Concepts of the Nursing Profession

Karin A. Polifko, PhD, RN, CNAA
Remington College
Orlando, Florida

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By Karin A. Polifko, PhD, RN, CNAA

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CHAPTER 19

Manager of Information Systems

Nancy N. Menzel

It is a very sad thing that nowadays there is so little useless information.
—Oscar Wilde

LEARNING OBJECTIVES

At the completion of the chapter, the learner should be able to do the following:

1. Identify information management trends.
2. Define informatics.
3. Describe the transformation from data to knowledge.
4. Discuss computer applications in health care.
5. Describe the nurse's role in informatics.

KEY TERMS

Bits
Bytes
Client
Clinical information systems
Computer-based patient record
Customers
Data
Data capture
Data integrity
Database
Electronic health record
Electronic medical record
Hardware
Healthcare information systems
Information
Information technology
Internet
Intranet
Minicomputers
Nursing classification systems
Nursing informatics
Nursing information systems
Operating system
Server
Software
Standardized nursing languages
Telehealth
Telemedicine

INTRODUCTION TO INFORMATICS

Health care depends on information, and nurses are at the command center of the information matrix. Here are just some of the questions others are likely to ask the nurse in a typical hospital setting: "Has Ms. B. had her x-ray?" "Does Mr. N. have an allergy to penicillin?" "Is Ms. Q.'s blood pressure stable?" Whether you observe a modern nurse standing in the center of an intensive care unit interpreting a cascade of visual, auditory, tactile, and olfactory cues or visualize Florence Nightingale doing the same in a Crimean hospital, the common denominator is the processing of **data** and **information** about patients and their environment. Because nurses in hospitals have an around-the-clock presence and physicians usually only an intermittent one, it is nurses who collect and transform data first into information and then into knowledge as the primary function of their job. Nightingale had few tools other than paper and a quill pen with which to augment her cognitive skills and to assist her in organizing data. In today's health care environment, nurses have the tool of **information technology,** which is "the management and processing of information, generally with the assistance of computers" (Hebda, Mascara, & Czar, 2005, p. 5).

Informatics is the process of using cognitive skills and computers to manage information. Many prefixes have been applied to informatics: health care, medical, and nursing, with health care informatics becoming accepted as a term more inclusive of all disciplines. Health care informatics encompasses "the retrieval, storage, presentation, sharing, and use of biomedical information, data, and knowledge for providing care, solving problems, and making decisions" (Shortliffe & Perrault, 2001). The American Nurses Association (ANA) (2001, p. 17) has defined **nursing informatics** as follows:

> Nursing informatics is a specialty that integrates nursing science, computer science, and information science to manage and communicate data, information, and knowledge in nursing practice. Nursing informatics facilitates the integration of data, information, and knowledge to support patients, nurses, and other providers in their decision-making in all roles and settings. This support is accomplished through the use of information structures, information processes, and information technology.

The purpose of informatics is to create and acquire knowledge in order to assist patients. As in General System Theory, where "'systems' of various orders [are] not understandable by investigation of their respective parts in isolation" (von Bertalanffy, 1968, p. 37), the output of informatics is greater than and different from the sum of the subsystems. The focus is on the interaction rather than the individual parts.

SIGNIFICANT TRENDS IN INFORMATION MANAGEMENT

The military, the government, and businesses long ago recognized that managing information was crucial to their missions. The first computers used in the United States were introduced in the military in the early 1940s and then in the U.S. Census Bureau. In the 1950s International Business Machines (IBM) began selling computers for businesses. However, health care organizations and providers have been very slow to adopt this new technology for managing health care information.

This lag began to close when Medicare legislation was passed in 1965, and the government began to require documentation of services before it would pay hospitals and physicians, creating a huge paperwork burden for providers. Looking for solutions, institutions and individual practitioners, such as doctors' offices, increasingly turned to computers to help manage financial information. Federal and private insurers and private accrediting bodies (e.g., Joint Commission on Accreditation of Healthcare Organizations) next called for using computerized medical records as tools for improving patient care quality; for example, retrospective chart audits against quality indicators. Most recently, the Centers for Medicare and Medicaid Services (CMS) has linked payment to performance, based on data on quality measures relating to treatment standards for three medical conditions common among Medicare recipients. Hospitals must transmit the data electronically. An emerging trend is the use of **information technology** (IT) to improve patient safety, such as use of bar coding for medication dispensing. With powerful forces mandating the use of information management systems, the nurse of the future will make increasing use of existing technology and devise new ways to use it to support practice.

THE NURSE AS INFORMATION MANAGER

According to Thede (2003, p. 261), "data are elements that have not been interpreted." Consider the number 100; by itself, it is meaningless. Now combine this number with another: 180/100. The nurse then recognizes these numbers (data) as a blood pressure reading, which the nurse collects. The nurse arrays a collection of these data to look for patterns to produce information. The nurse interprets the data in Table 19.1 to mean that the patient's blood pressure is approximately the same in both arms over a 15-minute period. To convert information into knowledge upon which to base action, the nurse must have additional information, that is, the normal range for blood pressure readings. Using the information that normal blood pressures are below 120/80, the nurse can now convert information into knowledge that this patient is exhibiting signs of hypertension and that intervention is needed. The nurse may create new knowledge by observing that other patients in similar situations exhibit a similar pattern (e.g., after administration of a particular drug intravenously).

Table 19.1

Date	Time	Blood Pressure	Arm
7/9/06	8:00 a.m.	180/100	L
7/9/06	8:02 a.m.	178/98	R
7/9/06	8:15 a.m.	182/102	L

Nurses are inundated with data and information about their patients every day (see Figure 19.1). Key roles for nurses are ensuring that the data are collected on time and recorded accurately, followed by transmission of information as needed to the people who need it, such as immediately notifying a physician that a patient's blood pressure is dangerously high. Thus, these are the main information management roles for nurses: (1) collect clinical data, (2) record data, (3) interpret data to produce information, (4) use information to produce knowledge, and (5) share knowledge and information with those who need it.

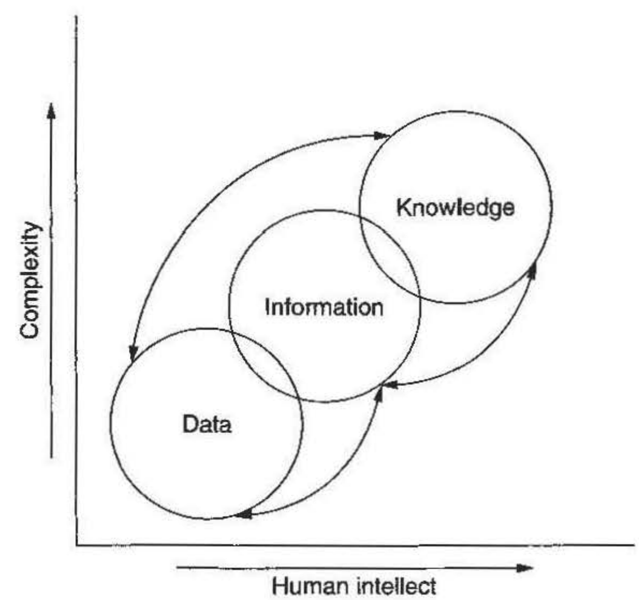

Figure 19.1 Transformation of data to knowledge.
SOURCE: From Scope and Standards of Nursing Informatics Practice, published by nursesbooks.org. Reprinted with permission.

To facilitate data capture, many systems for **standardized nursing languages** have been developed; they are called **nursing classifications systems.** The American Nurses Association (ANA, 2005) established in 1995 the Nursing Information & Data Set Evaluation Center (NIDSEC) for the following purpose:

> [T]o review, evaluate against defined criteria, and recognize information systems from developers and manufacturers that support documentation of nursing care within automated **Nursing Information Systems** (NIS) or within **computer-based Patient Record** systems (CPR).

As of mid-2005 NIDSEC standards listed 13 terminologies that ANA recognizes as supporting nursing practice:

- North American Nursing Diagnosis Association, Inc. (NANDA)
- Nursing Interventions Classification System (NIC)
- Nursing Outcomes Classification System (NOC)
- Nursing Management Minimum Data Set (NMMDS)
- Clinical Care Classification (CCC)
- Omaha System
- Patient Care Data Set (PCDS)
- PeriOperative Nursing Dataset (PNDS)
- SNOMED CT®
- Nursing Minimum Data Set (NMDS)
- International Classification for Nursing (ICNP®)
- ABC Codes
- Logical Observation Identifier Names & Codes (LOINC®)

The goal of standardized nursing classifications/nursing classification systems is to standardize terminology for clinical problems and nursing responses to permit assessments of quality of care, describe nursing interventions and outcomes, enable research, promote education, predict trends, facilitate comparisons of nursing care across populations, and provide nursing care information for health policy and administrative decisions. Although most of the recognized nursing classifications are hospital based, the Omaha System (see Figures 19.2 and 19.3) is designed for use in community, case management, educational, and long-term-care settings. It includes an assessment component (Problem Classification Scheme), an intervention component (Intervention Scheme), and an outcomes component (Problem Rating Scale for Outcomes) (Martin, 2005).

Data integrity "refers to the ability to collect, store, and retrieve correct, complete, and current data so it will be available to authorized users when needed" (Hebda et al., 2005, p. 65). Although data integrity is a phrase associated with electronic data, it also applies to data stored on paper. The acronym GIGO (garbage in, garbage out) addresses data integrity; if nonsensical material is entered into a computer, the computer will produce nonsense. Another definition of the acronym is Garbage In, Gospel Out, referring to the misplaced belief that if a computer says it's so, it must be. Sophisticated computer systems have built-in safeguards to prevent certain types of errors, such as prohibiting entering text into numerical fields, limiting a field's length (e.g., can enter 10 but not 1000), and offering drop down boxes to restrict entries to valid choices.

Data capture, or the process of encoding real-world health data into digital format, is available through a variety of electronic devices. For example, there are now digital pens, containing a tiny camera, which transmit information to electronic patient records from special paper forms. In addition, many biometric monitoring devices (e.g., blood pressure, intracranial pressure, fetal heart monitors) are equipped to transmit their data directly to the electronic patient record, eliminating the intermediate step of reading the monitor and keying in the results.

A current challenge in nursing is incorporating the rapid proliferation of new knowledge into the evidence base for practice. Fortunately, there are many tools to assist nurses in accomplishing this ongoing activity. Information management tools such as treatment protocols, clinical guidelines, drug databases, and clinical pathways made their first appearances as print documents; however, many have been converted

PROBLEM CLASSIFICATION SCHEME

Environmental Domain

Income
Sanitation
Residence
Neighborhood/workplace safety

Psychosocial Domain

Communication with community resources
Social contact
Role change
Interpersonal relationship
Spirituality
Grief
Mental health
Sexuality
Caretaking/parenting
Neglect
Abuse
Growth and development

Physiological Domain

Hearing
Vision
Speech and language
Oral health

Physiological Domain (continued)

Cognition
Pain
Consciousness
Skin
Neuro-musculo-skeletal function
Respiration
Circulation
Digestion-hydration
Bowel function
Urinary function
Reproductive function
Pregnancy
Postpartum
Communicable/infectious condition

Health-related Behaviors Domain

Nutrition
Sleep and rest patterns
Physical activity
Personal care
Substance use
Family planning
Health care supervision
Medication regimen

PROBLEM RATING SCALE FOR OUTCOMES

Rating	Knowledge	Behavior	Status
1	No knowledge	Not appropriate behavior	Extreme signs/symptoms
2	Minimal knowledge	Rarely appropriate behavior	Severe signs/symptoms
3	Basic knowledge	Inconsistently appropriate behavior	Moderate signs/symptoms
4	Adequate knowledge	Usually appropriate behavior	Minimal signs/symptoms
5	Superior knowledge	Consistently appropriate behavior	No signs/symptoms

(Continues)

Figure 19.2 Overview of the Omaha System.

SOURCE: Reprinted with permission from Martin, K. S., *The Omaha System, 2nd ed.* © 2005 by Elsevier, Inc.

INTERVENTION SCHEME

Categories

Teaching, Guidance, and Counseling
Treatments and Procedures
Case Management
Surveillance

Targets

anatomy/physiology
anger management
behavior modification
bladder care
bonding/attachment
bowel care
cardiac care
caretaking/parenting skills
cast care
communication
community outreach worker services
continuity of care
coping skills
day care/respite
dietary management
discipline
dressing change/wound care
durable medical equipment
education
employment
end-of-life care
environment
exercises
family planning care
feeding procedures
finances
gait training
genetics
growth/development care
home
homemaking/housekeeping
infection precautions
interaction
interpreter/translator services

Targets—continued

laboratory findings
legal system
medical/dental care
medication action/side effects
medication administration
medication coordination/ordering
medication prescription
medication set-up
mobility/transfers
nursing care
nutritionist care
occupational therapy care
ostomy care
other community resources
paraprofessional/aide care
personal hygiene
physical therapy care
positioning
recreational therapy care
relaxation/breathing techniques
respiratory care
respiratory therapy care
rest/sleep
safety
screening procedures
sickness/injury care
signs/symptoms-mental/emotional
signs/symptoms-physical
skin care
social work/counseling care
specimen collection
speech and language pathology care
spiritual care
stimulation/nurturance
stress management
substance use cessation
supplies
support group
support system
transportation
wellness
other

Problem Classification Scheme

Level 1
Domains (4)
- Environmental (includes Income)

  Level 2
  Problems (42)
  - Income

    Level 3
    Modifiers (2 sets)
    - Individual (who owns the problem)
    - Family
    - Community

    - Health Promotion (most+)
    - Potential
    - Actual

    Level 4
    Signs/symptoms
    - (low/no income)
    - (uninsured)
    - (each problem has a cluster of s/s that are unique to that problem and 1 "other")

  - Sanitation
  - Residence
- Psychosocial (includes Spirituality)
- Physiological (includes Circulation)
- Health-related Behaviors (includes Substance use)

Intervention Scheme

Level 1
Categories (4)
- Teaching, Guidance, and Counseling (i.e., range)

  Level 2
  Targets (75 actions and 1 "other")
  - Anatomy/physiology
  - Anger management
  - Behavior modification
  - Bladder care

  Level 3
  Client-specific information (not included in the Scheme itself)
- Treatments and Procedures (i.e., direct care, technical)
- Case Management (i.e., referral, coordination)
- Surveillance (i.e., monitor care over time, compare change)

Problem Rating Scale for Outcomes

When
- Admission
- Interim
- Discharge

What

	low				high	
• Knowledge	1	2	3	4	5	(what the client knows)
• Behavior	1	2	3	4	5	(what the client does)
• Status	1	2	3	4	5	(how the client is)

Figure 19.3 Understanding the Omaha System.
SOURCE: Reprinted with permission from Martin, K. S., *The Omaha System, 2nd ed.* © 2005 by Elsevier, Inc.

to electronic format, and the most up-to-date versions are widely available through computers and other hardware, such as hand-held personal digital assistants (PDAs).

HARDWARE

To access and manage electronic information, the nurse uses various types of **hardware,** the physical equipment of a computer system. An **operating system** (OS) is **software** that provides programmed instructions to the computer to control various resources, such as memory, data storage, and devices. "The purpose of an operating system is to organize and control hardware and software so that the device it lives in behaves in a flexible but predictable way" (Coustan & Franklin, n.d.). OS examples include Microsoft Windows XP (for stand alone computers) and UNIX (for large networked computers). The OS controls access to all other software installed on the hardware. Other types of software include word processing, database, and spreadsheet programs. Computer users are **customers** (jokingly referred to as "wetware").

There are many types of computers, with power and portability matched to the setting's need. In academic and government settings, supercomputers

CASE SCENARIO 19.1

Mrs. B. is 93 years old and lives by herself in a deteriorating house. A severe kyphosis and arthritis in her hips contribute to her unsteady gait. Rarely using her cane in the house, she steadies herself by holding onto furniture. She has extreme difficulty with homemaking and personal care activities. The student nurse visits on a forty-five-degree day and finds Mrs. B. shivering under a thin blanket. There is no wood for the stove that heats the house. Boxes filled with old papers are stacked within two feet of the stove, and the narrow, two-foot-wide pathway from the bathroom to the living area is crowded with old furniture and grocery bags filled with clothes. A single 40-watt bulb dangling from the ceiling lights the whole house.

The student nurse notes that Mrs. B. has no heat. Mrs. B. states, "I ran out of wood yesterday. I don't know what I'm going to do, but I'm not leaving this house!" Mrs. B. is unsure where she can obtain wood. "People from a church brought me my last load," she states. After taking Mrs. B's vital signs, which are within normal limits, the student asks permission to contact Concerned Neighbors, an organization that can provide Mrs. B. with firewood. Arrangements are made for a small load of split wood to be delivered that day. After preparing Mrs. B a warm cup of tea, the student expresses concern about the boxes of old papers stacked near the wood stove. "Those boxes have been there for years. I like to have paper handy when I light the stove." The student discusses fire safety concerns. "Over the years, I've collected lots of things. Some days I can straighten things up, but I stumble quite a bit. My feet get twisted up real easy. I don't dare go in the bathtub anymore." The student notes that Mrs. B. is wearing a Lifeline necklace and asks about her history of falls. "I fell coming out of the bathroom last week. I pushed my button and two nice gentlemen from the fire department came and helped me up." The student discusses ways to decrease Mrs. B's risk of falling, and she makes a referral to the Office of Aging for personal care and homemaking services.

Case Considerations

1. List four of Mrs. B's problems. Compare your list with a classmate's. Note that even though you may have identified similar problems, most likely the words you used to describe them differed. This is an example of the inconsistent terminology that standardized languages are designed to address to make sure all users have the same understanding.
2. Look at Figure 19.2. Classify the problems you identified in the first question into the appropriate domains: Environmental, Psychosocial, Physiological, or Health-related Behaviors.
3. Explain the purpose of categorizing problems into domains. See the following Web site for more information: http://omahasystem.org/.
4. Moving from the general to the specific, refer to Figure 19.2 to identify Mrs. B's problems by name.
5. Look at Figure 19.2, Intervention Scheme. Label each of the two interventions the student nurse carried out with one of the categories listed: Teaching, Guidance, and Counseling; Treatments and Procedures; Case Management; and Surveillance. Identify the targets of each intervention.
6. Look at Figure 19.3. Rank Mrs. B's Knowledge (K), Behavior (B), and Status (S) according to the scale given. Describe how this assessment of K, B, and S could be used to assess Mrs. B's outcomes over time.

WRITING EXERCISE 19.1

The text has given one example of the transformation of data to knowledge. (1) Identify at least two different examples of patient data that nurses collect. (2) Give an example of how these data are transformed into information and then knowledge. (3) Describe the persons with whom you would share the information or knowledge once you have created it.

are employed to crunch billions of numbers rapidly. Hospitals were once likely to use very large computers called mainframes, but many now find adequate computing power in newer **minicomputers,** which are smaller versions of mainframes; client-server networks are computers connected through one of them (a **server**). They form a local area network (LAN) that enables individual computers (**clients**) not only to store data locally but also to share data and programs. Larger systems are called wide area networks (WANs). Most hospital nursing stations and other large health care settings have computer terminals by which nurses access the LAN or WAN. Almost everyone is familiar with PCs (personal computers), small but powerful computers; these can be used alone or networked together in a LAN.

Data are stored in **bits** (Binary digITs) and 8-bit collections called **bytes** on a variety of devices. PC users are familiar with compact discs (CDs), DVDs, hard drives, and floppy disks. (The 3.5″ size disk no longer "flops.") Mainframe computers store data on magnetic tape or cartridges. Smaller networks may store data on a series of hard drives wired together.

WIRELESS AND MOBILE COMPUTING

Due to the need to manage information in settings remote from office or nursing station desktops, "laptop" versions of computers were developed to provide portable computing ability. The first portable computer (the Osborne) hit the U.S. market in 1981. It weighed 25 pounds and had a 5.5″ screen. New "notebook" computers weigh in at about 6 pounds. The **Internet** is a worldwide network of computers that can communicate with one another through specialized programming languages. An **Intranet** is a computer network restricted by password to a particular health care organization or other entity, such as a university. With the advent of wireless Internet and Intranet technology, using telephone or cable wires to connect computers to networks is now optional.

One disadvantage is that wireless devices communicate through electromagnetic spectra, increasing the potential of unauthorized users gaining access. The advantages of ease of use outweigh the risks, though, as long as effective security is built into the wireless network.

Similarly, there are handheld computers, PDAs, Wi-Fi (Wireless Fidelity) badges, and mobile telephones that allow access to electronic information, communication, and e-mail through devices that are small enough to fit into a pocket. The trend is toward merging all functions (communication; data creation, access, and storage; imaging) into a single device. Nurses can carry these devices to the point-of-care (the bedside or other setting).

HEALTH CARE TECHNOLOGY

The **electronic health record** (EHR), sometimes called a computer-based patient record (CPR), is a "secure, real-time, point-of-care, patient-centric information resource for clinicians" (Healthcare

Information and Management Systems Society [HIMSS], 2003, p. 2). "Real-time" refers to instant availability. The EHR is a lifetime record that will document every health care event "using standard terms in computerized systems" (Lunney et al., 2005). Because of the variability in languages used in computer systems, in 2003 the U.S. Department of Health and Human Services formed the EHR collaborative to recommend standards for the EHR. The American Nurses Association was one of eight organizations in the collaborative, which has released its report at *www.ehrcollaborative.org*. The EHR will enable sharing data through an electronic information exchange. In 2005, after the flooding from Hurricane Katrina washed away tons of hospital and medical records in New Orleans, the need for EHRs was writ large. There is no backup system for paper records, but electronic data can be stored compactly in redundant locations.

In 2004 the White House called for an EHR for every American in 10 years. In 2005 a bill was introduced in the U.S. Senate to "help develop a nationwide interoperable health information technology infrastructure that reduces health care costs, improves quality, facilitates health care research and the reporting of public health information, and ensures that patient health information is secure and protected" (U.S. Fed News, 2005). Chief among these laws will be establishing electronic standards. A likely normative standard-setter will be Health Level Seven (HL7), a not-for-profit, American National Standards Institute-accredited Standards Developing Organization. Its mission is

> To provide standards for the exchange, management and integration of data that support clinical patient care and the management, delivery and evaluation of healthcare services. Specifically, to create flexible, cost effective approaches, standards, guidelines, methodologies, and related services for interoperability between healthcare information systems.

The EHR has many advantages, according to the Institute of Medicine (2003):

- Has privacy features incorporated, such as audit trails
- Provides diagnostic decision support
- Improves quality of care
- Enhances patient safety
- Increases productivity
- Contributes to the development of evidence-based health care
- Allows transfer of information among different settings (e.g., hospitals, nursing homes)
- Enables rapid recognition and response to disease outbreaks and bioterrorism

Health care "smart" cards are an emerging technology that will be an integral part of EHSs. These cards resemble plastic credit cards, except that instead of a magnetic strip, they have an embedded microprocessor (computer chip) that stores a person's digitized health records, including insurance information, health history, drug allergies, x-rays, laboratory results, and other data. Smart cards require a special reader to download or upload information, which has been encrypted (coded to make data meaningless if a "hacker" gains access to it). Health smart cards are in widespread use in Europe. In the U.S., a large obstacle to widespread use is the lack of standards for digital data, making data sharing nationally impossible.

The College of American Pathologists (CAP) developed one of the reference terminology systems (SNOMED CT) to be used in EHRs. CAP promotes its system of universal health care terminology with more than 344,000 concepts as one that is "building a seamless infrastructure of worldwide care while integrating an overwhelming amount of clinical data" (SNOMED International, n.d.). SNOMED CT has licensed to the National Library of Medicine its mappings to several nursing terminology systems (e.g., NANDA, NIC, NOC, the Omaha System), ensuring the inclusion of nursing in the EHR.

> SNOMED CT® is one of a suite of designated standards for use in US Federal Government systems for the electronic exchange of clinical health information . . . The NLM, on behalf of the Department of Health and Human Services, entered into an agreement with CAP for

> a perpetual license for the core SNOMED CT® (in Spanish and English) and ongoing updates. The terms of this license make SNOMED CT® available to US users at no cost through the UMLS [Unified Medical Language System] Metathesaurus (National Library of Medicine, 2004).

EHRs are the "gold standard" toward which the world is moving for computerizing health records; however, there is in existence and in use a less comprehensive system: the **electronic medical record** (EMR), although the terms are sometimes used interchangeably. EMRs are computerized versions of paper records with "interoperability within an enterprise (hospital, clinic, practice)" (Waegemann, 2003, p. 44). They contain information regarding the current care episode and may contain free-form text and other noncoded entries, limiting their usefulness. In addition, there is no way (or motivation) to share this information with other health care enterprises due to the lack of uniform standards for EMRs. Nevertheless, Medicare announced in mid-2005 that it would give U.S. physicians free EMR software to computerize their practices with the intent to improve patient care. Each system is expected to cost between $20,000 and $25,000. One clinic in New York was able to expand its waiting room by switching to EMRs, saving 3500 square feet of room previously needed to store paper records (Rogers, 2005).

Hospitals and similar institutions use **health-care information systems** (HIS). The HIS may be supplied by a vendor or be developed internally ("homegrown"). The HIS is usually divided into a **clinical information system** (CIS) that focuses on patient care and an administrative information system to manage business functions, such as billing, scheduling, and human resources. Just as a hospital is divided into clinical departments, so too are CISs, with separate systems for nursing, radiology, pharmacy, and the laboratory. However, the product (quality patient care) is more than the sum of its parts, which must integrate functions to achieve this aim. The CIS unites all departments and provides additional features beyond data storage to facilitate patient care. "Clinical information systems with applications to support human decision-making and outcomes analysis are slowly being integrated into practice" (Androwich et al., 2003, p. 35).

Nursing information systems (NISs) are part of most CISs. Their purpose is to support nursing practice by providing the information nurses need to practice and the ability to document care. At the end of the last century, although vendors and early adopters predicted many benefits from using NISs (e.g., increased time to spend with patients, better documentation, and increased nursing productivity), a recent Cochrane Review of published research did not find evidence that these systems affected practice (Currell & Urquhart, 2003). In 2003 Androwich and associates, writing for the American Medical Informatics Association and the ANA, called for "a new generation of clinical information systems . . . to support nursing practice" (p. 49), after concluding that "what we have been doing is not working" (p. 47). The next generation of nurses will drive that change by softening the rigid perspective of nursing as a stand-alone component in patient care and adopting a patient-centered approach, working not only with other clinicians but also with CIS vendors to improve electronic information management.

PATIENT SAFETY

When the Institute of Medicine (IOM) released a report in 2000 that 98,000 Americans lost their lives every year due to medical error, the public and health care providers took notice. The IOM pointed out that contrary to the belief of consumers, practitioners, and hospital administrators, the cause of most medical errors was faulty systems, not faulty individuals. In other words, there is a chain of events occurring at the "blunt end" (e.g., inadequate policies, lack of safeguards, staff shortages) that leads up to the final error being made by the nurse, doctor, or other provider at the "sharp end" (the place where the error occurs). The report called for increased use of computers to reduce these adverse events through improved systems management.

The IOM followed this recommendation with another report (2001) calling for more computerization to improve health care quality in the twenty-first century.

> Although growth in clinical knowledge and technology has been profound, many health care settings lack basic computer systems to provide clinical information or support clinical decision making. The development and application of more sophisticated information systems is essential to enhance quality and improve efficiency (p. 15).

As a result of these reports, the U.S. Department of Health and Human Services Agency for Healthcare Research and Quality (AHRQ) became actively involved in the patient safety initiative to reduce medical errors and improve patient safety in federally funded health care programs, and by example and partnership, in the private sector (AHRQ, n.d.). One of its initiatives is the use of information technology to reduce error and prevent adverse medical events. How can technology help meet these goals?

One approach the IOM (2000) recommended was computerizing physicians' orders.

> Having physicians enter and transmit medication orders on-line (computerized physician order entry [CPOE]) is a powerful method for preventing medication errors due to misinterpretation of hand-written orders. It can ensure that the dose, form, and timing are correct and can also check for potential drug-drug or drug-allergy interactions and patient conditions such as renal function (p. 191).

Under the manual system prevalent in most institutions today, physicians write orders by hand or give them verbally, and then a nonphysician transcribes them by keying them into a CIS or other order entry system. This process produces high risk for adverse events from prescribing errors, transcription errors, adverse drug events, and treatment delays. Some studies have shown the CPOE can reduce medication errors, the largest source of medical error, by as much as 81% (Koppel et al., 2005). However, despite the promise of CPOE systems, physicians have been resistant to switching to direct data entry due to their frustrations with many aspects of existing systems and their perception that data entry is clerical work. Once improved systems are designed using human factors engineered to make the process more efficient than handwriting and the different types of errors that CPOE introduces are reduced, clinician acceptance should improve.

Clinical decision support systems (CDSSs) are another potentially powerful information-technology solution for reducing errors in the increasing complex health care environment.

> [CDSSs] are computer-based information systems used to integrate clinical and patient information to provide support for decision-making in patient care. They may be useful in aiding the diagnostic process, the generation of alerts and reminders, therapy critiquing/planning, information retrieval, and image recognition and interpretation (Tan, Dear, & Newell, 2005).

One system under development (N-CODES) is intended to assist novice nurses in making decisions in critical-care environments based on information processing theory (O'Neill, Dluhy, & Chin, 2005). This resource would be very helpful at 3 a.m. to a novice nurse trying to decide what to do after detecting a new symptom in an acutely ill patient.

Smart infusion pumps are another example of technology's potential to reduce adverse events, particularly at the interface between nurse and patient. The Institute for Safe Medication Practices (2002) describes their potential for patient safety.

> These infusion systems allow hospitals to enter various drug infusion protocols into a drug library with pre-defined dose limits. If a dose is programmed outside of established limits or clinical parameters, the pumps halt or provide an alarm, informing the clinician that the dose is outside the recommended range. Some pumps have the capability of integrating patient monitoring and other patient parameters such as age or clinical condition.

WRITING EXERCISE 19.2

Describe a decision-support system intended for student nurses. On what area would it focus? What kinds of questions would it help you answer? With what piece of hardware would you want to access this system? How long do you think it would take to develop the system? Should nursing programs provide your system to students, or would students buy it like a textbook? Name your system and bring details of it to class.

However, as with any technology, nurses have a responsibility to ensure that these high-tech infusion systems are operating as intended. Hardware and software failures have occurred with these automated pumps, putting patients at risk in ways not associated with manual systems. For example, in 2005, the Food and Drug Administration (FDA) required Baxter to recall over 200,000 of its pumps due to flaws that resulted in deadly consequences. One design error was locating the on and off switches side by side, leading some nurses to turn off the pump by mistake instead of activating it.

Information technology assists nurses in performing one of their essential functions: monitoring. Although some of this technology, such as heart monitors, have been in use for about 50 years, the newest generations of these devices are "smarter," in that they can not only directly record their readings in the computer-based patient record but also convert data to information by using computerized arrhythmia analysis to alert nurses to potential deviations from normal. In fact, automated external defibrillators (AEDs) take information processing one step further by not only interpreting the rhythm but also administering an electrical shock to the heart if the machine were to diagnose asystole or ventricular fibrillation. These devices are considered reliable enough to sell for home and public access use.

Other uses of IT to promote patient safety include wireless monitoring devices attached to vulnerable patients to reduce hospital nursery abductions and wandering by Alzheimer's patients, to cite just two examples. A defined perimeter is equipped with sensors that sound an alarm if the monitoring device breaches it. These monitors have quickly become the standard for patient security in facilities and are finding new uses in homes. Newer generation devices contain global positioning devices to pinpoint the location of lost persons, which is the same technology LoJack uses to find stolen cars.

Automated pharmacy systems have also been shown to be effective in reducing medical error. These systems include ones that replace pharmacists' manual review of a patient's record with computerized reviews of clinical information, laboratory results, and other medications prescribed to assess whether new orders are compatible and therapeutic. This type of expert system requires a preprogrammed **database** (information stored in records and fields to allow retrieval by the customer) containing medical knowledge and algorithms (rules). For example, if the physician prescribes a drug that can impair kidney function while the patient has a laboratory result indicating kidney damage, the expert system would flag this conflict for resolution by a clinician. Similarly, if a physician orders a "sound-alike" drug, such as Accupril, the system will issue a warning, questioning the prescriber as to whether this is the actual drug intended or whether it is really Accutane, Accolate, or Aciphex.

Some institutions have installed automated dispensing machines in the pharmacy and on nursing units, reducing (but not eliminating) the errors

CASE SCENARIO 19.2

A 34-year-old woman with AIDS developed a fever and hypotension due to suspected pneumonia. Her past medical history included several AIDS-related complications, but a recent test showed that her viral load was undetectable on a drug regimen of stavudine, lamivudine, and Kaletra (a combination pill containing lopinavir and ritonavir). Given her critical condition, an infectious-disease consultant recommended changing her stavudine, which is associated with lactic acidosis, to abacavir. The intern caring for the patient used a preprinted antiretroviral order template (paper form) to execute the medication orders, requesting a new agent, Trizivir, a combination pill containing abacavir, lamivudine, and zidovudine.

The following morning, a pharmacist noted that the patient's revised orders called for continuation of stavudine, lamivudine, and Kaletra in addition to the new order for Trizivir. The patient was thus set to receive double doses of lamivudine and thymidine analogs, any of which could be terribly toxic in overdose. Apparently, the execution of orders via the template did not automatically cancel the other, free-form orders, a processing issue the intern failed to recognize. Fortunately, the pharmacist caught the error minutes before scheduled administration, and the patient suffered no adverse event because only Trizivir was administered (AHRQ, 2005).

Case Considerations

1. Identify at least two causes of this "near miss" (an error that doesn't result in an adverse medical event).
2. If you were a safety consultant to this hospital, what recommendations for information technology would you make to prevent future occurrences of similar situations?
3. When information technology is introduced, what are some new types of medication errors computerization could produce?
4. If the pharmacist had not discovered the error, what would have been the nurse's responsibility before administering these drugs? How likely is it that the nurse at the sharp end would have caught the error?
5. What would be the consequences to the nurse if she had administered the double dose and it resulted in an adverse drug event?

associated with manually pouring medications according to orders. At the sharp end of pharmacy activities, where up to 30% of errors are made, are bar code medication-dispensing systems. In the optimum version of these systems, the patient wears a bar-coded wristband, the nurse wears a bar-coded badge, and each drug is bar-coded. These systems support the five rights of medication administration: right patient, right time, right drug, right dose, and right route. At the time when a medication is due to be administered to the patient, the nurse goes to the patient's room with the medication cart, a wireless tablet computer, and a bar code scanner. The nurse scans the patient's wristband, after which the medication to be given appears on the screen of the computer. The nurse then scans the medication's bar code. If it is valid for that patient according to the five rights, further information about the medication, along with any alerts, appears on the screen. Otherwise, the system emits a warning. After administering the drug, the nurse scans his or her badge, triggering electronic charting. Several systems sold commercially today automate only part of the process, leaving room for much improvement in work-process convenience and safety.

RESEARCH APPLICATION ARTICLE

Nebeker, J. R., Hoffman, J. M., Weir, C. R., Bennett, C. L, & Hurdle, J. F. (2005). High rates of adverse drug events in a highly computerized hospital. *Archives of Internal Medicine, 165,* 1111–1116.

It should be clear by now that there are powerful consumer, professional, legal, governmental, regulatory, and business forces pressuring health care institutions and practitioners to turn to information technology (IT) to reduce medical error. In light of the hype and the hope associated with this movement, how effective is IT in reducing adverse drug events (ADEs), which are a significant problem in all health care settings? A team of three physicians, a nurse, and a pharmacist (Nebecker, Hoffman, Weir, Bennet, & Hurdle, 2005) asked this question in a study conducted in a Veterans Administration (VA) hospital that had computerized many of its medication processes. Among the IT advances at this facility were "CPOE, bar code-controlled medication delivery, a complete electronic medical record, automated drug-drug interaction checking, and computerized allergy tracking and alerting" (p. 1111). In addition, the facility had full-time patient-safety coordinators, unit dosing (medications packaged singly rather than in bulk), clinical pharmacists who made clinical rounds with the physicians, and resident physicians supervised by senior doctors. However, the CPOE in use did not have decision-support capabilities. The U.S. government has singled out the VA's "cutting edge" innovations in health care IT as exemplars for medical error reduction.

During a 20-month period in 2000, pharmacists reviewed charts of randomly selected patients admitted during the study time frame and identified ADEs. The researchers defined ADEs as injuries resulting from the use of a drug that started in the hospital. Of 937 charts reviewed, pharmacists found 483 certain or probable clinically significant ADEs. A majority of the ADEs were due to drug interactions. Nine percent of the ADEs were considered serious, the rest moderate. "Errors occurred at the following stages of care: 61% ordering, 0% transcription, 1% dispensing, 13% administration, and 25% monitoring" (p. 1113). The authors concluded that the CPOE had worked as intended to eliminate transcription errors but that an associated clinical decision support system was needed to reduce prescribing errors. They also noted that electronic medical records made ADEs more visible to researchers. It is sobering to consider these troublesome findings of persistent adverse events in light of the VA's position at the "bleeding edge" of health care IT. We are in the infancy of harnessing this technology for patient safety.

TELEHEALTH

In 1998 physician Jerri Nielsen, who was stationed at the South Pole in deepest winter, detected a lump in her breast. Unable to be flown out to treatment due to severe weather, the plucky doctor selected a welder (because of his manual dexterity) to help her perform a breast biopsy. She transmitted pictures over the Internet of the resulting slides to pathologists who confirmed the diagnosis of breast cancer. Planes dropped in chemotherapeutic medications, stopping the spread of cancer until she could be evacuated. That is an extreme example of **telehealth,** but a memorable one.

According to the Office for the Advancement of Telehealth (n.d.), telehealth "is the use of electronic information and telecommunications technologies to support long-distance clinical health care, patient and professional health-related education, public health and health administration." Telehealth removes time and distance barriers to the delivery of health care.

Certainly the placement of health information on the Internet has resulted in a communication revolution with not only professionals but also the public able to benefit from the easy access to evidence-based information. Unfortunately, this ease of access is both an advantage and a disadvantage, because there is a lot of unreliable, misleading, and false health information available as well. There are no peer reviewers for Internet content. Be sure to refer clients interested in researching health topics to reliable sources, such as government-run Web sites such as Healthfinder (http://www.healthfinder.gov/) or the National Institutes of Health (http://health.nih.gov/).

Telemedicine refers more narrowly to delivering medical consultation and treatment to clients at distant locations. For example, a dermatologist at a university-based medical center could provide services to a geographic area that has no physician trained in that specialty through the use of videoconferencing (real-time two-way transmission of voice and digitized images). However, there continues to be obstacles to delivering medical services this way; among them are the sophistication of the videoconferencing equipment needed at both ends, interstate licensure issues, and lack of reimbursement for this type of remote service. However, pioneers press on with successes such as performing surgery robotically with the surgeon in one country and the patient in another (telesurgery).

One of the most promising uses of telehealth is in home health care for disease management. To successfully manage a chronic disease such as congestive heart failure or diabetes requires a high degree of interaction between the client and the home health nurse or other clinician. Telehealth permits the transmission over the telephone of biometric information (e.g., blood pressure, blood glucose, blood oxygen, cardiac rhythm) collected by a specialized device placed in the home. In addition to the transmission of physiological information, there is also two-way communication of compliance information and education on a more frequent schedule than could be provided by in-person visits, which are more costly. Another application is nurse monitoring of the biometric data for a group of clients. Remote disease management prevents hospital admissions and emergency department visits, so as the U.S. population ages and the burden of chronic disease grows, this use of technology will expand.

RESEARCH WITH IT

It is obvious that health care institutions and providers are collecting massive banks of electronic data. How can nurse researchers convert these data to information and then to knowledge? One approach is to automate the statistical analysis of selected data in large databases to test a hypothesis. In their seminal study in 2002 Aiken and colleagues determined that hospital patient mortality and morbidity were directly related to patient-to-nurse ratios, with high ratios resulting in more deaths and more failures to rescue. To reach these conclusions, the researchers identified and analyzed selected information from the following large databases: the 1999 American Hospital Association (AHA) Annual Survey, the 1999 Pennsylvania Department of Health Hospital Survey, and discharge data for surgical patients from 210 acute-care hospitals. However, they judged hospital administrative databases containing information about registered nurse staffing unreliable, so they collected survey data for this measure instead.

An emerging technique in nursing research is data mining. Like the optimistic child who cheerfully shovels out the manure filling a horse stall because "there's got to be a pony in there somewhere," data miners view large databases as opportunities to use technology such as machine learning, artificial intelligence, pattern recognition, and visualization to discover associations and rules existing in the data. For example, a researcher interested in the work status outcomes of employees who file workers compensation claims could access a state's database of claims and instruct the computer to find patterns. The endeavor might identify previously overlooked factors that are associated with return-to-work success. Data mining unlocks the vast storehouses of already-collected data to allow nurse researchers access to the "gold" within them.

Also useful to nurse researchers are search engines for the databases that contain indexes to scientific journals, such as PubMed or CINHAL. Gone are the days when the researcher had to comb volumes by hand listing articles in print, write down their titles, and then search for hardcopies of them. With more journal articles available electronically (either duplicating the print version or published online only), the nurse researcher can now complete in a matter of hours a literature search that once took days or weeks.

PRIVACY AND SECURITY ISSUES

Just as when patient information is collected on paper, so too must health care organizations (HCOs) protect the privacy of electronically stored health care information. The Health Insurance Portability and Accountability Act (HIPAA) and other federal laws require HCOs to provide physical, technical, and administrative safeguards to ensure the integrity and security of the protected health information (PHI) they collect, store, and transmit.

Every HCO must name a chief privacy officer to keep health information confidential. HCOs also have chief information officers to provide broad oversight of the information system. Because the news is filled with stories of identify theft resulting from unauthorized access to electronic credit-card databases, consumers are concerned that having their PHI stored electronically is riskier than paper records. However, HCOs go to great lengths to prevent illegal intrusions and unauthorized access.

Electronic safeguards include

- Passwords: special codes that customers use to gain access to a network. These provide very limited security due to vulnerability to hacking and the carelessness and forgetfulness of customers.
- User authentication: the following biometric security technologies are already in use: iris recognition, digitized fingerprints, facial recognition, hand geometry, and voice recognition. These provide a high level of security.
- Audit trail: ability to track what electronic information has been accessed, by whom, when, and where. If designed correctly, audit trails can provide HIPAA-required information to consumers about who has accessed their health data. This is a feature not available with paper records.
- Firewalls: hardware or program barriers to prevent security threats from entering through the Internet.
- Encryption (coding) of data. Public-key encryption is a system that uses two keys to transmit information securely over the Internet: a *public key* known to everyone and a *private key* known to only the recipient, who is the only one who can decode the message.
- Virtual private networks (VPNs): enhance security for settings where there are users at remote locations (e.g., a state's public health department headquarters may have numerous regional offices).

With most HCO information stored electronically, a loss of data or service interruption would have a drastic, negative effect on the ability to deliver patient care. HCOs have extensive contingency plans in the event of a disaster to ensure that the system can be restored with data intact. Some of these methods include frequent backup (making copies) of data, storing backed-up data off site, and data mirroring (creation of duplicate data in real time).

Staff education is very important for data integrity and security as well. Before you, as a nursing student, will be allowed to access any HCO's computer system, you will be required to complete institution-specific training. The facility's information technology staff will perform periodic audits to ensure that you are limiting your access to information needed for your assignment only.

PROFESSIONAL NURSE'S ROLE

Nobel prize-winning physicist Max Planck (1858–1947) stated, "An important scientific innovation rarely makes its way by gradually winning over and converting its opponents: What does happen is that the opponents gradually die out." In nursing, those resisting the information revolution are gradually fading away. As the generation that spent their childhoods without computers retires, the Millennium Generation (the e-Generation?) will take their place. They will bring to their practice their expectations that almost all information can be digitized, stored, retrieved upon demand, and harnessed to meet their needs.

Nursing is in the midst of a sea change from a "high touch" profession to a "high tech/high touch" one. IT can assist nurses in spending more time with patients and less time completing tasks. For example, monitoring systems placed on a premature infant collect and record biometric data, giving the nurse time to rub the tiny infant's back, which pleases both of them. However, for this symbiotic system to work, nurses must meet IT at least halfway. Here are some steps to take:

1. *Increase your knowledge.* You may be entering the profession with little IT knowledge or a lot. In this rapidly changing field, yesterday's information may be obsolete tomorrow, so stay connected to groups that can expand and update your knowledge. Join the American Medical Informatics Association Nursing Informatics Working Group (www.amia.org/working/ni/main.html) or the American Nursing Informatics Association (ANIA) (www.ania.org). Once you graduate, take continuing education courses in informatics or attend an informatics conference. You may become so interested that you go on to get a graduate degree in this nursing specialty.
2. *Embrace technology in the workplace.* Speak up to volunteer to try new IT applications, or recommend IT innovations you've read about in other settings. Evaluate how IT can automate repetitive tasks in your work area. It was Kansas nurse Sue Kinnick who first had the idea to use bar coding for medication administration. She had an epiphany as she watched a rental car attendant use a bar-code scanner to check in her vehicle. She championed this idea through her employer, a Veterans' Administration hospital. Perhaps you can be the next Sue Kinnick. Tired of being called through the room intercom to come to the front desk for a telephone call? Ask for a wireless hands-free telephone to wear as you care for patients.
3. *Work with specialists.* If your HCO is considering changing or introducing new technology, it's important for nursing to be at the table during decision making. "If you're not at the table, you're on the menu," is an old political adage. If possible, a certified informatics nurse should represent nursing during the planning phase and assist during the implementation phase. The American Nurses Credentialing Center (ANCC) offers certification to nurses with a minimum of a baccalaureate degree and specified education and experience in informatics. ANCC (2005) describes the specialty:

> The Informatics Nurse is involved in activities that focus on the methods and technologies of information handling in nursing. Informatics nursing practice includes the development, support, and evaluation of applications, tools, processes, and structures that help nurses to manage data in direct care of patients/clients. The work of an informatics nurse can involve any and all aspects of information systems including theory formulation, design, development, marketing, selection, testing, implementation,

training, maintenance, evaluation, and enhancement. Informatics nurses are engaged in clinical practice, education, consultation, research, administration, and pure informatics.

4. *Work with vendors.* Few nurses have the programming skills to write their own software programs. However, they do have specialized knowledge of how nurses work and how IT can support their practices. If nurses want a better patient-care information system, they must share this knowledge with vendors.
5. *Be vigilant.* No IT "solution" replaces your clinical judgment. The nurse may delegate to machines certain tasks, such as monitoring biometric parameters, but the nurse remains responsible for the accuracy and timeliness of data collection, analysis of data to produce information, and the synthesis of knowledge. Just as humans are fallible, so are machines. Embrace technology, yes, but temper that embrace with critical thinking and common sense.

CHAPTER SUMMARY

Nurses are Information Central in health care. Nurses collect, store, retrieve, analyze, safeguard, and transmit health care client data, information, and knowledge. Information technology has the potential not only to assist nurses in performing their duties but also to improve patient care and reduce adverse events. Because of this potential, there are powerful forces outside of health care demanding the management and processing of information with computers and the adoption of standards to facilitate a lifetime Electronic Health Record for every American. Nursing informatics combines nursing, computer, and information sciences to enhance and support patient care. In the move to computerization of health care information, nursing recognizes several classification systems to standardize terms relating to nursing diagnoses, nursing interventions, and evaluation of outcomes. Most health care organizations (HCOs) use health care information systems to manage both clinical and administrative information. They must comply with federal laws to safeguard the confidentiality of this information. Advances in information technology include software and hardware systems to reduce adverse events (particularly during medication administration), miniaturization of wire-free hardware to allow exchange of information at point-of-care, biometric data capture systems, wide availability of health information on the Internet, and delivery of health care services without the barriers of time or distance (telehealth). The new generation of nurses will harness technology as a tool to improve patient care. However, evidence-based clinical judgment will remain at the heart of nursing practice.

> *We are drowning in information but starved for knowledge.*
>
> —John Naisbitt

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