The Scope of Nursing Informatics Practice

During their initial deliberations, the review and revision workgroup members identified the need to develop a revised definition of nursing informatics specialty to better reflect the contributions and evolution of this nursing specialty within the health care environment. They focused not only on the immediate contemporary world and the impact of the COVID-19 pandemic but envisioned significant future influences related to the 2021 publications of the American Association of Colleges of Nursing (AACN) *Essentials: Core Competencies for Professional Nursing Education* and the National Academy of Sciences, Engineering, and Medicine (NASEM) *The Future of Nursing 2020–2030: Charting a Path to Achieve Health Equity*.

Extensive review of the draft nursing informatics scope and standards document during the 2021 online public comment period confirmed the draft definition was not favorably endorsed. As a result, the workgroup members examined numerous other existing definitions of informatics specialties and crafted this concise definition:

> **Nursing informatics is the specialty that transforms data into needed information and leverages technologies to improve health and health care equity, safety, quality, and outcomes.**

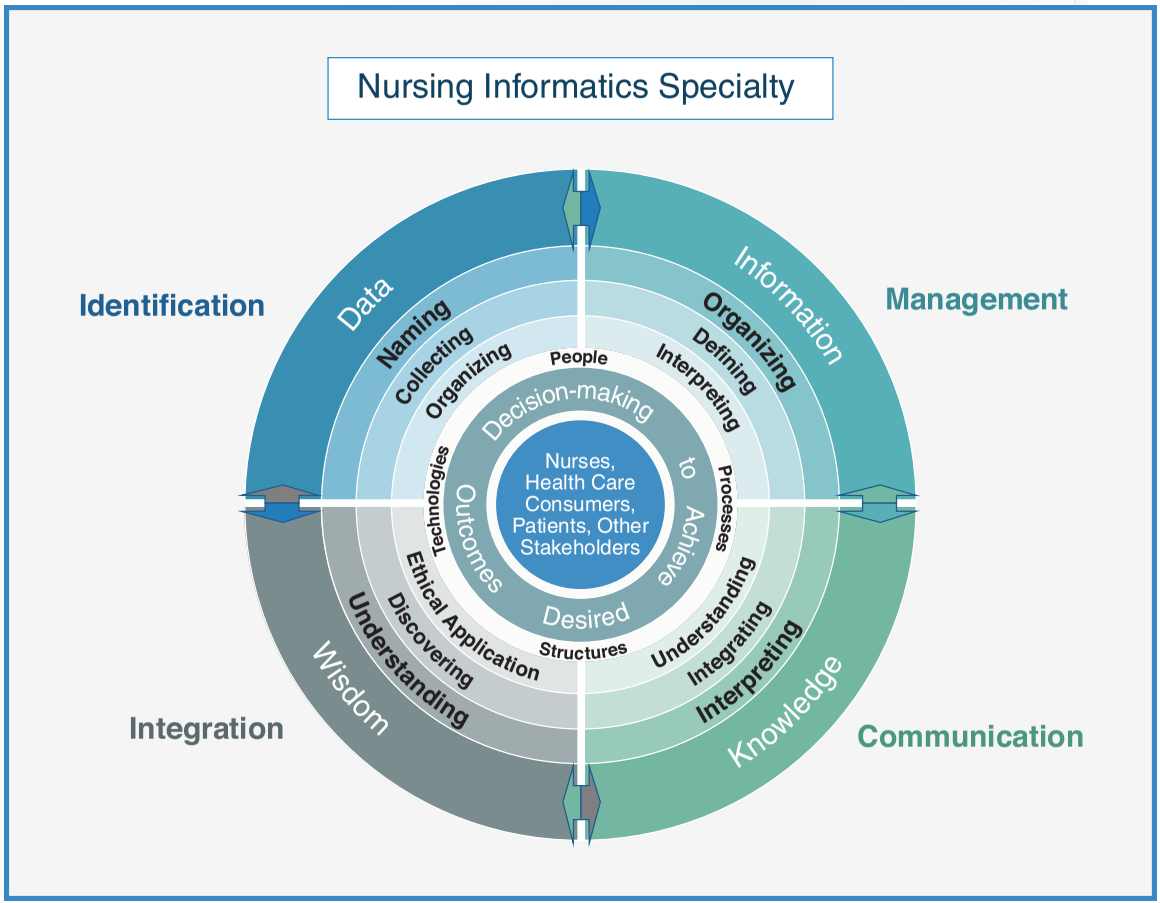
The nursing informatics specialty and its constituent members of informatics nurses (IN) and informatics nurse specialists (INS) contribute to achieving the important goal of improved health of populations, communities, groups, families, and individuals. An informatics nurse is a registered nurse with an interest or experience in an informatics field, most

often nursing informatics. The informatics nurse specialist is a registered nurse with formal graduate education in informatics. The INS is expected to have experience in informatics projects or processes and have achieved and maintains applicable certifications. The evolving nursing informatics practice environment reaffirms the need for the informatics nurse to consider graduate level preparation to assume the informatics nurse specialist role supporting work in operations as project managers, analysts, and department leaders and doctoral preparation for system level leaders, innovators, and data scientists. The term informatics nurse is often used in this document as the global inclusive term representing the IN and INS collective.

Nursing informatics activities include, but are not limited to, the design, development, implementation, and evaluation of effective informatics solutions and technologies within the clinical, administrative, educational, and research domains of practice. Advocacy, policy development, and identification of issues, challenges, and opportunities are also important practice initiatives. The value of nursing informatics becomes more evident from this perspective.

Figure 1. The Nursing Informatics Specialty Components and Relationships introduces a conceptual framework that serves as a lens through which to view nursing informatics practice. It provides a rich representation of the diverse concepts and relationships important to this specialty. Nurses, health care consumers, patients, and other stakeholders are the center of interest or focus. The immediate surrounding concentric circle represents the action of decision-making to achieve desired outcomes. The next adjacent concentric circle bearing the people, processes, structures, and technologies terms is intended to characterize those important active supports, facilitators, and agents incorporated within nursing informatics practice. The externally positioned identification, management, communication, and integration terms are co-located and aligned respectively with data, information, knowledge, and wisdom, the foci of those actions.

FIGURE 1 Nursing Informatics Specialty Components and Relationships



VALUE STATEMENTS

With a unique contextual understanding of the health care ecosystem, INs and INSs are essential to harness the rapidly increasing power of technology, information, and communications to advance health and health care delivery across the spectrum of human experience. Using their continually evolving knowledge and skills, these nurses provide value in the following ways:

- **Unique combination of nursing and informatics practice expertise**

Informatics nurses ensure clinical context is brought to system design, closing the semantic gap between clinical practice and information systems to preserve data, information and meaning. They serve as lead innovators and entrepreneurs for advancement of nursing practice using technology, information, and communications. Informatics nurses engage the appropriate subject matter experts, clinical and operational end users, and other stakeholders in requested projects and initiatives.

- **Expert understanding of health care delivery and operational flow**

Informatics nurses provide an in-depth understanding of clinical care delivery operations in nursing and ancillary areas and the impact of system change within and outside health care delivery. Their expertise in applied clinical informatics helps INs reduce or eliminate the burdens of current and developing technology. Informatics nurses are critical resources for analyzing, designing, and implementing effective user experiences for nurses, patients, families, and other members of the health care team.

- **Data, information, and knowledge management for individuals and populations**

Informatics nurses keep concepts of care and patient outcomes at the forefront by applying concepts of nursing theory during management of

data. They help ensure that data and information quality remain crucial aspects of current and emerging analytics and resulting outcomes. Bringing workflow and practice awareness forward helps ensure the right information is available in the right format to the right people at the right time for the right purpose. Adding nursing clinical expertise enhances efforts in data science, natural language processing, machine learning, precision medicine, and other developing strategies.

- **Informatics leadership and organizational strategy**

Informatics nurses promote collaboration with clinicians, vendors, quality and safety partners, information technology (IT) professionals, and other stakeholders to develop and implement efficient and effective solutions for clinical problems. Informatics nurses influence key stakeholders at the executive level, as well as external leaders, on overall strategy, policy development, vendor selection, and executive sponsorship for informatics initiatives.

- **Health care policy influence**

Informatics nurses advocate for ethical standards and principles during policy development. They inform state and federal decision-makers on legislation that impacts the direction of technology, data, information, and communication solutions used by health care professionals, patients, families, consumers, and populations. Informatics nurses help communicate the need for new advisory opinions, declaratory rulings, or position statements to appropriate entities. They hold important roles in educating clinical and technology leaders on proposed and final regulations to support overall health care strategy and compliance activities.

- **Scientific research and discovery**

Informatics nurses conduct basic and applied research to improve the design, implementation, and use of technology, data, information, and communication solutions in health care delivery. They integrate current evidence in the design, implementation, and evaluation of informatics

solutions. By using Learning Health System principles, they identify new knowledge and the best application of that new knowledge.

- **Integration of sociotechnical framework**

Informatics nurses contribute to improving the user experience by incorporating a sociotechnical framework. They help provide optimization of technology for improvements in patient safety, quality, and clinical team efficiencies, effectiveness, and satisfaction. Their expertise in applied clinical informatics can reduce or eliminate the burdens of current and developing technologies. Informatics nurses apply usability and design principles to minimize negative impacts and maximize positive impacts.

- **Education across the spectrum of healthcare systems**

Informatics nurses are key contributors in assisting organizations in becoming a Learning Health System. They help design, develop, and implement learning solutions and educational programs to achieve informatics competencies and meet end-user needs.

METASTRUCTURES, CONCEPTS, AND TOOLS OF NURSING INFORMATICS

Metastructures

Nursing Metaparadigm

The nursing metaparadigm is comprised of four key concepts: nurse, person, health, and environment (Francis, 2017). The nurse continuously collects data about persons, health, and environmental factors that influence health maintenance and the healing process. Nurses, using their education, intellect, and experiential knowledge, place these data into categories to create information. Finally, using critical thinking and wisdom, the nurse can formulate a plan and prioritize interventions or actions that lead to the most positive outcomes possible for the situation.

Clinical judgement is the "observed outcome of critical thinking and decision-making" (NCSBN, 2019, p. 1). Decision-making is the process of choosing among alternatives and is dependent upon access to quality data. Decision-making in health care is guided by critical thinking, an intellectually disciplined process. The decisions are characterized by the outcomes of the resulting actions. Clinicians, as knowledge workers, make numerous decisions that influence the lives and well-being of individuals, families, groups, communities, and populations.

For example, the nursing process includes assessment, diagnosis, outcomes identification, planning, implementation, and evaluation and is dependent upon quality data and critical thinking skills that are supported by information and communication technologies. Effective clinical judgement is dependent upon the ability of the nurse to use their nursing knowledge to interpret available data and information. Properly designed and implemented technologies optimize the nurse's ability to collect, categorize, and analyze data. This enables sharing of relevant information between all members of the health care team, including the patient, to promote team collaboration and enhance the continuity of care. The informatics nurse is ideally suited to help select, implement, and evaluate technology that assists members of the care delivery team in reaching the goal of positive patient safety and quality outcomes.

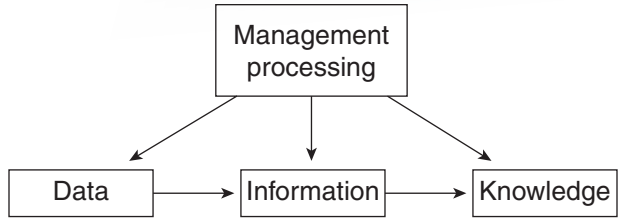
Data, Information, Knowledge, and Wisdom

In 1989, Graves & Corcoran expanded on the work of Blum (1986) to describe the nursing informatics concepts of data, information, and knowledge. Their seminal work provided a definition of nursing informatics and an information management model that identified data, information, and knowledge as key components of NI practice (Figure 2).

The three concepts as defined by Blum are:

- *Data:* Discrete entities that are described objectively without interpretation.
- *Information:* Data that have been interpreted, organized, or structured.

FIGURE 2 Conceptual Framework for the Study of Nursing Knowledge



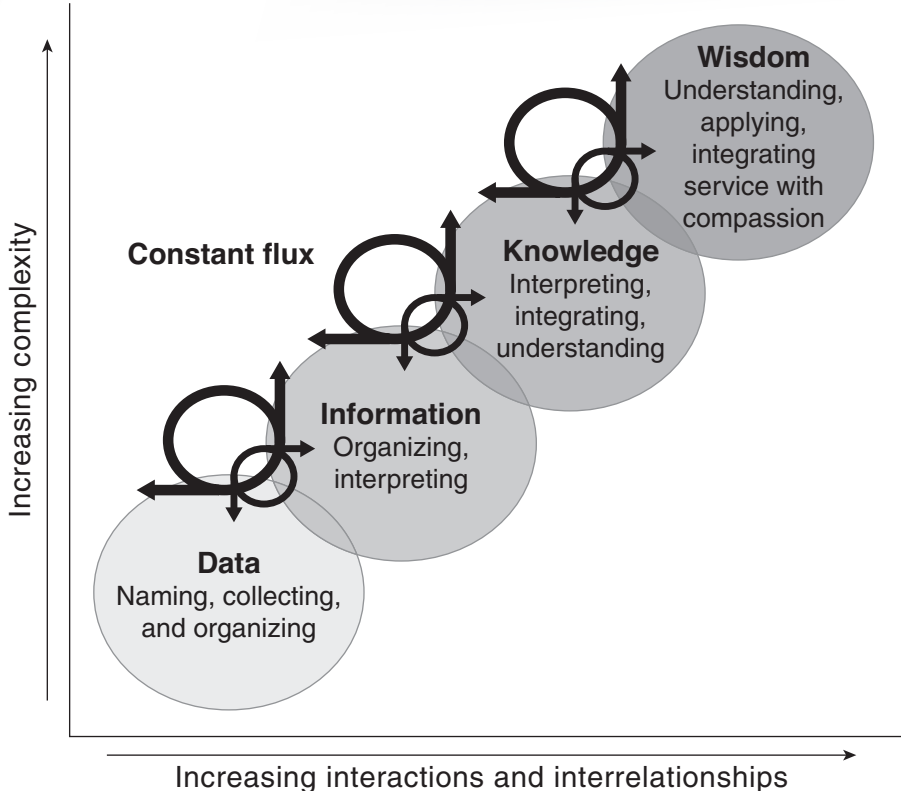
Source: Graves & Corcoran (1989). Reprinted with permission of the publisher.

- *Knowledge:* Information synthesized so that relationships are identified and formalized.

Data, information, and *knowledge* are of value to all health care providers across the continuum of care. Nelson expanded upon their original model by adding the concept of wisdom (Figure 3). This model depicts how data are transformed into information and information into knowledge, with each level increasing in complexity and requiring greater application of human intellect. The x-axis represents the nonlinear interactions and interrelationships between the four concepts. The y-axis represents the increasing complexity of the concepts, as well as the dynamic interactivity of the inter- and intra-environmental factors that influence the movement across and within the data-to-wisdom continuum.

Wisdom, defined as the application of knowledge in the management of human problems, consists of knowing when and how to apply knowledge to deal with complex or specific human needs (Nelson & Joos, 1989; Nelson & Staggers, 2016). Whereas knowledge focuses on what is known, wisdom focuses on the appropriate application of that knowledge and an appreciation of the consequences of selected actions. For example, a knowledge base may include several options for managing an anxious family, wisdom involves nursing judgment about which of these options is most appropriate for a specific family and applying the selected option in the delivery of nursing care.

FIGURE 3 Revised Data Information Knowledge Wisdom (DIKW) Model—2013 Version



The following example highlights the differences in and relationships between data, information, knowledge, and wisdom in a typical patient care situation. For example, when a nurse receives a list of numbers such as 28, 68, 94, 98, and 110 (data) without context, it is meaningless. However, if the numbers are ordered, structured, and identified, the nurse recognizes this series of numbers as vital signs and will regard those numbers as information (T 98°, P 94, R 28, and BP 110/68). Once the data are organized into a recognizable format, the nurse must apply experiential, contextual, and situational knowledge of the patient's past and current situation to interpret the meaning of those values. If these vital signs were obtained

from a newborn, they mean one thing, but if obtained from an adult, they have a very different meaning. The nurse's knowledge of normal vital sign values for different types of patients, and the condition of the patient from whom the numbers were obtained, provide a context within which the nurse can interpret the information. Then the nurse will know if the numbers represent a normal, expected result or an abnormal, even pathological result. The numbers must be then placed in a context so that the nurse can take appropriate clinical action, thereby demonstrating "knowledge-in-use" or wisdom.

Benner (1982) defined the experiential stages of the nursing professional and later contributed Thinking-in-Action as an approach to administration of care (Benner et al., 2011). The addition of wisdom raised new and important research questions, challenging the profession to develop tools and processes for classifying, measuring, and encoding wisdom as it relates to nursing and informatics education.

Wisdom in Nursing

As nurses we seek to better understand how to gain nursing *wisdom* and apply it in our daily practice. ANA added wisdom as a core nursing metastructure that is supported by nursing informatics and integrally connected to nursing actions. Wisdom is the application or use of knowledge to solve human problems (ANA, 2008). However, the concept and experience of wisdom in nursing practice was not well defined; hence, Matney developed the *Theory of Wisdom-in Action (WIA) for Clinical Nursing* (Matney, 2015). As an emerging theory on nursing wisdom, the WIA for Clinical Nursing represents the output of IN and INS contributions to patient care and reinforces the informatics specialty within the domain of nursing practice.

Matney created the theory in three phases. In phase one, a preliminary theory was developed deductively using derivation and synthesis, based on theories and models from psychology, education, and nursing (Matney, Avant, & Staggers, 2016). Pertinent concepts were identified, and nursing-specific definitions were created. Next, a constructivist grounded theory approach inductively captured the experience of wisdom in nursing practice, based on wisdom narratives from 30 emergency

department nurses (Matney, Staggers, & Clark, 2016). Finally, the theories were synthesized into the resultant *Theory of Wisdom In Action (WIA) for Clinical Nursing* presented in Figure 4 (Matney, Avant, Clark, & Staggers, 2020).

The theory describes two antecedent dimensions: person-related and setting-related factors and two types of wisdom processes. General wisdom processes apply to patient care and describe the actions nurses take during a stressful or uncertain event. Personal wisdom develops afterwards, as a feedback loop with reflection, discovery of meaning, and learning, followed by increased knowledge and confidence.

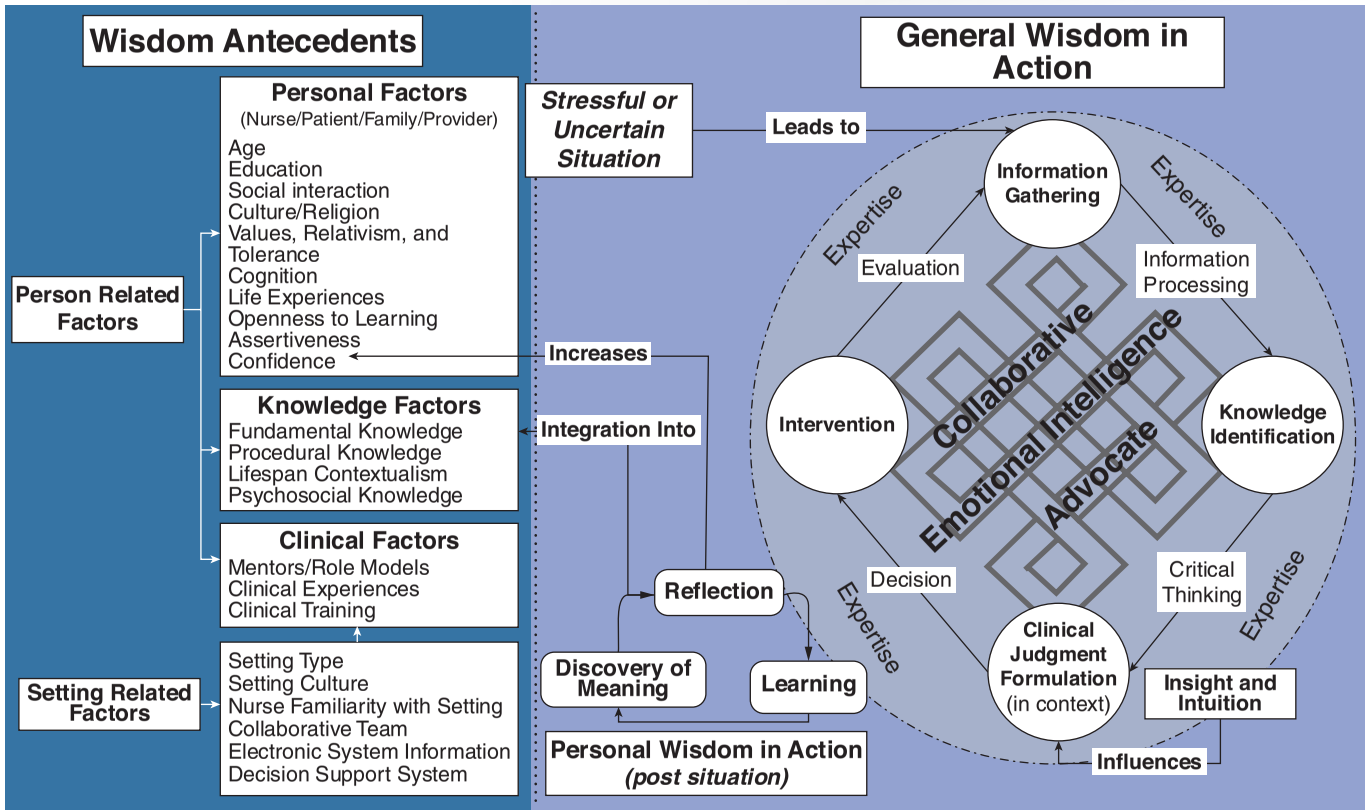
The theory demonstrates how wise nurses make decisions in stressful situations using an iterative process that includes applying knowledge based on skilled clinical judgment. Implemented decisions produce consequences, which, in turn, imitate reflection, discovery of meaning, and learning. Finally, new information is integrated back, refining knowledge and judgment when necessary.

The Theory of WIA expands well beyond what is encompassed by the processing and transformation of data to information and synthesis of information to uncover knowledge. Having knowledge supports decision-making regarding the science of nursing, but those components are insufficient when it comes to the affective emotional processes that occur simultaneously with technical processes during wisdom in action.

The theory can guide the IN and INS regarding the use of the types of information accessed and knowledge needed. This will be of importance to those who need to understand and articulate what is valuable information within an electronic health record. The Theory of WIA provides informatics nurses with a beginning understanding of the psychosocial process of wisdom in nursing practice. It clearly articulates that some aspects of wisdom are amenable to informatics methods and tools, whereas other aspects are personal and reflective.

Wisdom is critical for all areas of nursing practice. The Theory of WIA for Clinical Nursing provides a working framework for translating wisdom in clinical nursing practice into theoretical and practical terms, depicting

FIGURE 4 Theory of Wisdom-In-Action for Clinical Nursing (Matney, Avant, Clark, & Staggers, 2020)



both the science and the art of nursing. This novel theory displays how nurses' practice incorporates wisdom and reveals that wisdom-in-action requires clinical skills, experience, knowledge, and affective proficiency.

Value of Integrating Nursing Informatics into Practice

Data, information, knowledge, and wisdom are central to effective health care delivery systems. Nurses are skilled in managing and communicating information and delivering quality care. Nursing informatics is also concerned with the creation, structure, storage, delivery, exchange, interoperability, and reuse of nursing and clinical information along the continuum of care. As electronic health information systems are integrated into every nursing role and setting, the use of technology at the point of care delivery; the external use of clinical information for quality, legal, and regulatory activities; and the use of analytics of data and metadata contribute to the creation of new nursing knowledge. Such an evolution in the health care environment and ubiquitous use of data, information, and knowledge resources contribute to the blurring of the boundaries between the roles of nurses, informatics nurses, and informatics nurse specialists.

Nursing Knowledge Representation

> *"If we cannot name it, we cannot control it, practice it, finance it, teach it, finance it, or put it into public policy" (Clark & Lang, 1992, p. 109).*

Standardized nursing terminologies are essential to representing nursing in the documentation of patient care and the continued evolution of the nursing body of knowledge. Nursing leaders have developed many different vocabularies and ways of organizing data, information, and knowledge pertinent to nursing through numerous established research initiatives that have spanned decades. In the early 1990s, ANA began to formally recognize these languages, vocabularies, and terminologies as valuable representations of nursing practice and to promote the integration of standardized terminologies into information technology solutions. In its 2018 position statement, ANA reaffirmed support for standardized nursing terminologies: "The American Nurses Association continues to

advocate for the use of the ANA recognized terminologies supporting nursing practice within the Electronic Health Record (EHR) and other health information technology solutions" (ANA, 2018).

Table 1 provides the ANA currently recognized standard nursing terminologies.

The SNOMED-CT reference terminology includes clinical concepts describing nursing care such as diagnosis, intervention, and outcome. Of note, while nursing concepts are included in SNOMED-CT, "the concepts were not developed exclusively for nursing" (Coenen et al., 2001). "Data in healthcare systems must persist in content and meaning across organizations and time to support direct patient care . . ." and ". . . the specification of data has a direct relationship to patient safety and the effective re-use of clinical data for knowledge acquisition" (Coenen et al., 2001). Maps between the coded concepts from one code system to another are published to support interoperability. This mapping from one terminology to another enables data to be passed between systems. Despite the significant adoption of "maps," there is no normative guidance on how maps should be used and no objective quality measurement for the terminology mappings (Coenen et al., 2001).

TABLE 1 ANA-Recognized Standard Nursing Terminologies

Interface Terminologies	Minimum Data Sets
Clinical Care Classification System (CCC)	Nursing Minimum Data Set (NMDS)
International Classification for Nursing Practice (ICNP)	Nursing Management Minimum Data Set (MMMDS)
NANDA	**Reference Terminologies**
Nursing Interventions Classification System (NIC)	Logical Observation Identifiers Names and Codes (LOINC)
Nursing Outcomes Classification (NOC)	Systemized Nomenclature of Clinical Terms of Medicine—Clinical Terms (SNOMED CT)
Omaha System	
Perioperative Nursing data Set (PNDS)	
Alternative Medicine Billing and Coding (ABC Codes)	

The federal standards related to implementation and use of health care terminologies and clinical information systems is under the oversight of the Health Information Technology Advisory Committee (HITAC).

> The Health Information Technology Advisory Committee (HITAC) was established in the 21st Century Cures Act (P.L. 114–255) and is governed by the provisions of the Federal Advisory Committee Act (FACA), P.L. 92–463, as amended, 5 U.S.C. App. 2, which sets forth standards for the formation and use of federal advisory committees. The Health Information Technology Advisory Committee (HITAC) will recommend to the National Coordinator for Health Information Technology, policies, standards, implementation specifications, and certification criteria, relating to the implementation of a health information technology infrastructure, nationally and locally, that advances the electronic access, exchange, and use of health information. HITAC unifies the roles of, and replaces, the Health Information Technology Policy Committee and the Health Information Technology Standards Committee, in existence before the date of the enactment of the 21st Century Cures Act (HealthIT, 2022).

Such diversity and disparity confirm that informatics nurses must seek a broader picture of the implications of their work and the uses of languages and vocabularies for documentation by end users and in outcomes analysis. For instance, nurses mapping a home care vocabulary to an intervention vocabulary must see beyond the technical aspect of the work to understand how a case manager for a multisystem health organization or a home care agency may be basing knowledge of nursing acuity and case mix on the differing vocabularies. By envisioning the varied uses of the terminologies, the IN and INS promote continuity in the patient care process by harmonizing concepts across disparate organizations and EHR systems. Success in this area mandates active informatics nurse participation in associated standards initiatives, such as the work being done by Health Level Seven International (HL7) and the International Health Terminology Standards Development Organization (IHTSDO).

Concepts and Tools from Information Science and Computer Science

Clinical Decision Support and Expert Systems

Nurses' decision-making is the cognitive evaluation of one or more factors in relation to the delivery of nursing care. Proficiency in decision-making is a requirement for the execution and delivery of nursing care to improve the health of persons, families, groups, communities, and populations. An expert or decision-support based system can augment the clinical decision-making process through system evaluation of specific data points and information such as abnormal lab results, active procedural or medication orders, or clinical documentation.

With data and information, an expert system can generate care suggestions or warnings, such as potential medication interactions that might result in an adverse drug event, based on a predefined set of rules, augmenting nurses' existing knowledge. These care suggestions can take the form of active alerts or passive reminders that promote safety and improve quality of care and should be designed to include interventions supported by evidence. Nurses must thoroughly evaluate system generated data, information, and knowledge-based recommendations and employ wisdom in the decision-making process.

Big Data, Data Lakes, Analytics

The NI practice environment is constantly advancing with the emergence of new technologies and tools. With the advent of Big Data (Johnson, 2019) and the move towards data lakes (described below), there is an expanded capacity for greater precision in the IN and INS roles for analyzing and querying data. The IN and INS systematically extract and analyze health care data from these large or complex datasets to actively improve system and care efficiencies and population outcomes. In documentation frameworks, the IN and INS use Big Data by supporting the use of standardized terminologies, ontologies, and classification systems mapped to nationally accepted clinical nomenclatures (e.g., SNOMED CT®, LOINC). In doing so, endorsement of research-based assessment scales and instruments encoded with these nomenclatures allows interoperable nursing data reuse for

comparative effectiveness research, quality metric implementation, and knowledge generation (Harper & Sensmeier, 2015; HIMSS, 2015; Keenan, 2014).

Working with data requires the IN and INS to have knowledge of the different data storage options and approaches to processing stored data. Databases and data warehouses are characteristically relational databases and position data in structured or modeled formats creating discrete and unconnected "silos." Data lakes are centralized repositories accommodating structured, semistructured, and unstructured data (O'Dowd, 2018; Rouse, 2019; Watts, 2017). While each supports Big Data analytics, highly structured data are less agile in configuration and reconfiguration for analytic models, queries, and machine learning applications to allow discovery of patterns and relationships between the data (HIMSS, 2015; Watts, 2017).

Collaborating with or assuming the role of a data scientist, the IN and INS engage with other stakeholders to prepare, manage, and examine data to extract specific meaning based on the initial requirements of the data warehouse. Configuration of the data warehouse is based on which data type to include or exclude to accommodate the end user's objectives. For example, a query on pressure injury for a specific hospitalized patient population occurring within a specified time frame would require patient care data. The identified data elements extracted from the database for the query would be represented in the report or data visualization dashboard for analysis of cost and quality of care delivery.

Data scientists actively partner with the IN and INS to help scale algorithms needed to extract meaningful information from data lakes. A data lake accepts and retains all forms of data in an unstructured, unorganized, and nonhierarchical configuration and uses cloud-based distributed frameworks because of the magnitude of data volume (Marr, 2018; O'Dowd, 2019). The data scientist employs data analytic models guided by the expertise of the IN and INS to verify the accuracy of data requirements for and outputs from the analytic applications that use artificial intelligence (AI), machine learning (ML), natural language processing (NLP), and deep learning (DL). The primary goal is for the

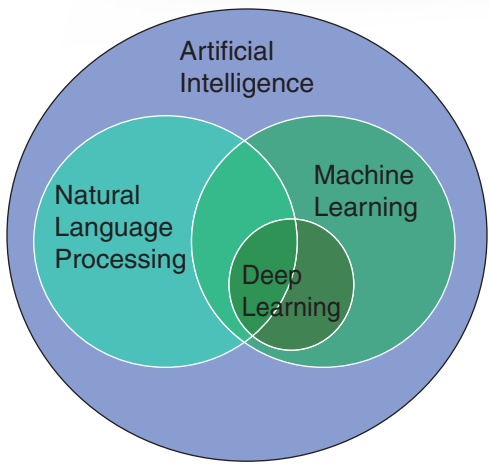
information generated to improve the quality, cost, efficiencies, and outcomes of a care ecosystem.

Artificial Intelligence (AI), Machine Learning (ML), Natural Language Processing (NLP), and Deep Learning (DL)

Artificial intelligence (the mathematical expression of human intelligence to engineer expert systems), software as a medical device, and adaptive statistical models used to optimize device performance (FDA, 2019.; McCarthy 2007) encompass the algorithm platforms of NLP, ML, and DL (Figure 5). Application of AI in health care is quickly evolving as a transformative change agent across the care continuum, in addition to personalized medicine initiatives (FDA, n.d.; FDA, 2019; Rigby, 2019; DHHS, 2017). The IN and INS are active participants in scoping the requirements and workflows to facilitate development of AI modeling techniques (Figure 5). Guided by the requirements for the target clinical application, each unique AI technique contributes to the discovery of information from data patterns or images.

Figure 6. provides details of additional relationships between AI, NLP, ML, and DL operations. Natural language processing is the confluence

FIGURE 5 Relationship between AI, NLP, ML, and DL.



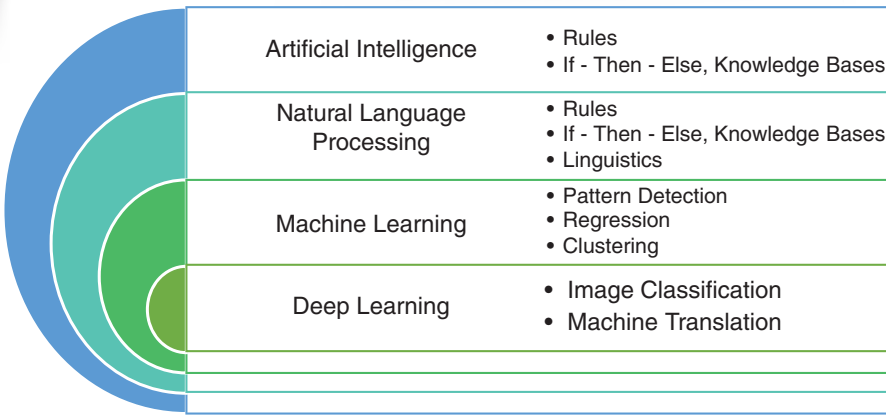
Adapted from R. Mulkar, 2019, rutumulkar.com/blog/2016/NLP-ML

between AI and computational linguistics (Mulkar, 2016; Nadkarni et al., 2001; Sarkar, 2018). Working from unstructured data, NLP rules and analytical models extract semantic concepts or perform syntactic analysis by converting text into machine-readable structured data (Jiang et al., 2017; Nadkarni et al., 2011; Tutorialspoint, 2021). While NLP relies on linguistics and the human use of language, ML procedures only utilize algorithmic techniques and structured data and are often applied within the NLP space. Machine learning techniques cluster patients' traits and outcomes targeting disease indicators for individual and population health interventions (Jiang et al., 2017). The linear regression models applied to ML form neural networks with many layers and provide the foundation for DL (Jiang et al., 2017; Mulkar, 2016). Also used in NLP, DL focuses on the quantitative interpretation within data sets and vision-based classifications primarily in medical imaging (Mulkar, 2016; DHHS, 2017).

Forecasting and Predictive Analytics

Forecasting and predictive analytics can be applied in nursing practice to improve relevance and performance of nursing interventions. Informatics nurses collaborate with data scientists or directly engage in data

FIGURE 6 AI, NLP, ML and DL Operations.



Adapted from T. Danner, 2020, aunalytics.com/artificial-intelligence-machine-learning-and-deep-learning%E2%81%A0/

preprocessing to create machine learning algorithms used in health care databases to promote knowledge discovery from direct patient care information. By combining clinical nursing knowledge along with discovery of unique patterns in patient data, evidence-based personalized and precise interventions are created for each patient. Patient-centric algorithms enable development of forecasting and predictive analytics that contribute to high value care individualized for the patient to forecast future health patterns. This can help prevent advancement into high-risk groups requiring expensive and suboptimal interventions.

User Experience and Related Concepts

What is the primary goal of informatics nurses and what do they ultimately seek to accomplish? Answers to these questions are important and help define what makes nursing informatics practice unique and how it creates demonstrable value.

The fundamental answer involves creating an environment of technology and data systems that enable those in that environment to successfully accomplish their desired goal(s). Members of the environment are referred to as a user, "the person who interacts with the system, product or service" and includes nurses, patients, consumers, and others (International Organization for Standardization, 2018a).

The strategy of informatics nurses when creating and maintaining this environment is to make all aspects of user interactions with technology and data both easy to use and beneficial. As such, informatics nurses are the barons of what is referred to as "user experience." The International Organization for Standardization (ISO) defines user experience as the "user's perceptions and responses that result from the use and/or anticipated use of a system, product or service" (International Organization for Standardization, 2018b).

Note the definition provides additional information:

- Concepts of user perceptions and responses are described as "the users' emotions, beliefs, preferences, perceptions, comfort,

behaviors, and accomplishments that occur before, during and after use."

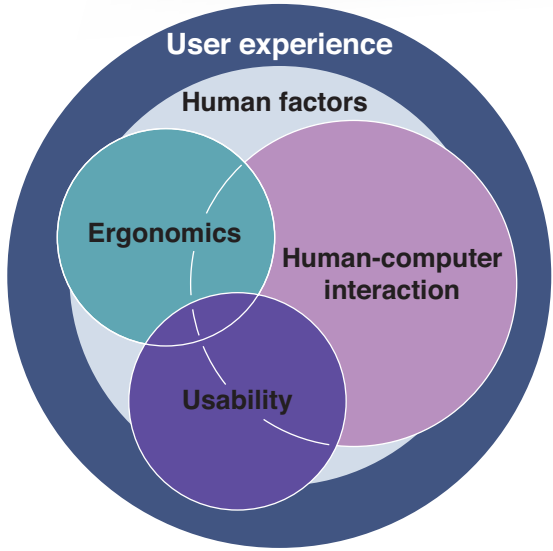
- The user experience is created as "a consequence of brand image, presentation, functionality, system performance, interactive behavior, and assistive capabilities of a system, product or service. It also results from the user's internal and physical state resulting from prior experiences, attitudes, skills, abilities and personality; and from the context of use."
- The context of use is "a combination of users, their goals and tasks, resources and environment." The "environment" in the context of use includes the technical, physical, social, cultural, and organizational environments (International Organization for Standardization, 2018c).

Concepts within the ISO definition and notes are important to examine together as they paint a picture of user experience that should always be considered by informatics nurses when planning, implementing, evaluating, and maintaining technologies and data systems in nursing practice environments. User experience envelopes a wide range of experiences from nursing units to complex environments with many users interacting with mobile health applications (apps). The design of user experience in health care is less about technology and data or even aesthetics. It is about the best way to deliver patient care.

Anything informatics nurses do that changes the practice environment impacts the user experience and patient care. From software updates to new technologies, small projects to large endeavors, the individual and collective impact of these on the user experience should be evaluated before and after implementation. These questions must be answered:

- How does the technology, software, or other change impact user experience?
- Does it make work in the technical, physical, social, cultural, and organizational environment easier and more beneficial to nurses?
- What are the risks, and can those risks be mitigated?
- And what is the impact on the attainment of desired goals?

FIGURE 7 Terms and Their Relationships, Nelson and Staggers, 2016, p.353



User experience encompasses several related concepts of fundamental interest to informatics nurses. These include human factors, ergonomics, human computer interaction (HCI), and usability. Nelson and Staggers (2018) identified the interrelationship of these terms as displayed in Figure 7.

Human Factors. ISO defines human factors as the "scientific discipline concerned with the understanding of interactions among human and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance" (ISO, 2016, 2.3). An example would be the use of a human factors approach to study prescribing errors in order to plan effective mitigation strategies for slips and lapses, rules-based mistakes, and knowledge-based mistakes (Sutherland et al., 2019).

Ergonomics. ISO defines ergonomics as, "the study and design of working environments and their components, work practices, and work procedures, for the benefit of worker's productivity, health, comfort and safety" (ISO, 2019, 3.13). An often used example of ergonomics and

nurses involves prevention of back injuries and the safe transfer of patients (Anderson et al., 2019).

Human-Computer Interaction. Human-computer interaction (HCI) refers to "a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them" (Association for Computing Machinery [ACM] Special Interest Group, 1996). Perhaps the best example of technology where HCI design has been limited involves the electronic health record with the highest number of reported EHR patient safety incidents (Palojoki et al., 2017).

Usability. ISO defines usability as "the extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use" (ISO, 2018a, 3.1.1). An ISO note to this definition further describes the specified users, goals, and context of use as the specific combination being considered. As an example, the American Academy of Nursing recently released a position statement advocating for the need to improve usability in EHRs in order to improve nurses' well-being and joy in work, a goal consistent with optimal user experience (Boyle et al., 2019).

Value of User Experience

It is imperative that informatics nurses demonstrate the value of user experience to their organization. While it would be great to create a practice environment that nurses love, without demonstrable value to the organization, that practice environment is not likely to be built. For the organization, the greatest value of user experience involves improved productivity, enhanced patient outcomes, and reduced costs.

Improved productivity of individuals or groups occurs through greater efficiency, effectiveness, and satisfaction in an environment that is created specifically to enhance user experience. For example, documentation is key for quality assessment and outcomes, but the burdens imposed by EHR documentation can create significant unintended consequences. Enhanced usability and clinical decision support can enhance cognitive support and improve patient outcomes. This results in a reduction in costs associated

with user learning and support needs as well as a decrement in use errors. Significant cost savings also occur with reduced development failures and associated rework resulting from a mismatch in what nurses need to practice to optimally achieve desired patient- and consumer-centered goals in contrast with what is actually delivered and implemented.

Achievement of these outcomes requires a team of experts working together to create a successful user experience. Knowledge and skill in the following areas are important (U.S. General Services Administration Technology Transformation Service, 2022; Tutty et al., 2019):

- Project management
- Content strategy
- Information architecture
- User research
- Usability evaluation
- Information architecture
- User interface design
- Interaction design
- User centered design
- Visual design
- Accessibility
- Analytics
- Interoperability
- Governance

Equally important is working collaboratively with others whose decisions also influence user experience, such as IT professionals, vendors, regulatory bodies, and payers. Free online resources to assist in these efforts include the following:

- DesignModo UX (designmodo.com/design/ux-design/)
- Nielsen Norman Group (nngroup.com)
- Smashing Magazine UX Design (smashingmagazine.com /category/ux-design/)

- Stanford User Experience Community (ux.stanford.edu/content/resources)
- UX Booth (uxbooth.com)
- UX Magazine (uxmag.com)
- UX Myths (uxmyths.com/)
- UX Pin (uxpin.com)
- Usability.gov (usability.gov)
- UsabilityGeek (usabilitygeek.com/)
- Health IT Usability (NIST; bit.ly/30eAop8)

The need for informatics nurses knowledgeable in user experience will continue to grow. Successful incorporation of emerging technologies, new data sources, and the continued need for interoperability will challenge environments. Augmented and virtual reality, wearables, chatbots, artificial intelligence, natural language processing, robots, and more will require expert ability in user experience redesign. The health care environment must be continually reshaped to enhance the capabilities of technology and data systems that best enable the successful accomplishment of patient-centered goals by all users. As such, it is important for informatics nurses to routinely advocate for users in planning, implementing, evaluating, and maintaining optimal user experience environments. Otherwise, user experience will continue to "just happen" along with negative consequences and the loss of important benefits.

PROFESSIONAL PRACTICE AREAS

Informatics nurses and informatics nurse specialists most commonly practice in interprofessional health care environments interacting with a variety of other stakeholders involved in health care delivery. They collaborate with clinicians of all levels and specialties, information technology (IT) professionals in various domains, as well as leaders and administrators during all phases of developing and implementing a plan or project. INs and INSs are also found in non-health care environments, such as in the insurance industry, government and regulatory organizations, technology vendor domains, and many other settings, providing advice, guidance, and leadership to help transform health care and advance the entire health care

ecosystem via project management and informatics processes, tools, and structures.

INs and INSs use scientific, project planning, management, and informatics principles to employ creative strategies to provide the best informatics solutions based on the current evidence. They bring the perspectives of nursing and health care consumers to interprofessional work through a solid understanding of health care delivery processes and the value of consumer advocacy. INs and INSs may need additional education or other types of advanced preparation, in project planning, management, and application of management principles and concepts as their assignments and roles evolve.

Because of the common tendency to confuse roles with titles, this section describes the following examples of dynamic and evolving practice areas of nursing informatics:

- Management, Administration, and Leadership
- Clinical Informatics
- Data Management and Analytics
- Patient Safety and Quality
- Research and Evaluation
- Compliance and Integrity Management
- Coordination, Consultation, Facilitation, and Integration

Management, Administration, and Leadership

Management is defined as "an art of getting things done through and with people in formally organized groups and involves working with others to achieve organization's goals by efficiently deploying limited resources in the evolving world" (Ranjan, 2017).

Administration refers to the process of running an organization, office, or business. This includes creating rules and regulations, making decisions, management of operations, creating an organization of staff/employees/people to direct activities towards achieving a common goal or objective. (Machado, 2018)

Leadership is the ability to provide the setting where everyone feels empowered to contribute creatively to solving the problems. Leadership is an ability, meaning a leader has a capacity to do something through talent and skill (Smith, 2010). Ward (2019) suggests that leaders provide inspiration as they direct action and are persons who others want to follow as they exhibit leadership skills and personality.

Leadership is a critical skill for nursing informatics practice at all levels. Leadership is characterized by the combination of superb communication skills, collaboration, change management, risk assessment and mitigation, as well as coalition building using political finesse, business acumen, and strategic application knowledge with all levels of stakeholders. (See Professional Performance Standard 11. Leadership and the accompanying competencies for more detail.) Informatics nurses serving in the professional practice area may put most of their energy into leadership and management. In other positions, administration may be part of a position merged with other practice areas depending on the size of the organization and may focus on determining utilization of organizational resources.

Administration and leadership practice in nursing informatics incorporates both higher-level and mid-level administrative tasks. Increasingly, INs and INSs are attaining senior leadership positions. Positions may be titled Chief Nursing Informatics Officer (CNIO), Chief Information Officer (CIO), Chief Clinical Informatics Officer (CCIO), and more recently, Nursing Informatics Executive Leader, director, or similar leadership titles. In these professional practice areas, nursing informatics leaders are expected to be visionaries and establish the direction and strategies for large-scale informatics solutions. Nursing informatics leaders often serve as catalysts for developing strategic plans and creating national or system policies and procedures, while serving as the champion for integrated projects and systems. In midlevel management positions, INSs may supervise resources and validate activities for all phases of a project.

A crucial responsibility for any nursing informatics leader and innovator is fostering teams and interprofessional collaboration. In 2016 the Interprofessional Education Collaborative published an update of its core

competencies and accompanying subcompetencies for interprofessional collaboration that can be a resource for informatics nursing practice:

> **Competency 1** Work with individuals of other professions to maintain a climate of mutual respect and shared values. (Values/Ethics for Interprofessional Practice)
> **Competency 2** Use the knowledge of one's own role and those of other professions to appropriately assess and address the health care needs of patients and to promote and advance the health of populations. (Roles/Responsibilities)
> **Competency 3** Communicate with patients, families, communities, and professionals in health and other fields in a responsive and responsible manner that supports a team approach to the promotion and maintenance of health and the prevention and treatment of disease. (Interprofessional Communication)
> **Competency 4** Apply relationship-building values and the principles of team dynamics to perform effectively in different team roles to plan, deliver, and evaluate patient/population-centered care and population health programs and policies that are safe, timely, efficient, effective, and equitable. (Teams and Teamwork) (Interprofessional Education Collaborative, 2016)

Although the IN and INS may lead teams and projects, the output of these teams is generally enterprise wide and reflects concerns and actions of interprofessional stakeholders.

Project Management (PM)

Project management concepts are deployed in many settings. Project management is defined as a planned set of interrelated tasks that need to be completed within a certain time frame, involves knowing what the goals are, how to achieve them, what resources are needed, and how long it will take to achieve a specific goal, not just specific to systems development but general practice (Sipes, 2020). The Project Management Institute (PMI) has developed *A Guide to the Project Management Body of Knowledge* (**PMBOK®** Guide-6th Edition; PMI, 2017) which defines the discipline and contains

TABLE 2 Project Management Phases [Sipes, (2020) *Project Management for the Advanced Practice Nurse, 2nd Ed.*]

Initiation/ Design	Planning	Implementation/ Execution	Monitor & Control	Close Out & Evaluation
Goals and Objectives Charter Scope Feasibility	Current State Future State Risk Analysis	Implement all tracking tools develop in planning	Ongoing	Lessons Learned Knowledge Transfer Performance Metrics

the project management framework comprised of five basic stepwise phases of project management:

1) Initiation and Design,
2) Planning,
3) Implementation/ Execution,
4) Monitor and Control, and
5) Close-out and Evaluation/Lessons learned (Table 2).

The PMI provides updates to standards of practice for project managers and supports best practices. PMI's certification, the Project Management Professional (PMP), is becoming more recognized by clinicians as a foundation to enhance and organize practice. Typical examples of roles utilizing project planning and management concepts and principles include:

- An INS at a large hospital system manages and supervises an electronic health record implementation and associated education teams, consults and represents nursing interests on various IT committees, performs project management for multiple systems such as documentation, data analysis, resource management and other projects, and also provides oversight of nursing standards and vocabularies used in applications.
- A project director or higher-level leader for a clinical software company manages implementation teams for various client projects (hospitals to ambulatory facilities to home health) and

consults with clients on all aspects of systems selection, customization, adoption, and use of software.
- A grants administrator and researcher for an information science research agency seeks and writes grants that would fund NI-related projects, designs budgets, and ensures optimal allocation of resources.

As an IN or INS, project management skills that are useful in managing projects and initiatives include defining scope; doing a gap analysis, workflow, or SWOT analysis; developing a Gantt chart outlining the project tasks, stakeholders, and timeline; monitoring the progress on an initiative; and proactively managing barriers that arise during the project. Other efforts include activities that ensure testing, evaluation, and training initiatives have been developed and rolled out; communication and change management plans have been fully developed and implemented; and a maintenance plan has been launched prior to closing the project. The IN and INS will also apply concepts of project planning and management to many other facets of clinical practice, such as quality improvement and policy development.

According to the Institute for Healthcare Improvement (IHI, 2020), managing a quality improvement project is a critical skill for anyone, including INs and INSs, interested in providing and making care delivery—and systems of care—better in their health care organization. To successfully manage improvement, team leaders need specialized skills in quality improvement (QI) project management, which has not typically been part of the QI curriculum. IHI has developed tools to effectively manage quality improvement projects, specific ideas to try within each strategy, and offers a workspace to note next steps to implement the strategy at ihi.org/resources/Pages/Tools/default.aspx.

Systems Development Life Cycle (SDLC)

Another concept integrated within nursing informatics is the Systems Development Life Cycle (SDLC) which is more specifically focused on IT, EHR, or systems development projects. The SDLC provides a framework for technical and nontechnical activities to deliver a quality system that

meets or exceeds expectations, and involves end-to-end people, process, and software/technology deployment. The SDLC phases include planning, systems analysis and requirements, systems design, development, integration and testing, implementation and deployment, operations and maintenance. The IN and INS may engage in discrete work elements, hold leadership and management positions, or contribute in many diverse ways.

SDLC can also be used to identify the Software Development Life Cycle that focuses on software components development planning, technical architecture, software quality testing, and deployment of working software.

Clinical Informatics

"Clinical informatics is the application of informatics and information technology to deliver healthcare services. It is also referred to as applied clinical informatics and operational informatics" (Clinical Informatics, n.d.). "Clinical informaticians transform health care by analyzing, designing, implementing, and evaluating information and communication systems that enhance individual and population health outcomes, improve patient care, and strengthen the clinician-patient relationship" (Gardner et al., 2009). Clinical informatics includes topics ranging from clinical decision support to visual images (e.g., radiological, pathological, dermatological, ophthalmological, etc.), from clinical documentation to provider order entry systems, and from system design to system implementation and adoption issues (Clinical Informatics, n.d.). It should be noted that as informatics evolves, Clinical informatics is giving way to a more global practice and definition, i.e., Health Informatics.

In addition to nursing informatics, Health Informatics includes:

- *Pharmacy informatics* - "Pharmacy informatics is the scientific field that focuses on medication-related data and knowledge within the continuum of healthcare systems - including its acquisition, storage, analysis, use and dissemination - in the delivery of optimal medication-related patient care and health outcomes" (HIMSS, n.d.).

- *Medical informatics* - "Medical informatics is the interdisciplinary study of the design, development, adoption and application of IT-based innovations in healthcare services delivery, management and planning" (HIMSS TIGER Interprofessional Community, 2020).
- *Nutritional informatics* - Nutritional informatics is "the effective retrieval, organization, storage and optimum use of information, data and knowledge for food and nutrition related problem solving and decision-making. Informatics is supported by the use of information standards, processes and technology" (HIMSS TIGER Interprofessional Community, 2020, p. 7).

This is only a small sample of the numerous disciplines that now recognize informatics principles and are utilizing those principles to enhance research, education, and patient care.

Data Management and Analytics

Data management, measures, and analytics are the foundation of improvement initiatives. Tremendous volumes of health care data are available, but the amassed electronic data remain uncapitalized. The information and knowledge that generate the wisdom and critical thinking needed in the industry are lacking. However, value-based purchasing models are driving use of data in significant new and innovative ways to compete in the health care industry (McBride and Tietze, 2019, p. 426). Informatics nurses can contribute significantly to health care organizations' ability to manage data to create, and maintain measures of quality, safety, cost, and population health.

Data Management

Health care organizations are now competing and being paid based on performance. This requires the health care industry to manage data effectively for valid and reliable information upon which performance can be evaluated. The informatics nurse may have a significant role in how effectively organizations capture data within the clinical workflow in structured and reliable ways so that data can be exported for electronic reporting. In

2011, the American Hospital Association (AHA) reported that 80 percent of the effort to capture valid and reliable data was related to the hospital collecting the correct data within the clinical workflow of the clinicians, and the remaining 20 percent of the effort depended upon the vendor designing the EHR to appropriately capture the information (Eisenberg et al., 2011). The INS can be involved in analyzing end-user patterns, assuring data integrity, and helping to design improvement strategies to ensure information reflects practice quality within organizations. The INS supports planning, analysis, development and implementation solutions, data validation, submission, evaluation, and maintenance of measures (Norris et al., 2015).

Master Data Management and the INS Practice Role

The National Quality Strategy (NQS)—better care, healthy people and communities, and affordable care—requires that health care organizations (HCO) invest time and resources to manage enterprise data effectively and efficiently. To meet NQS goals and to competitively survive in the new health care payer market, HCOs must now make integrated data and analytics a core asset to meet the challenges of accelerating payment reform. HCOs compete based on how well they manage and use analytics within their organizations to achieve their strategic plan goals. Such goals include quality and efficient care, population health improvement, and often their research and education efforts.

The informatics nurse role in supporting master data management is focused on developing people, technology, and processes to support the organization in designing effective enterprise data use. The INS engages in activities associated with culture, governance, and organization in the people domain. In the technology area, the INS may address source system data accuracy and reliability and the Enterprise Data (ED) Strategies/ Business Intelligence (BI) infrastructure and data models. INS activities in the process domain encompasses such initiatives as:

- Communicating information about programs and releases;
- Ensuring existing reports and key performance indicators (KPIs) are inventoried and reconciled for accuracy;

- Incorporating the voice of the customer (VOC) as an integral business requirement;
- Employing agile design/build/deploy; and
- Employing use-based data quality.

Use of Human-Computer Interaction (HCI) Tools and Methods

In the domain of professional practice for data management and analytics, INs and INSs use HCI tools and methods, such as heuristics and cognitive walk-throughs, to evaluate the match of systems to users, tasks, and contexts. An excellent example of this type of data management and analytic work product is from the Nursing Knowledge and Big Data Science Conference (NKBDSC) working group on Encoding and Modeling nursing sensitive data. The goal of this working group is to "develop and disseminate LOINC and SNOMED Clinical Terms for electronic health record nursing assessments and incorporate them into a framework and repository for dissemination" (NKBDSC, 2019). Recent work has included wound and pain assessment mapping and modeling.

Standardization of Data Capture

Data management through standardization of data capture is required for valid and reliable use of data for analysis. This practice area includes the development, use, and maintenance of clinical vocabularies, languages, and taxonomies. Nursing languages must be periodically re-evaluated for their applicability and currency. Analysis of a meta-database, such as the Unified Medical Language System (UMLS), requires knowledge of nursing and medical vocabularies to analyze groups of taxonomies and map them to similar terms. An example is the effort to map SNOMED CT to the International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM) to aid in meeting and attesting to meaningful use requirements and electronic clinical quality measures (eCQM). IN and INS expertise should be included in these efforts to support the collection, reporting, and analysis of nursing-sensitive data, as well as eCQM required for many of the new and emerging payer models.

Analytics

INs and INSs engage in the process of knowledge discovery in databases (KDD). Using sound methodologies and practical evidence-based recommendations, the INS can discover information and knowledge related to diverse areas of nursing practice. Knowledge discovery methods (data mining and machine learning methods) combined with statistical analysis and data visualization techniques help identify and understand patterns in very large data stores, such as enterprise data warehouses.

Outcomes analysis may be related to any domain of nursing practice: clinical, education, research, or administration. Analysis can include the use of human computer interaction principles and methods to help identify the complexity and levels of outcomes for consumers, populations, and institutions.

Informatics nurses serving as analysts use many tools and methods to: (1) maintain data integrity and reliability, (2) facilitate data standardization, aggregation, and analysis, and (3) develop and analyze process, outcomes, and balancing measures. These techniques allow nurses to contribute to building a knowledge base consisting of the data, information, theories, and models used by nurses and other stakeholders in decision-making that supports quality health care. The levels of competencies for informatics nurses in analytical roles range from basic to advanced, such as those of data scientists. Examples of INS competencies for intermediate analytics include the ability to:

- Analyze data and information accurately, using the appropriate tools and techniques;
- Utilize data from within the EHR, including analyzing, generating or contributing to performance, workflow, quality, management and other reports; and
- Utilize data management, data mining, and data sharing techniques, resources and tools (hitcomp.org/competencies/).

Examples of analysis activities include:

- An INS in an acute care setting retrieves electronic data from the EHR to determine if a sepsis alert is triggering correctly as the clinical decision support (CDS) strategy was designed to perform. Analysis continues to determine if the algorithm within the CDS is properly identifying sepsis risk.
- An INS with expertise in quality improvement (QI) manages the electronic clinical quality measures data for a large health care system. The INS retrieves data from the EHR and the enterprise data store to determine if the data are being accurately reported to the Centers for Medicare & Medicaid Services (CMS) and The Joint Commission.
- An INS in a clinical analytics role supports the organization by designing and retrieving reports from the enterprise data store using business intelligence tools to support the information requirements of senior management in evaluating quality, cost, and safety.
- An analyst applies knowledge discovery methods to warehoused electronic data to build a predictive model of patient falls.

Patient Safety and Quality

Managing Regulatory Requirements

Managing regulatory requirements is a significant professional practice component for the informatics nurse. Health care regulatory requirements have historically been influenced by major events such as the landmark reports *To Err Is Human: Building a Safer Health System* (IOM, 1999), *Crossing the Quality Chasm: A New Health System for the 21st Century* (IOM, 2001), *Health IT and Patient Safety: Building Safer Systems for Better Care* (IOM 2011), *Taking Action Against Clinician Burnout: A Systems Approach to Professional Well-Being* (National Academy of Medicine, 2019); the downfall of Enron, passage of the Sarbanes-Oxley Act of 2002 (SOX); and pay-for-performance incentives adopted by the Centers for Medicare & Medicaid Services (CMS).

Privacy and Security

The significance of safeguarding the privacy and security of health information has become a primary and critical issue for health care providers and informatics professionals in today's world of cybersecurity aimed at preventing cyberattacks, ransomware, and theft. Though not a new issue, the relevance to INS practice is more pressing than ever as new ways in which health data are collected, used, and shared not only promise innovation but also increase the potential for misuse and breach.

Computerized information systems must support compliance with the 1996 Health Insurance Portability and Accountability Act (HIPAA) by limiting access to personally identifiable health information to only those who require and are authorized access. HIPAA was subsequently amended and expanded in 2013 to address the increasing need for privacy of personal health information (PHI). The HIPAA regulations apply to organizations defined as covered entities (CEs), such as health plans, health care clearinghouses, and certain health care providers. These regulations have significant implications for the INS professional role in organizations that are covered entities.

With the passage of the Health Information Technology for Economic and Clinical Health (HITECH) Act of 2009 as a part of the American Recovery and Reinvestment Act, unprecedented amounts of PHI data were being exchanged in electronic format along with increased vulnerabilities of exposure. As a result, along with the HITECH Act came additional provisions for HIPAA that went above and beyond the original protections established in 1996. These updated requirements are also known as the Omnibus HIPAA rule. These changes significantly expanded individual rights and provide increased protection and control over health information, along with significant penalty increases for violations. The HITECH Act requires the Department of Health and Human Services (HHS) to perform audits, increases penalties for noncompliance based on level of negligence, and outlines breach notification requirements.

In addition to HIPAA and the Omnibus HIPAA rule, the INS must consider other important regulatory requirements for privacy and security such as the:

- Genetic Information Nondiscrimination Act (GINA);
- Updates to any state regulatory requirements; and
- International laws such as the General Data Protection Regulation (GDPR) effective May 6, 2018.

The resultant practice functions include activities such as privacy and security assessments and audits to detect red flags, use of reporting systems that will preserve confidentiality or anonymity, and timely enterprise risk management (ERM) reporting of risks and opportunities at a high level for immediate leadership attention through risk scoring and mapping (ASHRM, 2011).

Other Standards, Directives, Guidelines, or Mandates

The 2009 American Recovery and Reinvestment Act (ARRA) and HITECH Act have driven information technology and EHR installations in the United States to a new national level, emphasizing the use of technology for patient safety and error reduction in health care delivery. Organizations such as the Agency for Healthcare Research and Quality (AHRQ) and the Institute for Healthcare Improvement (IHI), as well as non-healthcare organizations like Leapfrog, provide incentives for health institutions to implement informatics solutions.

The continuing requirement to meet meaningful use standards has supported the increased pace of technology adoption. Mandates now direct organizations to use value-based rather than return-on-investment models to justify health IT, and the pay-for-performance models are accelerating EHR installations. Online quality data and reported metrics are more visible to both consumers and hospital and organizational boards. Organizations will continue to increase the transparency of data and, more importantly, improve the care being delivered. Regulatory requirements and standards will continue to shape the future. INSs are involved in

defining these and future standards, and in designing, building, implementing, using, and certifying products that comply.

Unintended Consequences of HIT

Today, health care organizations attempt to achieve high reliability in a time when technology outpaces our ability to use it. The cost of this fast pace of adoption becomes less clear as medical errors are the third leading cause of death in the United States. The distance between health care's search for high reliability, innovative HIT, and skills to equip informatics nursing will be the marathon for the next decade (Classen et al., 2011; Makary & Daniel, 2016).

Assessment, planning, intervention, evaluation, and advocacy for the safety of patients is foundational to nursing practice. In the era of technology-assisted health care, the informatics nurse is prepared and alert to unintended consequences of HIT. The informatics nurse can view the indelible link between quality and safe care in the context of the entire care continuum, complexity of the system, and high risk of health care delivery which is highly augmented by HIT. As a member of the interprofessional team, the informatics nurse offers perspective and a deep understanding of the interrelated systems and factors that contribute to risk. Advocacy for patient safety is core to nursing informatics and will remain the challenge for informatics nurses in the future.

The unintended consequences of HIT have generated an urgent imperative for increased application of safety science in health care. Studies by significant health care quality organizations such as the Institute of Medicine, Joint Commission, ECRI, Institute for Safe Medication Practices (ISMP), FDA, and others have begun to explore HIT-related safety issues. However, unanswered questions remain and no remedies have been identified for untoward outcomes for even simple applications of technology ("A Brief Look at ECRI Institute's 2019 Top 10 Health Technology Hazards," 2019; Anonymous;, 2009; Harrington et al., 2011; Yao et al., 2018). Simple questions regarding workflow and HIT persist despite widespread EHR adoption (Institute of Medicine, 2011; Piscotty et al., 2015).

While alarms, barcoding, copy-paste, and smart pumps were considered patient safety enhancements, a deeper understanding of the impact and consequences of rapid adoption are emerging (Kelly et al., 2016; Yao et al., 2018). Although usability, human factors, summative and formative testing, and standardization are clearly linked to increased patient safety in critical tasks, large knowledge gaps remain in new graduates, leaders, and the general workforce. Legal implications of HIT continue to surface, emphasizing the need for nursing informatics expertise and foresight in health care organizations to prevent liability (Schencker, 2016). Currently, HIT implemented with the assumption of increasing safer care has created struggles to identify and understand the untoward outcomes. The IN and INS provide expertise and remedy in helping to close the gaps.

Research and Evaluation

Informatics nurses and informatics nurse specialists, particularly those with formal research training, may conduct research into the design, development, implementation, and evaluation of informatics solutions, models, and theories. INS researchers use systematic methods of inquiry (including traditional and newer techniques) to identify, retrieve, represent, and evaluate data, information, and knowledge within informatics solutions and data repositories.

Research in nursing informatics may span a range of activities, including exploratory research (such as data mining/visualization), experimental research (randomized trials), or process/quality improvement. For example, an INS might conduct research projects to develop and refine standardized nursing vocabularies or to link nursing interventions to outcomes in large data sets. This work may include the evaluation of organizational attributes for successful optimization of documentation systems or the usability and usefulness of hardware, software, or consumer-based interactive solutions. Nursing informatics research and evaluation examples include:

- Evaluation of effectiveness of methods for information systems implementation, acceptance, utilization, and optimization:

  - Clinical decision-making in nursing; and
  - Documentation burden.
- Research about the effects of systems/consumer applications:
  - Care processes/workflow/quality;
  - Outcomes of individuals/populations; and
  - Clinician/consumer satisfaction.
- Research in theoretical/applied informatics:
  - Representation of concepts/terms including clinical vocabularies; and
  - Extracting data from nursing/consumer text.
- Research in consumer communication and usage of technology:
  - Tools for social/behavioral determinants of health reporting;
  - Technology-based support groups;
  - Tools for communicating with the health care team; and
  - User experience: design, use, and usability.

Compliance and Integrity Management

Health information technology (HIT) has been promoted as a key element in the National Quality Strategy (NQS) to achieve three aims: better care, affordable care, and healthy populations and communities (AHRQ, 2017). These requirements have resulted in a demand for health care organizations to have robust reporting systems to monitor compliance and integrity of their information and reporting activities, infrastructures, employees, and business partners, along with the ability to capture and manage reporting of quality indicators for all three triple aims that have now been expanded to include a fourth aim—improving the work life of health care providers, including clinicians and staff (digital.ahrq.gov/acts/quadruple-aim).

Following the report *To Err Is Human: Building a Safer Health System* (IOM, 1999), compliance and integrity management have increased importance. Along with developing organizational cultures that encourage ethical conduct and regulatory compliance, mechanisms must be in place to prevent and detect inadvertent omission or commission as well as civil and criminal conduct.

Accreditation organizations, such as The Joint Commission (TJC), Healthcare Facilities Accreditation Program (HFAP), and Det Norske Veritas Healthcare, Inc. (DNV), affect care delivery via their directives. Robust reporting requirements accompany the initial application and continued monitoring activities. Government agencies, such as the Centers for Medicare & Medicaid Services (CMS), the Food and Drug Administration (FDA), the Centers for Disease Control and Prevention (CDC), the National Institutes of Health (NIH), and the National Institute of Standards and Technologies (NIST), provide regulatory guidance.

Examples of compliance and integrity management activities for informatics nurses in these roles include:

- The security officer for a hospital ensures that HIPAA standards are met by software vendors within the organization, periodically monitors software audit logs for breaches, ensures that passwords are not shared, and confirms that backup and disaster procedures are in place and operational.
- A compliance officer for a state health agency writes and enforces policies that conform to state and national laws respecting records retention.
- A care coordinator administrator for a hospital system ensures the confidentiality of data transmitted via telehealth and telemedicine devices.
- An internal auditor reviews charges to documented care given for appropriate reimbursement or abnormal billing practices.

The IN and INS must have and maintain the knowledge to effectively apply current ethical standards and regulatory requirements to help health care organizations to:

- Revise operational procedures for staff;
- Establish technical processes to maintain compliance; and
- Meet new regulatory mandates at local, state, national, and global levels.