized by practice, schools can still use resources of distance education, online and hybrid education.

Digital education, also known as e-learning or digital learning, is defined as the act of teaching and learning by means of digital technologies, characterized by specific pedagogies and instructional methods, contexts of provision, and technical affordances of hardware and

software. Modalities of digital education range from the basic conversion of content into digital formats to complex deployment of digital technologies *(56)*.

Recently, the literature also shows the use of augmented reality (AR), defined as a technology that improves present reality with virtual content. In the field of health, AR has potential for use in surgical and health education practices, such as the use of smart lenses whereby you can keep your hands free, centering your attention on the task that the operator carries out. Nursing is an interesting field for AR, as these characteristics are applicable to many tasks such as venipuncture, dressing change, and wound and diabetic foot treatment. Instances of AR use are often in specific fields, such as in the clinical environment and mainly in nursing education *(57)*.

Teaching approaches for students can use new resources such as AR and virtual reality games to provide an immersive learning experience. Using the right tool with adequate content and learning objectives, these technologies improve teaching and learning in every clinical practice environment. There is a growing interest in games and their potential to contribute to teaching and learning in health care, and there is a wide range of opportunities of which nurses can take advantage. Games and gamification help in interventions to change health behavior and optimize attention and participation in a collaborative system.

Virtual reality (VR), defined as a computer-simulated reality, can artificially recreate experiences for the user, including the senses of sight, hearing, touch, and smell. In comparison, AR unites the virtual and real worlds, complementing instead of replacing reality. AR complements the real-world environment and enhances the user experience with sensory information from the computer, such as sound, video, or Global Positioning System (GPS) data. Nurses could identify current games and technologies and customize them as part of a goal-oriented, patient- and family-centered care planning activity *(58)*.

In education, AR will allow students to practice and repeat clinical skills in a simulated patient care environment, which is also a more controlled environment than real health service contexts. One benefit is that virtual reality can allow individual students to repetitively practice skills such as sterile techniques and emergency response skills at their own pace and time, overcoming the problems of random access to opportunities and resource limitations in nursing laboratories that have limits on the number of students who can practice in turn. VR can also improve ability, such as for administering injections or inserting nasogastric tubes. The use of VR to improve physical skills has been tried in teaching delicate surgical procedures without putting a patient at risk *(59)*.

Moreover, one of the most important themes to include in nursing education is the proper and ethical use of digital tools.

Continuing education is an important topic for faculty and nurses. However, in terms of regulation and practice, continuing education hours are not required in many countries, such as Argentina, Bahamas, Barbados, Bolivia (Plurinational State of), Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, Guatemala, Guyana, Haiti, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Saint Vincent and the Grenadines, Trinidad and Tobago, Uruguay, and Venezuela (Bolivarian Republic of) *(60)*.

The International Council of Nurses (ICN) highlights that "... nurses ensure that the use of technology and scientific advances are compatible with the safety, dignity, and rights of people. In the case of artificial intelligence or devices, such as care robots or drones, nurses

ensure that care remains person-centered and that such devices support and do not replace human relationships." Also, nurses are accountable for data integrity to support and facilitate ethical standards of care *(61)*.

In a region where 30% of people do not have Internet access, it is essential that everyone work to ensure that no one is left behind, with sustainable public health interventions based on renewed knowledge. A delicate equilibrium is needed between the most advanced technology and the needs of the unconnected *(62)*. Consequently, it is fundamental to develop national legislation and data protection policies. Nurses are able with leadership to influence legislators and public policy-makers about data privacy, confidentiality, and safety *(63)*.

KEY ELEMENTS FOR DIGITAL TRANSFORMATION IN NURSING EDUCATION

- ✓ Nurses should demonstrate skills in using ICTs.

- ✓ Technological ability, information literacy, and information management are key competencies for successful nursing practice.

- ✓ The nursing curriculum should integrate informatics and digital health at all levels of education.

- ✓ Faculty to teach informatics is required, and the existing national informatics specialty organizations or health informatics societies should coordinate with universities and services to provide continuing education programs and professional certification.

- ✓ Schools of nursing should have experienced informaticians with the academic background to cover necessary content for each level of the nursing curriculum.

- ✓ Successful online instructors should maintain near-constant contact with their students through multiple modes of communication.

- ✓ Recognize that the design or re-designing of nursing workflow and care processes is key to understanding how ICT can be used to improve and facilitate nursing practice.

- ✓ Knowledge of the linkage between the national health system and how technology can be used to provide better access to the system and increase equality, access, and continuity of care.

- ✓ Knowledge of local and national legislation related to patient data protection and privacy.

- ✓ Ethics is a fundamental element in the handling of patient data.

1.2 Digital transformation of nursing practice

The key words for the digital transformation of nursing practice are networking, integration, information, and communication. The art and science of nursing has long required the use of data to create information and knowledge from which to make informed clinical decisions and

to create care systems that are efficient and effective for patients, families, consumers, communities, populations, and professional care partners. The better the quality of data nurses have, the better the assessment they can make, and the better the care plan they can provide to ensure best practice, desired outcomes, patient recovery, or a dignified death.

Initially, nurses adopted a computerized system for recording data, administration, payroll, and medication administration. More recently, this information is incorporated into the EHRs system since the focus is the patient. The advancement of technology is bringing many opportunities, and nurses should be aware that education is ongoing and will improve nursing practice. Knowing the functionalities of the health information system and the principles of its digitalization is essential to exercise nursing practice safely, bringing visibility to their unequivocal participation in population health *(64)*.

Technology resources are important instruments to facilitate access to information and, gradually, identify increased possibilities to apply the resources to enhance care activities. Nursing information systems increasingly act as catalytic agents to restructure the profession, forcing nurses to explore the nature of the profession, the essence of the practice, and the body of scientific knowledge, leading them to acquire increasingly specialized skills to provide a better level of health care to patients and citizens *(64)*.

Adoption of technological resources in practice will make nurses see trends in the health system more clearly as a challenge and unique opportunity for growth. Thus, new roles and new careers demand specialized knowledge. Since there is no single and comprehensive system as a solution to meet all the needs of the health and nursing area and innovative solutions need to be developed to respond to the increasingly complex demands of providing care, it is essential that nurses be involved in the development and/or selection of computerized systems, providing knowledge and experience for planning, management, teaching, and health care. The opportunities are ample for those who decide to incorporate technological resources in daily practice and to make them an instrument for improving the quality of patient care and the infrastructure to exercise the profession with dignity and with the perspective of growth and development.

A set of resources, areas, and technologies that are involved in the digital transformation of nursing practice are detailed below:

ELECTRONIC HEALTH RECORDS

An electronic health record (EHR) is a health record residing in an electronic system specifically designed for data collection, storage, and manipulation, and to provide safe access to complete data about patients. EHRs typically integrate clinical decision support tools, offering important clinical information for the care of patients. EHRs offer many benefits compared to paper records: accessibility, support for multiple views, improved communication between providers, communication with patients, data aggregation, access to knowledge bases, and integration with decision support tools. EHRs are effective tools for documenting and sharing healthcare information. Additionally, nursing documentation is a key tool to guarantee the continuity of care and communication with other professionals and is the instrument to represent the capacity of nurses to communicate the state of health, the needs, and the reactions of patients to the received care. However, a very large change takes place in the form of work when moving from a clinical record in paper-based format to an electronic record *(2, 65)*.

The active inclusion of documentation in the EHR can contribute to the improvement of attention and the continuity of care. Also, a comprehensive approach to care can be improved by having data and patient outcomes. The nursing information integrated in the EHR gathers all the most important data on the patient's health and all the care received, including diagnoses and care planning *(66, 67)*. However, in countries where EHRs are extensively deployed there is a growing concern about EHR documentation burden and its potential role in clinician burnout *(68)*. Thus, there is a need to balance documentation with time to attend to care priorities.

An important aspect for nurses when they adopt, use, record, analyze, implement, and evaluate EHR is the attention to ethics and the legal recommendations, as they have the obligation to practice safety and ethically. Being aware of the concerns surrounding ethics in the informatics field, including those of patient autonomy and privacy, the nurse can act as a bridge with patients, so that patients know their right to unrestricted access to their own medical record and that they should have control over their own data – how, when, and by whom their data are being used.

INTERNET OF THINGS AND WEARABLES

Internet of things (IoT)–enabled devices and sensors provide different services including data readings and personal support. Connected to smart home devices, surveillance cameras, animal monitoring sensors, as well as human health monitoring sensors for patients with diabetes and Alzheimer disease, the IoT has revolutionized monitoring and enabled real-time analytics and actions by healthcare professionals, such as preventing or responding to situations on time to avoid risk and negative outcomes. Recent studies also used the IoT in surveillance of mosquitoes to map breeding spots and provide early warning tools to limit the spread of mosquito-borne infections such as Zika virus disease and dengue in Brazil *(69)*.

Wearable technologies enable the continuous monitoring of human physical activities and behaviors, as well as physiological and biochemical parameters during daily life. The most measured data include vital signs such as heart rate, blood pressure, and body temperature, as well as blood oxygen saturation, posture, and physical activity. Wearable devices can be attached to shoes, eyeglasses, earrings, clothing, gloves, and watches. Wearable devices also may evolve to be skin-attachable devices. Sensors can be embedded into the environment, such as in chairs, car seats, and mattresses. A smartphone is typically used to collect information and transmit it to a remote server for storage and analysis. These devices have been developed for health consumers, including on-wrist activity trackers and mobile phone apps and add-ons *(70)*. Mobile devices such as smartphones have been used to extend the expertise of the nurse in support of patient self-management in areas such as HIV prevention *(71)*, medication adherence *(72)*, and symptom monitoring and management *(73)*.

Although data from wearables can provide useful information for nurses, effort is still needed to help patients sustain the use of the devices and understand the accuracy of the data. Nurses and patients need to treat data from wearables as they do other clinical data to maintain privacy *(74)*.

TELEHEALTH AND TELENURSING

Telehealth is considered the set of activities relating to health, services, and methods carried out at a distance with the help of ICTs. It includes, among others, telemedicine and tele-education in health *(2)*. Since 2008, the International Council of Nurses (ICN) considers

telenursing as a service that allows nurses to administer care to rural or remote populations, maintaining effective communication with healthy or sick patients and those with noncommunicable diseases, and effectively intervening in the promotion of and education for a healthy life and self-care, among others *(75)*.

Telenursing can make it possible to maintain an open channel between nurses and patients *(76)* by providing nursing services through computers and mobile devices, allowing patients to connect with their nurses through mobile devices, computers, mobile apps, video technology, and remote patient monitoring. Nurses use a variety of tools when providing care through telenursing. They can send information to their patients through apps or websites, and they can regularly monitor specific patient conditions through remote monitoring. In a large pre-COVID-19 telehealth demonstration project in the United States that enrolled both English- and Spanish-speaking participants, video visits with the nurse were a highly rated feature of a multifaceted telehealth system. Telehealth physical therapy is another option for patients who are working through the recovery process. Telehealth is more prominent than ever, as more patients are interested in direct interactions with their healthcare providers *(77)*.

Social networks

Social networks have been widely used, especially during the COVID-19 pandemic, for health interventions, health campaigns, health education, and disease outbreak surveillance. In turn, healthcare organizations have institutional accounts to connect with their clients and their employees. A review carried out on the purpose of using social networks in health highlighted that health institutions mainly used social networks for information surveillance, dissemination of health information, and combating misinformation (fake news); they also intervened in people's health by offering resources and information, motivating participation in health events and support groups *(78)*.

Social networks can be an approach that delivers the best possible outcomes for patients and can be incorporated and used to facilitate effective communication between patients and nurses to improve health care *(79)*. Social networks have an impact on healthcare consumers (patients), specifically through empowerment in online communities. Online specialty communities that discuss individual cases and have the power to share these experiences in terms of specific health issues, such as cancer, provide new channels of support for healthcare consumers and professionals. Professional teams can benefit from the opinions and comments of patients on social media networks to perceive the quality of care received *(80, 81)*, as well as to gain an understanding of a particular phenomenon; for example, Alzheimer disease and dementia caregiving by Hispanic family members as a foundation for intervention development *(82)*.

Although AI is not a new technology, it has recently been applied frequently to show how large amounts of data can be analyzed and predict aspects of healthcare delivery. In addition, other methods such as machine learning, big data, and deep learning are also recurring themes in the literature. The following paragraphs summarize some aspects of these resources that can be considered as advanced technologies to be explored by nurses to improve practice, teaching, management, and research.

Artificial intelligence

AI is *"... the science and engineering of making intelligent machines, especially intelligent computer programs" (83)*. Increasingly sophisticated AI, such as personalized advertising and

self-driving cars, is revolutionizing a diverse range of professional sectors. In the healthcare sector, AI is being adopted to aid healthcare professionals deliver high-quality care more efficiently and equitably *(84)*. AI can support less experienced healthcare professionals who may have fewer resources to still deliver high-quality care through learning from others' experiences, such as the identification of rare disease symptoms through massive database searches *(85)*.

In the context of nursing, examples of the application of AI demonstrate the potential impact that the use of these technologies can have in practice. For example, speech recognition technologies can speed up and enhance nursing documentation *(86)*. In addition, as an AI technique, machine learning has been used to develop a tool to aid nurses in using standardized technologies, by automatically suggesting the most relevant terms to be used *(87)*.

Ronquillo et al. *(84)* on behalf of the Nursing and Artificial Intelligence Leadership (NAIL) Collaborative reported on opportunities and priorities for AI in nursing. While many gaps were noted, the authors identified three priorities that must be addressed in the near future: (1) nurses must understand the relationship between the data they collect and AI technologies they use; (2) nurses need to be meaningfully involved in all stages of AI – from development to implementation; and (3) there is a substantial untapped and unexplored potential for nursing to contribute to the development of AI technologies for global health and humanitarian efforts. Other applications include text mining where AI technologies are being used on millions of nursing notes to identify patients with fall history or drug and alcohol use disorders *(84)*.

The influence of AI on decision-making and human work is an area that needs immediate research to support practice in the next decade. AI technologies can provide practitioners with enormous benefits in data analysis and advanced support for clinical decision-making. There are many of the supposed potential benefits of AI in the examples already mentioned. The ethical principles of beneficence, non-maleficence, autonomy, and justice, along with human rights like dignity, respect for life, freedom, health, self-determination, equity, justice, privacy, and property must be considered when implementing AI *(88)*.

Nurses should assess their role, processes, and knowledge in the face of emerging ethical frameworks that explore the opportunities and risks that AI and other similar innovations bring, while advocating patient participation in the development and application of AI and helping mitigate issues of introducing bias, and privacy or confidentiality concerns, particularly for disadvantaged, marginalized, and underrepresented groups *(87, 89, 90)*.

BIG DATA

The complexity of data generated in health care is growing and is one of the main areas that must be addressed to achieve better results for patients *(91)*. An effective use of health IT should be an approach to help manage the massive amount of patient data generated and stored, to guide nurses and physicians in the decisions they make about patient care.

Different approaches for the analysis of big data have great potential to generate a new standard of evidence and can provide nurses with complete data from which they can plead the needs of patients and nurses, which would otherwise require a lot of resources for compilation. Projects such as the Retrospective Graph Review and the extraction of data that were recorded using natural language techniques seek to provide the quantitative or qualitative data requested by the user. These data extraction techniques were initially

designed to identify events and trends in patient safety but are evolving along with the capabilities of EHRs and the use of big data to enable expanded application and representation of another medium to connect the nurse in the extraction of data needed to explore and advance the quality of care. The benefits of evidence-based cohort research data delivered when and as needed to the nurse are important to the outcomes of selected and planned procedures for each patient. The nurse's voice is essential for understanding what data should be translated into processable information and how to communicate that information in the patient care setting *(92)*.

The application of big data can take advantage of management systems to build quality indicators in patient care. The optimization of heat control processes helps to continuously improve management effectiveness and professional efficiency. Through data cleaning and processing, quality indicators can be presented in different visual formats, presenting the quality of care from different perspectives, so that weaknesses can be quickly identified and corrected. Supervisors can use this to manage nursing staff who have quality-related issues from all levels of care *(93)*.

Brennan and Bakken *(94)* have argued that nursing needs big data, and big data needs nursing. The former is illustrated in the examples above. Examples of how nursing can contribute to big data analyses include:

- Expertise and a social obligation to apply their expertise in multiple areas of relevance to big data and data science, including defining important questions, extending data sources, applying data mining and modeling methods, and addressing ethical, legal, and social implications (ELSI);

- Extensive experience in working with populations at high risk for health disparities and can provide insights related to the representativeness of big data sources and potential scientific biases;

- A holistic approach that complements the reductionist approach taken by many data scientists;

- Offering definition and context to data elements;

- Expertise in the use of theories to organize variables and interpret analysis results;

- Creating interventions that assist patients and others in interpreting and acting on the information afforded through data science investigations, extending the interpretation component of the data science pipeline (i.e., more human-in-the-loop).

Visualization of data and information is a key component of big data analytics and is an essential part of assisting patients and others in interpreting and acting upon the output of such analyses in practice. Moreover, the health literacy, numeracy, and graph literacy of the individual viewing the visual output must be considered in the design of the visualization, to ensure that it is comprehensible and meets user needs *(95)*. For example, a nurse-led study focusing on visualization of longitudinal patient-reported outcomes found that visual analogies rather than graphs increased patients' comprehension of their health status *(96)*. Participatory design of the visualizations is especially relevant for patients and other lay audiences *(97)*.

BLOCKCHAIN

Familiarity with technologies that facilitate the privacy and security of healthcare data is a core competency for nurses. One such technology is blockchain. A blockchain is a type of distributed ledger technology (DLT) that consists of a growing list of records, called blocks, that are securely linked together using cryptography. Used in public health and health care, this technology has the potential to address the challenges of data standardization, systems interoperability, and clinical record accessibility to support a safer, patient-centered approach *(98)*.

Nurses and other healthcare professionals will need to advocate for patients to gain control over their data. Blockchain can support the empowerment of patients in managing their own health and social data, ensuring that citizens can use their data *(99)*. It is noteworthy that an added value of blockchain technology is related to boosting the continuity of care, facilitating communication between the different actors involved to provide the best results for patients and citizens. Nurses are instrumental in improving access and outcomes of a person-centered approach, ensuring continuity of care in primary health care services.

With blockchain technology, nurses responsible for accessing, recording, and processing social and care data can be more secure in the knowledge that these data will be accurate and consistent, which will lead to better patient care and, as such, measurable outcomes. With a database built for information related to health and social care, providers can benefit from better accessibility, accuracy, and security, which results in better outcomes for everyone *(100)*.

Blockchain technology can be used, for example, for the prevention and monitoring of complications related to the peripheral insertion of central catheters. It is possible to obtain information to ensure the traceability of the procedure, from information about the catheter manufacturer (material, expiration date, and indications for use), the medical indication, and the patient's informed consent for the practice, obtaining information about which peripheral route was used for catheter insertion, the sterile technique used, the duration of the procedure, and the indications for care *(101)*.

PRECISION HEALTH CARE

Precision health care, supported by precision medicine and precision nursing, can improve clinical decision-making with the aim of tailoring optimal healthcare decisions around the individual characteristics of patients. Precision health is represented using biomarkers that can provide useful information about susceptibility to a particular disease, exposure, course, and response to treatment. Omics,[1] imaging, and clinical biomarkers are being studied for their ability to positively impact healthcare management. The term precision medicine refers to the adaptation of medical management to the individual characteristics of each patient, to guide healthcare management with the most effective diagnosis and treatment options for patients and, therefore, improve quality of care and disease management *(102)*. Clinical nursing practice models are also evolving through individual-centered clinical decision-making.

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[1] Omics, defined as probing and analyzing large amount of data representing the structure and function of an entire makeup of a given biological system at a particular level, has substantially revolutionized methodologies in interrogating biological systems. *Source*: Dai X, Shen L. Advances and Trends in Omics Technology Development. Front Med (Lausanne). 2022;9:911861. Available from: https://doi.org/10.3389/fmed.2022.911861.

Nurses play a key role in health care, promoting, protecting, and optimizing health through closely interconnected and multidisciplinary care for people and their families. The integration of biomarkers into nursing research and practice has led to an important advance in science by objectively identifying health risks and more accurately identifying the different mechanisms responsible for adverse clinical conditions and, in this way, developing, guiding, and finalizing personalized interventions to improve the management of their patients. Nursing professionals are critical to supporting precision health care, including the correct administration of medications in accordance with modern concepts of pharmacogenetics. The nurse benefits from the inclusion of biomarkers in pathways of care, which helps nurses more efficiently deliver personalized therapies and provide comprehensive care to patients, especially those with frailty issues *(103)*.

Beyond biomarkers, a group of center directors, supported by the National Institute of Nursing Research, proposed the Nursing Science Precision Health Model, which includes four precision concepts (i.e., components) that reflect the nursing perspective: (1) precision in measurement, (2) precision in characterization of phenotype including lifestyle and environmental factors, (3) precision in characterization of genotype and other biomarkers, and (4) precision in intervention target discovery, design, and delivery *(104)*. The model components are underpinned by an informatics and data science infrastructure to support key areas of nursing work such as symptom management and enabling patient self-management.

ASSISTED LIVING

Assisted living technology includes a variety of communication and networking devices that utilize displays, sensors, apps, and robotics and can be used to compile data, to control daily routines, reduce social loneliness, help people continue to live independently in their own home as they age, and provide domestic help to assess daily activities such as medication, feeding, bathing, dressing, and assisting with mobility *(105, 106)*.

More and more intelligent environments are part of health institutions, through sensors, screens, and computational elements as part of infrastructure design and development. These elements are often seamlessly integrated into routine objects and networked with each other. There is no doubt that digital technology allows eliminating middlemen and expensive physical infrastructure. However, this does not mean that physical contact disappears entirely. Hybrid formats can be created where the digital coexists with the physical, where the use of these technologies serves to support the irreplaceable human contact, critical thinking, and affective skills *(107)*. For example, a study in the United States found that residents living with sensors were able to reside at a nurse-led aging-in-place facility 1.7 years longer than residents living without sensors *(108)*. The study findings suggest that health alerts, generated by automated algorithms interpreting environmentally embedded sensor data, may enable care coordinators to assess and intervene on health status changes earlier than without sensor-generated alerts.

KEY ELEMENTS FOR DIGITAL TRANSFORMATION IN NURSING PRACTICE

- ✓ Dissemination and use of emerging and digital technologies in nursing practice.

- ✓ Training and updates (according to technological changes) in the workplace, which allow nurses to adopt the use of new technologies that support their daily practice.

- ✓ Participation of nurses in the design and development of technologies and in the implementation of new patient care support systems.

- ✓ Train and employ nurses who can lead the change and digital transformation.

- ✓ Ensure connectivity, access, and correct use of smart devices (cell phones, tablets, etc.) as part of the nurses' daily work tools.

- ✓ Implement the use of EHRs and ensure the recording of nursing information in the patient's medical record.

- ✓ Recognize the resources that technology can bring to all levels of care.

- ✓ Ensure the use of ethical and legal practices in accessing patient data following local, regional, and international legislation on data privacy and confidentiality.

- ✓ Recognize the functionalities that will enhance nursing practice and patient care delivery.

- ✓ Be ethical on the use of information systems for health and stimulate colleagues to act ethically. Nurses should be prepared to face questions related to ethics and patients' rights and make decisions that are consistent with the requirements of the profession, the organization, and perhaps most important, what is in the best interest of their patients.

- ✓ Participate in the definition of competences in digital health to influence legislators.

- ✓ Ensure continuing education in a lifelong span.

- ✓ Promote better clinical decision support systems and more intelligent information on the EHRs.

- ✓ Nursing practice can be strongly supported by the appropriate ICT resources to strengthen the commitment to the health care of the population.

- ✓ Effective communication is essential in the daily life of nurses and health professionals in general, and the incorporation of technological resources can change the dynamics of communication.

- ✓ Implementation requires interdisciplinary collaboration and a lot of effort and coordination. This is something the nurse is very well prepared to lead, but despite the increased interest in precision health, most nurses still need to acquire the knowledge and skills to incorporate such skills and resources into nursing science and practice.

1.3. Roles in nursing informatics

Although there is a political and technical commitment with the implementation and importance of digital health, and institutions are working hard in this regard, nursing support technology has little financial investment by institutions and is also not updated to respond to practice and social trends. The renewed awareness on the use of digital technology brought about by the COVID-19 pandemic provides impetus for change, and the profession needs to be aware on usability and implementation principles to avoid, for example, contributing to alert fatigue, and to refute disruptive workflow processes without generating additional documentation burdens. There is wide variation around the world in the access to, integration, and sustainability of digital technology, as well as context-specific solutions that vary by care unit.

Digital technology offers opportunities to support new models of care and approaches to nursing practice, and new roles and opportunities for action in different sectors of population health care *(84)*. The profession can review cultural interpretations of how technology can be considered to complement nursing practice and the nursing process, and collaborating with technology developers, providers, and patients will be essential to ensure success.

Digital health should be considered as a constituent part of the renewed nursing roles and responsibilities in health institutions. Specific knowledge and skills in digital health should include:

- Capacity to oversee the safety and security issues of implementation of technology in the workplace;

- Acknowledgment of current medical systems, and continually seeking opportunities to organically integrate technology to a greater extent within these systems;

- Participating in the development, implementation, and evaluation of strategies for the use of technology, data, and evidence-based information systems in health to enhance processes and improve patient outcomes;

- Bringing technical and strategic vision and informatics knowledge, but also knowledge of clinical workflows to make that happen;

- Critical capability and knowledge to integrate new technologies in a medical environment, supervised by technology experts;

- Performing regular testing of existing technology already on-site, to ensure that continued use is safe and advisable; collaborating with healthcare executives and staff members to measure feedback on currently integrated technology;

- Auditing workplace technology for efficiency and ethical perspectives;

- Participating in the construction of policies for the safe use of technology, without excessively compromising the job of the professional team.

2. CONCLUSIONS

The use of ICTs for health is a support for the provision of health. Such technologies change the way nurses plan, provide, document, and review the clinical care of patients. Using ICTs fundamentally modifies the way nurses receive and review diagnoses, make clinical decisions, plan interventions, and communicate and socialize with patients and their families. ICTs can be used both in management systems, communication systems, and support systems as well as in clinical decision support systems. Management systems allow the acquisition, storage, transmission, and visualization of administrative or clinical activities related to patients. Communication systems can be used for diagnosis, management, counseling, education, or support and can be implemented to facilitate communication between healthcare professionals or between healthcare professionals and patients. There is a wide range of communication systems, ranging from e-mail and cell phones to telemedicine and telecare systems. Automated systems may also be accessible from various devices, such as computers, cell phones, or personal digital assistants *(109)*.

Thus, leaders are aware that they must deploy the digital process and select from among a range of ICTs the best strategies available to address the needs of each region, considering the diversity of situations. Technological resources are important tools to support health promotion. To achieve better results, national strategies must be in place and be considered as the major strategy for the country, involving all levels of stakeholders and citizens.

Technology can be either the latest innovation like the most sophisticated robot at one's bedside, assuring communication with family members or friends, or can be what is available to provide access to care, like a simple radio and notebook connected through a satellite in an indigenous village. Nevertheless, quality of care is always affected by the competencies, abilities, and capacities of the nursing professionals *(17)*.

The wide variety of healthcare applications is growing, while patients are increasingly informed, empowered, and with access to the Internet, and so are demanding healthcare models that adapt to their lifestyles.

Virtual care modalities that exploit the Internet and mobile technology, remote care, and telehealth can be useful in different situations in which health care is not accessible to the population. Several points need further discussion, such as the focus of attention, data privacy, and the availability of data to patients. It is also necessary to explore contacts and discussions about access, cost, use, waste of electronic resources, and the impact on the relationship between health professional and patient, as well as the role of professionals.

The patient experience is the main force driving change in health care. Smartphones allow patients to have instant and unlimited access to a wealth of health-related information. Patients are more informed and use technology to investigate diseases, treatments, and medicines, as well as to connect with others who share health experiences. The patient can still choose a health service and professional based on the information available on the Internet. Certainly, training added to the professional environment will guarantee proper health care with the use of technology now and in the future.

The development and use of ICT resources requires that planning and actions be effective and accessible, from the design of innovative tools that can be adapted to each location, region, and the available economic resources, to monitoring the needs of citizens and the community. Technology only makes sense if it is to bring improvements, optimize processes, time, and

human and financial resources. It is, therefore, urgent to identify needs and evaluate best practices in the design of systems so that usability and adoption of present functionalities are not barriers that may exclude citizens from the universe of digital health. However, if there is no commitment, coordination, and capacity for adoption by all involved, significant changes will not be produced in the provision of health care to the population.

3. CALL FOR ACTION

Because of their number and presence in the health services, nurses are in a unique position to guide and manage changes in the healthcare system and use and store patient information. Nurses can participate in all stages of this redesign to ensure that, in the future, they lead the use of technology in the patient care environment.

To implement changes, it is essential that nurses participate in the implementation of digital health, ensuring that such resource is part of the national strategic planning and that both the public and private sectors are supported in this transformation. Universities also need to favor the inclusion of training and access to the technologies so that there is no inequality of conditions.

The shortage of nurses in the world is a current problem, accompanied by greater life expectancy due to advances in medical science. Governments should support and invest in new technologies that will certainly not replace the professional but will improve the outcomes and provide better quality of care to the population.

New nurses will witness a disruption and a substantial change in digital technology during their career. Without immediate action, the nursing profession will miss a remarkable opportunity to generate new roles, knowledge, and relationships within the future of health. Nursing will continue to offer value and importance to healthcare systems in the coming decades; however, investments should consider the role of nurses and provide opportunities to increase the knowledge and enhance the competencies of nurses related to the inclusion of digital health systems now and in the future *(32, 34)*.

PAHO looks forward to working with governments, nurses, and academia to increase the investments and actions related to the role of nurses in digital health.

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ANNEX. Pan American Health Organization mandates supporting the development of conditions and capacities in human resources for health and digital transformation

Mandate	Name	Objective	Year
CD51/13	Strategy and Plan of Action on eHealth	To help ensure the sustainable development of the Member States' health systems, including veterinary public health. To improve health services access and quality, based on the use of information and communications technologies (ICTs), the development of digital literacy and ICTs, access to information based on scientific evidence and ongoing training, and the use of various methods. To facilitate progress toward the goal of societies that are more informed, equitable, competitive, and democratic. In such societies access to health information is considered a basic right of the people.	2011
CSP28/12	Strategy and Plan of Action on Knowledge Management and Communications	This strategy and plan of action seeks to guide the Member States in adoption of standards, policies, and procedures with regard to knowledge management and communications by ensuring convergence of the projects, initiatives, products, and services of the Region on these subjects to benefit health.	2012
CSP29/10	Strategy on Human Resources for Universal Access to Health and Universal Health Coverage	Intended to guide national policies on human resources for health, taking into account that the availability, accessibility, acceptability, relevance, and competence of these resources are key for achieving the objectives of universal access to health and universal health coverage and the 2030 Agenda for Sustainable Development. The lines of action of the Strategy are: (1) strengthen and consolidate governance and leadership in human resources for health; (2) develop conditions and capacities in human resources for health to expand access to health and health coverage, with equity and quality; and (3) partner with the education sector to respond to the needs of health systems in transformation toward universal access to health and universal health coverage.	2017
CD56/10	Plan of Action on Human Resources for Universal Access to Health and Universal Health Coverage 2018–2023	Seeks to reduce the shortfall of approximately 800 000 health workers in the Region and set a course that countries can follow in order to secure the human resources necessary to achieve the global goal of universal health by 2030.	2018
CD57/9	Plan of Action for Strengthening Information Systems for Health 2019-2023	To strengthen the activities of Member States aimed at upgrading health systems through the use of interconnected and interoperable information systems. To introduce information and communication technologies and improve information exchange and the management of structured and unstructured data for the benefit of public health. To help laying the necessary foundations for quality management of data and information; the collection and use of cumulative knowledge and experience for the production of health sector intelligence to support decision-making; policy development, monitoring, and evaluation; the introduction of cost-effective technology solutions; the improvement and adoption of standards; the drafting of legislation; and the	2019

		strengthening of human resource capacity for proper implementation of information systems for health as appropriate to the contexts, needs, vulnerabilities, and priorities of Member States.	
CD59/6	Roadmap for the Digital Transformation of the Health Sector in the Region of the Americas	This policy aims to support ministries of health to participate in a safe, ethical, equitable, inclusive, and cost-effective way in the digital transformation processes of governments, with a view to accelerating the adoption and implementation of interoperable digital health solutions across all sectors through a multi-stakeholder approach.	2021
CE168/11	Policy on the Application of Data Science in Public Health Using Artificial Intelligence and Other Emerging Technologies	To provide strategic and technical guidance to Member States for the successful development and implementation of data science policies and initiatives that can be utilized in public health through the application of emerging technologies to gather and organize extensive data and information (e.g., health, sociodemographic, medical, and economic data) in a coherent structure.	2021

The digital transformation in nursing education and practice

Digital health refers to "the cost-effective and secure use of information and communications technologies in support of health and health-related fields, including healthcare services, health surveillance, health literature, and health education, knowledge and research."

The adoption of digital health solutions has been accelerated by the COVID-19 pandemic, proving they are key for the delivery of care at all levels of the public health system: the patient, the community, the care team, the healthcare institution, and the political and economic environment. Digital health is an integral part of health priorities and can be beneficial when used in an ethical, equitable, and sustainable way. The comprehensive benefits of digital health include facilitating the assessment, diagnosis, and management of health problems in a safe and effective manner, thereby fostering greater equity in access to timely medical care; addressing unmet health needs; and strengthening the capacity of the whole sector to access the information needed to understand complex scenarios and make decisions, among others.

This publication presents the possibilities of incorporating and using technologies in the education and practices of nurses in their various contexts of activity and proposes a digital transformation of nursing as part of the increased technological advance in health care. It also contemplates regulatory and normative aspects in digital health. This digital transformation depends on a range of aspects, such as investment, infrastructure, professional recognition, cultural change, educational update, new skills, and competencies. It positions the nurse as a health agent capable of transforming nursing processes for a future setting where patients will be more digitally empowered and more knowledgeable on their own health status.

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