CHAPTER 1

Emerging Perspectives in Health Information Systems/Technologies (Health IS/IT)

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LEARNING OBJECTIVES

- Overview the field of health information systems/technologies (health IS/IT) to showcase emergent thinking and perspectives
- Highlight major health IS/IT components
- Outline key health IS/IT themes vis-à-vis the organization of this text
- Conceptualize health IS/IT cultures

CHAPTER OUTLINE

Scenario: Charting the Future of Philips HealthSuite Digital Platform: Toward a New Vision of Connected Health

I. Introduction
II. Scoping the HMIS Field: A Digital Health Ecosystem Perspective
   - Routine Business vs. Health (Clinical) Data, Information, and Knowledge
   - The Need for and Challenge of a Digital Health Ecosystem
III. Major Health IS/IT Components
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Scenario: Charting the Future of Philips HealthSuite Digital Platform Toward a New Vision of Connected Health

Amsterdam-based Royal Philips has recently announced joining hands with Seoul-based Samsung Electronics Co. Ltd. to usher in a new era of connected health on a global scale. Notably, this collaboration involves linking both the Philips HealthSuite digital platform and the Samsung ARTIK Smart IoT platform seamlessly to advance the evolving healthy living ecosystem of connected Philips’ health-assistive devices effectively and to allow previously stored health information contained in Philips HealthSuite to be securely accessed and shared via the Samsung’s cloud platform.

Directing a new vision for connected health, these shared platforms will enrich each other in terms of value-added capabilities to deliver e-care services anywhere, anytime for subscribing patients in the following innovative ways:

- Critical and relevant health information can be continuously gathered, compiled, stored securely, and analyzed from a mix of different device types, apps, and sensors ranging from medical system such as image scanning and lab test reporting systems, personal health records (PHRs), and electronic medical records (EMRs), to wearables and device-linked mobile apps such as portable heart rhythm sensors, health-fitness trackers, smart watches, blood glucose monitors, and other Philips–Samsung connected health consumer products and gadgets;

- Not only will subscribing patients have easy and secure access to their own health and clinical information anytime, anywhere, but they will also be empowered to better monitor their status of health and well-being with the use of Philips–Samsung platforms jointly with their caregivers to achieve a seamless continuum of care;

- Care providers will now have real-time, holistic, and digital information when attending to their subscribing patients so as to support timely and effective clinical decision making. Moreover, care teams can be guided toward the most appropriate care vis-à-vis their patients’ specific situation(s) through meaningful health analytics while abnormal test observations of individual patients can be flagged automatically and care providers alerted before the impending conditions become acute; and

- Third-party developers will also be empowered to swiftly generate interoperable connected health as well as Internet of Things (IoT) solutions by leveraging the use of integrated datasets stored within both these Philips–Samsung platforms, thereby allowing leaders of health systems to gain evidence-based insights in pursuing organizational and financial decisions to benefit their patient populations and society.

Altogether, as noted by James Stansberry, the Senior VP and GM of ARTIK IoT, Samsung Electronics:

This is an incredibly exciting time in health care, as the industry begins to harness the power of data to bring better care to consumers. Samsung ARTIK-enabled devices and cloud services integrated with Philips HealthSuite can address the growing need for connected health platforms that can safely access, share, and analyze information, helping health systems and providers achieve their goal of delivering better care to consumers, from prevention and detection to diagnosis and treatment (Ibid).
Visualize how this new Philips–Samsung collaboration will impact the future of virtual delivery of global healthcare services in light of rapidly increasing mobility of patients on the one hand, and for older adults and the elderly who may be less mobile on the other. Additionally, reflect upon why and how third-party developers, designers, and informaticians may now be empowered to generate better and more useful apps that will bridge the gap between professionally and personally relevant health datasets across the health continuum. Finally, what other innovative health services may also be potentially supported on the Philips–Samsung platforms and how will such collaborative efforts usher in a new era of connected health?

I. Introduction

The historical evolution and cumulative knowledge development of health IS/IT over the last several decades have been meaningfully converging and have continued to transform traditional healthcare services delivery systems and health organizational informatics environments both in North America and globally. Specific to the healthcare industry, administrators, clinicians, researchers, and other health practitioners, including health informaticians, are being increasingly pressured to adapt health IS/IT and applications of health informatics (HI) to growing public and private sector expectation. Major sources of concerns include the escalating costs of traditional care delivery systems; decreased funding from governments and third parties; better informed patients regarding treatment alternatives, including more patient-centric and ethical approaches to applying clinical informatics (CI) and information processing methods; as well as increased participation and expectation from new and emerging forms of health organizational governance and community-based digital health reporting structures.

Today, new perspectives in health management information systems (HMIS) have evolved because of rapid and exciting breakthroughs in health IS/IT and communication networks, including new media. Specifically, such thinking calls for more productive and effective health data sharing, big data analytics to guide and improve the coordination of healthcare services delivery, and the application of precision medicine to redefine health care and shared clinical decision making via more integrated and interoperable health IS/IT systems. Accordingly, a critical effort to bridge the concepts of corporate digitization of CI and systems, on the one hand, and the negotiated management of healthcare services delivery, on the other, has called for a major revision of this adaptive health IS/IT text. Indeed, those who understand health IS/IT and informatics concepts, trends and challenges, and the potential benefits of related applications will be better prepared to work collaboratively using agent-based groupware, artificial intelligence, and net appliances during the current era of knowledge explosion and shared data digitization to achieve greater group productivity, improve health organizational agility, and cultivate a more positive inter-organizational partnership in the context of the growing number of electronic health (e-health) services delivery networks that are beginning to inter-connect.

In this chapter, the primary objective is to overview the major underlying themes of health IS/IT within the context of the need for and challenge of building a sustainable digital health ecosystem. Section II focuses on scoping the health IS/IT field by emphasizing the basic health vs. business data concepts and showing how e-technology and HI application concepts are contributing to the push toward health organizational digitization and transformation. Section III then surveys major components of health IS/IT and highlights the key themes in the health IS/IT field to show how the various chapters in the latest edition of this
text are linked and organized. Section IV highlights cornerstones of health vs. business IS/IT cultures for driving current healthcare organizational digitization and transformation, while Section V concludes the chapter with a focus on how the different themes may be combined to achieve effective health IS/IT best practices in the coming era.

II. Scoping the HMIS Field: A Digital Health Ecosystem Perspective

Healthcare (and clinical) informatics, or more generally for readers of this text, HMIS, may be viewed as an eclectic field. In this context, a typical health IS/IT system may be conceived as an integrated health information processing engine that links interrelated human–computer components for the accurate and rapid collection of various patient-related data, information, and knowledge elements to generate aggregated, well-classified, and needed administrative and clinical information, knowledge, and insights so as to aid users in shared decision making, including detection, control, analysis, diagnosis, treatment planning and evaluation, and many other subsequent health-related physical and cognitive activities. Other terms referring to a related or similar conceptualization of health IS/IT systems that are commonly encountered in the extant HMIS literature include health or healthcare information systems (HIS or HCIS), CI, medical information systems (MIS), medical informatics (MI), HI and telematics, e-health, and more recently, digital health (D-health).

Aside from the Affordable Care Act’s mandate to measure meaningful use of various health IS/IT enterprise systems (primarily, the use of EHRs throughout the daily operations across many U.S. hospitals and health services centers), the core health IS/IT field integrates multifaceted concepts to be intelligently deployed in various connected domains. These core domains include strategic health IS/IT planning and management, the design and development of health IS/IT corporate infrastructure, application portfolios, and end-user interfaces, as well as practical implementation and ongoing evaluation of the impact of health IS/IT resources management on clinical decisions, including policy oversights on standards adoption, data and systems security and sharing, health data stewardship, privacy, and confidentiality.

Pertinent health IS/IT resources management encompasses routine health database administrative chores, CI apps and telematics, specialized health operational analysis and computer modeling, health data analytics as well as mostly automated user-assisted health information management, laboratory testing and radiological imaging systems, and decision aid systems. As with previous editions, we intend here to extend the term adaptive HMIS (and health IS/IT) to emphasize the need for an agile approach to health information administration and management. Health IS/IT students must learn how to apply data science thinking, HI and CI methods, and health IS/IT planning strategies from an adaptive but integrated perspective.

Routine Business vs. Health (Clinical) Data, Information, and Knowledge

On the basis of this generalization of the health IS/IT field, health (clinical) data, information, and knowledge (insights) are therefore uniquely differentiated from business data, information, and knowledge (insights) in specific terms, that is, the emphasis toward the need for complex professional “expertise” and higher-level processing to have taken place in order to convert static health data being gathered to aid useful clinical interpretation and insightful decision making under increasingly complex and risky situations. While a lot of
business data, information, and knowledge elements are also non-trivial and often require expert judgments at a strategic level, at the operational level, it is common for raw business data gathered at the source to be conveniently automated for routine processing. Yet, unlike routine business data applications that can often be easily automated, health data and informatics applications are largely textual in nature and cannot be easily automated as these data elements must involve some form of expert input, yielding a resulting decisional interpretation that will eventually impact best practices. Healthcare-related knowledge, as the term suggests, refers to the cumulative experiences of applying health information to clinical decisions, thereby producing “wisdom,” “rules of thumb” (heuristics), and “associations” to be used for future health-related consults.

Health data elements, in and of themselves, are specific facts and parameters. A good piece of datum is characterized by its accuracy, reliability, completeness, accessibility, timeliness, and security. Accuracy is achieved when health data recorded are true, correct, and valid about the status of a patient’s condition; for example, a temperature of 104°F recorded as 101°F is inaccurate, constituting a medical recording error. Reliability means that the recorded data are trustworthy and consistent; for example, if the allergy list of a patient exists in the food services system, the same list should appear in the pharmacy system. Completeness entails that all required health data should (and must) be recorded; for example, a unique identifier must exist in the patient master index (PMI) for each patient recorded in a database to differentiate one patient from the other. Accessibility refers to empowering appropriate personnel with valid access authorization and authentication to view the relevant data wherever and whenever required; for example, physicians should be able to view the electrocardiography (EKG or ECG) or electroencephalography (EEG) reports of their patients following their rounds in the wards. Timeliness ensures that the available health data are current for the decision tasks at hand, while security and privacy stipulate that only designated persons with valid access rights and verifiable authenticated identities can view or make changes to any or all relevant aspects of the recorded data. This will ensure patients’ data privacy, confidentiality, and safeguard against data misuse.

Clinical datasets are unique. Unlike financial and accounting data, clinical data are typically non-transactional. Indeed, data about a patient may be entered by different personnel, by different departments, and at different times to show the progression of health status of the patient; for example, a nurse may jot down the demographics of a patient when he or she first arrives, then the physician or other specialists may record their observations and diagnoses about the patient. These data are mainly textual in nature, although many of the patient’s monitored health indicators, such as weight, temperature, blood pressure, and glucose level, can be measured quantitatively. The physician and specialists may also send the patient for laboratory tests and other scans which will give rise to other types of quantitative and qualitative (interpretative) data once results are being aggregated. Put together, clinical data can range from health-related data derived from statistical and complex simulation models and tabular and graphical presentation data to digitized images to subjective opinions and interpretations of the same underlying data. Similarly, when a patient is discharged, the process will create further clinical (e.g., changes to their health status information) and administrative–financial data (e.g., billing and accounting data).

In the context of present-day health organizational digitization and transformation, health IS/IT are therefore used primarily to gather and analyze patients’ clinical and financial records, following which these various sources of data elements are aggregated and manipulated using necessary and relevant models (including built-in knowledge elements as needed) to support health providers
(e.g., health administrators, clinicians, nurses, and other healthcare professionals) in making timely decisions to improve the efficiency, effectiveness, and efficacy of health services rendered or to be rendered to the patients. Health data collected must be meaningful and worthwhile. While health databases must be properly organized and be made available to their users in a timely fashion, it is critical to consider and understand the needs of their users prior to the data collection process. Otherwise, managing and maintaining inappropriate and unnecessary data, especially in large medical databases, may drain valuable health organizational resources. Users of medical and health-related data range from patients to care providers, government agencies, healthcare planners, judicial agents, educators, researchers, and third-party funders/payors. Different types of users may also require different scopes, formats, and presentations of data. To design and build an effective health IS/IT, it is critical to fully comprehend the need for and challenge of a digital health ecosystem in which health IS/IT systems basically function seamlessly to improve the quality of patient care services being delivered anywhere, anytime.

The Need for and Challenge of a Digital Health Ecosystem

A 2018 Federal Ministry for Economic Cooperation and Development (BMZ) report to encourage strategic partnership for a Digital Africa notes that attempts to invest in digital healthcare infrastructure and build toward a future digital health ecosystem are critical. The BMZ report further argues that such efforts will lead to a seamless exchange of health information among care provider organizations and improve the coordination of care delivery services nationwide. Such investments can also ultimately benefit the health and well-being of the entire targeted population, aside from both enhanced national productivity and wealth. One part of this cited BMZ report notes: “Digital health ecosystems and applications will deliver an additional dimension to support national health services. It will enable individual providers to offer better quality health care and, as a long-term vision, ensure innovation, safety and value in addition to quality in health care."

Conceivably, a digital health ecosystem may be best structured as a holistic linking of ecologically consistent embedded units of health IS/IT applications to support and improve well-coordinated, integrative care delivery across the relevant geographic biosphere. As shown in Figure 1-1, this digital health ecosystem can function via complex physical–biological components interacting at various levels, including: (a) the clinical care and practice level, (b) the public health and policy level, and (c) the clinical research level.

The simple logic behind promoting a vision of a healthy, interoperable, and learning health IS/IT ecosystem is to achieve the right channeling of health information; in short, it is to create an environment where the right information will continually be made available to the right people at the right time “across products and organizations in a way that can be relied upon and meaningfully used by recipients.” At the clinical care and practice level, therefore, the key health data exchanges involve quality measures captured from patients to be provided to the care practitioners as the practitioners interact actively with health decision support systems (HDSS) to offer guidance for patients’ diagnosis, therapies, and rehabilitative activities. Here, both individual patients and care providers will be able to access, share, and meaningfully capture, store, and use relevant health information for care delivery to maintain the desired patient health outcomes. Importantly, the emphasis on health IS/IT will be to focus on quality and safety in the care delivery process.

At the public health and policy level, the focus of health IS/IT will shift toward population-based health statistics with
emphasis on regional information management and exchange. Here, data derived from population health analysis will dictate public health policies, which will in turn be used to guide ongoing and evolving professional services and best practices. Beyond this and at the clinical research level, big data and analytics will then be channeled to benefit both healthcare organizations and the public communities by enabling better insight into clinical practice guidelines about various care services such as pain management and alternative cancer treatments for various forms of cancer. While the use of a commonplace health IS/IT such as an EHR is clearly meaningful in recording medical histories for individual patients to aid clinical diagnosis and therapeutic treatments at the clinical care and practice level, the big data generated by EHRs has the potential to improve research analysis and provide analytical insights toward boosting overall public health at the clinical research level.

Even so, the key challenge in digital health ecosystem-based management is the need to achieve seamless connectivity and interoperability among different components within and among ecosystems. This entails the ability to steer key stakeholders toward an operational digital health strategy, the ability to translate a viable and sustainable e-health strategy into a strong digital health ecosystem, and the need to monitor and evaluate outcomes and results being achieved to guide future directions. Unlike other service sectors, such as banking, insurance, and retailing, which have successfully implemented powerful, connected e-business ecosystems globally, the challenges for building an e-healthcare ecosystem have to do with the difficulties faced in sharing and exchanging clinical data across often diverse systems. This is chiefly due to the uniqueness of individual health data, characterized by these recordings being largely textual, poorly structured, and kept separately in siloed systems which are not easily interoperable. Moreover, different care providers tend to abbreviate as well as interpret the same or almost similar medical terminology quite differently.

Aside from increased health data and health IS/IT complexity, many health processes, regulatory factors, and emergency health decisions, by their very nature, are also non-trivial, sometimes excessively complex, and multifaceted. For example, unlike well-structured routine business decisions, treatment pathways for older and elderly adult patients often differ substantially even for patients diagnosed with similar symptoms due
to the tendency for these patients to become multi-morbid.

Nonetheless, just as with many other industries, a growing trend toward emphasizing big data analytics has already begun to revolutionize the healthcare industry in more ways than one could imagine. Today, owing to the extensive adoption of technologies such as EHR, computerized physician order entry (CPOE), and clinical decision support systems (CDSS) across hospitals and clinics in North America and elsewhere, care providers can better meet the changing needs of patients by coordinating care in a more efficient and effective manner via big data tracking and disease pattern analytics. Similarly, healthcare administrators and office managers can better account for expenses, eliminate waste, and compute income generated from different forms of services rendered due to the implementation of enterprise resource planning (ERP), supply chain management (SCM), and customer relation management (CRM) systems. The growing complexity of the health IS/IT landscape as well as increased complexity of the regulatory mechanisms, especially for health data confidentiality and privacy, storage, dissemination, and use, continue to impact the challenges faced in building a sustainable digital health ecosystem. Owing to the unpredictability of these various interacting components within the digital health ecosystem, it is further argued that the management of such an ecosystem simply has to be adaptive, including the need for broad representations and participation from major stakeholders, and its future sustainability being dependent on the quality of leadership that will be defined from evolving health IS/IT governance.8–10

**An EHR: Defining the Basic Functions of a Typical Health IS/IT System**

To understand the basic functions and capabilities expected of a typical health IS/IT system, we focus here on the EHR—one of the premier and most used health IS/IT systems for clinical care services.11 **Table 1-1** depicts the 2015 base EHR definition of the most basic capabilities for operating an EHR,12 highlighting the changes that have evolved since the 2014 edition.

A basic function of the EHR is to identify and maintain a patient record, in particular, changing patient demographics and clinical health information such as historical records of events and episodes. In other words, appropriate and sufficient individual patient data must be gathered and tracked over time from various sources before any clinician (EHR user) can meaningfully interpret the data to satisfy the long-term administrative and clinical needs of patients and/or their respective care providers. The fundamental value of such a system lies in properly managing its data collection and verification processes as well as providing an overall picture of the progression of health and well-being of the patient over his or her lifetime. Therefore, EHR data collection is not just about collecting every piece of information, but rather, collecting only those pieces that are meaningfully connected and vital to assist patients, providers, and other secondary users (e.g., third-party funders and researchers).

Another key function is to manage the patient’s problem, medication, and medication allergy lists based on interactions with a clinician, including physicians and/or specialists, along a longitudinal basis. In the 2015 edition, documentation of smoking status and implantable device list have been added as highlighted in Table 1-1. To improve data timeliness, validity, and integrity, the preferred strategy in data collection methods for problem diagnosis is to use automated and direct data input at the source, such as the use of a point-of-care barcode scanner, and to warehouse the data either centrally or via online distributed network technology. Such approaches would require that the acquired input data first be converted into standardized
### TABLE 1-1 2015 Base EHR Definition

<table>
<thead>
<tr>
<th>Capabilities</th>
<th>Criteria</th>
<th>Changes from Earlier Office of the National Coordinator (ONC) for Health IT Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Includes patient demographic and clinical health information, e.g., medical history and problem lists</td>
<td>Demographics</td>
<td>Gender identification and sexual orientation fields added</td>
</tr>
<tr>
<td></td>
<td>Problem list</td>
<td>Minor update (SNOMED CT VERSION)</td>
</tr>
<tr>
<td></td>
<td>Medication list</td>
<td>No change as with previous ONC requirements</td>
</tr>
<tr>
<td></td>
<td>Medication allergy list</td>
<td>No change as with previous ONC requirements</td>
</tr>
<tr>
<td></td>
<td><strong>Smoking status</strong> (new)</td>
<td>New smoking status documentation</td>
</tr>
<tr>
<td></td>
<td><strong>Implantable device list</strong> (new)</td>
<td>Unique device ids linked to a patient's implantable device</td>
</tr>
<tr>
<td>Capacity to offer CDS (Clinical Decision Support)</td>
<td>CDS</td>
<td>Standard Information button</td>
</tr>
<tr>
<td>Capacity to support computerized physician order entry (CPOE)</td>
<td>CPOE (Meds, Labs, Rads)</td>
<td>No change as with previous ONC requirements—use of CPOE</td>
</tr>
<tr>
<td>Capacity to capture/query information relevant to healthcare quality</td>
<td>Clinical quality measures (CQMs)</td>
<td>CQMs being meaningfully derived from captured data; ability to export CQM data</td>
</tr>
<tr>
<td>Capacity to exchange e-health information with, and integrate such information from, other sources</td>
<td>Transition of care</td>
<td>Transport requirements updated to allow easier navigation of an inbound CCDA received from another provider</td>
</tr>
<tr>
<td></td>
<td>Data export</td>
<td>Export summaries for single patient, subset of patients, or for all patients</td>
</tr>
<tr>
<td><strong>Application access</strong> (new)</td>
<td></td>
<td>EHRs to have open interfaces so as to permit other systems to access certain patient data</td>
</tr>
<tr>
<td></td>
<td>Direct project</td>
<td>Send/Receive with EHRs/Patient Portals (PPs) via EDGE Protocol</td>
</tr>
</tbody>
</table>

codes. This strategy is preferred over traditional manual and mechanical input and conversion methods that rely chiefly on clerical transcription of patient data from various self-reports and handwritten documents via the keyboard or some other input devices that are also prone to human errors. Regardless of the way patient-related data are gathered, coded, and entered into an EHR, the input data elements should be cleaned and meticulously verified for accuracy and validity before these data can be helpful in aiding the EHR users in clinical diagnosis.

A third function is to manage the clinical documents and notes with the capacity to support physician order entry. Here, different types of clinical documents and notes may be captured in the EHR; these include, among others, patient-specific care plans, guidelines, and protocols; tracked patient-specific instructions and orders for diagnostic tests; tracked order sets based on provider inputs or system prompts; records of test results, consents, and authorizations; and external clinical documents such as reports or scanned images. CPOE is the primary technology of choice here to be extended from the EHR so as to support administration of medications, laboratory testing, and/or diagnostic imaging in coordinating the continuing care of the patients.

Another technology to enhance EHR functions is the capacity to provide clinical decision support. Here, three common forms of health data management technologies are often employed to aid clinical decisions. Database management enhances data collection and storage activities, improves data integrity, reduces data update anomalies, and promotes preservation and structuring of data for efficient data processing and effective data retrieval activities. Data analytics construct, establish, manage, and interrelate models that may be needed by the health IS/IT users to rationalize the data being linked, analyzed, or computed. In fact, not all data collected are directly useful in the healthcare delivery process. Some information is collected merely to assist in the organization and generation of comparative data and statistics, or simply for research. More intelligent HDSS can assist care providers and clinicians in making more complex decisions that may require expertise within a specialized domain. In this case, apart from the use of database management technology and analytics, knowledgebase management systems come into play. Knowledgebase management assembles, stores, accesses, updates, and disseminates knowledge elements that may enhance the processing of such specialized decisional processes.

Additionally, quality displays and most appropriate representations of health data are important because not only can inappropriate representations of data slow down the process of data interpretation, but the decisions made from poorly represented data could also be error-prone and could generate unwanted and/or inappropriate clinical interventions. Hence, the capacity to capture and query information relevant to healthcare quality is pertinent. Application of a poor image compression technique or the use of an inadequate digital image resolution, for example, may not only slow down the reading of a scanned image for a radiologist, but it can easily lead to risky misdiagnosis on a patient's health condition. Accordingly, computerized software and intelligent graphical interfaces can be built to compact large amounts of information conveniently and to support individual users in filtering out the irrelevant information that may not be needed for a particular or specialized task application.13

Finally, interoperability or the capacity to share e-health information with, and integrate such information from, other sources cannot be overemphasized. Such a capability would be important not only for proper data export and transitions of care but also for access to previously recorded data stored in other systems and for the purpose of integrating and aggregating data from diverse data systems.
III. Major Health IS/IT Components

An understanding of the adaptive but integrated health IS/IT begins with differentiating among its five major components and their interrelationships:

1. Data/information/knowledge (Content and Data Component)
2. Hardware/software/firmware/server (Infrastructure Component)
3. Process/task/system (Data Analytics Component)
4. Systems Network Integration/Media Interoperability (Network Compatibility and Communications Component)
5. User/administration/management facing (Platform/Interface Component)

The content (and data) component, which we have discussed, forms the central core of all health IS/IT. It encompasses the specification of, organization on, and interrelationship among data, information, and knowledge elements required of integrated HMIS. Raw data form the basic building blocks for generating useful information that is to be stored; processed data are transformed into information that serves as useful output to inform end users deliberating on various types of decisions (identification, diagnostic, therapeutic, and consultative or second opinions). Some pieces of data about children may be that of the medication that they are allergic to (e.g., penicillin). Another example would be their vaccination records, including immunization dates and types. Having these data readily available will help determine when and whether the child is due for a particular vaccine, and such knowledge should be passed on to new care providers who may be assigned for future care delivery.

The combination of effective data, information, and knowledge resource management involves designing the critical databases and instituting various intelligent data-mining algorithms, rule engines, and online analytical processing (OLAP) tools to manage the increasingly complex and information-intensive care decision situations physicians are faced with daily. In other words, organized information and captured experience will, in turn, yield the essential knowledge (and intelligence) for guiding future clinical services. Figure 1-2 shows the conceptual flow of the data–information–knowledge paradigm within the HMIS organizational and changing healthcare provider decision-making contexts.

Ultimately, the health IS/IT used to support key decision-making functions of care providers and administrators within the organization must be reformed to achieve greater integration of data, information, and knowledge across organizational stakeholders. The Philips–Samsung’s newly proposed integrated platforms, discussed in the chapter-opening scenario, are examples of how innovative health IS/IT applications can better integrate enterprise databases (such as EHR) and other uncoordinated data systems such as CPOE and HDSS/CDSS to support integrated healthcare delivery at a regional or even global level. In an integrated and well-designed health IS/IT, the goal is to distribute these information-related elements efficiently, effectively, and appropriately throughout the organization for enriching learning among organizational users and for enhancing the delivery of care services across different providers.

The “infrastructure” component is elaborated next. Here, the hardware/software/network component features prominently as it entails the choice deployment of various information and computing-related technologies to support health IS/IT and CI applications and use. Briefly, this component involves configuring various hardware, software, user interface, and communication-enabling infrastructures,
associated devices, and applications in such a way as to best achieve seamless information services integration throughout while connecting individuals, groups, and organizations.

The Philips–Samsung initiative, for example, is the joining of two major platforms created for integrating and securely storing as well as distributing data and information from both enterprise and related health IS/IT systems such as connected medical devices and wearables. It would be important to ensure that all such connected consumer-assistive devices can access the HMIS infrastructure seamlessly, better yet, these devices can access a “virtual” version of an application customized to a user-friendly interface. In this sense, for any patient and/or care provider, the infrastructure layer must and will be supportive of the end users, aiding the performance of tasks to be accomplished by these users and helping them to thrive when interacting within the ecosystem of the resulting technology-driven environment. Furthermore, new and emerging health IS/IT technologies and methods play an increasingly significant role in enhancing healthcare organizational delivery of patient care-related services. This brings us to the third basic HMIS component.

The data analytics component exemplifies the primary data processing and internalized data analytic engine for health IS/IT. Here, the focus shifts from just having information to informing (or descriptive analytics as to describe “what happened?”), from having a vague understanding to providing a highly probable diagnosis (or diagnostic analytics as to explain “why did it happen?”) and from merely guessing to offering rational insights such as a prediction (or predictive analytics as to project “what will happen?”), and finally, from repeated analysis to an optimization of task analytics such as toward a prescription (or prescriptive analytics as to surmise “how can we make it happen?”).

In practical terms, existing administrative-based health IS/IT, such as financial IS/IT, human resources IS/IT, facility utilization and scheduling systems, materials management systems, facilities management systems, and office automation systems, as well as clinical-based health IS/IT, such as EHR, CPOE, and HDSS/CDSS, must all be designed to collect relevant data and accumulate useful information for organizational data analytics processing that encompasses the entire spectrum of human–computer decision-making activities.
as depicted in **FIGURE 1-3**. It is possible, too, that over time organizational, structural, and procedural changes and/or regulatory changes may require different analytics processes previously instituted to be altered or completely deleted—yielding to new processes, tasks, and applications. Therefore, a systems perspective is critical in order to achieve optimality among the different analytics processes and applications.

Surely, the integration/interoperability (network compatibility and communications) component that is discussed next serves as a key determinant of HMIS success from an enterprise view. Often, the key to positioning today’s healthcare services organizations for future success is to ensure the interoperability of systems used in managing existing and ongoing healthcare information services vis-à-vis its competitive marketplace environment. The ONC has done a tremendous job in pushing U.S. hospitals and health centers to comply with the 2014–2015 “interoperability” mandates, creating a vision of stepping-stone compliance in the U.S. healthcare provider organizational environments to achieve efficient, effective, and excellent delivery of healthcare services. This creates a learning system for care providers on how the different organizational health IS/IT could be designed to fit well together to achieve an integrated, enterprise-wide solution. On a global scale, this is exactly what the collaboration between Philips and Samsung platforms is doing so as to provide care services to subscribing consumers anywhere, anytime.

As early as 1980, Lincoln and Korpman recognized the difficulties with computer applications in healthcare services delivery. In their classic paper, “Computers, Healthcare, and Medical Information Science,” they argued that the goals for medical information science, although easy to state, are difficult to achieve for several reasons. First, adapting well-tested information processing procedures and methods from other fields into medicine is difficult because of the uncertainty and sophistication surrounding the medical context, the wide spectrum of medical data, and the vagueness, disparity, and variation of organizational healthcare objectives. Second, this challenge is further exacerbated by the apparent dissonance between the often-embedded ambiguity in medical data structure and the rigidity of computer logic structure. Specifically, in medicine, the materials cover the entire range of patient care data and the methods used span a wide range of disciplines, including the management, behavioral, and fundamental sciences, not just information processing and communications.
This brings us to the final but most critical health IS/IT component, the platform/interface component, which brings together and intelligently coordinates all of the other health IS/IT components. Based on a shared technological infrastructure, for example, various users are, in turn, empowered to perform designated tasks and activities that will support the overall business goals of the care provider organization—that is, to serve their clients (patients, clinicians, administrators, and more) both inside and outside the organization in the most efficient, productive, and effective manner. The function of this critical user component, when blended appropriately with all the other health IS/IT components, is to engender a holistic conceptualization that absorbs the many insights and interactions inherent in any organizational health IS/IT endeavor. It is the gateway for users to access all of the available health IS/IT features, functions, and capabilities.

Altogether, an adaptive, interoperable health IS/IT perspective encompasses a combined interaction of data-related elements, appropriate technologies and methods, designated task and analytics processes, and intended users’ facing to inform and supply the needed information to support key organizational decision-making activities. The health IS/IT is an integral part of the organizational system, a mechanism that is central to integrating the enterprise and its various components. Every unit of that enterprise, which presumably is interrelated, must necessarily complete its purpose by working in unity. Like a jigsaw puzzle comprising a mass of irregularly shaped pieces that form a picture when fitted together, an adaptive, interoperable health IS/IT emerges when the different components of the enterprise fit together. The relationships among these major enterprise components are illustrated in TABLE 1-2, which may be further used to outline the different parts of this text.

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### TABLE 1-2  Adaptive HMIS Text (4e): Content and Organization

| Part IV HMIS Standards, Policy, Governance, Ethics, and Future | Chapter 12. Clinical Confidentiality, Privacy, and Ethical Issues in the Digital Age  
Charie Faught |
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|  | Policy Review III. Health IS/IT Standards Adoption in Health Systems  
Sanjay Sood and Joseph Tan |
|  | Chapter 13. Can AI Determine Consumers’ Preferences on Healthcare Services? A Case Study of Zocdoc Using Social Media Analytics  
Adela Lau, Kristine Baker, Katherine Kempf, Katie Schwalm, Sijuade Oke, Eric Tsui, Liege Cheung, Marie-Claire Slama, and Min Su |
|  | Chapter 14. Healthcare Globalization through Health Information Technology–Enabled Initiatives  
Anantachai Panjamapirom and Philip F. Musa |
|  | Chapter 15. Healthcare Futures: Emerging Healthcare Technology  
Phillip Olla, Rajib Biswas, and Joseph Tan |
|  | Mini-Case (Part IV). The Leadership of Future Health  
Joseph Tan with Joshua Tan |

| Part V HMIS Practices and Cases | Case 1. Digital Health Technology Commercialization Strategies  
Greg Moon and Phillip Olla |
| --- | --- |
|  | Case 2. The Impact of Electronic Medical Records (EMRs) on Clinical Workflow and Practices: Perspectives of MS, a Physician Resident in Ottawa, Canada  
Brandon Lam with Joseph Tan |
Mohan Tanniru, Jack Weiner, and Monica Garfield |
|  | Case 4. Theranos: Innovating an Industry Primed for Innovation  
Chloe Nyitray, Brandon Nixon, Grace Simpson, and Joseph Tan |
|  | Case 5. Patients Like Me (PLM): Social Media in Public Health  
Phillip Olla, Brianna Mozariwskyj, and Vickee Le |
Five major themes underlie this multidisciplinary HMIS field—these themes help structure the scenarios, chapters, reviews, mini-cases, and major cases sequenced in this revised fourth edition of *Adaptive HMIS*:

1. emergent health IS/IT perspectives;
2. health IS/IT technologies and applications;
3. health IS/IT planning and health services management;
4. health IS/IT standards, policy, governance, ethics, and future; and
5. health IS/IT cases and practices.

**Part I**, comprising Chapters 1–3, emphasizes emergent HMIS perspectives. *Chapter 1* overviews the field of health IS/IT from currently developing perspectives of health IS/IT and clinical informatics, in particular how health organizational digitalization is transforming health services delivery locally, regionally, and globally. *Chapter 2* discusses the concepts of Precision Medicine as a new approach to decoding the biology of health and disease. This is followed by *Technology Review I* to unveil fundamental (but contemporary) thinking on the nature of big health data analytics, including key concepts on big health data and datasets, their sources and emerging analytic techniques, as well as the complex step-by-step process needed to extract meaningful insights from such massive data captured and accumulated in health warehouses, including streaming datasets. *Chapter 3* then delves into unveiling the intricacies and cognitive barriers challenging the digital health commercialization process. Following this, *Policy Review I* discusses the access and digital equity issues for seekers of online health information. Finally, we close Part I by incorporating a mini-case for class discussions that offers a challenging perspective on mental health behavioral analytics. Together, these chapters, shorter reviews, and the mini-case will set the stage for readers to reflect on how emerging trends and diverse perspectives in health IS/IT education, research, and development may be applied to transform the traditional healthcare services delivery.

**Part II**, comprising Chapters 4–7, surveys the technology and application layers of HMIS. *Chapter 4* focuses on the fundamental building blocks of digital health systems, that is, the digital data. This is supplemented by *Technology Review II*, an in-depth look into the broader area of geospatial data, geospatial technology, IoT, and cloud computing for health systems. *Chapter 5*, which introduces the readers to key digital health enterprise software, details three health organization management systems: SCM, CRM, and ERP. *Technology Review III* emphasizes the transformative power of SCM for health systems. *Chapter 6* familiarizes readers with four key patient-care coordination technologies, namely, EHR, CPOE, CDS, and PP. This is supplemented by *Chapter 7* focusing on the critical domain of pharmacy informatics with illustrative details on technologies for the medication use process and professional education. Finally, we close Part II by incorporating a mini-case for class discussions that offers illustrative examples of a mobile fitness device known as Lose IT! Altogether, these chapters, the appended review, and the mini-case are meant to broaden the readers’ thoughts on how HMIS applications have significantly and will continue to impact our daily lives and well-being, both individually and socially.

**Part III**, which encompasses Chapters 8–11, informs readers about HMIS planning, design, and management issues. *Chapter 8* covers digital health strategic planning and strategies, accompanied by *Policy Review II* on the roles and responsibilities of health systems leaders and managers. *Chapter 9* presents decision aiding and predictive systems, re-affirming a framework for data mining and machine learning for health systems management, whereas *Chapter 10* offers professional and practical advice on the role of informatics in public health services. We then followed this with *Chapter 11* by reinforcing the concepts of health IS/IT implementation from the different perspectives, including those of project
management, innovation procurement, and IT services management. Finally, we close Part III by incorporating a mini-case for class discussions that offers a challenging perspective on physician intervention in reducing readmission and tele-health. Together with these chapters, the policy review and the mini-case aim to challenge our thinking on how best to manage HMIS, the need to plan in advance, and the type of strategies available for us to begin generating new approaches toward implementing health IS/IT solutions for increasing health and well-being for ourselves, our communities, and our world.

Part IV of the text, which covers Chapters 12–15, acquaints the readers with HMIS standards, policy, governance, ethics, and the future. Chapter 12 presents clinical confidentiality, privacy, and ethical issues in the digital era and is supplemented with Policy Review III focusing on the health IT standards adoption in health systems; Chapter 13 opens up the scope of earlier discussions on data analytics by transitioning into artificial intelligence (AI) and social media analytics to studying consumers’ preferences on healthcare services; Chapter 14 surveys healthcare globalization through health information technology-enabled initiatives, while Chapter 15 jumps forward with the futures of health services by projecting from current and emerging health technology innovation and diffusion. A mini-case on the challenging perspective of future health leadership at the societal and community level closes Part IV of the text.

Part V is devoted to assembling a series of selective cases intended to pull together parts and pieces of HMIS perspectives, methods, and applications as presented throughout the earlier parts of the text. In no particular order, these cases are intended primarily to stimulate class discussions and interactions among students and instructor(s). Case 1, Digital Health Technology Commercialization Strategies, focuses on digital health technology commercialization strategies, essentially illustrates and extends the thinking of Chapter 3 on digital health commercialization (in alignment with Part I on HMIS emergent perspectives). Case 2, The Impact of Electronic Medical Records (EMRs) on Clinical Workflow and Practices: Perspectives of MS, a Physician Resident in Ottawa, Canada, offers insights into the acceptance, use, benefits, and challenges of a patient-record oriented system to aid routine decision making for clinicians vis-à-vis their daily clinical workflow activities (in alignment with Part II on HMIS technology and applications). Interestingly, Case 3, St. Joseph Mercy Oakland (SJMO): Digital Leadership in Health Care, zooms in on HMIS planning and management (in alignment with Part III theme). Case 4, Theranos: Innovating an Industry Primed for Innovation, touches on key HMIS dimensions of standards, governance, politics, and ethics, aligning with topics covered largely in Part IV. Case 5, Patients Like Me (PLM): Social Media in Public Health attempts to integrate the emerging healthcare technologies alongside a more down-to-earth practice-based viewpoint, essentially integrating views toward future health from the current digital age with a focus on the patients and their social contacts, thereby combining thoughts from Part I through Part IV and bringing a closure to the entire text.

At this point, it appears timely to close the chapter discussions with a brief review on HMIS cultures.

IV. HMIS Cultures

Why do HMIS cultures matter? A health information system exists as part of a larger system to support one or more of a combination of administrative, financial, clinical, research, or managerial activities occurring within a health organization. Yet, it is the culture of the health services organization that largely determines the appropriate product mix, roll out, and use of HMIS solutions within the organization. More likely than not, existing and traditional HMIS applications often tend
to be disintegrated so that critical information embedded in the different parts of the organization is not going to be transparent among employees of the organization.

In terms of HMIS cultures, based on what we now know about successful and effective health IS/IT leadership, a healthcare services organization may intentionally or unintentionally adopt and nurture one of four cultural orientations: an information-functional culture, an information-sharing culture, an information-inquiring culture, and an information-discovery culture. Understanding the different characteristics of each of these cultures is important to guide managers, administrators, and systems analysts in generating appropriate health IS/IT solutions for the organization.

An information-functional culture essentially takes the traditional view that information is power and that giving up information implies a power loss in terms of controlling others. It also follows that as most organizations are structured functionally, information-functional culture therefore limits the flow of information within a functional area such as human resources, accounting and finance, sales and marketing, and IT. For example, nurses in an emergency unit of a health system adopting an information-functional culture will attempt to safeguard their own use of patient-gathered information as well as limit the sharing of patient records as a way of exerting power over nurses in other units. Thus, whenever nurses from the acute care unit or other units need to schedule a care routine of a discharged patient from the emergency unit, they will have to involve the emergency nurses.

In contrast, an information-sharing culture promotes trust among employees of different units within the same system. While needing to be sensitive as to the privacy, confidentiality, and security of particular information under his or her safeguard, it is important that nurses, physicians, and others be able to share certain types of information with fellow employees for the benefit of the entire system.

For example, the chief medical officer (CMO) of a hospital who wants to see that his or her direct reports work collaboratively to benefit the efficient and effective running of the entire hospital must not only encourage sharing of information among individual physicians, but he or she should also focus on making information—especially on procedural problems and patient care process failures—transparent among the individual physicians in the hospital.

An information-inquiring culture essentially makes transparent the core values, beliefs, and purpose of the organization and ensures that critical information about the due processes, procedures, and functioning of the system is easily accessible for all employees throughout the system. Employees are also encouraged and trained to actively monitor such information and to align their daily actions and behaviors with the trends and new leadership directions of the system. For instance, all nurses and doctors of a health system could be asked to greet and politely interact with incoming and discharged patients to promote its reputation as a united system that is focused on patient care and customer satisfaction. All employees are also clear about how conflicts should and can be resolved quickly and the due procedures for attending to patient complaints.

Finally, an information-discovery culture entails that the system is able to share insights freely and encourages its employees to collaborate in offering new products and/or services that meet the needs of existing and new clients. Employees throughout the system are also provided with a comprehensive view of how the system functions and how it will support them in their attempt to deal with crises and radical changes and/or finding ways to achieve competitive advantages against its competitors. For health learning systems, it is necessary to start moving toward the adoption of an information-discovery cultural orientation, especially among the physicians, because of the need for a learning system to move away
from strong traditional roots in which physicians are only accustomed to make their decisions independently about the patients under their care, when they are, in fact, having the need to coordinate that care among multiple caregivers within the system that they practice.

Understanding HMIS applications begins with having an appreciation of how health systems function and how IT should be deployed productively within these systems. The complexity of health learning systems and the intricacy of its myriad processes often are the root cause of IT failures in health systems. Many health executives thought that slapping a complex HMIS on top of the problems encountered in a health learning system would resolve its woes when, in many cases, it not only worsens them but also adds unnecessary expenses when the root causes of these problems are not well understood. It is far more important to map out the processes, simplify the complexity, consolidate the needs, and identify the core IT requirements. From here, management has to nurture, cultivate, and respect the working of the HMIS culture and implement appropriate health IS/IT solutions accordingly.

▸ V. Conclusion

This chapter starts out with a real-world scenario describing the emergent perspectives of HMIS and how these perspectives are impacting the futures of health services delivery. It briefly highlights the major components of a typical health IS/IT system and outlines key health IS/IT themes that aided in providing an organizing structure to group the wide-ranging contributions submitted to this revised fourth edition of Adaptive HMIS. Importantly, students should appreciate the strategic, tactical, and operational functioning of a health learning system, including the HMIS cultures, before championing appropriate health IS/IT solutions that can be efficiently and effectively deployed in these systems to be used toward their intended capacity, thereby achieving the overarching goals and objectives of the health learning systems.

For the rest of Part I and beyond, it is hoped that the emergent HMIS perspectives on new medicine will open up the readers’ minds in showcasing how the new technology of precision medicine (Chapter 2) and digital health commercialization (Chapter 3) are rapidly changing the landscape of medicine, bringing about more targeted healing to individuals impacted by different forms of diseases while monetizing digital health analytics. It is hoped that instructors will find these initial chapters in Part I helpful in encouraging students to become excited about the new world of HMIS. The scenario at the beginning of each chapter, the Technology Reviews, the Policy Reviews, and the minicase(s) at the end of each part, together with the specific chapter questions and citations noted at the end of the chapters, and the Glossary and Index appended at the end of the text are multifaceted approaches to motivating and enriching the students’ learning repertoire—to help student readers seek better answers to many more questions about HMIS—as new knowledge and technological breakthroughs in HMIS-related fields continue to emerge in a rapidly changing world.

Notes


Chapter Questions

1-1 What are emergent perspectives of health IS/IT?

1-2 Why is it difficult to integrate IT and medicine? Discuss the need for an integrative perspective for managing health IS/IT.

1-3 List the five major components of a health IS/IT system. Discuss which component deserves the most attention in today’s health IS/IT environment and why. Provide specific examples of each component in the context of your work.

1-4 If you were the Chief Information Officer, which of the four types of health IS/IT cultures would you pursue and why?

1-5 What is the concept of a digital health ecosystem? What significance and impact does such a concept have on the transformation of healthcare services delivery systems in the United States, and other developed and developing countries?