CHAPTER 2

The Scope, Definition, and Conceptual Model of HIS

LEARNING OBJECTIVES

By the end of this chapter, the student will be able to:

- Describe the definition, purpose, and scope of health information systems (HIS) using the conceptual model.
- Define the components of HIS according to the conceptual model, including technology and infrastructure; systems and management; people and processes; data and informatics; analytics; and global HIS, policy, and research.
- Explain the progression and maturation of HIS.
- Describe the organizational and community settings in which HIS and informatics can be used.

▶ Introduction

Before delving into the depths of HIS, it is important to lock in some key concepts regarding the scope of HIS. Reviewing the overall structure of how systems and their uses fit together takes the mystery out of computer systems. The conceptual model adopted in this text provides a tool for understanding—not just the "systems" of HIS but also the art and science of making use of systems and information (informatics), the data created and captured in these systems, and the variety purposed for the data, such as research, policy, and public health. Each of these uses of data

depends on the foundational HIS that create and capture data through clinical and administrative work in healthcare organizations of all types, shapes, and sizes. This chapter describes and builds the layers that comprise the scope of HIS Model.

In this text, we will define the scope of HIS as including all computer systems (e.g., hardware, software, operating systems, and end-user devices connecting people to the systems), networks (the electronic connectivity between systems, people, and organizations), and the data those systems create and capture through the use of software. Each key layer of this progression through the totality of HIS

relies on the foundation of core systems and requires professionals who specialize in that layer's work. Next, we look at the various layers of HIS one at a time: systems; health informatics; data and analytics; and research, policy, and public health.

▶ Systems and Their Management

Well-architected, properly managed computer systems form the foundation of the ability to create, transmit, and use information. With the availability of the Internet, development of cool new devices, and advertisements everywhere from vendors touting the ease of "cloud computing," it is sometimes tempting to think that access to high-quality, useful systems and information is as easy as 1-2-3—all that is necessary is to "plug into" one of these devices or some other easily accessible computing modality. The hard truth is that the myth of "plug-and-play" simply delays the realization that meaningful health information and data—whether available via the Internet, over a secure internal network, or through the use of an iPad or new innovative device—are only as good as the HIS platform and technical foundation that serves as the data source. In other words, the access devices and networks do not actually create data; instead, **data** are created and captured in painstakingly and properly implemented HIS that provide features and functions to support the **workflows** (sequences of common tasks) and **processes** (end-to-end methods) of healthcare providers and organizations, patients, and public health professionals.

HIS that create and capture data (which can then be coalesced into meaningful information and used for multiple purposes) serve as the *foundation* upon which all other information- and data-related capabilities depend. It might seem old-fashioned, but the source systems and devices that support the

work of providers and healthcare organizations remain the essential building blocks of all other advanced uses of data and information, and computerized workflow support modalities such as health informatics, data analytics and outcomes analysis, research and public health data surveillance, and predictive modeling techniques (Restuccia, Cohen, Horwitt, & Shwartz, 2012). We will talk more about these source systems and their management in Chapters 5–7.

The HIS Model in **FIGURE 2.1** depicts this relationship: HIS and their management form the footing for health informatics; data and analytics; and research, policy, and public health uses of HIS. These components of the total scope of HIS, in turn, rely on the fundamental HIS for the capabilities and data that HIS provide so that these components can exist. For example, without the foundational HIS, informatics would have no systems capabilities, features, nor functions to work with in redesigning workflows and calculating rules and alerts, or clinical decision support (CDS) and artificial intelligence (AI) aids to help in the advancement of the practice of medical, nursing, or other health-related professions.

Likewise, without well-managed HIS used to support key work processes such as the many clinical care (within and among clinical settings) and administrative functions (e.g., billing and payroll), data would not be created and captured for use. Data to be used for informatics, analysis, research, policy analysis, and public health surveillance need to come from somewhere—they need to be *real* data values, emanating from *real* healthcare processes and patients, which are then made available for these secondary purposes on any large scale (Kern et al., 2011).

Health Informatics

Informatics is the use of information systems and technology to redesign, improve, and
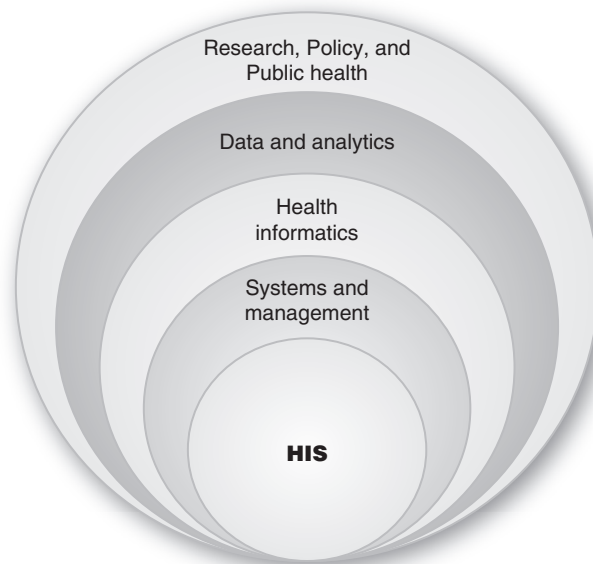
FIGURE 2.1 Scope of HIS Model for the Health Professions.

recreate the way work is done in disciplines such as medicine, nursing, medical imaging, and public health. In most cases, informatics focuses on certain quality- or process-improvement objectives, but this varies based on the setting in which the informatics activities take place. Informatics comprises the "use" of the computer capabilities that HIS provide to end users. In health care, this includes the activities of physicians, nurses, and other clinicians in the various settings in which they do their work, as well as professionals working in public health in its various environs, such as community settings, public health clinics, and other public health organizations. Through informatics, HIS are expected to enable improvements in the efficient delivery of health care, quality of services provided, and health outcomes across the U.S. population.

Data

Much of the value of systems goes beyond their support of clinical and administrative workflows and processes and is locked up in their data. Creating this resource can yield additional value, the rewards of which are reaped at an exponential scale through secondary uses of these data. While primary uses of data involve the transactions that support day-to-day activities of professionals and organizations, the only way to create *information* is through the **aggregation** and compilation of these data to create something greater than the single units of data. In other words, data aggregation creates meaningful information that is relevant to people of health care. Thus, the creation of information and ability to conduct analysis and gain knowledge are completely dependent upon the creation and capture of the individual data elements in the first place.

If someone attempts to create information out of proxied, extrapolated, or estimated data even for a very specific purpose, the only fruits of those data will be educated guesses. Or if data are not readily accessible from bona fide data systems such as those used in the real

world to document clinical care, researchers and analysts must perform primary data collection, which is time-consuming, arduous, and limited as a practical matter. It involves hand-abstracting of medical records (with proper permission, of course) or personal information. For example, if a researcher wishes to study the quality of care in a diagnostic category such as heart failure, it is vastly easier to do so with the availability of real-life HIS data sources than by attempting to gather that data piece by piece. With real data, emanating from real activities conducted in real organizations through real processes, high-quality analysis and research drawing meaningful inferences, associations, outcomes, and evidence can be accomplished. Data created and captured in systems represent a treasure trove to be carefully stewarded and valued every step of the way. Everything else in the conceptual model displaying the progression of information from HIS rely on these data.

The importance assigned to data is not unique to the healthcare field. "**Business intelligence" (BI)** is a popular term for the value realized by flexibly analyzing comprehensive stores of data representing the totality of an organization or the provider's scope of activity. In other words, data from various systems that support clinical and financial transactions can be combined to enable analysis and insights into the entirety of the activities within the scope of that entity. In health care, this concept leads to the notion of "**clinical intelligence" (CI)**.

Research, Policy, and Public Health

At the pinnacle, data created and captured in HIS become available for research. These data fuel the work of university researchers—with their inherent expertise, curiosity, and desire for insight—and enable analysts to measure the health of patient populations and provide evidence for improving efficiency and effectiveness of healthcare processes and outcomes. Policy makers rely on research that predicts the long-term implications of steps taken in the delivery of health care and implementation of healthcare laws and regulations; that is, they rely on researchers' findings, such as studies carried out in university settings, or analyses performed by governmental agencies and organizations dedicated to health care and public health (Davis, Doty, Shea, & Stremikis, 2008; Fryer, Doty, & Audet for the Commonwealth Fund, 2011; O'Malley, Grossman, Cohen, Kemper, & Pham, 2009). The simple data captured, one patient at a time, in **electronic health record (EHR)** systems at separate organizations are ultimately aggregated into databases that can be made available to researchers and analysts. These aggregated data for research and analysis—the proverbial acorn—ultimately guide the work of policy makers and public health professionals responsible for governmental, political, and legal decisions about healthcare directions, policies, programs, and investments—the mighty oak tree (**FIGURE 2.2**).
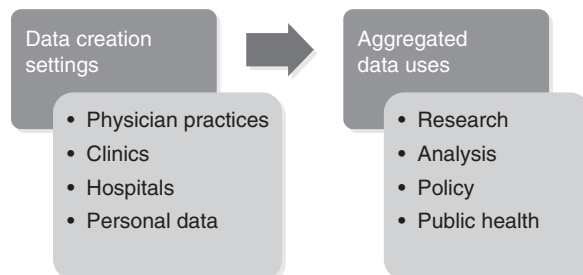

FIGURE 2.2 Data creation/data aggregation.

Data creation settings
- Physician practices
- Clinics
- Hospitals
- Personal data

Aggregated data uses
- Research
- Analysis
- Policy
- Public health

Public health officials are in a position to harvest the bounty of the entire HIS data chain, as the scope of their work expands from the purview of a person, an organization, or a group of patients, to the entire country, ultimately reflecting an international scope. As data are aggregated from systems that support clinical care or business activities across organizations and geographies, they can be analyzed according to several dimensions, such as demographic characteristics (e.g., female versus male, age groups, or race or ethnicity), pathogen (e.g., tuberculosis or anthrax), disease (e.g., cancer, heart disease, or acute illnesses), providers (e.g., hospitals, primary care physicians, or specialists), payment mechanisms (e.g., fee-for-service, health maintenance organization [HMO], preferred provider organization [PPO], Medicare, Medicaid, or uninsured), or other characteristics to better understand trends across an entire population. Such analysis of population-wide characteristics and activities is not confined to the boundaries of an organization (e.g., a hospital) or a segment of the population (e.g., patients insured by a certain carrier or analyses pre- and post-healthcare reform). Rather, inquiries and reports of interest to public health officials reflect the full expanse of their responsibility or perspective, such as a county, region, nation, or the world, as opposed to a subset consisting of those persons who are covered by insurance, are cared for at a particular institution, or live in certain geographies that may be over-represented by the available data. The options or variations available for a particular scope are completely determined by the data available for such analyses and the generalizability of those data to an appropriate population. In this text, we also consider the types and sources of data that can be used for these analyses.

Progression and Maturation of HIS Through the HIS Conceptual Model

We can outline the steps in the progression of the use of HIS and HIS data according to the HIS conceptual model.

1. Foundation (HIS). The progression begins with a strong foundation of technology and infrastructure and core HIS and their effective and proper management. None of the subsequent layers of HIS can exist without the foundational, infrastructure, and core systems.

2. Use (People, Process, Data, and Informatics). HIS software system capabilities support clinical and business transactions and the knowledge-workers who use them, enable key supporting processes, and facilitate redesign and improvement of these workflows and processes, a discipline referred to as health informatics. A key concept in HIS is that success is not just a function of technology and systems but is also an outcome of the balanced involvement of people-process-technology. People in this case are the clinical and administrative health professionals, who, through their involvement in the definition of requirements for HIS, think of new, better ways to work and care for patients (processes) using HIS that the systems then enable (technology). The support of healthcare activities—and use of HIS by the professions of medicine, nursing, and public health to develop more effective workflows in the care of patients—is the unique discipline of informatics. All these systems create and capture data that can then be analyzed to improve outcomes and assess the effectiveness of processes. The term "informaticist" has emerged as our world has become automated. This role is found at the intersection of computers and the work of professionals using those systems, such as physicians, nurses, and public health experts, and the work of IT professionals designing, building, and implementing those systems, such as computer systems engineers, systems analysts, programmers, trainers, and testers.

3. Learning/Knowledge (Analytics: BI/CI/AI). The use of data for learning and gaining new knowledge begins when transactional data are created and captured in HIS through the use
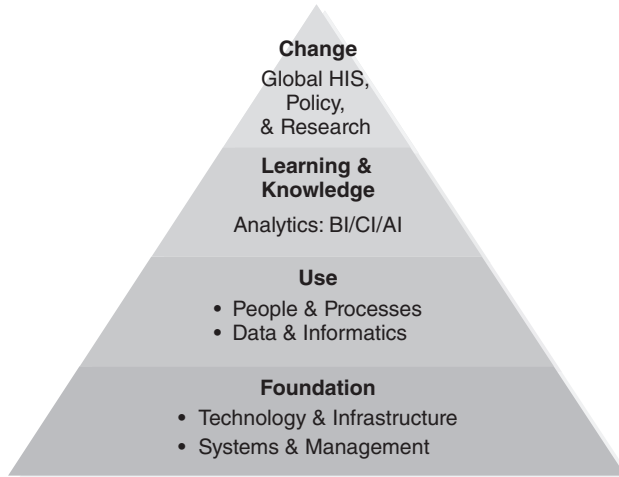
FIGURE 2.3 HIS progression and maturation.

of HIS software and then coalesced into databases and **analytics** platforms. Subsequently, these data are used for analysis and creation of information, including CDS, BI, and CI, ultimately leading to enhanced knowledge about health care and public health (**FIGURE 2.3**). AI employs newer technological capabilities, such as machine learning and natural language processing, that change the interaction between people and technology, releasing them from the more menial key-stroke navigation of an already programmed workflow, to tapping more into their creativity and power of thought due to the precision and speed of these analyses. Newly gained knowledge through these analytical capabilities represents secondary uses of data, which can reveal ways to improve healthcare processes, health outcomes, population health, and overall efficiency and effectiveness in health care (Committee on Data Standards for Patient Safety, 2003).

4. Change (Global HIS, Policy, and Research). Eventually the progression and maturation of the use of HIS and the data they produce and our exploitation of these data will improve our ability to conduct research, create effective policy, and improve the public's health through change. The path to change for the better is illuminated by evidence produced through use of systems, analytics, and research using data created and captured in HIS.

▶ HIS Uses in Organizational and Community Settings

With so many different types of organizations and players using health data, the answer to the question "What does this organization or entity use HIS for?" will differ for each type of organization or entity. Likewise, the mission, vision, and goals of each organization will drive the types of systems that are "core" to its purpose. In each instance, one must answer the question "What is the fundamental reason for using HIS?" This requires thinking through the types of systems and access to data that different kinds of providers will need to deliver care to their patients and measure outcomes of that care, as well as the types of HIS needed by different types of payers, patients/consumers, public health agencies, or research organizations.

Inpatient, Outpatient, and Ambulatory Healthcare Provider Organizations

Provider organizations comprise the settings in which healthcare services are delivered, including hospitals such as free-standing community hospitals, academic medical centers, specialty hospitals, rural hospitals, and multihospital systems, integrated delivery networks, physician offices, physician groups and multispecialty practices, home health agencies, and outpatient clinics of all types, such as surgical centers, community clinics, imaging centers, and urgent care centers. Anywhere care is delivered, HIS and the data they house are playing an increasingly essential role. The Internet was a game-changer in the spread of HIS across all these settings, spearheaded by the work of a few pioneering organizations such as Kaiser Permanente, Intermountain Health care (IHC), the Veterans' Administration (VA), and many others.

The current norm in U.S. health care is for processes in all areas of financial, administrative, and clinical activity to be automated. The HIS and technology products and services supporting the highly diverse collection of healthcare providers are the basis of what has grown into a multibillion-dollar HIS industry.

The market for commercial HIS products for all areas of the HIS Planning Framework, along with consulting services to help an increasing number of hospitals, clinics, and physician practices implementing them, has fueled the steady growth of HIS in healthcare organizations for the past 50 years. Coverage of the healthcare landscape is progressively broadened from the original hospital-centric model to clinics, provider offices, hospice facilities, home health groups, and other clinical delivery settings. Of course, these HIS also connect to external partners such as retail pharmacies, reference laboratories, medical equipment stores, clinics for employees in businesses and for students in schools, and now the retail world of minute clinics in grocery stores and other commercial environments. From the early HIS origins in hospitals and large clinics, systems have spread to all types of healthcare delivery organizations as well extended out from those organizations to patients and consumers where they work and live.

Patients'/Consumers' Homes

Consistent with the spread of mobile computing and use of the Internet throughout our society and world, patients can increasingly access their patient records and providers wherever they chose to do so, as well as monitor their personalized health data. Additionally, vast sources of health-related information are accessible through the Internet for consumers interested in learning about various health or medical conditions, services, and products. The age of patient engagement is upon us. Increasingly, members of the C-suites of healthcare institutions have realized that they can achieve the best outcomes in organizational performance and clinical care by enlisting patients in the process. Likewise, many people now expect to be part of their own healthcare process, consistent with how they drive participation in other types of commerce and consumption of goods and services.

While this sounds quite logical, it is a far stretch from the not-too-distant era of the "passive patient," a time in which physicians were seen as almost god-like figures and providers were reluctant to share the contents of a patient's medical information with the patient or family. In fact, part of the author's education in medical records science in the 1970s consisted of learning how to carefully manage the situation in which patients asked to see the contents of their medical records. Legally, patients have always had a right to that information, but providers actively avoided showing them the information for fear they would not understand it or could not handle knowing what was going on inside their own bodies. The language and values of health care reflect this

traditional expectation of the obedient patient as being either "compliant" or "not compliant" with the instructions or prescriptions of the expert, superior clinician. Patients who do not "follow doctor's orders" are seen as deviant or irrational and are blamed for poor outcomes (Euromed Info, n.d.). In fact, the term "patient" is linguistically derived from the passive voice in the English language and implies the entity receiving something, in an inferior position, from someone or something (in this case, the clinician or physician who prescribes a regimen of treatment and therapy) from a superior, dominant position (Wanner, 2009).

Modern-day consumers are playing an increasing role in their health care by taking advantage of the connectivity and empowerment of access to information—a role inherent to the information age. Just as we use computers to research and obtain services and products in retail, food, and entertainment, we now *expect* to be able to access our personal health information from providers and interact electronically in the care process from our homes or places of work. A growing body of evidence is now emerging in the literature showing that clinical outcomes, patient satisfaction, and cost performance improve when patients are engaged and activated in the processes of their care. HIS is a powerful facilitator of such engagement (Courneya, Palattao, & Gallagher, 2013; Hibbard & Greene, 2013). Plus, as the tipping point is within our collective sight vis-à-vis the adoption of EHRs in most hospitals and physician practices, innovators are enthusiastically embracing new means of personal connectivity and engagement in the healthcare arena using IT tools widely applied in other industries (Lohr, 2009; Office of the National Coordinator for Health IT, 2013).

Payers, Insurance Companies, and Government Programs and Agencies

The mechanism by which hospitals, physicians, clinics, and all other healthcare providers are paid for the healthcare services provided to their patients involves insurance companies or payers of one type or another. Several types of payers are found in the U.S.: private insurance companies, government programs, and, of course, self-pay. Private payers or health insurance companies include companies such as United Health, Aetna, Blue Cross/Blue Shield, Cigna, and others. Government-funded health coverage programs include Medicare (health insurance for people aged 65 or older or with certain illnesses such as permanent kidney failure and those with certain disabilities), Medicaid/MediCal (state-specific health insurance for people and families with low incomes), State Children's Health Insurance Plan (SCHIP, state-administered programs using federal money for uninsured children younger than 19 years of age from low-income families), TriCare (health insurance for active and retired members of the military and their families), and Department of Veterans Affairs (government-sponsored programs for military veterans, covering the care they receive from doctors, hospitals, emergency rooms, and immunizations) (Brigham Young University, n.d.; Healthcare.gov., n.d.). Self-pay is becoming a larger piece of the healthcare pie now with an increased proportion of plans including high deductibles. Many people choose to forgo health insurance altogether due to the high cost and lack of accessibility because of denials and other barriers.

Public Health Organizations

Public health organizations exist to monitor, protect, and improve the public's health. Among other roles, they serve as a "safety net" by providing health care for patients who are uninsured or underinsured (e.g., through public health county hospitals and community clinics). In addition, public health services include preventive programs operated by municipal or county Departments of Public Health, such as free clinics, school-based immunizations, health-related and nutrition educational programs, birth control education, distribution of condoms, inspection and safety

🔍 CASE EXAMPLE: VISTA'S FUTURE: EXCHANGING INNOVATION FOR COMMERCIALIZATION?

In the 1980s and 1990s, some of the pioneering work that led to the development of EHRs was done in military healthcare settings. The Veterans Health Information Systems and Technology Architecture, commonly referred to as the VistA system, provided an early and shining example of the benefit and power of a comprehensive, integrated EHR. The VistA system was enormously important to the development of EHRs because it supports not only care delivered in inpatient hospital settings, but care for ambulatory patients as well.

A group of adventurous, committed programmers used the tools at hand including the availability of the MUMPS (Massachusetts General Hospital Utility Multi-Programming System) programming language, like many clinical HIS still in use today, some inexpensive equipment, and bootstrapped the development of a computer system pretty much below the radar of the senior management and mainstream "mainframers" of the day, eventually emerging with what became the VistA system. Not only was great progress made in the evolution of HIS through these efforts, but also over the years the thousands of VA hospitals and clinics have served as training grounds in which numerous medical students and clinicians learned to care for patients using computers to support the care and administrative processes. In fact, this system is so widespread that nearly 70 percent of all physicians practicing medicine in the U.S. today have used it as part of their medical training.

Given the Harvard Kennedy School Innovations in American Government Award in 2005, the VistA system has served the healthcare needs of veterans and those caring for them for the past 35 years. Its early story is worth telling as it is an example of what is now referred to as the agile development methodology. The VistA system:

- supports in-patient and ambulatory care,
- has analytical and research support capabilities,
- is integrated,
- is distributed but standardized, with data from all VA hospitals and clinics available for analytics and benchmarking purposes, and
- is interoperable.

And they say it can't be done.

Contrary to commercial EHR vendors, VistA does not withhold functionality in order to maximize profit. Rather, it was built with taxpayer dollars and therefore is in the public domain. So, the software is available for the cost of the media for delivering it. It is open source, meaning the code underpinning the system is freely available and may be redistributed. VistA is interoperable, built using standard programs, and built collaboratively with physicians who guided the functionality on behalf of clinical care. Contrast this with commercial HIS products currently available:

VistA Characteristics	Commercial HIS Characteristics
End-users collaborated in requirements	Built by company team for commercial use
Clinically oriented	Billing oriented
Standardized programming using MUMPS	Applications interfaced

🔍 *CASE EXAMPLE: VISTA'S FUTURE: EXCHANGING INNOVATION FOR COMMERCIALIZATION?* *(continued)*

VistA Characteristics	Commercial HIS Characteristics
Decentralized	Centralized
Grassroots innovation, mission oriented	Commercial goals
Longitudinal data	Episodic data
Built for veterans, altruistic	Built to sell commercially, profit motivation
Open source programmers	Billionaires

The VistA story is a massive, unequaled success. At last count, 167 hospitals nationwide, on the same system, integrated and interoperable, with analytics on a massive longitudinal data set to evaluate clinical effectiveness and develop clinical guidelines. And, of course, a few well-publicized problems along the way. Let's look at the themes identified throughout this book that encourage successful HIS projects and outcomes. The VistA system involved the key end-users, the physicians, in the definition and development process. The project failed politically, ultimately, but succeeded in its intent. *Currently, the* U.S. *is on the brink of retiring VistA and deploying a commercial system.* Why is the VistA system seemingly at the end of its life cycle now? Politics and leadership problems. Ironically, this was a missed opportunity for all citizens, since VistA was not allowed to participate in the healthcare.gov initiative.

So, now, what do we do? These mavericks, who probably didn't view themselves that way when they started, but eventually adopted that identity, developed a system that has done more than any other HIS in the U.S. It has served its constituents very well, not perfectly, but very well. Software decisions are difficult and often, as in this case, highly politicized. We must ask the tough questions and ensure that we don't exchange innovation for commercial gain.

ratings of restaurants, violence prevention programs, environmental health alerts, and a host of other services aimed at maintaining and preserving the health of a population of people within a certain region, state, or locale. Put simply, the role of these public health organizations and initiatives is to attend to the "public's health." In other words, public health organizations always think in terms of the populations whom they serve; they are *not* invested in the for-profit or medical care business of health care. Such organizations are typically funded by government programs at the federal, state, county, or local level, and they exist to keep the entire community of people in their jurisdiction or community protected from environmental risks and able to maintain their health to the degree feasible. A public health organization measures its target population's health by collecting and examining statistics such as infant mortality; mortality and morbidity rates; biological surveillance; immunization rates; rates of communicable diseases such as tuberculosis, HIV/AIDS, and meningitis;

deaths and injuries due to violence; air quality; and a variety of other metrics that tell public health officials about the status of and threats to a population's health (World Health Organization, n.d.).

Public health organizations whose primary goal is to measure, monitor, and report key public health statistics nationally are another type of entity whose mission it is to maintain, monitor, and improve the public's health. These organizations depend on a variety of data sources to create such public health information:

■ Data from hospitals, clinics, and physician practices gathered through the claims administration processes for Medicare, Medicaid, SCHIP, and other government-sponsored health insurance programs.

■ Data from laboratories across the nation set up specifically for bio-surveillance and homeland security.

■ Data voluntarily provided to federal or research organizations that are committed to the study and evaluation of healthcare quality and cost issues.

■ Data from their own healthcare provider settings for caring for their patients and monitoring health issues and risks to the communities they serve.

Examples of national organizations of this type include the following (Medical College of Wisconsin, MPH Program, n.d.) (**TABLE 2.1**):

TABLE 2.1 Organizations Participating in Various Layers of the HIS Model

Layers of HIS Model	Organizational Setting				
	Primary Care (Physician Practices, Clinics)	**Community Hospitals**	**Academic Medical Centers, Health Systems**	**Public Health Organizations**	**Policy, Research, and Quality/Cost Third Party Reporting Organizations**
HIS Tech and Infrastructure	X	X	X	X	
Systems and Management	X	X	X	X	
Data and Informatics	X	X	X	X	X
People and Processes	X	X	X	X	X
Analytics, BI/CI/AI			X	X	X
Global HIS, Policy, and Research			X	X	X

- Centers for Disease Control and Prevention (CDC): Provides online resources for dependable health information.
- Public Health Institute: Promotes health, well-being, and quality of life for people across the nation and around the world.
- Rural Assistance Center: Provides health services-related information for rural America.

Each of these institutions rely on their version of HIS, to study the effects of risks to populations, to monitor the occurrence and etiology of disease, to intervene in outbreaks affecting the public's health, to communicate with populations and other agencies, and to care for patients. Both primary and secondary uses of data are extensive in public health organizations and initiatives.

Health Information Exchanges and Regional Health Information Organizations

Since the early 2000s, provider organizations in some regions have been entering into collaborative arrangements of varying scopes and business models with the goal of sharing patient-related health information, securely, between providers organized into not-for-profit, collaborative "data sharing" organizations in that region. Examples of regional organizations that might participate in these consortia include hospitals and hospital systems, clinics, physician practices, emergency responders such as paramedics, tumor registries, imaging centers, community clinics, public health institutions, and others. The idea is that these providers seek to make patient data that they have in their own systems available to other providers if needed to support care for the same patient. The aim is to improve the timeliness of data availability, support clinicians in emergency situations when patients need care at an organization where they typically do not receive care, make existing data available in an emergency to help speed diagnosis and treatment, reduce the need to repeat tests that have been performed at another clinical setting for which the results are stored and readily available within that organization's EHR, save the patient the discomfort and inconvenience of repeated care and testing, facilitate cross-continuum care models such as **accountable care organizations (ACOs)** and **medical homes**, and reduce costs and waste when possible.

These pioneering cooperative, collaborative efforts have met with mixed success, but have sprouted (such as the Rhode Island statewide information network) and in some cases taken root (such as the Michiana Health Information Network) across the U.S. Many of these initiatives have struggled mightily and then failed due to lack of a sustainable business model, unworkable technical models, lack of cooperation on the part of member organizations, difficulties extracting data from member organizations' systems, or lack of cooperation between competitor providers and vendors. Despite these challenges to forerunners in **health information exchange (HIE)**, progress continues and is beginning to show signs of sustainability. However, questions exist as to the best way to share data, and **interoperability** has entered the scene as the method of choice for the government through the **Health Information Technology for Economic and Clinical Health (HITECH) Act** and **Meaningful Use (MU)**, although not without great controversy as to method and vendor compliance. As EHRs have become more commonplace, integrative technologies that enable extraction and sharing of data securely have also become more robust, but the question remains: will EHR vendors honestly enhance their products' capabilities and provide the technology and software capabilities necessary to share patient data securely as a standard part of their software? Each of these factors may facilitate sharing this information among regional providers.

In addition to today's rapid advancement of ubiquitous technological capabilities in the private sector, a federal mandate related to

HIE, included as part of the American Recovery and Reinvestment Act (ARRA) of 2009, is contained in the HITECH Act. This act has allocated funding of $27 billion in incentives for hospital and physician providers to adopt EHRs and achieve MU criteria (Figure 2.1), including, among many types of EHR capabilities, electronic HIE (Blumenthal & Tavenner, 2010). Thus, organizations designed to accomplish HIE—sometimes called **regional health information organizations (RHIOs)**—have gained momentum as a result of the HITECH Act; HIEs enable participating provider organizations to securely exchange patient care-related data and achieve MU criteria in their quest to reap the rewards of HITECH's financial incentives. By sharing patient data securely according to the requirements set out by HITECH and MU criteria (**FIGURE 2.4**), HIEs and other forms of HIE move us slowly but surely closer to a more integrated, less wasteful U.S. health system. Examples of successful HIEs include Rhode Island Health Network, Michiana Regional Health Information Network, Delaware Health Information Network, and others. Examples of failed RHIOs include Santa Barbara RHIO, early iterations of California Health Information Network, and others. Thus far, smaller regions have achieved the best early results. Owing to their more cohesive, less competitive provider environment and smaller scale, these less complex regions have improved the chances of connecting a more manageable scope of organizations, data, and patients for whom data are exchanged (Adler-Milstein, Bates, & Jha, 2009, 2011). Providers participating in these HIEs and taking advantage of their interoperability capabilities vary widely, and widespread use of such capabilities will likely take many years to realize (**EXHIBIT 2.1**).

Of course, all this work in MU initiated through the HITECH Act is now being built upon by Medicare Access and CHIP Reauthorization Act of 2015 (MACRA). MACRA combines quality and process improvement activities into one program, the new Merit Based Incentive Payments System (MIPS) and the Quality Payment Program (QPP), discussed in more detail in Chapter 9. To summarize the relationship of MACRA and the QPP including MIPS on MU, MIPS consolidates several programs, including Medicare EHR Incentive Program for Eligible Clinicians, Physician Quality Reporting System (PQRS), and the Value-Based Payment Modifier (VBM), into one program. So, MU requirements and incentives for eligible clinicians have given way now to MIPS requirements and incentives. MIPS emphasizes progress and reporting in

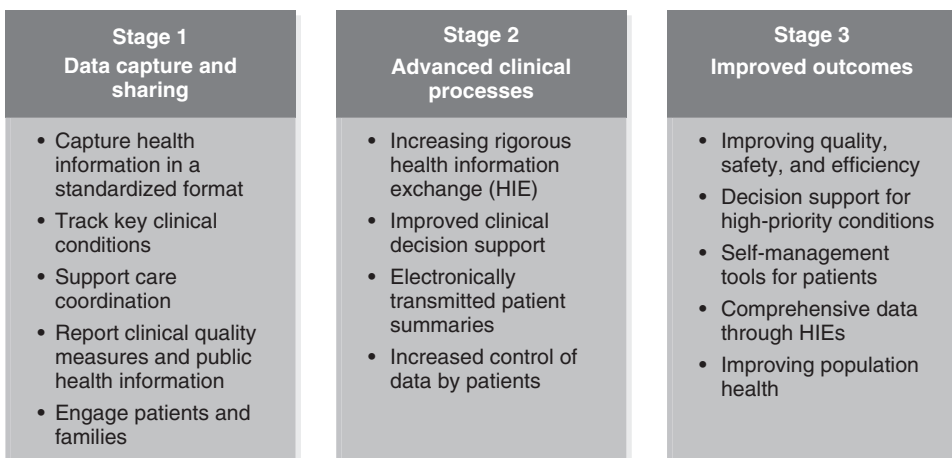| Stage 1 Data capture and sharing	Stage 2 Advanced clinical processes	Stage 3 Improved outcomes
• Capture health information in a standardized format • Track key clinical conditions • Support care coordination • Report clinical quality measures and public health information • Engage patients and families	• Increasing rigorous health information exchange (HIE) • Improved clinical decision support • Electronically transmitted patient summaries • Increased control of data by patients	• Improving quality, safety, and efficiency • Decision support for high-priority conditions • Self-management tools for patients • Comprehensive data through HIEs • Improving population health

FIGURE 2.4 Summary of Meaningful Use Criteria Stages 1, 2, and 3.

EXHIBIT 2.1   MU Stage 2 and Health Information Exchange Highlights

The MU Stage 1 and Stage 2 define a common data set for all summary of care records, including an impressive array of structured and coded data to be formatted uniformly and sent securely during transitions of care and, upon discharge, to be shared with the patient themselves. These include the following:

- Patient name and demographic information
- Vital signs
- Diagnosis
- Procedures
- Medications and allergies
- Laboratory test results
- Immunizations
- Functional status, including activities of daily living and cognitive and disability status
- Care plan field, including goals and instructions
- Care team, including primary care provider of record
- Reason for referral
- Discharge instructions

Data from The Office of the National Coordinator for Health Information Technology (ONC). EHR incentives & certification: How to attain meaningful use. Retrieved from http://www.healthit.gov/providers-professionals/how-attain-meaningful-use

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four areas: Quality, Promoting Interoperability (PI), Improvement Activities in the areas of care processes and patient engagement in and access to care, and Cost. Provider incentive payments are now being replaced through MIPS (Quality Payment Program, n.d.).

External Regulatory, Reporting, Research, and Public Health Organizations

Each type of healthcare provider is accountable to its community and board constituents as well as to regulatory oversight bodies, and each collaborates with myriad third-party organizations ("third party" means an organization or agency that is not part of the provider organization). Some third-party organizations set standards (metrics) for healthcare providers to use when measuring the quality and cost of the services they provide. The third-party organizations then collect the reported measures from participating health providers and create statistical benchmarks from the aggregate data for those providers to use when evaluating their performance against the performance of other like organizations and implementing quality-improvement and cost-control initiatives. Examples of such third-party or external organizations include The Leapfrog Group, whose mission is to promote improvements in the safety of health care by giving consumers data to make more informed hospital choices, and state organizations such as the California Health Care Foundation's report cards on hospitals and long-term care facilities, among others. These external organizations may also be state or federal regulatory agencies that are given the responsibility of monitoring the safety and compliance of provider organizations serving certain constituents (e.g., state or county populations, cardiology patients, children, or aged patients); their responsibilities are typically outlined by governmental regulations that are often funded by a governmental agency.

A third-party external reporting agency may also monitor key metrics regarding quality of care for a particular state or the country as a whole. For instance, the Department of Health Services (DHS) and Office of Statewide Health

Planning and Development (OSHPOD) of the California Health and Human Services Agency are state-based agencies charged with ensuring safety in hospitals and other healthcare settings. Provider organizations are required to report data to those state agencies on a regular basis about all services provided to their patients and communities, as well as any untoward events, such as wrong-site surgeries or hospital-acquired infections, that occur to patients. Chapter 11 discusses external reporting organizations in more detail.

Other examples of external organizations to which healthcare providers submit vast amounts of data and reports reflecting services provided, safety practices, costs, and outcomes of care include **The Joint Commission**, a quasi-regulatory organization that inspects and accredits hospitals based on their ability to meet a rigorous set of scored criteria, and the Cardiac Reporting Organization, which was established to monitor cardiac mortality rates nationally (Shahian et al., 2011; The Joint Commission, n.d.). Regulatory requirements are mandatory and failure to provide required data and reports—or submission of data reflecting poor performance that could harm patients—may result in the hospital or provider being reprimanded and monitored, fined, subjected to a temporarily suspended or revoked license, or closed. Other third-party reporting relationships may have to do with a provider organization voluntarily providing data and reports to an external reporting group so that it can be compared to similar organizations regionally or nationally in an effort to continually improve participants' cost performance, clinical quality of care, and transparency to their communities. Examples of these types of relationships include the Institute for Health Care Improvement (IHI), The Advisory Board, The Leapfrog Group, and the Cal Hospital Compare (formerly known as California Hospital Assessment and Reporting Taskforce [CHART]) (Agency for Healthcare Research and Quality, n.d.; California Hospital Assessment and Reporting Taskforce,

n.d.; Leapfrog Group, n.d.). CHART for example, is a voluntary program in which 86 percent of California hospitals are participating; it provides scores for clinical quality, patient experience, and patient safety for California hospitals, is searchable by zip code, rates hospitals on a five-level scale of superior to poor, and provides a web capability to report issues (Cal Hospital Compare, n.d.) (**EXHIBIT 2.2**).

To support this kind of reporting, the third-party organization's reporting databases must be populated with and reporting capabilities able to create a compilation of clinical and cost-related data from hospitals, clinics, and physician practices, that is, data originating in these providers' own smaller-scale HIS that support their clinical and business processes and activities. Data submitted to the third-party organizations come directly from the multiple HIS supporting patient care and reporting capabilities at the provider organizations; none of these external organizations is the original source of the data. Rather, these external entities review, report, aggregate, and consolidate data from many provider organizations; then benchmarks or report cards on the provider organizations' performance can be compared to the benchmarks or report cards for all other organizations that submit data and reports to that same third-party reporting organization. Whether such reporting is voluntary or mandatory, it is the job of all provider organizations to responsibly, promptly, and transparently report the numbers, types, mishaps, costs, and quality associated with the services they provide to interested parties, such as quality monitoring groups, payers, government, communities, and patient populations. Such reporting relationships represent **secondary uses of data**, data originally created and captured in the clinical and administrative transaction systems of health provider organizations. In contrast, the original patient care and administrative transactions represent the **primary uses of data** created and housed in these providers' HIS. **FIGURE 2.5** is an overview of

EXHIBIT 2.2   Sentinel Events Most Frequently Reported to The Joint Commission

Top 10 most frequently reported sentinel events for 2017	
Unintended retention of a foreign body	116
Fall	114
Wrong-patient, wrong-site, wrong-procedure	95
Suicide	89
Delay in treatment	66
Other unanticipated event*	60
Criminal event	37
Medication error	32
Operative/post-operative complication	19
Self-inflicted injury	18

*Includes asphyxiation, burn, choked on food, drowned, or being found unresponsive.

https://www.jointcommission.org/assets/1/18/Physician_Leader_Monthly_March_2018.pdf

Reproduced from DYK (Did You Know?). Sentinel events most frequently reported to The Joint Commission. Available at http://webmm.ahrq .gov/dykarchivecase.aspx?dykID=40. Reprinted with permission of AHRQ WebM&M.

the primary and secondary uses of HIS data and systems by providers of care and others in the healthcare ecosystem (Committee on Data Standards for Patient Safety, 2003).

Public Health Reporting Systems. Local, county, state, and national public health organizations and reporting agencies exist to monitor and protect the public's health for the citizens living within their purview. Just as healthcare provider organizations must automate their clinical and administrative processes using HIS, so public health organizations must design, implement, and use computer systems to collect and analyze data reflecting the health of a population. This paves the way for implementing effective programs to support that population's health status and create initiatives for the management of chronic disease (O'Carroll, Yasnoff, Ward, Ripp, & Martin, 2003). Examples of such HIS reporting systems for public health purposes include systems for detection and monitoring of public health problems; analysis of public health-related data; and public health knowledge management, alerting, and response. The Public Health Information Network (PHIN) initiative of the federal government
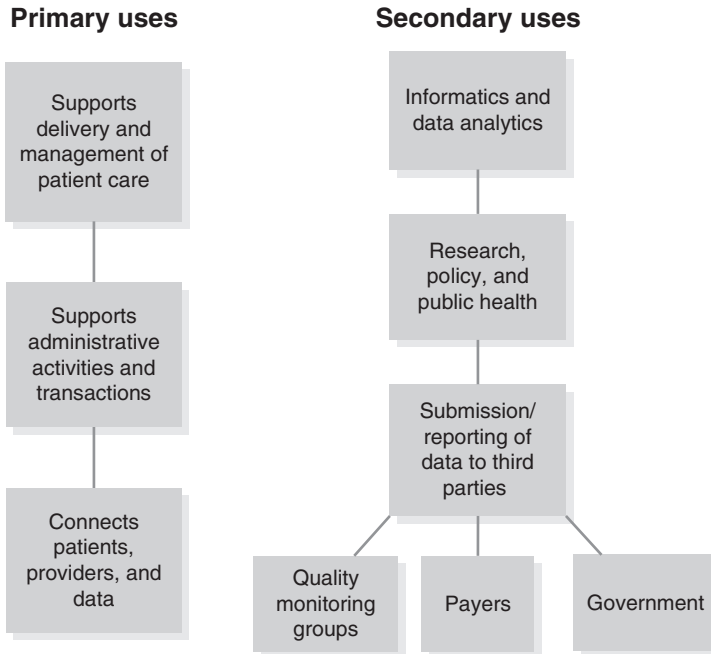
Primary uses

Secondary uses

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┌──────────────┐          ┌──────────────┐
│  Supports    │          │ Informatics  │
│  delivery    │          │   and        │
│  and         │          │ data         │
│  management  │          │ analytics    │
│  of patient  │          └──────────────┘
│  care        │                 │
└──────────────┘          ┌──────────────┐
       │                  │  Research,   │
┌──────────────┐          │  policy, and │
│  Supports    │          │ public health│
│ administrative│         └──────────────┘
│ activities   │                 │
│ and          │          ┌──────────────┐
│ transactions │          │ Submission/  │
└──────────────┘          │ reporting of │
       │                  │ data to third│
┌──────────────┐          │ parties      │
│  Connects    │          └──────────────┘
│  patients,   │
│  providers,  │
│  and data    │
└──────────────┘
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FIGURE 2.5 Primary and secondary uses of HIS data.

Data from the Institute of Medicine Report *"Key Capabilities of an Electronic Health Record System: Letter Report."* Washington, DC: The National Academies Press, 2003.

works in conjunction with the National Health Information Infrastructure to establish standards (Consolidated Health Information) for automation of clinical health data for public health reporting purposes. Timely access to such clinical data and connectivity between laboratories to facilitate sharing results data will improve the opportunities for responding to public health issues such as outbreaks of disease, disaster, or terrorism (Public Health Informatics Institute, n.d.).

Summary

The scope of HIS includes a universe of data-related systems, processes, and new knowledge created from using those systems and the data derived from them. The ability to maximize the depth and breadth of HIS utility for the goals of improving outcomes and developing knowledge depends on the development and maturation of systems and their use as reflected in the HIS conceptual model. The layers of this model provide a comprehensive view of the total scope of HIS activity:

- *HIS and Management:* Building the foundational HIS that support healthcare activities and the competent management of those systems so they support and feed the other layers of the Model.
- *Health Informatics*: Enhancing the use of those systems to improve how work is done and deriving meaning from data.
- *Business Intelligence/Clinical Intelligence*: Using data and creating information from which to learn and build knowledge, which leads to further creation of relevant information and new uses of data for analytics, including CDS, BI, and CI.
- *Research, Policy, and Public Health*: Eventually improving the health of populations through evidence-based change driven by well-informed research, policy, and public health.

HIS supporting clinical, administrative, and research/reporting activities are used extensively in a wide variety of organizational and community settings, including inpatient and outpatient healthcare provider organizations; patients' and consumers' homes and places of work or livelihood; payers, insurance companies, and government programs and agencies; public health organizations; HIEs and RHIOs; and regulatory, reporting, and research organizations.

Key Terms

Accountable care organizations (ACOs)

Aggregation

Analytics

Business intelligence (BI)

Clinical intelligence (CI)

Data

Electronic health record (EHR)

Health Information Technology for Economic and Clinical Health (HITECH) Act

Health information exchange (HIE)

Informatics

Interoperability

Meaningful Use (MU)

Medical homes

Primary uses of data

Processes

Public health

Regional health information organization (RHIO)

Secondary uses of data

The Joint Commission

Workflows

Discussion Questions

1. What are the key steps in the progression of HIS according to the HIS conceptual model? What is the relationship between the various layers?

2. Why is it necessary to be attentive in entering data elements that may not have a clear relationship to the work being done? How does the information use or data collection of a laboratory technician in a hospital differ from that of a public health administrator at a county agency or a specialist physician at an outpatient facility?

3. As more healthcare provider organizations adopt EHRs, what do you think will be the effect on healthcare-related research? On public health issues?

4. Why are healthcare organizations just in the beginning stages of engaging patients in their care? Do you think HIS has anything to do with this change? Do you think this will have a beneficial effect for the organizations? For the patients? Explain.

5. Insurance companies use a lot of data from provider organizations' HIS to process claims and calculate reimbursement. How important is this practice to the overall healthcare process? Given that this process involves money for the provider organizations, which is more important: HIS for patient care or HIS for gaining reimbursement for that care?

6. Military personnel and veterans often get their care from military or VA healthcare providers, but some of their care is received in non-military settings. How might clinical data from one setting be sent to another for purposes of caring for these military patients?

7. What are *primary* uses of HIS? What are *secondary* uses of HIS? Which of these can best help the U.S. healthcare system improve?

8. Public health reporting and surveillance systems have gotten much more

attention since the terrorist attacks on the U.S. on September 11, 2001. Do you think this is justified? Who do you think should be responsible for surveillance—healthcare providers like hospitals and physician offices or the government?

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