Nursing Informatics Through the Lens of Interprofessional and Global Health Informatics

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Learning Objectives

- Learn the meaning of nursing informatics within the field of health informatics, to understand its interprofessional nature
- Understand the breadth of the field "from cells to populations" on the micro level (individuals) to the meso level (organizations) and the macro level (countries)
- Understand the role of each individual as a healthcare stakeholder
- Recognize the areas where informatics, nursing, and health informatics have aligned to reached milestones
- Comprehend why a global informatics perspective is essential
- Understand the importance of the interprofessional and global aspects, as well as training and curricula development tied to competency attainment in nursing informatics

Key Terms

- Nursing informatics
- Health informatics
- Inter- and multi-professionalism
- Global health informatics
- Connectivity
- Knowledge generation
- Democratization of knowledge
- Transparency
- Visualization
- Cognitive support
- Mobility
- Data
- Information
- Knowledge
- Data analytics
- Interoperable systems
- Safe systems
- Patient safety
- Privacy
- Confidentiality
- Security
- Ethics
- Management
- Leadership
- Education
- Global case studies
- Future
- Vision

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Introduction

Nursing informatics has evolved significantly since the first edition of *Nursing Informatics: Where Caring and Technology Meet* was published by Marion J. Ball and colleagues in 1988. More editions followed in 1995 and 2000 [1] and the fourth in 2011 [2]. Nursing informatics continues to address how enabling technology can advance patient care from a nursing perspective. However, as increasing practical evidence from implementations is available, the focus has shifted toward added value in care and research seen through an interprofessional lens.

The International Medical Informatics Association (IMIA) defines nursing informatics as the science and practice that "*integrates nursing, its information and knowledge and their management with information and communication technologies to promote the health of people, families, and communities worldwide*" [3]. This definition was first coined in 1998, updated in 2009, and is still relevant today.

From the nursing perspective, healthcare is always a multifaceted, multidisciplinary activity. Many nurses manage overall care processes and serve as a focal point of information exchange between patients and providers. This circumstance has led nurses to become an integral part of the multi-professional team of caregivers. Likewise, nursing informatics—rooted in nursing data, information, and knowledge—considers not only nursing data but all data to render the full picture of the patient. This might be one of the reasons why nursing informatics as a discipline has incorporated all aspects of health informatics.

For this reason, a textbook on nursing informatics must include core topics that reflect not only nursing but also health and biomedical informatics, such as data modeling; designing standards, artificial intelligence (AI), data analytics, decision support, and interoperable and safe systems; ensuring patient safety; managing the technology and the people to provide valuable systems and enable the workforce to use them properly; and so much more. Therefore,

there are no clear boundaries between nursing and health informatics although nursing informatics has retained a unique core dedicated to nursing via its alliance with nursing education. This association has shown to be extremely beneficial over the years; its impact is reflected by the increasing number of nursing informatics courses at all academic levels and in continuing education. This phenomenon is witnessed around the globe that parallels the political and professional call for "digitalization of nursing and healthcare." This digitalization is meant to enable, advance, and transform nursing and interprofessional practice. For example, to realize the continuity of care through digital networks by reaching remote and underserved populations through telecare and to shape the patient-provider relationship as a new bond that guides self-management of diseases via wearables and personal health records. This transformation process also impacts nursing and health science in the sense that more and more up-to-date patient data become available digitally, leveraging new research designs to find their way into nursing science that make use of new AI methods. At the same time, discussions about the role of observational data to accrue nursing and health evidence and discourses about the ethics of big data in nursing and healthcare cannot be neglected. They are an integral part of this transformation process. The digitalization process will continue to influence the transformation of nursing and interprofessional education significantly. Online learning and teaching are now the new normal, accelerated as a consequence of the COVID-19 pandemic. Finally, nursing management will continue to change too as more data about care processes become digitally available. These new data streams must be converted into intelligence that drives evidence-based decisions. These are just a few examples illustrating how digitalization affects and changes the nursing realm in a significant way and, likewise, touches the entire health domain.

Although there are differences in the adoption of health IT and informatics around the world, the health informatics language is virtually the same.

International health IT standards, including terminologies and classifications as well as data and information models, are an integral part of this language. Building on these foundations, health IT applications share many common features and IT vendors are operating worldwide. Driven by the sciences, nursing and health informatics is shaped by experts who share their experiences and studies on the global level at conferences and through their membership of international societies, such as the International Medical Informatics Association (IMIA), the European Federation of Medical Informatics (EFMI), and the Healthcare Information and Management Systems Society (HIMSS). All of them embrace nursing informatics as a field of science and practice and weave it into the health informatics agenda. TIGER, the Technology Informatics Guiding Education Reform initiative [4], took a leading role by establishing a structure for bringing together international experts in the field of nursing and health informatics from all continents to learn from each other and to build a network of common resources, research projects, and educational events. TIGER is a living example of global health informatics, which will be extensively described in various chapters of this book.

As transformed practice environments emerge under the changes in the healthcare industry as a result of globalization and the economics of quality care, healthcare practice demands that all practitioners be skilled in working collaboratively with other disciplines. The marketplace demands these skills, in addition to professions-specific skills, creating the urgent need for educators to shift from focusing solely on profession-specific skills to preparing students for the realities of communicating and working with other healthcare professions in practice. The need for an interprofessional, competency-based, global approach sets the stage for this fifth edition of nursing informatics as a textbook that covers the many complex aspects of (nursing) informatics from the perspective of all health professionals, with the patient as the focal point of care.

Breadth of the Field

The breadth of health informatics translates to nursing informatics and covers all topics of the health sciences from a nursing and interprofessional perspective. It embraces the entire field from cells to populations. It integrates science and practice at the micro, meso, and macro levels meaning that individuals, organizations, and societies are both the target groups and the actors within nursing informatics. Whatever the specific direction is, the patient stays at the center of nursing and personal healthcare focus in a hospital, in a clinic, or at home. This is the yardstick for the quality of all nursing and interprofessional endeavors. The patient is also the one whose role has changed from somebody who is cared for to someone who directly participates in the care process and decides, together with all integrated healthcare providers, about the next steps in a co-created manner. The sovereignty of the patient guides the activities in nursing and, thus, is a core focus in nursing and health informatics too. This is not only a shift in the paradigm of healthcare but also of nursing; while serving as healthcare providers, nurses must now integrate the patient as a central member of the healthcare team. However, this empowerment entails a series of questions that need to be answered by nursing and health informatics related to the following:

- Proper data access via interoperable systems
- Data sharing, in conformity with local law, and with the patient's and the provider's intent
- Context of the data for adequate interpretation
- Mechanisms to manage flexible data storage
- Communication
- Analysis that transforms data into intelligence that all members of the health team can understand

Mobile technologies, inclusive of wearables, social media, and apps, have paved the way toward lowering the threshold to use (health) IT by virtually anybody. This fact comes along with

great promises but also great risk as hurdles still exist. The digital divide of society can leave the frail and poor, the vulnerable, and those with poor digital health literacy behind. Patient and citizen education is, therefore, crucial and is needed more than ever. Educators, nurses, and all clinicians must be capable of understanding informatics methods and tools, not only how to use them but also how to teach these mechanisms and their implications for the patient, the organization, the profession, and society. By taking on this role, nurses and nurse informatics specialists are building bridges between different worlds that require a set of core digital competencies. Nurses and healthcare providers must speak their professional language. At the same time, they also need to communicate and negotiate with people in the field of data and technology, such as bioengineers, computer scientists, statisticians, bioinformaticians, data science experts, epidemiologists, economists, and healthcare managers. This seems complicated and hard to achieve, but it is not impossible with an adequate education. The informatics avenue is rewarding as new professional opportunities arise for nurses, physi-cians, pharmacists, and the entire interprofessional team. Therefore, this textbook will cover many pressing topics within the informatics fields (from a discipline perspective) and provide a clear picture of how competencies translate into potential professional careers in this continuously evolving field.

Milestones of Informatics

Current nursing informatics education stands on the shoulders of significant achievements in informatics. Health and biomedical informatics are on the verge of revolutionizing healthcare and health sciences even further. Figure 1.1 provides an overview of these monumental achievements and illustrates the fundamental advancements of digitalization. These achievements allow us to see the essence of informatics and digitalization as it shapes the healthcare environment. It is clear that nursing and health informatics touch the very foundational aspects of our lives as health professionals, patients, and citizens. It is also obvious that digital competencies go much further than

Fig. 1.1 Milestones of digitalization
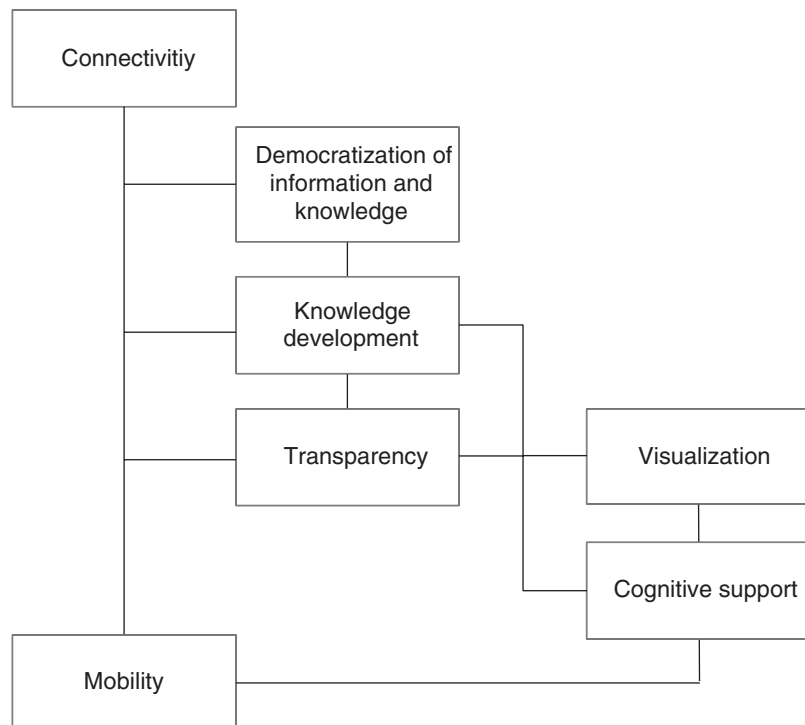
knowing how to operate a specific software application.

Digitalization has become inherently intertwined with the notion of **connectivity**. This is not surprising as the term information and communication technology (ICT) reflects networks such as the Internet protocol, the World Wide Web, and Internet applications like social media. Connectivity encloses the connection between machines as well as between man and machines, indicating that the opportunity to connect digitally facilitates social interactions in a very similar way. Connectivity promises the crossing of space and time but also of hierarchies and professions. In healthcare, telemedicine and telehealth have already shown great potential during the COVID-19 pandemic [5], as well as before that in countries with a large territory and rural regions, such as shown in studies from Australia, Canada, and the United States [6]. Another classic use case of connectivity is patient discharge management that bridges different settings, including clinical professions [7]. Without digital technology, information cannot be easily shared across various healthcare settings. However, connectivity can hold its promises only in an interoperable environment in which systems can exchange signals, data, and information in a meaningful manner. Without health IT standards, such interoperable connectivity is not achievable. Connectivity comes with other challenges as well—first and foremost, IT security as connectivity also opens the door to cyber-attacks. This is why the connectivity of health IT systems is still an endeavor that requires research, knowledge, and intentional efforts to implement them against all the odds.

Due to the pervading nature of connectivity, informatics is all about distributing and sharing particular knowledge at a universal level. This fact has caused, to a great extent, the **democratization of information and knowledge** (such example is the development of Wikipedia). Knowledge—previously physically confined in libraries with limited access—has been opened and is now available 24/7/365. In healthcare, the National Library of Medicine (NLM) has contributed to this megatrend with the PubMed portal and its arsenal of tools [8]. Other databases with a similar focus are CINAHL for nursing, research, and the allied health sciences [9], as well as the Cochrane Library [10] for high-quality, evidence-based medicine—to name a few. Medicine, nursing, and healthcare are fortunate to have such resources at their fingertips. The democratization of knowledge was further fueled by open access publications that have gained increasing popularity in the last decade by attaining support through networks like the global alliance of the Open Access Initiative 2020 (OA2020) [11], through open data initiatives like the Human Genome Project [12], and freely documented development projects such as the Corona-Warn-App development in GitHub [13]. Democratization starts with the broad availability of scientific data and knowledge—across the globe—and continues by gaining benefit through increased literature reviews as well as meta-analyses, paving the way toward evidence across the healthcare system(s). Democratization also encompasses more transparency, diffusion of knowledge, and learning across borders, for example, worldwide massive open online courses (MOOCS) [14], and practicing global classrooms at universities [15].

Knowledge development has been given particular emphasis due to the electronic availability of large amounts of patient data in electronic health records (EHRs) and the availability of data from citizens via social media or other means. The principles of Learning Health Systems (LHS) [16] have been devised based on the notion that practice can contribute to the development of evidence through large amounts of observational data and speed up the cycle of obtaining valid results. This concept of practice-based evidence is meant to complement the classical route of evidence-based practice relying on high-quality randomized and controlled studies. In the same way, precision medicine and precision healthcare data-driven approaches build upon massive amounts of data to identify subgroups of patients who react differently to treatments or have a different profile of their genotype and phenotype [17]. This leads the way to specific knowledge and individualized interventions.

While interoperability is the foundation of achieving connectivity, it is also the key to reaching **transparency**, yet another milestone of digitalization. It is closely linked with the democratization mentioned above. Transparency is a feature that sheds light on previously enclosed and impassable areas. It builds on the availability of up-to-date, relevant, and high-quality data from all sources necessary and spans across multiple time points. Through transparent data, nursing can manifest its vast contributions to healthcare [18], and it is self-evident that these requirements cannot be achieved without digital media.

Notwithstanding, transparency does not come as a by-product of any sort of digitalization. To analyze the data in response to specific questions, the data must be comparable across units within one organization, across organizations and regions or countries, and over time. This kind of comparability is rooted in a shared understanding of what this data should express, which is achieved through the use of standardized terminologies. Healthcare has a long tradition of using classifications, first and foremost, the International Classification of Disease (ICD) codes for medical diagnoses [19]. However, nursing can also look back at a history of different terminologies that have been successfully implemented. Examples for successful implementation include NANDA for nursing diagnosis, the Nursing Intervention Classification (NIC) and the Nursing Outcome Classification (NOC), the International Classification of Nursing Practice (ICNP), the OMAHA system, and the Clinical Care Classification (CCC)—to name a few [20]. At the level of multi-professional classifications, SNOMED CT (Systematized Nomenclature of Medicine—Clinical Terms) has been gaining popularity and acceptance entailed by use in many countries. It has been mapped with several nursing classifications, but further work is needed for integration into nursing practice [21]. Transparency also demands flexible analytics capacities, including proper data storage and advanced statistics.

Transparency makes use of another great accomplishment of digitalization, i.e., **visualiza-tion** of data, which can be attributed to both the physical and virtual worlds. The complexity of data and data analyses can be reduced by visualization (such as color-coded heatmaps, examples see [22]) so that the results become more comprehensible and the message becomes more understandable. Healthcare, nursing, and medicine have benefited from digital visualization, not only in 2D, 3D, and 4D diagnostic imaging and signal processing, but also when it comes to learning anatomy and using anatomy for various purposes, such as the Visible Human Project [23]. Recently, augmented reality (AR) has enabled the blending of digital objects with physical reality, and virtual reality (VR) has extended the horizon of what is possible through visualization. Applications in therapy, such as motor training of patients with paresis, and education via simulation or serious games [24], are available.

Aside from visualization, any **cognitive support** can be leveraged by digitalization. Memory support is a trivial example that has penetrated our life through calendar reminders, storage of important information, and easy retrieval through intelligent search machines. Clinical decision support systems (CDSS) are another way of cognitive support, helping to remember a myriad of facts and drawing conclusions from them. Early on, clinical decision support systems—also in nursing—demonstrated their use to leverage patient safety [25]. These systems may come as a light version of supporting clinical workflows with intelligent information logistics, i.e., providing the right information at the right time to the right person, or as highly advanced systems with very little human input, with the "healthcare provider in the loop" [26].

Cognitive support not only affects the work of healthcare professionals, including nurses, but is also a means for patients to manage disabilities and improve cognition.

Mobility is transforming healthcare by enabling providers to deliver better care. The increasing use of mobility in healthcare improves efficiencies, enhancing the patient experience both inside and outside the hospital, optimizing communication and collaboration between

patients and healthcare providers as well as providers and their peers. Mobility is not just empowering health organizations with mobile devices and apps but also significantly enhancing the patient-provider relationship. Due to the digital connectivity, data, information, and knowledge are highly mobile and underpin the motto of telenursing and telemedicine of "move the data, not the patient," which proves valuable in the case of immobile patients. Likewise, teleservices allow health professionals to use their time in the office to communicate with the patients remotely instead of traveling long distances [27]. At the same time, mobile devices such as smartphones and tablets enable health professionals, patients, and citizens to access relevant information at the point of care wherever this happens to be. Digitalization can also support health professionals either staying where they are or moving around, giving them the freedom of choice. In the case of patients with limited sensory-motor or cognitive resources, mobility can be achieved by utilizing intelligent devices, including smartphones and tablets, which can guide people to better orientate themselves.

AI-empowered systems increasingly influence all these fields by data and algorithms and their practice. AI may, as a result of this, appear in an "embodied manner," such as is true for intelligent devices and robots or, in a "disembodied manner," like the use of data analytics to build new knowledge, enable transparency, and better visualization. Supporting humans in various ways is the mode of action whereby the focus is on the augmentation of human capabilities rather than on automation and replacement of people [28]. The more data is captured outside the confines of healthcare organizations, the fuzzier the boundaries become between care and research, and the more ethical issues arise. Have the patients given their consent in an adequate manner, is the context of the data clear, is the data unbiased, and are the AI results understandable for health professionals and patients? These are only a few questions that are coming to the forefront through new AI techniques.

These milestones demonstrate that digitalization is not merely a technological topic but also a process that impacts our lives in manifold and fundamental ways. Nursing and health informatics touches not only the daily routine of nurses but of all health professionals in an all-encompassing fashion. For this to happen reasonably and adequately, digitalization needs to be shaped so that its tools, methods, and implementations work according to various needs in a usable, meaningful, legal, and ethical manner. Workforce development and patient education for digital literacy are, therefore, indispensable prerequisites.

Reference of This Book to the Informatics Milestones

Digitalization has changed our society and world, as witnessed by everyone in our daily lives. In contrast to previous generations, students nowadays experience what connectivity, mobility, visualization, and cognitive support mean to them as consumers when using social media apps on mobile devices or relying on the navigation system when driving a car. They can see that open access to knowledge matters to them at the university, and they can comprehend that transparency of data and facts have a significance for governing an organization and a national healthcare system, as we all witnessed during the COVID-19 pandemic.

While these experiences can help us better understand what digital health signifies, they are not sufficient enough to translate digital options into the complex reality of nursing and healthcare practice. This book, therefore, aims to motivate nursing students and nurses, as well as other healthcare providers, educators, and students, to explore and deepen the understanding of nursing and interprofessional health informatics and what digitalization implies for patient care in detail. It is a field of significant importance as it shapes and transforms how nursing and healthcare are performed in an unprecedented manner to better patient care. In order for nurses and the interprofessional health team to play an active part in the new digital world, they must speak the informatics language

and have a comprehensive understanding of the principles of digitalization and what consequences it has. Far beyond making paper electronic, digitalization opens new avenues while also requiring proper and careful planning to avoid adverse events due to health IT.

This book also makes reference to the milestones of informatics as presented above. *Connectivity* of systems, organizations, and humans are golden threads woven throughout the book, which are already prepared by Part II "360° Stakeholder Perspective," where the voices of the many professions are orchestrated to build the interprofessional backdrop of this book. There is no fully fledged interprofessional care without *Connectivity* that enables people to communicate and share data. From a technical point of view, *Connectivity is* significantly covered in Part IV "Interoperable systems," which highlights intramural, intermural, and population-wide connectivity through interoperable systems. While *Connectivity* is often discussed with a positive connotation, as an enabler, it also comes along with new threats in the form of cyber-attacks, which is addressed in Part V "Safe Systems and Patient Safety" and with new legal and ethical challenges as presented in the Part "Privacy, Security, Confidentiality and Ethics in Healthcare." *Connectivity* and data sharing lay the foundation to accrue data in EHRs, data warehouses, and data lakes to be used for data-driven and open *Knowledge Development* at various levels. While *Connectivity* has been presented as the golden thread of this book, there is data (re-)use as another major strand that characterizes this book. It is not only in Part II "Using Data and Information to Generate Knowledge" that the various sources of data and analytical methods are described, this theme is resumed in the last Part, "Future Trends in Health Informatics" discussing the future of data-driven medicine and healthcare. Learning health systems (LHS), the meta-concept that combines data provision, analysis, and the dissemination of the results under one roof, is at the core of *Knowledge Development*, and extensively presented in this book. LHS are also mechanisms—

particularly if at a regional, national, and supranational level—for broad dissemination of the findings that contribute to the *Democratization of Knowledge and Science*. It is no longer the academic institutions alone that generate knowledge through scientific studies, each hospital in a region, country, or worldwide can contribute data, prediction models, and knowledge. Further *Democratization* takes place when citizens themselves actively collect data and becomes part of the scientific process, as shown in one of the chapters.

Concomitantly with data-driven knowledge development, *Transparency* as an outcome of applying informatics methods in up-to-date and relevant data is similarly addressed by several chapters in this book to allow for a transparent skills-based allocation of human resources, to meet the requirements of customers for more cost and quality transparency, to build trust in information through a transparent manner of how applications work and trust in the digital transformation process through making data transparent.

Visualization of data and aggregated findings, yet another milestone of informatics also in healthcare, accompanies many health informatics tools to make an abundance of data and highly abstract findings tangible, as illustrated in chapters of Part II "Using Data and Information to Generate Knowledge." For example, in the case of merging and geospatial mapping of health and community data to identify social determinants of health or in the case of a Tower Control dashboard to visualize clinical cases and alert the care providers. As explained in this section, visualization techniques aim to support human cognition and perception to direct attention to the most important statements. Interestingly the authors refer to the historical example of Florence Nightingale, who was the first to visualize statistical findings from the Crimean War in coxcomb or polar area diagrams. Also in the future, *Visualization* will play a predominant role, e.g., in the form of AR in surgery, as shown in Part X "Future Trends in Health Informatics." How to achieve further *Cognitive Support* not only is

described in the in Part III "Interoperable systems" when focusing on decision support systems, but resonates virtually in all chapters of Part II "Using Data and Information to Generate Knowledge."

Finally, the last informatics milestone, *Mobility*, is reflected through the chapters on telemedicine and mHealth in various sections following the idea of moving the data not the patients who can, for example, stay in their community and still receive the same high-quality care or allowing for portable clinics in low-resource areas that are connected with hubs. Mobility is also mirrored by the myriad of apps on mobile devices that allow data from social media to be collected directly from citizen scientist donors that can ensure patient safety, but that must also be tested for trustfulness before being used to empower their users.

Summary

By the end of this book, readers will gain substantial knowledge that will help them understand the importance of health informatics and how to apply it to nursing and other health professions. Through the variety of topics described, readers will obtain an overview and the necessary terminology to better communicate with individuals from other disciplines, make decisions and direct health IT projects, and become champions in their own organizations toward better use of data, information, and knowledge. They will also gain a clear understanding that connectivity and interprofessionalism belong to each other, serving as the catalyst for becoming proficient in transforming patient care through enhanced cooperation and coordination. In addition, readers will also have obtained insights into the active role of patients and citizens in a digital world and that the digital divide in our society needs to be addressed sooner than later if we want to address health disparities at the local and global levels. Readers will also discover how health IT entails risks, develops an understanding of the ethical dimension, and becomes aware of the legal constraints. Above all,

readers will not only become more knowledgeable but also responsibly minded.

Conclusions and Outlook

The book serves as a compass for global citizens seeking a professional career in nursing and health informatics practice and science. It also serves as a source for nurses and health professionals to upgrade their knowledge and enlarge their professional radius of action. Encompassing the interprofessional and global perspective of nursing informatics adds a new dimension and opens the door to further developing the field. It is within our reach to enact change if only we reach for it.

Review Questions
1. Why is healthcare always a multifaceted, multidisciplinary activity from the nursing point of view?
2. What are the milestones of informatics, health, and nursing informatics?
3. What is meant by the breadth of the field?

Appendix: Answers to Review Questions

1. Why is healthcare always a multifaceted, multidisciplinary activity from the nursing point of view?

Very often nurses serve as focal points in sharing and exchanging information among the providers and also between the providers and the patients and their relatives. Nursing—though rooted in nursing data, information, and knowledge—considers not only nursing data but all data to render the full picture of the patient.

2. What are the milestones of informatics, health, and nursing informatics?

Connectivity, mobility, democratization of information and knowledge, knowledge development,

transparency, visualization, cognitive support, and assistance/ambient assisted living.

3. What is meant by the breadth of the field?

Nursing informatics covers all topics of the health sciences from a nursing perspective. It embraces the entire field from cells to populations. It integrates science and practice at the micro, meso, and macro levels meaning that individuals, organizations, and societies are both the target groups and the actors within nursing informatics. As educators, nurses must be capable of understanding informatics methods and tools, not only how to use them but also how to teach the mechanisms and their implications for the patient, the organization, the profession, and society. Nurses and healthcare providers must speak their professional language. At the same time, they also need to communicate and negotiate with people in the field of data and technology, such as bioengineers, computer scientists, statisticians, bioinformaticians, data science experts, epidemiologists, economists, and healthcare managers.

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