# Measurement of Health Information Technology Adoption: A Review of the Literature and Instrument Development

A PLAN B PROJECT
SUBMITTED TO THE FACULTY OF THE GRADUATE SCHOOL
OF THE UNIVERSITY OF MINNESOTA
BY

Nawanan Theera-Ampornpunt

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF
MASTER OF SCIENCE

Stuart M. Speedie
Adviser

August 2009

# Acknowledgements

It has been a life-changing, dream-come-true journey for me to pursue my master's study in health informatics, a path none of the newly graduated physicians in Thailand had ever chosen before me and a path many didn't even know existed. I have been blessed to receive numerous opportunities, assistance, and support from so many people back home and in the United States. Without them, this project would not have been accomplished.

I immensely appreciate the mentorship, support, encouragement, and opportunities from my adviser, Prof. Stuart M. Speedie, who has given me so much and has supported me throughout my study. I'm also very grateful for valuable advices, comments, and support from my examination committee chair, Prof. Stanley Finkelstein, and from Prof. Connie Delaney who serves as a committee member.

I thank Dr. Guy Paré and Dr. Claude Sicotte for their permission to use their original instrument, as well as Dr. Mirou Jaana for her help in obtaining the instrument. I also acknowledge Dr. Terrence Adam, Dr. Ray Gensinger, Dr. Boonchai Kijsanayotin, Mrs. Rhonda Cady, and Ms. Kanaporn Tansriprapasiri for their help in reviewing my survey instrument. In addition, Dr. Kijsanayotin and Ms. Tansriprapasiri have been very supportive of this project, have provided numerous insights and suggestions, and have helped me get through challenges in countless occasions, for which I greatly appreciate. This project also benefited greatly from the Survey Research Methods class of Drs. Todd Rockwood and Michael Davern. Dr. Borwornsom Leerapan, Mr. Young-Taek Park, and Mrs. Jing Du also helped review parts of the initial survey draft.

I'm forever grateful for the scholarship and support I received from the Faculty of Medicine Ramathibodi Hospital, Mahidol University. I particularly thank Dean Rajata Rajatanavin, Dr. Artit Ungkanont, current Deputy Dean for Informatics, Dr. Piyamitr Sritara, former Deputy Dean for Informatics, all Assistant Deans for Informatics, and the staff of the Medical Informatics Division at the Faculty of Medicine Ramathibodi Hospital for believing in me and for their continuing support. I also express my sincere gratitude to Dr. Bordin Sapsomboon, Dr. Suchart Soranasataporn, and the late Dr. Yongyuth Kajorntham, all of whom had opened my eyes to the field of health informatics and provided support and opportunities that allow me to stand here today.

My family deserves most of the gratitude for all I have accomplished. The unconditional love and unwavering support from my mother Nuannoi and my father Roongroaj, who have always been there when I need them most, makes this work possible. Mom and Dad, thank you for everything. My younger brother, Nawanol, has also inspired me to bring out the best in myself, which is proven helpful in this project.

This work is dedicated to the health of the Thai people. We need to build a better health information technology infrastructure, a larger health informatics knowledge body, and a stronger health informatics community. One person can only do so much, but I hope one person's small step forward in this field would inspire others to take a similar path and jump into one of the country's most exciting, yet hardly explored, areas in biomedicine.

# Abstract

Studies have shown that adoption and use of health information technology (IT) plays a role in improving the quality and efficiency of care. There are many empirical studies on health IT adoption and use in the U.S. and other Western countries, but little is known about the state of health IT adoption in Thailand. In addition, there exist few articles that focus on the theoretical and methodological aspects of health IT adoption. This study begins with the review of theories related to IT adoption from several fields including health informatics, information systems, and innovation diffusions. A critical review of these theories offer a perspective on the conceptualization of IT adoption, which would help researchers conducting IT adoption studies on their framework development. A methodological review of studies involving health IT adoption and use also helps gain valuable insights on the study design, methods, and measurement of health IT adoption that allow health IT adoption researchers to conduct better studies. Insights from the theoretical and methodological reviews lead to the proposed modification of an existing conceptual framework of health IT adoption called IT sophistication. The modified IT sophistication construct focuses on 3 different aspects related to health IT adoption: the technologies and information exchange that constitutes an organization's IT infrastructure, the functions the available technologies offer, and the management and cultural practices that are known to influence successful adoption and use of health IT. A survey instrument was developed based on this framework, with the focus on measuring the hardly known state of health IT adoption in Thai hospitals.

# Table of Contents

# List of Tables

# List of Figures

# Measurement of Health Information Technology Adoption: A Review of the Literature and Instrument Development

## Introduction

Benefits of Health IT

Health information technology (IT) has received increasing attention among health care professionals, administrators, and consumers as a tool to improve quality and efficiency of health care, from when the Institute of Medicine published the "To Err Is Human" [1] and "Crossing the Quality Chasm" [2] reports to today's health care reform policy of President Barack Obama [3]. The first report highlights the error-prone nature of humans, which makes man-made medical errors in the processes of health care delivery inevitable. It argues that the number of medical errors would not be reduced by pointing fingers at health care professionals who make honest mistakes, but instead through a systematic change in the health care system [1]. The second report makes the case for the critical role of health IT in preventing errors and achieving safe, effective, patient-centered, timely, efficient, and equitable health care [2]. Most recently, President Obama's policy on health care reform [3] and his significant funding of health IT through the American Recovery and Reinvestment Act of 2009 [4] have created the long-awaited opportunity for widespread adoption of health IT, which many anticipate will bring about the much needed cost-savings and improved quality [5].

Many studies have demonstrated the benefits of health IT on the care quality and efficiency. Chaudhry et al. [6] systematically reviewed the evidence on the effects of health IT on health care quality, efficiency, and costs. Among the 257 studies reviewed, the literature shows three major benefits on quality, namely, increased guideline adherence, enhanced surveillance and monitoring, and decreased medication errors. The roles of health IT in improving patient safety and reducing medical errors were also discussed by Bates and Gawande [7]. In addition, one recent study found that the use of health IT was associated with fewer complications and lower mortality rates, which are key indicators of quality of care, as well as lower costs [8]. On the efficiency front, the benefit of health IT in terms of decreased utilization of care is evident from the systematic review [6]. One particular study performed a cost-benefit analysis of electronic health records (EHRs) in ambulatory primary care settings in the United States and estimated the net benefit from using an EHR for a 5-year period to be $86,400 per provider [9]. A RAND Corporation study reported that the potential cost savings of widespread adoption of EHR systems in the United States could reach $81 billion a year [10]. Walker et al. estimated a net value of electronic health care information exchange and interoperability up to $78 billion per year [11]. While there are critics of such cost-saving estimates who fundamentally disagree on the magnitude of the cost savings, how these estimates were derived and the operating health care environment in which these benefits could be realized, most critics still view appropriate use of health IT as a necessary, albeit insufficient, component for such cost-savings and argue that the health IT adoption rate is far too low for these benefits to accrue [12,13]. In order for the society

at large to benefit from such quality and efficiency gains of health IT, adoption and use of health IT in all settings needs to be facilitated.

Health IT Adoption

Health care organizations are in various stages of implementation of a wide range of health IT in the hope of improving patient safety, quality of care, and organizational performance [14-16]. In the United States, Jha et al. estimated based on a systematic review that as of 2005, about 24% of physicians used an EHR system, but only 9% used EHR systems with key functionalities such as e-prescribing. The review also suggested that about 5% of U.S. hospitals had a computerized physician order entry (CPOE) system [14]. In 2006, the American Hospital Association estimated that 68% of hospitals fully or partially implemented EHRs [16]. Although the number appears encouraging, the relatively low response rate (31%) and the potential selection bias due to the predominantly electronic survey mode suggest the actual numbers could be much lower. The recently published study on health IT adoption of U.S. hospitals suggested that only 1.5% of the hospitals currently had a comprehensive EHR system present in all clinical units, and an additional 7.6% had an EHR system present in at least one unit [17]. CPOE systems for medications had been implemented in only 17% of the surveyed hospitals [17]. It is clear from this study that the overall health IT adoption in the U.S. remains low.

Compared to the U.S., other Western nations have much higher use of EHRs in the ambulatory setting, with the United Kingdom, the Netherlands, Australia, and New

Zealand having more than 90% EHR adoption, although the adoption of health IT in the inpatient setting in these countries still lags behind their ambulatory setting [18]. Protti conducted a qualitative study to identify factors contributing to the high adoption of health IT in the general practitioners' office in 10 Western countries and found interesting similarities among these successful countries. The government's health policy that either directly or indirectly facilitates the use of technology, the presence of financial incentives for health IT adoption, the existence of a single unifying organization, and the full participation of general practitioners appear to be common facilitating factors [19].

In Thailand, there are few existing studies on health IT adoption. Kijsanayotin et al. surveyed penetration and adoption of health IT in Thailand's community health centers and found that basic IT infrastructure appears pervasive in most health centers [20]. However, most of the technologies used were administrative in nature and did not directly affect patient care or clinical operations, which are the critical points at which health IT could make an impact. In addition, a much larger portion of Thailand's health care delivery is performed in acute care hospitals, not community health centers. The limited capabilities, resources, and utilization of the country's community health centers limit the potential that policy on health IT adoption in these centers could make a large societal impact. Another study surveying adoption of health IT in Thai hospitals, demonstrated that in 2005, 88% of 504 Thai hospitals responding to the survey had adopted at least some health IT that involved patient care [21]. However, the crude nature of the adoption measurement and certain aspects of the survey design and methodology might have jeopardized the conclusions and policy implications of the study. Apart from

this study, there has been no known nationally representative study on the state of IT adoption in Thai hospitals [22]. With the country's extent of health IT adoption largely unknown, particularly in the most influential hospital setting, policymakers do not know the current status of health IT adoption and its gaps among different contexts, and little is available to guide public policy and decision-making. Coupled with the current lack of national health IT policy, agenda, and infrastructure, the lack of knowledge poses significant challenges and missed opportunities in efforts to improve the people's health through health IT. Ultimately, the country could socially and economically lag behind other countries with high adoption and strong national policy, and its people would be the ones to suffer the most.

With limited knowledge of the country's health IT adoption, there is a critical and urgent need to conduct more studies to measure adoption in various settings. The literature consists of many studies that measure health IT adoption or similar constructs. These studies vary widely on what they intend to measure, their underlying conceptual frameworks, how their constructs are measured, and the settings for which the measurement methods are designed. However, not many reviews of these studies have been published in the literature. A review of their measurement methods would reveal their strengths and weaknesses, which would allow the selection and modification of an appropriate method for a particular use. Furthermore, Thailand's context is much different from the U.S., where a majority of the instruments were developed. With the Universal Coverage scheme and heavy governmental influence, Thailand's health care system is fundamentally different from the U.S.'s predominantly private insurance-based

health system. The country's health IT environment and social context are also much different from other countries. To measure the level of health IT adoption in Thai hospitals, it is necessary to have an instrument that not only captures the level of adoption accurately, but also fits with Thailand's social and cultural context.

This study has two purposes. First, it conducts a methodological review of measurement methods of health IT adoption in the literature in order to gain insights in how health IT adoption is measured in existing studies. Then, from this review, it develops a new instrument to measure IT adoption in Thai hospitals, by modifying one of the existing instruments. Such an instrument would enable Thai researchers to study the extent and trend of health IT adoption in the country, the outcomes of such adoption, and the contextual facilitating factors and barriers associated with the adoption. Knowledge from these studies would guide the country's administrators and policymakers in developing targeted strategies to maximize adoption and its impact. In addition, the review of adoption measurement and the resulting instrument would contribute to the theoretical foundations of health IT adoption that informatics researchers around the world continue to study and refine.

## Objectives of the Study

The overall goal of this study is to provide an instrument that is appropriate for the measurement of health IT adoption in Thai hospitals. This instrument is intended to answer the questions: what is the current state of health IT adoption among Thai hospitals, and how does it vary by setting and organizational factors of the hospitals? This goal can be achieved by two specific objectives:

1. To conduct a methodological review of the existing literature on how health IT adoption is conceptualized and measured, identify strengths and weaknesses in each of the methods, and explore opportunities to improve them, and

2. To develop an instrument appropriate to measure health IT adoption in Thai hospitals based on the product of the methodological review and to establish its face and content validity.

## Review of the Literature

Before conducting the methodological review of health IT adoption, it is important to review and understand the theories related to IT adoption from the fields of health informatics, information systems (IS), innovation diffusion, and related areas. Such a cross-disciplinary theoretical review brings a rich body of theories and frameworks along with different insights and perspectives they offer from multiple disciplines [23]. These theories would let us better understand how the concept of IT adoption in other disciplines has evolved over time, which could offer insights valuable to health informaticians in conducting future studies and in solving implementation and adoption challenges. For the purpose of this study, the theoretical review provides a theoretical background that serves as the foundation for the methodological review of health IT adoption measurement and the development of the instrument. This section constitutes the product of that theoretical review.

### Information Systems Success

To measure the success of an IT implementation project, one needs to identify the appropriate measure of success to be quantified. Depending on the goal of the project, such a measure could be as simple as the performance or properties of the information system, or as complex as the performance of the interconnected operations within the organization that implements the technology. Realizing the difficulty in conceptualizing and operationalizing IS success, DeLone and McLean [24] proposed, based on Shannon and Weaver's [25] and Mason's [26] previous works, an IS success framework consisting

of 6 categories of IS success, which models the flow of information through various stages from its production through its consumption to its individual and/or organizational influences. The six categories are: system quality, information quality, use, user satisfaction, individual impact, and organizational impact (Figure 1). Their interdependent and temporal relationships are depicted in Figure 2. They also showed through a review of 180 literature articles that measures of IS success used in these studies can be organized into one or more of the proposed categories. This model was subsequently refined by the original authors to include service quality as another dimension and to distinguish intention to use from the actual system usage [27], but the overall structure and concept of the model remains essentially the same. In health informatics, van der Meijden et al. [28] used DeLone and McLean's framework to categorize the success outcomes of the clinical information systems evaluation studies they reviewed.

The importance of this multidimensional model of IS success to today's IT adoption research is that it illustrates the logical steps of how an information system makes an impact, and emphasizes that success depends on the perspective of the stakeholders and contexts. For many health informaticians, who would view better clinical, organizational, and societal outcomes as the ultimate success of health IT, its adoption and use is simply a component in a more complex pathway toward success. It is not the end by itself, but rather a means toward improved individual and organizational performance. Any study on health IT adoption and use must not lose sight that adoption and use is merely a necessary but not sufficient step toward the ultimate organizational

and societal success. Another important point from the proposed model is that the impact of IT can be observed at multiple levels, from the individual level to the organizational level, or even the societal level [27]. This suggests that the decision to adopt and use IT should be viewed as a multi-level process occurring at all levels that must work in concert in order to achieve the full impact of the technology.

| Shannon and Weaver | Technical Level | Semantic Level | Effectiveness or Influence Level | | | |
|---|---|---|---|---|---|---|
| Mason | Production | Product | Receipt | Influence on Recipient | | Influence on System |
| Categories of IS Success | System Quality | Information Quality | Use | User Satisfaction | Individual Impact | Organizational Impact |

**Figure 1.** DeLone & McLean's categories of information systems (IS) success. Reprinted by permission, DeLone WH, McLean ER, Information systems success: the quest for the dependent variable, Information Systems Research, volume 3, number 1, March, 1992. Copyright 1992, the Institute for Operations Research and the Management Sciences, 7240 Parkway Drive, Suite 300, Hanover, Maryland 21076 USA.

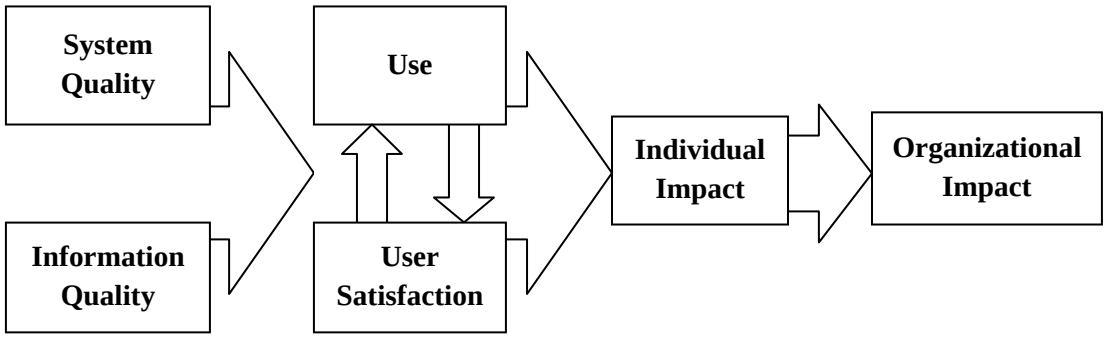



**Figure 2.** DeLone & McLean's original information systems (IS) success model. Reprinted by permission, DeLone WH, McLean ER, Information systems success: the quest for the dependent variable, Information Systems Research, volume 3, number 1, March, 1992. Copyright 1992, the Institute for Operations Research and the Management Sciences, 7240 Parkway Drive, Suite 300, Hanover, Maryland 21076 USA.

User Acceptance of Information Technology

At the individual level, several theories have been developed that focus on an individual user's acceptance of technology. Among the widely-accepted theories are: the theory of reasoned action [29], the technology acceptance model [30], the theory of planned behavior [31], and the social cognitive theory [32]. Each of these theories employs intention to use and/or use as key dependent variables, and proposes a variety of predictors that help explain the usage behavior. The distinction of intention to use from actual system usage is a fundamental one that has received wide acceptance in the IS and related fields. Intention to use is an attitudinal construct that is different from, although tightly related to and in many models a predictor of, system usage, which is a behavioral construct. The system use itself can be measured either objectively through system logs or direct observation, or subjectively by asking respondents to report their use [24]. Some of these models and their derivatives have been used in the health care context to study technology acceptance among physicians and health care professionals [33,34].

Given the multitude of theories on user acceptance of technology, Venkatesh et al. [35] reviewed eight technology acceptance models and proposed a unified model called the Unified Theory of Acceptance and Use of Technology (UTAUT) that integrates elements from the eight models (Figure 3). In this model, factors related to a user's belief that using the system improves his or her job performance (performance expectancy), his or her belief that using the system is easy (effort expectancy), and his or her perception that others believe he or she should use the system (social influence) determine the degree to which the user intends to use the system, which in turn determines the user's

extent of use. The user's belief that help is available to support his or her use (facilitating conditions) also helps determine the usage behavior.

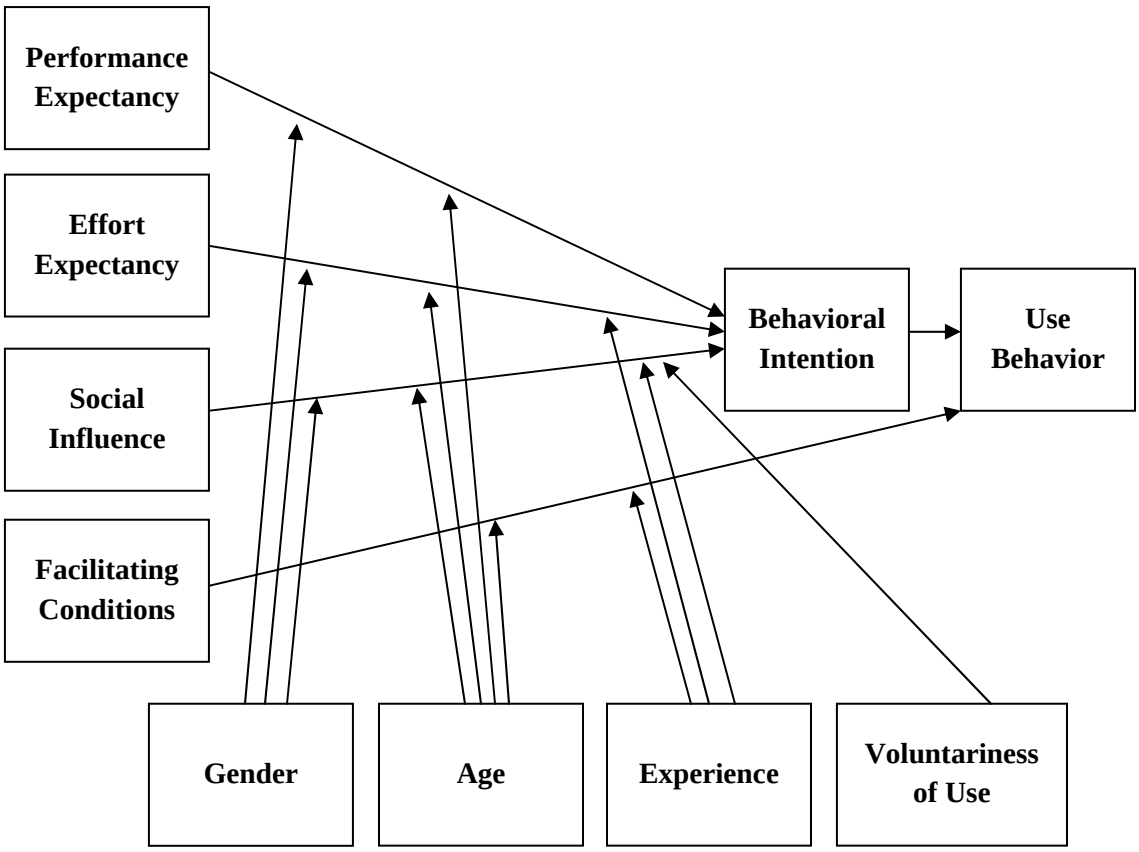



**Figure 3.** The Unified Theory of Acceptance and Use of Technology (UTAUT) model. Reprinted by permission, Venkatesh V, Morris MG, Davis GB, Davis FD, User acceptance of information technology: toward a unified view, MIS Quarterly, volume 27, number 3, September, 2003. Copyright 2003, Regents of the University of Minnesota.

The UTAUT model has been used in several studies on technology acceptance in health care settings [36-38]. A study by Duyck et al. [37] investigated the individual user acceptance of a picture archiving and communication system (PACS) by a radiology department's staff and found that constructs in the UTAUT model were predictive of intention to use PACS. Kijsanayotin et al. [38] studied user acceptance of health IT in

Thai community health centers and found that IT acceptance was influenced by the users' beliefs about the system. In addition, findings also showed that reported use of health IT in the health centers was predicted by intention to use and other contextual variables. This stream of research on user acceptance of technology has made significant progress toward identifying the determinants that explain variance in system use at the individual level and their interrelationships. However, with the focus on the variance model, the actual process in which an entity adopts a technology is often not addressed.

Innovation Diffusion

The diffusion of innovations theory describes the innovation-decision process that an individual employs to make use of an innovation. Rogers defined an innovation as "an idea, practice, or object that is perceived as new by an individual or other unit of adoption" [39]. An information technology that is perceived as new by the adopting entity is therefore considered an innovation, the diffusion process of which the entity must go through in order to successfully adopt the technology. The decision process to adopt an innovation occurs over time, consisting of a series of choices and actions [39]. According to the theory, there are 5 sequential stages in the innovation-decision process, as depicted in Figure 4 and described below:

1. Knowledge, a step when an individual realizes an innovation's existence and obtains an understanding about its functions.
2. Persuasion, when an individual forms a positive or negative attitude toward the innovation.

3. Decision, a stage when an individual "engages in activities that lead to a choice to adopt or reject the innovation" [39].
4. Implementation, which occurs when an individual puts the innovation into use.
5. Confirmation, a final step when an individual gathers supporting evidence of the decision already made. If the gathered information contradicts the previous decision, the individual may reverse the decision.

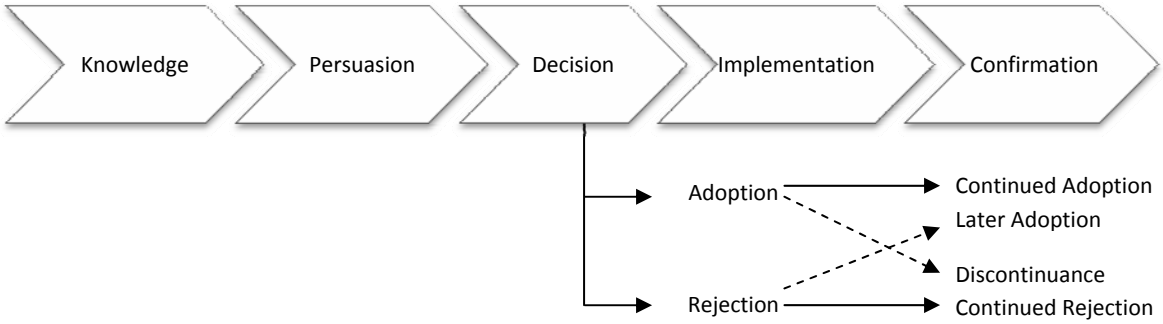



**Figure 4.** The innovation-decision process. Reprinted from Rogers EM, Diffusion of innovations, 5th edition, Free Press, 2003. Copyright 2003, Everett M. Rogers.

According to the diffusion of innovations theory, during the decision stage in the innovation-decision process, an individual engages in activities that lead to a choice either to adopt or reject an innovation. Rogers defined *adoption* as "a decision to make full use of an innovation as the best course of action available", whereas *rejection* is defined as "a decision not to adopt an innovation" [39]. Thus, IT adoption can be defined as a decision to make full use of IT as the best course of action available, contrast to the

decision not to make use of IT (i.e., rejection). It is important to note that according to this definition, IT adoption merely reflects the decision that has been made and the intent to use the technology. It does not represent the actual use of IT, which falls in the implementation stage of the diffusion of innovations theory [39]. Hence, adoption in the sense of the diffusion of innovations theory is equivalent to the intention to use concept in many technology acceptance theories. From this observation, two important points are worth further discussion. First, since adoption and use are two separate concepts, measuring IT *adoption* without taking into account the *use* of such a technology by users only tells one side of the story. Similarly, blind facilitation of IT *adoption* without sufficient emphasis on IT *use* would not yield the desirable impact. Second, because adoption is a mental state after a decision has been made [39], it is hard to objectively measure the abstract state of adoption with minimal biases. Therefore, many studies on individual adoption measure the actual or perceived IT use of individual users instead.

The innovation-decision process at the organizational level is very similar to that of individual users. One major difference, however, is that we now have two levels of decision-making processes to consider. IT adoption and implementation at the organizational level will not yield an impact unless individual users in that organization adopt and use the technology. Furthermore, in many cases, an organization must adopt the innovation before an individual in the organization can adopt it because of the policy or procedures of the organization [39]. Davidson and Heineke [40] presented a framework on diffusion of clinical information systems that integrates these two levels of adoption and use together. The framework views IT implementation in health care as

consisting of five steps, from making the technology available to adoption of the technology at the organizational level, followed by the use of health IT by individual health care professionals, change in work processes, and the evaluation of organizational impacts. Similar to the individual level, innovation *adoption*, at least in the diffusion of innovations theory's terminology, is just an abstract state of an organization after the decision has been made. Since it is difficult to measure the decision to adopt an innovation at the organizational level, and the downstream product of adoption (i.e., the *implemented* innovation) is far more important in creating the desirable individual and organizational impacts of adoption, many organizational studies instead measure the more tangible resulting organizational state after the decision to adopt has been made and the innovation has been implemented (or is being implemented). However, the term *adoption* is often used interchangeably with *implementation* in the literature and within the IS and informatics communities, even though they represent two distinct stages of diffusion according to Rogers [39].

IT Availability and IT Use

One simple way to measure the resulting state of IT implementation in an organization is to measure its existence or availability in the organization. IT availability is an outcome or a part of the outcome in several studies on health IT adoption [41-43]. In a 2004 conference in Canada convened to define necessary metrics to measure the process and performance of hospitals, measuring information system availability is one of the three phases of measuring impact of health IT [44]. However, availability merely reflects the potential that the technology could make an impact in an organization, but

without use, no impact could be realized. In these studies, researchers were aware that system availability does not equate to system use, so they also measured IT use as well [41-44]. As mentioned before, system use can be measured objectively through system logs or observation, or by relying on reported or perceived use using some form of questionnaires or interviews.

Incorporation, Routinization, and IT Infusion

Innovation researchers know the distinction between adoption and implementation well. They sometimes use the term *incorporation* to represent "the implementation activities directed toward embedding an adopted innovation within an organization" [45-48]. Zmud and Apple [45] argued that activities designed to increase the likelihood of broad incorporation may have much greater impact than efforts to increase the likelihood of broad adoption. They also reviewed the concept of *routinization* proposed by Yin [49], defined as "the permanent adjustment of an organization's governance system (e.g., its administrative infrastructure) to account for the incorporation of these technological innovations" [45]. Yin measured routinization by investigating the change in an organization's governance systems such as formal rules, budget, training procedures, or stable maintenance and supply arrangements. Zmud and Apple argued that routinization is one important aspect of incorporation, but there is a need to examine not just a change in the governance system, but also the adjustment in the organization's work systems and social systems [45]. They used the term *infusion* to represent another aspect of innovation incorporation in an organization involving adjustments in operational and managerial work systems and shifts in the technological

configurations to which they relate. The greater the degree of these work and social system adjustments, the greater the degree to which the innovation has been "infused" in the organization. According to Zmud and Apple, the infusion construct measures how advanced the use of an innovation is and how deep and comprehensive the innovation is embedded in the work systems [45]. A simple example they provided is the increasingly advanced levels of personal computer (PC) use from individual stand-alone users of organizational databases to multiple PC users with workflow linkages, and ultimately to multiple concurrent PC users of distributed systems such as order entry. All of these use the same technology (a PC) but yet the technology is used in increasing degrees of advancement and thus reflects the increasing levels of technology infusion in the organization. They also presented an approach to measure technology infusion by identifying a succession of technological configurations of the new work process, with each successive configuration incrementally built onto the functions achieved from prior configurations [45].

Zmud and Apple's work is an example of concepts that enhance our understanding of the complexity in measuring technology adoption and implementation. At the very least, it emphasizes that there are multiple configurations that a technology can possibly be embedded in an organization, each yielding a much different impact to the organization, even though it is the same technology and the decision to adopt the technology is rather simple to make. This suggests that a study that intends to measure the decision to adopt a certain technology will be much simpler than, although not as useful and interesting as, another study that measures the level of advancement or

sophistication of the technology in the organization. More importantly, their work shows that to measure the degree to which an organization implements and uses a technology, one should not simply measure whether the technology exists (or what kinds of technology exist) in the organization, but he or she should measure how the organization functions with that technology implemented as well. In other words, it is important to capture not only the technological aspect but also the functional aspect of technology implementation.

Infusion of innovation in an organization can be viewed as the depth of the adoption-implementation process [50]. The more advanced an innovation is embedded in the work process, the deeper the influence of the innovation in the work unit. In contrast, the diffusion, defined by Rogers [39] as "the process by which an innovation is communicated through certain channels over time among the members of a social system," can be viewed in the organizational context as the breadth of the adoption-implementation [50]. The more applicable units within an organization adopting and using the innovation, the wider the innovation could have an impact. Since they're two different yet equally important dimensions, an ideal measure of innovation adoption and/or use should include measurement of both.

IT Maturity

Another concept in the IS field that pertains to the complexity of IT in organizations is *IT maturity* (or IS maturity). The origin of the concept of maturity dated back to 1969 when Churchill et al. surveyed users of information systems and described

that the development of computer applications in business can be viewed as stages, from basic clerical applications to managerial and strategic applications [51]. In the description of these more advanced applications, they briefly introduced the idea of application maturity. This early work encouraged other researchers such as Greiner [52] and Nolan [53] to propose their own theories of IS development stages. Through a series of refinements, Nolan proposed a six-stage model, known as the stage hypothesis, of organizational use of information systems, which he and Nolan & Gibson through several publications suggested how it could be used to manage computer resources in an organization [53-61]. The six stages were: initiation, contagion, control, integration, data administration, and maturity. Nolan's model views development of information systems in an organization as a growth process that involves not only the increasingly matured configurations of information systems but also the more advanced IT organization, data administration activities, and user accountability. Benbasat et al. [62] reviewed Nolan's stage hypothesis in more detail and provided a critique of the model based on evidence from existing literature at the time. Since the model was rooted in the 1970s and early 1980s when data processing activities predominated, the model is somewhat outdated in today's IS environment where IT is considered not only an essential data processing tool to conduct all kinds of operations but also a strategic asset to leading organizations in any industry. However, it provides a great conceptualization of organizational IT as a dynamic evolutionary process that occurs over time and intertwines with increasing levels of operational and managerial complexity.

In the IS field, the concept of IT maturity is used to study the impact of information systems on job performance, interdepartmental communications, and organizational functions [63-65]. In some of these studies, another term is used to describe IT maturity. Saunders and Keller [64] described the level of maturity of the IS function as the *sophistication* of the mix of applications, specifically the technological advancement and variety of the applications, provided by the IS function. Gupta et al. used the term "IT management sophistication" as a synonym of IT maturity. In their context, IT management sophistication consists of management activities such as IT planning, IT control, IT organization, and IT integration [65]. The specific contexts notwithstanding, these studies viewed IT in an organization as a sophisticated mix of the technology, the functions it offers, and the IT management activities it requires.

IT Sophistication

In a study to evaluate the impact of IT on user satisfaction and job performance, Cheney and Dickson used what they called *technical sophistication* and *organizational sophistication* as independent variables [66]. Their technical sophistication measures the hardware and software systems and the recently implemented applications, and places the organization into one of four stages. Organizational sophistication, on the other hand, measures the level of planning, organization, and control activities associated with the management of an organization's computer resources [66]. The idea of IT evolution in the IT maturity concept together with Cheney and Dickson's concepts of technical and organizational sophistication led Raymond and Paré to conceptualize *IT sophistication* as "a construct which refers to the nature, complexity and interdependence of IT usage and

management in an organization" [67]. This multidimensional construct consists of 4 dimensions: technological sophistication, informational sophistication, functional sophistication, and managerial sophistication, each representing the respective component of IT in an organization.

Following the work of Raymond and Paré [67], Paré and Sicotte [68] modified the IT sophistication construct to study IT adoption in Canadian hospitals. In this health care context, IT sophistication consists of 3 dimensions: technological sophistication, functional sophistication, and integration sophistication. Technological sophistication was defined as "the diversity of hardware devices used by health care institutions," such as medical imaging technology, bar coding devices, and networking equipments. Functional sophistication represents "the proportion and diversity of processes or activities" supported by information systems, and integration sophistication refers to "the degree to which computer-based applications are integrated both internally via a common database and externally via electronic communication links" [68]. These three dimensions of IT sophistication are assessed for each of a hospital's three core domains, specifically, patient management and patient care activities, clinical support activities (laboratory, pharmacy, and radiology), and administrative functions (Figure 5) [68]. Based on this conceptualization, Paré and Sicotte developed and validated an instrument [68], which has been described and used by a number of U.S. and Canadian studies related to health IT adoption and its impact [69-75].

Paré and Sicotte's IT sophistication framework [68] represents significant advances in the area of health IT adoption. It is one of the few IT adoption conceptual frameworks at the organizational level that are devised for the health care industry, yet have roots in the IS field, enabling the cross-disciplinary knowledge transfer and enhancing the collective knowledge body of the two fields. Many health IT adoption studies use simple measurement of IT adoption and use, lacking a strong foundational conceptual framework, resulting in specific, practical knowledge that lacks theoretical and explanatory value generalizable to different settings. The lack of supporting theoretical framework on health IT adoption in many studies limits the potential to understand the interrelationships between different aspects of health IT in an organization and identify potential "attack points" that prevent the widespread adoption and use of health IT and full realization of its benefits. On the other hand, many theories and constructs in the IS field focus on management information systems (MIS) or electronic data processing activities that are very different from health care operations. The proposed framework by Paré and Sicotte [68] reflects multiple interdependent aspects of health IT that are necessary to make a significant impact. It pulls researchers, administrators and IT professionals away from the blind-sighted focus on the technological aspect and instead guiding them toward the holistic view of health IT as *technologies* that enable users to perform their *functions* and allow *information sharing* within and across the organization in the process. One important piece originally present in Raymond and Paré's framework [67], however, is noticeably missing from this conceptual framework: the managerial and organizational aspect of IT.

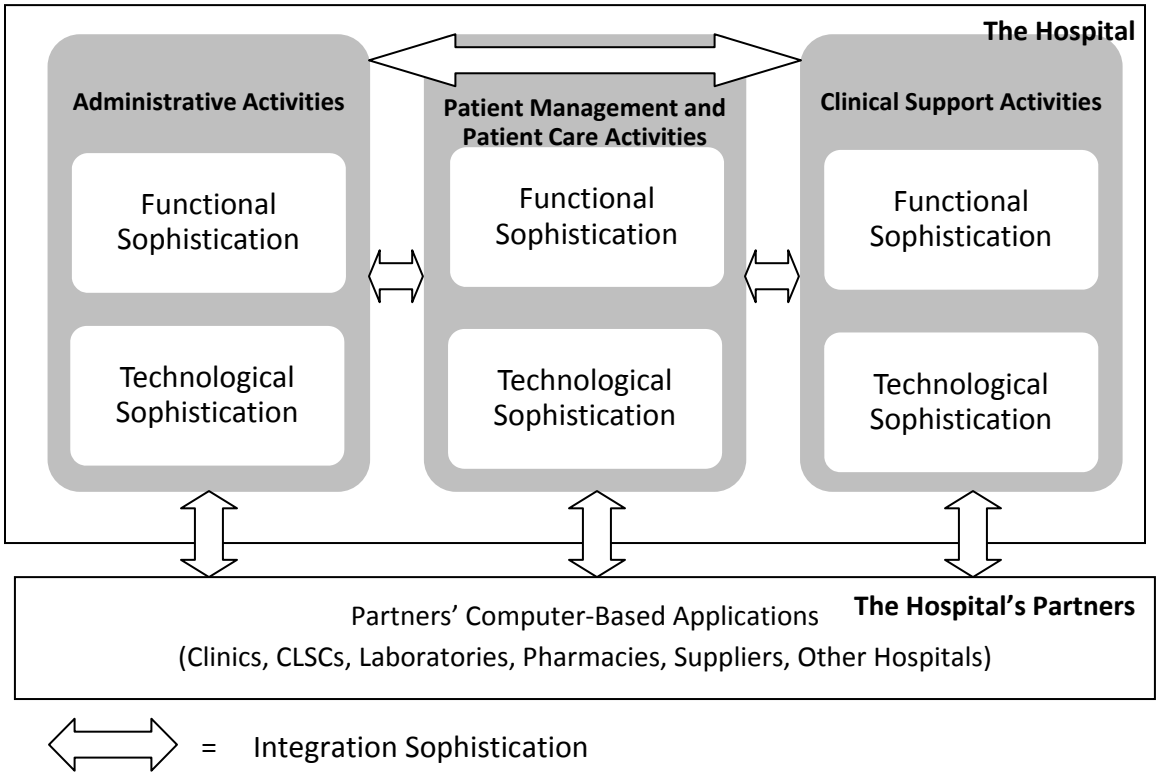



**Figure 5.** IT sophistication framework in hospitals. Reprinted by permission, Paré G, Sicotte C, Information technology sophistication in health care: an instrument validation study among Canadian hospitals, International Journal of Medical Informatics, volume 63, number 3, October, 2001. Copyright 2001, Elsevier.

IT Munificence

Another concept that is close to IT sophistication is *IT munificence*, proposed by Burke and Menachemi [76]. This latent construct was created using tenets from the diffusion of innovations theory and the strategic contingency theory. According to Rogers' diffusion of innovations theory [39], similar or functionally-related innovations should be grouped together as a technology cluster in order to facilitate more rapid diffusion. Burke and Menachemi also discussed the argument made by strategic

contingency theorists that managers have an important role in organizational design, and both technology and strategy are important to an organization's effectiveness [76]. They therefore classified hospital IT into 3 groups: clinical, administrative, and strategic. Clinical systems support the primary mission of a hospital to provide health care, while administrative systems support organizational functions that do not involve direct patient care, such as billing and personnel functions. Unlike clinical and administrative systems, strategic decision support systems provide strategic information to hospital executives for strategic planning, resource allocation, and oversight of operations. The IT munificence construct was conceptualized as consisting of an organization's strong technology base in clinical, administrative, and strategic functions and shared enterprise information systems, as well as IT capabilities that share information with external stakeholders [76].

IT munificence is similar to IT sophistication in that both emphasize not only the clinical functions, the key mission of health care organizations, but also administrative functions, although the specific categorization might be different. Furthermore, both concepts also include the extent of integration or data sharing between systems as part of the organizational IT infrastructure as well. However, unlike IT sophistication, IT munificence does not differentiate between the technological (devices and systems) and functional (work processes) aspects of IT.

IT Capability

Noticing that IT investment and implementation doesn't necessarily correlate well with better organizational performance, Bharadwaj [77] argued based on the resource-based view of organizational management that an organization creates competitive advantage by integrating resources within the organization that together create organizational capabilities that are not available in its competitors. Extending this perspective to IT, Bharadwaj defined an organization's *IT capability* as its "ability to mobilize and deploy IT-based resources in combination or co-present with other resources and capabilities" [77]. Key IT-based resources include tangible resources such as IT infrastructure, human resources with technical and managerial IT skills, and intangible IT-enabled resources such as knowledge assets, synergy, customer orientation, and organizational learning [77,78]. With this notion, Bharadwaj et al. [79] convened an expert panel to identify more components of IT capability. These include IT business partnerships, external IT linkages, business IT strategic thinking, IT-business integration, IT management activities, and IT infrastructure. In health care, the issue of competitive advantage is less important than delivering effective and efficient health care, but the IT capability concept is equally helpful in enabling health care organizations to utilize health IT for better service delivery. Khatri [80] identified IT capability in health care organizations as consisting of competent CIOs and management support, elevated status of the IT department in the organization, trusting relationships between IT managers and line managers, IT human resources, and IT infrastructure.

The concept of IT capability highlights one important point. For a technology to make its fullest impact, the organization that implements the technology must possess some capabilities that enable it to successfully incorporate the technology and sustain its use in the long run. In addition to the obvious technological and human infrastructure aspects, the organization must also have managerial and cultural environment that is conducive to the long-term technology adoption and use. Depending on the conceptual framework a researcher is operating on, this managerial and cultural aspect arguably may be considered as success factors or organizational readiness to adoption, but not as part of the adoption construct itself. However, including this managerial and cultural aspect as part of the IT adoption completes the picture because it suggests that adopting and implementing the technology would not be complete or successful without "adopting" necessary management practices and organizational cultures. It is important that studies on IT adoption also attempt to identify, or better, quantify, this managerial and cultural aspect in the organizations so that this critical aspect is not forgotten and the linkage between IT adoption and use and organizational impact is not lost.

Summary

To summarize, the critical review of the concepts and frameworks in the fields of health informatics, information systems, and innovation diffusion suggests the following key points that would be a helpful guide in the development of a conceptual framework on IT adoption.

1. The success of IT adoption or implementation depends on the perspective and context. Adoption, implementation, or use may not be the end goal, but merely a critical step toward individual and organizational impacts.
2. IT adoption occurs at multiple levels (e.g., individual, organizational, and societal) that must work together for the ultimate success.
3. It is important to be aware of the distinction between IT implementation (or equivalently, availability) and use,
4. A good model should have a holistic view of IT adoption and an underlying framework that attempts to explain the adoption-implementation process or the interdependent relationships among different aspects of IT adoption, which would more realistically reflect the actual complex structure or dynamics of adoption by the organization or individual and offer better generalizable insights than a mere description of a simple adoption state.
5. A method to assess IT adoption should not only measure the variety or extent of technologies adopted or implemented, but also the functions or work processes these technologies enable or support and the extent of data sharing among systems.
6. In order to obtain a comprehensive picture of a health care organization's IT adoption, a study that intends to capture the overall IT adoption by the organization should measure not only the clinical IT, but also the administrative IT. However, studies with specific focus on clinical IT may choose not to include administrative IT.

7. Because adoption in an organization can go in two directions (depth and breadth), adoption should be measured in both directions if appropriate.
8. The managerial and cultural aspect of IT adoption should be incorporated into the conceptual framework to ensure that the management practices and organizational cultures needed for a technology to be successfully implemented are not forgotten.

The area of health IT adoption is heavily influenced by the areas of IT adoption, innovation diffusion, organizational behavior, and IS in general. However, given the differences between the business MIS context and the health care and health IT context, a well-formulated conceptual framework of health IT adoption would also offer insights that are compatible with the health care environment. For instance, it needs to recognize the roles of health IT that reflect how health care organizations function, which could be much different from the roles of MIS or other information technologies in the business environment.

In order to drive the theoretical foundation of health IT adoption forward, it is important to review and analyze the existing studies on health IT adoption to evaluate the methodologies and measurement methods used and the extent to which these studies are grounded in a sound IT adoption conceptual framework. This would allow an understanding of the applicability and limitations of existing studies and their measurement methods. More importantly, it would enable the selection and refinement of the frameworks and instruments that will be useful for the subsequent study of health IT

adoption in Thailand as well as other future health IT adoption studies in general.

As previously mentioned the term *adoption* has been extensively used in the literature and often represents not just the abstract state of the decision to "adopt" information technology as used in the context of the diffusion of innovations theory, but also the subsequent implementation, and sometimes use, of the technology. Therefore, to be consistent with the terminology in the literature that the health informatics community is familiar with, in the remaining sections of this report the term *adoption* will continue to be used interchangeably with the term *implementation* to reflect the tangible implementation and use of IT in an organization, unless specifically stated otherwise.

## Methods

In order to conduct a methodological review of the literature on health IT adoption, a literature search of the PubMed database [81] was conducted using the search query [("information technology" OR IT) AND (sophistication OR adoption OR diffusion)]. From the search results, the researcher read the individual titles and abstracts and selected an article for further review if it described, in English, a research study, a review article, or a viewpoint on adoption of information technology in the health care environment. Full texts of these articles were obtained and scanned to determine if they meet the inclusion criterion for the methodological review. To be included in the review, an article must describe an original study that employs a qualitative or quantitative (or mixed) method to assess the extent of adoption, implementation, or use of IT by individual health care professionals or health care organizations in the health care setting of interest, whether the purpose was to understand, describe, or compare the states of adoption or use, to identify antecedents to successful adoption or use, or to use the extent of adoption or use as an antecedent to other outcomes. Scientific, non-scientific, peer-reviewed, and non-peer-reviewed studies were included. Articles that proposed a new concept or framework related to IT adoption or a new measurement method were included if part of the article described a validation study that met the same criterion above. A single representative article was selected for multiple articles that were part of the same study and used the same set of data. Articles meeting the criterion were included if they were published prior to July 4, 2009.

Articles that meet the criterion were read, with the study purposes, conceptual framework, study design and data source, details of the IT adoption-related variables measured, unit of observation, study sample, sample size, and key findings abstracted and summarized using the Matrix Method [82]. Whenever appropriate, the original instruments were obtained either from the Internet or directly from the authors. In addition, the bibliographic section of each article was inspected to identify additional references that might meet the criterion. Full texts of these articles were also obtained and similar reviews were done. Furthermore, because studies of health IT adoption may be presented in formats other than journal articles, additional online references related to health IT adoption were also searched through Google [83] and Google Scholar [84] using similar keywords. Full texts of the relevant references were then obtained and similarly subjected to the review process. Various types of references were included in the review as a result of this process, including journal articles, reports of industry or market research, reports by academic institutions, professional associations, and non-profit organizations, and news articles.

Given the vast number of studies related to health IT adoption that exist in the literature, it is unrealistic to expect that the universe of these studies could be identified and reviewed. However, the relatively generic, though probably not comprehensive search strategy described above was intended to capture the majority of important studies on health IT adoption that should offer valuable insights on how health IT adoption could be and has been measured.

From the literature review and the resulting summary review matrix, an analysis of the conceptual frameworks, measurement methods, and the instruments was performed to identify the strengths and design or methodological weaknesses of the studies. From this analysis, the conceptual framework and the accompanying instrument that is most appropriate for the current study was selected. Refinement of the conceptual framework was proposed, and modifications of the instrument were made accordingly. In addition, changes were made to the instrument to make it more compatible with Thailand's health care environment and allow the analysis of associated organizational factors. The modified instrument was intended to collect data from Thai hospitals' IT administrators nationwide on what is the current level of health IT adoption in their hospitals. This information would help describe the current state of adoption in Thai hospitals overall, compare the adoption level among the hospitals, and identify organizational factors and barriers associated with health IT adoption.

Subject matter experts in medicine, nursing, pharmacy, and health informatics were interviewed in person or via telephone to seek their opinions on the content of the instrument and establish face and content validity. Based on these comments, the instrument was revised and subsequently translated into Thai, with another round of interview conducted with experts who are fluent in Thai and are familiar with the Thai health care and health IT environment. The final instrument is intended to be used to collect data about health IT adoption in Thai hospitals, but the instrument validation (other than the establishment of face and content validity), pilot testing, and the actual data collection and analysis were not part of this current study.

# Results

## Methodological Review of Studies on Health IT Adoption

A total of 546 articles were found through the PubMed search. After selecting the relevant articles based on the titles and abstracts and reviewing the full texts, 54 articles were included for the methodological review. 69 additional references were included based on inspection of the original articles' bibliographic section (64 references) and online searches through Google and Google Scholar (5 references). Among these 123 references, 19 articles [42,69,71,74,85-99] were excluded because they describe the same studies as one or more of the remaining articles. None of the references were excluded because of the failure to retrieve the full texts. This resulted in a total of 104 studies [8,16-18,20,41,43,50,68,70,72,73,75,76,100-189] that were included in the methodological review. The literature review process is depicted in Figure 6. The list of studies by year of publication is presented in Table 1, and their detailed information is presented in the literature review matrix in Appendix A.

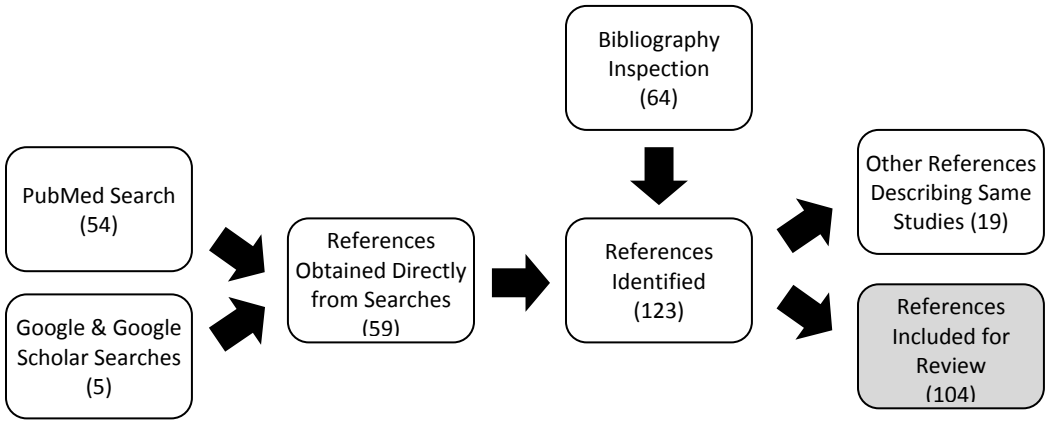



**Figure 6.** Summary of the methodological review literature retrieval process. Numbers in parentheses are the numbers of references in each step.

**Table 1.** List of studies in the methodological review by year of publication.

| Year of Publication | Number of Studies | List of Study Reference Numbers |
|---|---|---|
| 1994 | 1 | 100 |
| 1996 | 2 | 101,102 |
| 1997 | 2 | 50,103 |
| 1998 | 3 | 104-106 |
| 1999 | 2 | 107,108 |
| 2000 | 2 | 109,110 |
| 2001 | 3 | 68,111,112 |
| 2002 | 5 | 113-117 |
| 2003 | 5 | 118-122 |
| 2004 | 13 | 41,76,123-133 |
| 2005 | 16 | 70,134-148 |
| 2006 | 13 | 43,72,73,149-158 |
| 2007 | 12 | 16,20,159-168 |
| 2008 | 14 | 18,75,169-180 |
| 2009 | 11 | 8,17,181-189 |

**Table 2.** List of studies in the methodological review by settings.

| Settings | Number of Studies | List of Study Reference Numbers |
|---|---|---|
| Hospitals | 44 | 8,16,17,41,68,70,72,73,76,100,101,103, 104,106-112,116,118,122,126,134,136, 138,140,142,146,148,150,153,160,166, 173-176,180-183,186 |
| Ambulatory Physician Offices | 12 | 121,128,131,137,141,144,156,159,168, 169,171,187 |
| Medical Group Practices | 4 | 113,145,147,185 |
| Community Health Centers | 4 | 20,114,162,165 |
| Academic Health Centers | 2 | 50,127 |
| Emergency Departments | 2 | 120,188 |
| Intensive Care Units (ICUs) | 2 | 164,170 |
| Long Term Care | 1 | 75 |
| Multiple Specific Settings | 2 | 18,151 |

Studies that collected data from their samples without specific focus on particular settings are not listed.

Study Settings

Studies that were reviewed were conducted in various settings, from hospitals and ambulatory physicians' offices to more specific settings such as medical group practices, academic health centers, emergency departments, intensive care units (ICUs), community health centers, and long-term care, or even multiple settings (see Table 2). One particular study [151] asked experts to estimate the level of adoption in 8 different settings: physician practices, integrated delivery networks, stand-alone hospitals, skilled nursing facilities/rehabilitation hospitals, home health agencies, laboratories, pharmacies, and payors. Many studies obtained data from physicians of multiple specialties, while other studies collected data from other specific groups such as general practitioners and primary care physicians, residents, family physicians, ophthalmologists, nurses, health informatics experts or practitioners, or health care practitioners in multiple professions. When the targeted population consists of health care organizations, data were often collected from senior executives or IT executives of the targeted organizations, but sometimes departmental managers such as pharmacy directors, ICU directors, chairs of anesthesiology departments, and program directors of emergency medicine residencies were the targeted respondents. This is presented in detail in Table 3.

A large number of studies investigated health IT adoption in the U.S., but there were also studies that assessed health IT adoption in other countries. Table 4 lists the studies by countries in which they were conducted. Some of these studies compared the state of adoption in two or more jurisdictions [18,68,70,105,158,184].

**Table 3.** Studies in the methodological review by category of respondents/data sources.

| Respondent Category | Number of Studies | List of Study Reference Numbers |
|---|---|---|
| Executives of Targeted Organizations | | |
| - Chief Executive Officers or Other Senior Executives | 20 | 16,17,20,41,70,73,75,100,104,108, 113,117,123,134,146-148,165,171, 185 |
| - IT Executives | 15 | 20,68,100,106,119,125,136,139,142, 152,163,172,176,181,182 |
| - Pharmacy Directors | 14 | 103,107,109,110,112,118,122,126, 140,160,153,174,180,186 |
| - Directors of Medical Records Department | 1 | 100 |
| - Nursing Directors | 1 | 100 |
| - ICU Directors | 2 | 164,170 |
| - Chairs of Anesthesiology Departments | 1 | 179 |
| - Program Directors of Emergency Medicine Residencies | 1 | 120 |
| Physicians | | |
| - General Practitioners and Primary Care Physicians | 6 | 43,105,123,154,155,158 |
| - Family Physicians | 2 | 115,130 |
| - Ophthalmologists | 1 | 178 |
| - Multiple or All Specialties | 20 | 8,100,101,117,121,129,132,133,137, 141,149,156,157,159,161,167,168, 177,187,189 |
| - Residents | 2 | 127,144 |
| Nurses | 2 | 100,101 |
| Health Informatics Practitioners or Experts | 6 | 18,50,100,143,151,184 |
| Healthcare Practitioners and Clinicians in Multiple Professions | 4 | 124,135,150,162 |

ICU: intensive care unit, IT: information technology. Some studies may appear in more than one category. Studies that were unclear who the respondents were and studies not relying on respondent-provided data were not listed.

**Table 4.** List of studies in the methodological review by country.

| Country | Number of Studies | List of Study Reference Numbers |
|---|---|---|
| U.S. | | |
| - Nationwide | 63 | 16-18,41,50,76,103,104,106,107, 109-112,116-120,125,126,129, 131-133,137-143,145-148,151-153, 155-160,162,163,165-168,172-175, 177-180,182,183,185,186 |
| - Statewide | 12 | 8,70,72,75,115,136,149,161,171,176, 188,189 |
| - Certain U.S. Cities | 2 | 121,130 |
| - Certain Organizations in U.S. | 10 | 73,100,101,113,114,122,123,127,144 ,164 |
| Australia | 5 | 18,43,105,154,158 |
| Canada | 6 | 68,134,158,170,181,187 |
| Denmark | 1 | 184 |
| Germany | 2 | 18,158 |
| Japan | 2 | 108,150 |
| the Netherlands | 2 | 18,158 |
| New Zealand | 3 | 18,128,158 |
| Republic of Serbia | 1 | 102 |
| Spain | 1 | 184 |
| Sweden | 1 | 105 |
| Thailand | 1 | 20 |
| United Kingdom | 3 | 18,158,169 |
| Non-Specific (International) | 2 | 124,135 |

Some studies may have been conducted in more than one country.

Different studies reviewed had different units of observation from which they collected data, but these units of observation can be grouped into 3 generic levels of analysis: 1) the individual level, where adoption and use of IT by individual providers was observed, 2) the organizational level, in which adoption and use data are obtained from different health care organizations (such as hospitals, practice offices, or medical groups), and 3) the societal level, when adoption and use is quantified at the society, country, or jurisdiction level. Table 5 presents the classification of studies in the

methodological review into these 3 levels of analysis.

**Table 5.** Studies in the methodological review categorized by level of analysis.

| Level | Number of Studies | List of Study Reference Numbers |
|---|---|---|
| Individual | 33 | 8,43,100,101,105,115,123,124,127,129,130,132,133, 135,137,143,144,149,150,154-159,162,164,167,168, 177,178,187,189 |
| Organizational | 69 | 16,17,20,41,50,68,70,72,73,75,76,102-104,106-114, 116-122,125,126,128,131,134,136,138-142,145-148, 151-153,160,161,163,165,166,169-176,179-183,185, 186,188 |
| Societal | 2 | 18,184 |

Capturing data from a lower level of observation, such as at the organizational level, allows data to be analyzed both at that level and at a higher, more aggregate level, such as a comparison at the state level. On the other hand, it is not possible to conduct an analysis or draw conclusions at a lower level (such as analyzing individuals' adoption) from data obtained at a more aggregate level of observation (e.g., adoption data at the organizational level). Researchers must be careful when they analyze and draw conclusions on a unit of analysis that is at a different level from the unit of observation at which the data are collected, to prevent methodological problems such as the ecological fallacy or the error of reductionism [190]. The ecological fallacy occurs when a statement is made about a lower unit (e.g., individual providers) based on data at a higher unit (e.g., hospitals). For example, an observation that hospitals with higher revenues are more likely to adopt health IT doesn't necessarily suggest that physicians working in these hospitals are more likely to adopt and use the same technology than their counterparts. This is because the adoption process and dynamics at the organizational level is not the

same as those at the level of individual providers [190]. On the other hand, an error of reductionism is committed when a conclusion is drawn at a higher level from data collected at a lower level. For instance, observing that larger hospitals are more likely to adopt health IT should not automatically lead to a conclusion that states with a higher proportion of large hospitals will have a higher IT adoption rate among hospitals than states with predominantly small hospitals, again because the dynamics of adoption at the two levels are different and other contextual characteristics may be at play. Ideally, the unit of observation from which data were collected should be the same or very close to the unit of analysis from which conclusions are drawn to prevent these methodological problems [190]. The methodological review did not reveal studies that obviously committed these fallacies. However, researchers are often interested in understanding IT adoption and use at more than one level, and at times obtain data from multiple units of different levels (such as measuring adoption both at the hospital level and at the individual level). Sometimes policy implications are made at a higher level (such as social strategies to facilitate health IT adoption in a society) based on findings at a lower level. Thus, it is important to be cautious of fallacious conclusions or explanations that could arise from these mismatches.

Technologies Studied

Among the studies reviewed, some examined a large number of information technology, while others focused on a few specific clinical or administrative IT applications such as EHRs, computerized order entry systems, clinical decision support systems (CDSSs), pharmacy information systems, electronic scheduling and billing, or other basic technologies such as personal digital assistants (PDAs) and hand-held technology, networking, and personal computers. Details of the technologies studied appear in Table 6. This diverse set of technologies can be largely classified into clinical IT (such as EHRs, CPOE systems, and CDSSs), which directly supports patient care or clinical activities, administrative IT (such as electronic scheduling and billing), which supports administrative functions not directly affecting clinical activities, and infrastructure IT (e.g., networking and personal computers), which constitutes fundamental infrastructure supporting clinical and administrative functions. Different ways of categorizing health IT exist in the literature. For example, Paré and Sicotte [68] categorized IT in hospitals into patient management and patient care domain, clinical support domain (which supports functions in pharmacy, laboratory, and radiology departments), and administrative domain. Burke and Menachemi [76], classified health IT into clinical, administrative, and strategic IT. Finally, Ochieng and Hosoi [150], categorized IT in hospitals into clinical and administrative IT.

**Table 6.** Information technologies examined by studies in the methodological review.

| Technologies | Number of Studies | List of Study Reference Numbers |
|---|---|---|
| EHRs | 37 | 16-18,43,50,105,115,117,123,124, 132,135-137,141-143,145-147,149, 156,161,162,165,166,168,171,173, 174,176-178,180,183,187,189 |
| Computerized Order Entry Systems | 18 | 41,100,101,104,107,110,112,122, 126,136,140,141,148,160,170,174, 176,180 |
| Electronic Prescribing | 1 | 180 |
| CDSSs | 5 | 140,144,157,174,180 |
| Pharmacy Information Systems | 3 | 103,109,136 |
| Automated Medication Dispensing | 5 | 109,118,136,153,186 |
| Electronic Medication Administration Records | 6 | 118,122,153,170,176,186 |
| Patient management systems | 2 | 128,169 |
| Electronic Communications with Patients and Clinicians | 2 | 130,157 |
| Electronic Scheduling and Billing Systems | 2 | 121,141 |
| Telemedicine and Telehealth | 2 | 134,146 |
| PACS | 3 | 142,170,183 |
| Nurse Chart Applications | 1 | 183 |
| Anesthesia Information Systems | 1 | 179 |
| ICU Information Systems | 2 | 164,170 |
| PDA and Handheld Technology | 6 | 117,122,127,132,146,149 |
| Bar-coding Technology | 6 | 118,122,136,146,153,186 |
| Internet Access or Use | 7 | 20,117,121,123,127,130,132 |
| Local Area Networks | 2 | 20,102 |
| Wireless Technologies | 4 | 124,135,170,176 |
| Personal Computers | 8 | 20,102,106,117,121,127,128,130 |
| A diverse list of technologies or applications studied | 35 | 8,68,70,72,73,75,76,108,113,114, 116,119,120,125,129,131,133,138, 139,150-152,154,155,158,159,163, 167,172,175,181,182,184,185,188 |

CDSS: clinical decision support system, EHR: electronic health record, ICU: intensive care unit, PACS: picture archival and communication system, PDA: personal digital assistant. Some studies may have investigated more than one technology.

Study Design

Quantitative studies in informatics can be classified into either measurement studies or demonstration studies [191]. A measurement study is a study undertaken to develop and refine a particular measurement method, whereas a demonstration study intends to address a particular research question of direct importance. Among the studies reviewed, a few were measurement studies whose primary purpose was to develop and validate certain methods to measure IT adoption [68,76,181]. Others were demonstration studies, which could be further categorized into descriptive, comparative, and correlational studies [191] (Table 7). Some studies reviewed were descriptive and intended to describe or estimate the state of IT adoption or use. Others were correlational (or observational) studies aimed at exploring the relationships among adoption and other variables without manipulation of the study environments. None of the studies were comparative or experimental studies in which the investigators created "a contrasting set of conditions" and compared the outcome of interest across the conditions [191]. One additional study was qualitative and exploratory in nature, seeking to gain more insights or understanding of factors that may influence health IT adoption without explicit quantitative measurements [187].

**Table 7.** Studies in the methodological review categorized by type of studies.

| Type of Studies | Number of Studies | List of Study Reference Numbers |
|---|---|---|
| Quantitative Measurement Studies | 3 | 68,76,181 |
| Demonstration Studies | | |
| Descriptive | 64 | 16,17,20,41,70,75,102-110,112,114,117-119, 122-129,132,133,135,137,139,140-142,145,146, 151-158,160,161,163,166,168,171,172,174, 176-180,182,184,186,188,189 |
| Correlational | 64 | 8,17,50,72,73,100,101,103,107,109-113,115,116, 118,120,121,126,129,130-134,136,138,140,141, 143,144,147-150,153-155,157,159,160-162, 164-171,173-175,177-180,182,183,185,186,189 |
| Comparative | - | None |
| Qualitative | 1 | 187 |

Some studies may be classified into more than one category.

In most of the studies, IT adoption or use is among the outcomes, if not the main outcome, of the study, but in some cases it is one of the explanatory variables (Table 8). Among those studies that investigated the relationships between IT adoption or use and other variables, most investigated how characteristics or attitudes of the respondents, characteristics of their organizations, or environmental factors are associated with IT adoption or use. A small number of studies were interested in understanding how IT adoption or use influences other outcomes such as user satisfaction, attitudes toward IT use, clinical outcomes, and financial performance of health care organizations. These outcomes fit into DeLone and McLean's framework of IS success [24,27], which posits that IT adoption/use is related to user satisfaction, service quality, individual impacts, and organizational impacts.

**Table 8.** Dependent and independent variables of the studies reviewed.

| Dependent Variable | Independent Variables | Number of Studies | List of Study Reference Number |
|---|---|---|---|
| IT Adoption/Use | None | 36 | 16,18,20,41,43,70,75,76,102, 104-106,108,114,117,119, 122-125,127,128,135,137,139, 142,145,146,151,152,158,163, 172,176,184,188 |
| IT Adoption/Use | Individual Characteristics and Attitudes, Organizational, and/or Environmental Factors | 60 | 17,50,68,73,100,103,107,109, 110,112,113,115,116,118,120, 121,126,129,130,132-134,136, 138,140,141,143,144,147-149, 153-157,159-162,164-171, 173-175,177-182,185,186,189 |
| User Satisfaction | IT Adoption/Use | 1 | 101 |
| Attitudes Toward IT Use | IT Adoption/Use | 1 | 150 |
| Clinical Outcomes | IT Adoption/Use | 4 | 8,72,131,183 |
| Health Care Costs | IT Adoption/Use | 1 | 8 |
| Organizational Financial Performance | IT Adoption/Use | 2 | 72,111 |

Some studies may be classified into more than one category.

**Table 9.** Sampling design used by the studies reviewed.

| Sampling Technique | Number of Studies | List of Study Reference Numbers |
|---|---|---|
| Probability Sampling | | |
| Simple Random Sampling | 12 | 8,103-107,109,110,137,158,177, 178 |
| Stratified Random Sampling | 16 | 20,112,118,126,132,133,140,145, 153,154,157,160,161,171,174,186 |
| Multi-Stage Probability Sampling | 3 | 141,156,168 |
| Non-Probability Sampling (including Convenience, Purposive, and Quota Sampling) | 22 | 50,73,100,101,117,119,121,122, 124,125,127,130,135,139,143,148, 150,152,163,164,172,187 |
| Census | 32 | 16,17,68,70,75,102,108,113-115, 120,123,128,134,136,142,144,146, 149,155,162,165,166,169,170,176, 179,180-182,185,188 |

Studies with unclear sampling technique used are not listed.

Table 9 shows the classification of the studies reviewed based on the sampling design. Many of the studies used a probability sample to obtain the study data. Among these, some used a simple random sample drawn from a sampling frame they obtained. Others used a stratified random sample based on characteristics such as geographic location [20], urban/rural status [154], size of the practice or organization [112,118,126,140,153,160,174,186], practice site [161], respondent specialty [132,157], and a combination of two or more respondent and organizational characteristics [133,145,171]. A series of the National Ambulatory Medical Care Survey (NAMCS) studies employed multi-stage probability sampling to select geographic primary sampling units and physicians practicing within them [141,156,168]. Non-probability sampling such as convenience sampling, purposive sampling, or quota sampling techniques were used in a considerable number of studies. A problem with these non-probability sampling techniques is that the resulting sample are generally not representative of the population, so any findings observed in the sample are not likely to reflect findings in the population. For instance, obtaining data on IT adoption by a number of health care organizations that are part of a voluntary local membership network, though there are descriptive values on their own, may not be appropriate for a study aiming to estimate the extent of IT adoption in a larger group of organizations. Studies that use non-probability sampling therefore should be interpreted cautiously if the intent is to draw conclusions generalizable to a larger population. Rather than using probability or non-probability sampling, many of the studies reviewed appeared to use a census, which consists of all the units in the desired population, as a sampling frame.

One methodological problem that was revealed from the methodological review is the finding that several studies employed confidence intervals or frequentist statistical inference techniques such as t-tests, chi-square tests, or other advanced procedures to perform hypothesis testing on either a census study or a study that does not employ probability sampling techniques [17,113,115,120,134,164,165,170,188]. Only one study from the review was found to state that statistical significance was not appropriate since it was a census [75]. Statistical methods such as t-tests produce a p-value that represents the probability of obtaining a result as extreme or more extreme than the observed finding, assuming that the null hypothesis that no real effect exists is true [192]. It addresses how likely the finding would be observed simply by chance alone as an artifact of the sampling variability (i.e., sampling error). In a census study where the sample contains all instances of the targeted subjects in the population about which conclusions are drawn, the sample is the same as the population and represents the universe of all subjects from which data would be collected. In this case, no random sampling is employed, so any observed difference, large or small, is an actual difference that isn't due to chance (but could still be biased due to non-probabilistic errors such as nonresponses or measurement errors). Similarly, in a study employing non-probability sampling, an observed difference might be influenced by non-random errors resulting from problems in the study methods. Employing statistical tests to evaluate the likelihood of observing the outcome due to chance does not make sense (since random sampling chance does not play a role), so their resulting statistics should be interpreted cautiously. At the minimum, it should be noted that these frequentist statistics should be interpreted as if the sample

were randomly selected from a larger hypothetical population (for a census study) or the sample were representative of the population (for a study employing non-probability sampling), although it is not the case. Sometimes, it is unclear if the intention of the researchers is to draw conclusions entirely on the sample or to provide some statements about a larger group in which the sample is a subset. For example, a study that examines health IT use by all providers in one hospital may limit its scope at describing the pattern of IT use in the hospital, or alternatively, make claims that are applicable to providers both at the studied hospital and other hospitals. Since employing hypothesis testing techniques is not appropriate in the former (a census) but it might be in the latter (if the sample is representative), it is important that the researchers are aware of their objective and decide whether the statistical tests are appropriate.

Data Collection

Table 10 shows the data collection methods used by the studies reviewed. A majority of the studies used quantitative or objectivist [191] approaches to collect and analyze data. The predominantly used data collection techniques were surveys or structured interviews. But some studies used less common quantitative methods either alone [169] or in conjunction with data from surveys [144,151] or expert interviews [184]. These techniques included using the modified Delphi technique to reach consensus on an estimate of adoption [151] or using system logs to establish the objective assessment of IT use [144,169,184]. Some studies also employed qualitative or subjectivist [191] approaches such as interviews with experts [18,184] or qualitative interviews with participants [134,187]. Many studies mainly used IT adoption

measurement data they primarily collected, while others used secondary IT adoption data collected elsewhere to conduct their analysis (Table 11). There were also a few studies using both primary and secondary sources of IT adoption data. One of these studies used adoption estimates from the literature review together with primary data from expert interviews [18], while another realized the limitations of the secondary survey data they had and conducted a supplementary survey to obtain primary data [43]. The most common secondary data source of IT adoption among the studies reviewed was the HIMSS Analytics™ Database (formerly the Dorenfest IHDS+ Database™), which is an annually-updated database of IT environments of large health care providers in the U.S. [193,194]. Other secondary data sources included results from other previously conducted surveys or from an unspecified source (Table 11).

**Table 10.** Data collection methods used by studies in the methodological review.

| Method | Number of Studies | List of Study Reference Numbers |
|---|---|---|
| Quantitative | | |
| Survey/Structured Interviews | 98 | 8,16,17,20,41,43,50,68,70,72,73,75, 76,100-150,152-168,170-182,185,186, 188,189 |
| Modified Delphi | 1 | 151 |
| Secondary Data from System Logs | 3 | 144,169,184 |
| Qualitative | | |
| Expert Interviews | 2 | 18,184 |
| Participant Interviews | 2 | 134,187 |

No distinction was made between primary and secondary data sources using these methods. Some studies may have used multiple methods.

**Table 11.** Data sources of the studies in the methodological review.

| Source | Number of Studies | List of Study Reference Numbers |
|---|---|---|
| Primary Data* | 87 | 8,16-18,20,41,43,50,68,70,73,75,100-110, 112-115,117-131,133-137,139,140-146,149,150, 152-158,160-165,168,170-172,174,176-182, 185-189 |
| Secondary Data | | |
| HIMSS Analytics™ (Dorenfest IHDS+ Database™) | 7 | 72,76,116,138,166,173,175 |
| From Prior Surveys | 7 | 43,111,132,147,148,159,167 |
| System Logs | 3 | 144,169,184 |
| Literature | 1 | 18 |
| Unspecified Secondary Source | 1 | 183 |

Some studies may have used multiple sources.
* See Table 10 for data sources of studies obtaining primary data.

Surveys were the method of data collection used in the overwhelming number of studies, probably because data on the status of IT adoption or use are often not available publicly and it is often not feasible to directly observe the state of adoption in a large number of respondents. A survey allows the researchers to obtain data directly from the respondents, although there are some issues that could arise when a survey is conducted. First, a low response rate and any differences in responses among respondents and nonrespondents could result in biased estimates or wrong conclusions. This problem will be exacerbated if the mode of survey encourages high IT adopters to respond to the survey to a different degree than low IT adopters. Furthermore, appropriate survey design and wording are crucial to prevent respondents' misunderstanding or confusion. Lastly, self-reported answers to a survey may not be entirely truthful. For this reason, some studies used other sources of data such as system logs which are generally more objective

and more accurate than self-reported responses. In cases where a survey is the best available data collection method, appropriate attention to the survey administration methodology, survey design, and item wordings, such as following well-established methods as recommended by Dillman [195] would reduce the likelihood and severity of these problems.

**Table 12.** Survey modes used among the studies obtaining primary data using surveys.

| Survey Mode | Number of Studies | List of Study Reference Numbers |
|---|---|---|
| Single-Mode | | |
| Self-administered Paper-Based Survey | 45 | 8,17,20,68,70,73,100-110,112,113, 115,118,122,123,126-128,130,136, 137,140,143,144,149,150,153,154, 157,160,164,174,177,181,186,188, 189 |
| Telephone Survey | 4 | 129,131,134,185 |
| Interviewer-administered Face-to-Face Survey | 3 | 141,156,168 |
| Self-administered Electronic Survey | 13 | 119,120,124,125,135,139,152,155, 163,170,172,179,180 |
| Mixed-Mode | | |
| Paper-based and Electronic Surveys | 9 | 50,75,121,133,145,162,165,176, 182 |
| Paper-based and Telephone Surveys | 3 | 41,158,161 |
| Electronic and Telephone Surveys | 2 | 142,178 |
| Fax and Web-based Surveys | 2 | 16,146 |
| Paper-Based, Telephone, Fax, and Electronic Surveys | 1 | 171 |
| Unspecified | 2 | 114,117 |

The different survey modes used among the studies obtaining primary data from a survey are presented in Table 12. The most common mode of survey was the self-administered paper-based surveys (either by mail or in person). Others used interviewer-administered telephone surveys, interviewer-administered face-to-face surveys, or self-administered surveys conducted via the Web or electronic mail. Some studies, however, used mixed-mode surveys consisting of paper-based and electronic surveys, paper-based and telephone surveys, electronic and telephone surveys, fax and Web-based surveys, and a combination of paper-based, telephone, fax, and electronic surveys used in a study [171]. Two studies did not report the survey mode employed [114,117].

The mode of a survey is an important aspect of survey methodology that is sometimes overlooked by researchers. Different modes may result in different likelihoods that certain groups of subjects would respond [195]. This is particularly important in surveys of IT adoption, because electronic surveys may encourage respondents with strong technical background, good attitude toward IT, or more advanced IT infrastructure to respond while others with little technical skills, poor attitude toward IT, or primitive systems are less likely to respond. This could result in estimates of IT adoption that are too optimistic, and it may also jeopardize the validity of hypothesis testing. Although electronic surveys are usually less costly than mail or telephone surveys, researchers must be aware of their pitfalls and address these non-response bias issues before conclusions are drawn about survey results. Furthermore, many researchers used multiple survey modes to increase the overall response rate of their studies or to reduce costs, but this often produces unintended consequences in terms of measurement differences that might

occur simply because different modes are used [195]. Although mix-mode surveys are sometimes desirable, researchers should be cautious when multiple modes are used and attempt to design the survey format that assures respondents have a "common mental stimulus" regardless of the survey mode, to the extent possible [195].

**Table 13.** Study design of survey studies reviewed.

| Design | Number of Studies | List of Study Reference Numbers |
|---|---|---|
| Cross-sectional | 56 | 8,17,20,50,68,70,72,73,75,100-102,105,106,108, 113-115,117,120-123,127-131,133,134,136,137, 142-145,149,150,154,155,157,158,162,164,165,170, 171,176-182,185,188 |
| Longitudinal/ Repeated Survey Series | 29 | 16,41,103,104,107,109,110,112,118,119,124-126,135, 139,140,141,146,152,153,156,160,161,163,168,172, 174,186,189 |

Most of the surveys in the review were cross-sectional in nature, which allows the researchers to see a snapshot of the state of IT adoption or to identify associations between IT adoption and other factors, but not to establish causation. In contrast, some conducted a series of surveys over a period of time, which allows longitudinal comparisons of health IT adoption and its trends, or possibly enables researchers to argue for causality [183]. Table 13 classifies the survey studies reviewed into either cross-sectional survey or those that were part of a repeated series of surveys. One of the longitudinal series of surveys that measures health IT adoption is the National Ambulatory Medical Care Survey (NAMCS) [141,156,168], which conducts annual probability surveys of U.S. physicians providing direct patient care conducted by the National Center for Health Statistics, the Centers for Disease Control and Prevention. Annual NAMCS data from 2001 to 2006 were used to investigate how EHR use in

physician offices had progressed over time. The American Society of Health-System Pharmacists (ASHP) also conducted a series of annual nationwide surveys of hospital pharmaceutical processes, which contains some items related to adoption and use of pharmacy IT tools [103,107,109,110,112,118,126,140,153,160,174,186]. Another large scale nationwide survey series was the American Hospital Association (AHA)'s 2005 and 2006 studies of health IT adoption in U.S. hospitals [16,146]. Though not scientific surveys, the Healthcare Information and Management Systems Society (HIMSS)'s Annual HIMSS Leadership Surveys [119,125,139,152,163,172] of the current and future use of health IT by health care facilities across the U.S. are widely known in the industry. Some studies (for example, Ash et al. [41] and Simon et al. [189]) conducted a repeated survey within the sample previously studied in order to track the progress of health IT adoption within the same groups.

Conceptualization of IT Adoption

Another striking observation arising from this review is the consistent lack of a conceptual framework underlying IT adoption. Only a relatively small number of studies drew on existing theories or proposed a new framework to conceptualize IT adoption. Theories discussed include the diffusion of innovations theory [50,76,130,138,150], the IT sophistication model [68,70,72,73,75,181], the IT munificence construct [76], the organizational behavior theory [50], innovation diffusion and infusion [50], the theory of reasoned action [150], the technology acceptance model [144], the information technology adoption model [144], the UTAUT model [20], the concepts of automation and usability [8,164], the chasm theory of marketing [115], the resource dependence

theory [166], and the strategic contingency theory [76]. The majority of the studies did not mention or propose a theory or a conceptual framework on which the measurement of IT adoption in the studies was based. Such a theory would frame how IT adoption should be looked at and thought about [190]. It allows us to link an empirical study to a large body of knowledge contributed by other research. An empirical study without an underlying theoretical framework would be appropriate if it is a descriptive study that does not intend to extrapolate beyond the findings observed, or if the researchers use an inductive approach to build a theory from the ground up. However, it is important that researchers determine how empirical results from their IT adoption studies could contribute to the body of knowledge other than simply a description of the state of adoption. This could be achieved by having a theoretical or conceptual framework that drives how IT adoption should be operationalized, how its relationships with other factors should be investigated, and how empirical results would lead to confirmation, refutation, extension, or modification of a certain IT adoption theory. By this virtue, we will continue to have refined theories that help explain or let us understand a complex structure and a dynamic process like health IT adoption.

Most of the studies viewed IT adoption as simple measures such as IT availability and IT use. IT availability was often measured as whether or not or the degree to which certain technologies or specific functionalities were available, while IT use was measured as the respondent-reported extent of use, the system-logged extent of use, or the expert-estimated extent of use (Table 14). Sometimes, what a study actually measured appears to be availability of certain technologies or functions, not the extent of use, even though the

term "use" was used [108,113,117,118,128,141,153,156,159,165,168,170,178,182,186, 187], highlighting how tightly linked these two concepts are. Other studies conceptualized IT adoption as constructs such as IT diffusion (breadth) and infusion (depth) [50], IT sophistication [68,70,72,73,75,181], IT munificence [76], and automation [8,164].

**Table 14.** IT adoption measures used in the studies reviewed.

| IT Adoption Measure | Number of Studies | List of Study Reference Numbers |
|---|---|---|
| IT Availability | 78 | 8,16,17,20,41,102-104,106-114,116-126, 128-131,135-142,145-148,150-156,158-166, 168,170-180,182,183,186-189 |
| IT Use | | |
| Self-Reported | 33 | 20,43,100,101,104,105,107,112,115,123,127, 128,130,132,133,140,143,144,149,154,157, 158,161,162,167,171,174,176,177,179,180, 185,189 |
| System-Logged | 3 | 134,144,169 |
| Expert-Estimated | 2 | 18,184 |
| IT Diffusion (Breadth) and Infusion (Depth) | 1 | 50 |
| IT Sophistication | 6 | 68,70,72,73,75,181 |
| IT Munificence | 1 | 76 |
| Automation | 2 | 8,164 |

Some studies may have used multiple measures of adoption.

Operationalization of IT Adoption

Measurement of health IT adoption varied from study to study. Many used one or more dichotomous variables to determine whether an information technology is adopted or used [102,103,109-111,115,117,118,121,123,126,127,132,137,141,147,153,160,166, 170,175,180,183,186]. For example, in a survey of residents' use and acceptance of the

Internet and IT tools in one academic medical center, Parekh et al. [127] asked whether the respondents use computers, the Internet, PDAs, and other specific technologies. Realizing that each respondent might define a technology such as an EHR system differently, some studies used a more elaborate definition when these dichotomous questions were asked. For example, Simon et al. [147] asked whether the organization had "an electronic database with the patient's medical record" and whether progress notes were "contained in an electronic medical record" to determine if an EHR was adopted. In another study, Simon et al. [161] defined an EHR as "an integrated clinical information system that tracks patient health data, and may include such functions as visit notes, prescriptions, lab orders, etc." A nonscientific survey of U.S. physicians in 2004 defined an EHR as "a computerized record system that requires you to enter data on patient encounters in such a way that each piece of data can be searched for individually" [137].

Binary outcomes are generally uncomplicated to answer and may be desirable due to the potentially higher response rate associated with simpler or shorter surveys. Sometimes it is even necessary if it is not possible to obtain a more fine-grained indicator from the data source. However, it is not possible to gauge how much or how frequent the technology is used rather than just getting a yes/no response or to classify how IT is implemented or used. Other studies therefore used other approaches to quantify the extent of IT adoption or use. Egger Halbeis et al. [179] classified adoption of anesthesia information management systems into successfully implemented, in the process of implementing, selected but not yet installed, and searching for or about to begin looking for a system. This categorization enables researchers to capture a snapshot of various

implementation stages different respondents are going through. Similar categorizations of the implementation status or implementation plan were used in other studies [16,41,43,119,122,125,136,139,142,145,146,148,152,155,163,172,176,178]. Two AHA surveys classified adoption of health IT into fully implemented, partially implemented, and not implemented [16,146]. Ash et al. [41] and Ash et al. [104] used a single 3-point ordinal scale to measure availability of CPOE in U.S. hospitals. The response categories were not available, partially available, and completely available. In addition to a binary question of whether computerized medical records were used in their practice, Henderson et al. [43] asked general practitioners in Australia who responded affirmatively to the binary question in an ordinal scale question if medical records in their practice were fully computerized (including all externally generated correspondence), fully computerized (other than externally generated correspondence), and partially computerized.

Ordinal scales are helpful not only to assess where an organization is on the progression of implementation stages or to what extent a technology is available, but also to estimate the extent of use by individuals. Ash [50] measured the breadth and depth of computerized patient records adoption in U.S. medical centers in 4-point ordinal scales. Frequency or extent of respondents' use of health IT was measured in ordinal scales by several studies [20,133,144,154,157,161,176,189]. Lastly, a series of ASHP national surveys [107,112,140,174] used scales to gauge the extent to which medication orders were directly entered into computer systems, together with other binary and categorical outcomes related to adoption and use of pharmacy-related IT.

In some cases, numerical variables such as counts or proportions were used to quantify IT adoption or use. Counts were often used to obtain the number of computers or particular hardware devices in use in the organizations [20,102,106,117,128], or the number of IT applications reportedly adopted [76,138,175]. But other uses of count data also existed, such as the numbers of system operations a user performs [169] or the total number of telehealth transmissions [134] as a measure of system use. Others used the counts to determine the proportion of technologies adopted and used the proportion as the measure of IT adoption. For example, Burke et al. [116] divided the number of IT functions a hospital adopted by the number of all available functions inquired to determine the proportion of technologies adopted. On the other hand, Lorence and Churchill [143] directly asked respondents to estimate the percentage of patient record information present in the computerized format. Similarly, Weir et al. [100] asked users of an order entry application to provide numerical estimates of the proportion of ordered entered directly through the system and the proportion of nurses using the software. In two separate surveys, respondents were asked to estimate the extent of physicians' use of CPOE and the proportion of orders physicians entered using a computer using visual analog scales [41,104].

Several studies used checklists or multiple dichotomous items to assess how different technologies or different functions were adopted. Annual HIMSS Leadership Surveys [119,125,139,152,163,172] and the Medical Records Institute's Annual Surveys of Electronic Health Record Trend and Usage [124,135] used multiple checklists to determine what technologies were currently used. In addition, availability and use of

various specific applications or system functions was also evaluated using multiple questions in several other studies [101,108,113,114,120,128,129,145,149,150, 154,156,158,159,161,162,167,168,171,182,187-189]. A survey conducted by Sequist et al. [162] asked whether 10 specific IT functions were available and used by U.S. Indian Health Service health centers before and after EHR implementation, and how frequent, in ordinal scales, the EHR system was used. Menachemi et al. [149] supplemented binary questions on whether PDAs and EHRs were routinely used by a checklist of PDA and EHR functions used. A similar approach was used in the 2005 and 2006 NAMCS surveys [156,168] which, unlike simple dichotomous questions originally used in 2001-2003 NAMCS surveys [141], supplemented a simple scale of whether EHRs were fully or partially used with a series of questions asking if each specific EHR function was available and used.

This approach of incorporating a list of items on specific health IT functionalities has two advantages over a simple binary or categorical question. First, it allows researchers to assess the extent of IT adoption and use in terms of functions available or used, which can be considered the "depth" (infusion) of IT adoption. Furthermore, it enables researchers to use responses of these specific functions to overcome the differential definitions of a technology among respondents and across different studies. This can be achieved by determining what the minimal functional requirements are for a system to be considered, for instance, a basic or a comprehensive EHR system, and from a list of responses to multiple questions, determine if the functions used by a respondent meet the functional requirements defined. The 2005 and 2006 NAMCS surveys [156,168]

and another survey conducted by Shields et al. [165] used the minimally necessary functional definition of a comprehensive EHR system based on the Institute of Medicine's Committee on Data Standards for Patient Safety letter report [196], consisting of 4 core features: computerized medication order entry, computerized laboratory order entry, computerized laboratory results, and physician notes. Jha et al. [17] used results from an expert panel [15] to help define EHR features that constitute basic and comprehensive EHR systems. They described eight functionalities that "should be present in at least one major clinical unit" of a hospital in order to be considered as a *basic* EHR system, which include electronic capture of patient demographics, problem lists, medication lists, discharge summaries, laboratory reports, radiologic reports, diagnostic-test results, and computerized provider order entry of medications [17]. The panel also identified 24 functions that should exist in all major clinical units of a hospital to be considered as a *comprehensive* EHR system. A variation of these requirements was used by DesRoches et al. [177] to assess adoption of basic and fully functional EHRs in an ambulatory setting.

In a number of studies, responses to a list of IT applications or functions were used to generate summary numeric variables used in further analysis. Chew et al. [130] created an index of professional Internet use based on the number of positive responses to dichotomous questions asking if respondents used Internet for particular work-related purposes. In addition to analysis of individual items, Paré & Sicotte [68], Jaana et al. [70], Hart [72], Culler et al. [73], and Alexander [75] used composite scores based on items in each of the IT sophistication dimensions (technical, functional, and integration)

to conduct their analysis, an approach similar to that of another study by Jaana et al. [181]. Likewise, Amarasingham et al. [8] and Amarasingham et al. [164] assessed the degree of clinical processes automation by computing an index based on multiple 5-point scales. Multiple binary outcomes of IT functions usage were also combined to create a summated index [131,185]. Lastly, Li et al. [173] used data on health IT adoption from the 2006 HIMSS Analytics™ Database (formerly Dorenfest IHDS+ Database™) and a modification of the adoption model proposed by Garets and Davis [197] to classify the stages of EHR adoption into 4 levels, ranging from Stage 0 to Stage 3, which were used in subsequent analysis.

Summary of the Methodological Review

In summary, a considerable number of studies that measured health IT adoption were reviewed. These studies varied greatly in terms of study objectives, settings, populations, and technologies studied, data collection techniques and data sources used, the underlying conceptual frameworks, and how IT adoption was measured. The methodological review allows us to understand what have been done and how it was done in the area of health IT adoption. It provides an opportunity for us to look back and critically evaluate the methodological approaches used to investigate health IT adoption, which will allow researchers to realize their strengths, limitations, and methodological concerns. From this insight, they should be able to choose the approach that would work best in their particular situation, while also understanding and trying to address methodological issues that might arise from their choice.

Limitations of the Methodological Review

The methodological review itself has some limitations. First, it was not intended to evaluate a comprehensive list of studies that measured health IT adoption, particularly because such a list would be prohibitively long. In addition, the list of studies identified directly from the search strategy was not a complete list, but instead it had to be supplemented by a considerable number of studies obtained through other means such as the bibliographic inspection. Although this indicates that the search strategy alone might not be so optimal, the use of this search strategy together with the "snowball" approach based on bibliographic inspection resulted in a list of studies that include most of well-known studies on health IT adoption in the recent literature. The fact that the researcher found, among the literature on health IT adoption, repeated citations of key health IT adoption studies included in the review, provides considerable confidence that the list of studies obtained, although probably not comprehensive, captured many, if not most, of the important health IT adoption studies. Since the goal was never to comprehensively describe the methodological approaches used by all studies on health IT adoption, but instead to describe the approaches used by a fairly large sample of studies so that insights could be gained that would lead to well-informed conduct of future adoption studies, the researcher feels that the methodological review has accomplished its goal.

Another important limitation of this review is the fact that one researcher was responsible for identifying the studies meeting the criterion for review, abstracting the details of the studies, and classifying the studies based on a variety of methodological aspects. It is possible that certain aspects of a study might be misunderstood, resulting in

an incorrect description or classification of the methodology. Although considerable effort was made to carefully and repeatedly review the studies, the researcher cannot absolutely guarantee that mistakes were not made. In addition, information about certain methodological aspects was not described in sufficient detail in some of the studies, forcing the researcher to make the best judgment based on the researcher's understanding of the study according to the details described. Certain misinterpretations could be made, although the researcher attempted to keep these to a minimum.

Regardless of these potential problems, the methodological review can equip health IT adoption researchers with a valuable retrospective view of previous studies that provides an opportunity to conduct better subsequent studies. Avenues for future research include studies that investigate whether different approaches to measure health IT adoption would lead to different conclusions, how health IT adoption studies should be designed and conducted to minimize these methodological issues, and a development of a novel approach to enable cross-study comparisons of the state of adoption over time or across geographic borders. In addition, a periodic review of how the conceptualization and measurement of health IT adoption evolves would also be of significant theoretical and practical value.

## Instrument Development

Conceptual Framework

The methodological review reveals that there are a few health IT adoption constructs used among the 104 studies reviewed (Table 14). Among these, IT sophistication is selected as the measure of health IT adoption for a study to be conducted in Thailand. According to Paré and Sicotte [68], IT sophistication is defined as a construct referring to "the diversity of technological devices and software applications used to support patient management and patient care, clinical support, and administrative activities" and "the extent to which computer-based applications are integrated (electronic and automatic transfer of information)." They conceptualize that it comprises three dimensions: technological sophistication, functional sophistication, and integration sophistication. Technological sophistication represents "the diversity of the hardware devices used by health care institutions, referring to various domains such as the newest ones including medical imaging, bar coding devices, data warehousing, wireless networks and PACS equipment," while functional sophistication reflects "the proportion and diversity of processes or activities (e.g., vital sign recording, medication administration, staff scheduling, post-operative report dictation) being supported by computer-based applications. "[The] degree to which computer-based applications are integrated both internally via a common database and externally via electronic communication links" is referred to as integration sophistication [68]. The technological and functional sophistication dimensions are each categorized into three domains: patient management and patient care activities, clinical support activities (including pharmacy,

laboratory, and radiology), and administrative activities.

The IT sophistication construct is selected as a measure of health IT adoption in Thailand for multiple reasons. First, it offers a powerful way of looking at health IT adoption. The model acknowledges that the same technology can be used in a variety of ways and to the differing extent by different organizations, and thus measuring the availability of the technology alone (which corresponds to the technological sophistication) will not be adequate without measuring how the technology is used in the context of how an organization operates (i.e., the functional sophistication). Most studies on health IT adoption examine the extent to which certain technologies are available or used in an organization, or the extent to which a limited number of IT functions exist. Few take a comprehensive look at how clinical and administrative IT helps individual providers perform their work in the context of the organization. The IT sophistication framework proposes a holistic view of IT adoption while offering a way to examine the relationships between different aspects of adoption. Equally important, this construct includes the extent to which an information system exchanges data with other systems within and outside the organization. As the health informatics community would assert, health information exchange is one of the informatics solutions that would greatly benefit the patients, providing better quality care while reducing redundancies in the provision of care [198]. By specifically including the integration aspect of health IT in the construct, the attention health information exchange deserves is raised to the level equal to the adoption of the technology.

Another strength of this construct is that its structure lends itself to easy expansion and modification. Although the conceptual model of IT sophistication proposed by Paré and Sicotte is a significant improvement over simple measures like IT availability or use, it is yet not a complete picture. Technology availability, computerization of work processes, and information exchange between information systems are three important aspects of IT adoption, but the original model of IT sophistication in the IS field as proposed by Raymond and Paré [67] also views IT management processes as another IT sophistication dimension. This managerial dimension was defined as "the mechanisms employed to plan, control, and evaluate present and future applications," manifested by the degree of formalism of the IT management process, the extent of IT-business alignment, and the position of the responsible IT manager. They also argued that this dimension includes "aspects of the preceding managerial practices such as the underlying aims of the firm in adopting IT, the degree of formalization of the adoption process and the implication of top-management in the IT adoption" [67].

Realizing that IT management activities and associated organizational cultures are important in the successful adoption of IT in health care organizations as well, it is important that this managerial and cultural aspect is not forgotten. A number of studies in the health informatics domain view management practices and organizational cultures such as project management, change management, involvement of users and stakeholders in the implementation process, and adequate training as success factors for or organizational readiness to successful health IT adoption [199-203]. Although it is agreed

that these characteristics are critical for successful adoption, viewing them as antecedents to IT adoption may lead to misunderstanding that they are static properties of the organization, or that sustained possession of these practices are not required once IT adoption is accomplished. Rather, these management practices and organizational cultures are dynamic processes that should be "adopted" together, if not prior to, the adoption of technologies themselves, and should be retained in the organization if continued IT adoption is desired.

With the addition of the managerial dimension and a few modifications, a new model of IT sophistication is proposed. In this model, IT sophistication is defined as the extent to which IT and associated managerial practices and organizational cultures are adopted and employed in an organization. The conceptual framework of IT sophistication, modified from Paré and Sicotte [68], is presented in Figure 7.

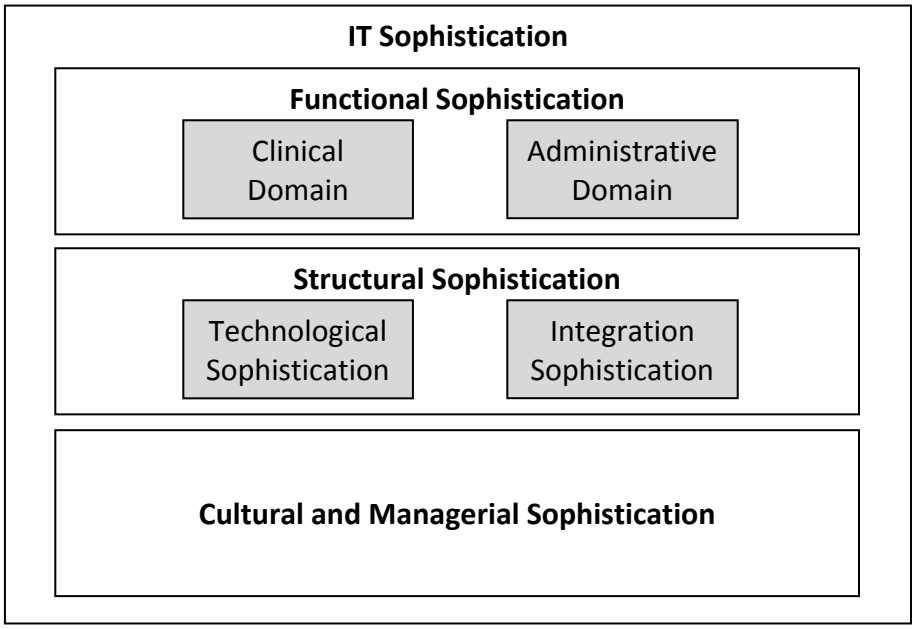



**Figure 7.** The modified conceptual framework of IT sophistication.

In this modified model, IT sophistication consists of 3 first-level dimensions of sophistication: structural sophistication, functional sophistication, and cultural and managerial sophistication. Structural sophistication is defined as the extent to which information technology serves as part of the organization's infrastructure. The two sophistication dimensions originally proposed by Paré and Sicotte [68], namely technological sophistication and integration sophistication, become second-level dimensions of this new structural sophistication, particularly because both are part of an organization's IT infrastructure and support the work performed by individuals. Technological sophistication is defined as the extent to which information technology, including hardware devices and software applications, are made available in an organization to support its operations. Similar to Paré and Sicotte, integration sophistication refers to the extent to which information sharing and exchange takes place among information systems within an organization and with information systems of outside entities.

Functional sophistication reflects the extent to which work processes within an organization are assisted by information technology. These work processes are divided into clinical and administrative domains (simplified from Paré and Sicotte's model with 3 domains). The clinical domain include activities that directly involve patient care by providers and clinical support activities such as those of the pharmacy, laboratory, and radiology departments that enable providers to deliver care. The administrative domain, on the other hand, consists of activities that neither directly involve patient care nor perform clinical functions supporting care delivery. Unlike Paré and Sicotte's

conceptualization of the technological sophistication dimension, however, this modified model's technological sophistication is not further divided into domains because it is realized that some technologies such as networking and bar-coding can be used to support a variety of clinical and administrative activities. Thus, the nature of their use depends on the context of the work, which belongs to the functional dimension, and should not be distinguished in the technological dimension. A significant modification of the IT sophistication model is the addition of the cultural and managerial dimension. This new dimension is defined as the extent to which an organization possesses or adopts management practices and organizational cultures that facilitate successful and continuing adoption of information technology.

The depiction in Figure 7 also illustrates the interrelationships among the dimensions. The framework posits that adoption of management practices and cultures conducive to successful implementation would enable the adoption of the IT infrastructure, consisting of the technologies and the exchange of information. This in turn enables the utilization of the technologies to support the clinical and administrative work processes. Adoption of a lower IT sophistication component enables adoption of the higher components. In other words, computerization of work processes would not happen without adoption of the technologies that make these computerized functions possible. Similarly, adoption of the technologies and integration of systems will likely be unsuccessful without adoption of certain management practices and cultures. The direction of these relationships is not necessarily one-way (bottom-up), however. The computerization of the work processes also enable more technologies to be adopted and

more information to be shared with other systems, while adoption of more technologies would also enable an organization to better adopt and retain certain practices and cultures. For example, by having more sophisticated information technology, an organization would be able to better plan its strategies, communicate its visions, plans, and progresses, and manage subsequent projects.

Instrument Development

Based on the modified conceptual model, a new survey instrument was developed. Items from Paré and Sicotte's original instrument, obtained from the authors, were used as the basis of the modification. The modifications include:

1. The extensive addition of essential work processes and activities conducted in hospitals. The original Paré and Sicotte's instrument contains only a handful of work processes in each domain that may not be adequate to capture the extent of computerization in a wide array of activities a hospital performs. Many activities related to the emergency room, patient management, inpatient care, outpatient care, nursing, surgery/operating room, laboratory, radiology, pharmacy, and administrative functions are added to the new instrument.
2. The change in the question format of items related to the functional sophistication from simple checklists of whether the work processes are computerized to 5-point scales measuring the extent of computerization of the work processes. While the different work processes computerized reflect the depth (i.e., infusion) of functional IT adoption, the scales allow researchers to

capture the breadth (i.e., diffusion) of functional IT adoption across departments within the organization at the same time. This would offer a more complete picture of functional process computerization than simple binary responses.

3. Changes to questions on technological sophistication to include additional technologies and applications that are relevant to hospitals but are not present in the original instrument, as well as technologies common in Thai hospitals.
4. Addition of items related to the newly proposed cultural and managerial sophistication.
5. The addition and revision of questions related to the hospital profile, the IT management profile, and the respondent's profile, in order to allow subsequent validation of the instrument and investigation of organizational factors associated with IT adoption of Thai hospitals.
6. The extensive revision of the question formats, item wording, survey layout, and other design aspects to minimize the possibility of misunderstanding and confusion by respondents.

Development of Cultural and Managerial Sophistication Items

Identification of the managerial and cultural sophistication items was based on a wide array of case studies, scholarly articles, and research studies. The literature contains a rich body of descriptive and prescriptive articles on health IT implementation successes and failures, where a number of certain management practices and organizational values are a recurring theme. At the American Medical Informatics Association (AMIA) 2006

Annual Symposium, ten AMIA working groups sponsored a workshop to examine issues related to success and failure of health IT implementations. Among the topics discussed, lessons learned from experience were shared. The importance of project and risk management, change management, sufficient training, the attention to lessons learned from the past was highlighted. Participants also proposed that best practices for health IT projects are identified, with issues such as change management, common vision among all stakeholders, and workflow and process redesign emphasized [204]. A similar consensus was reached by an expert panel gathered to generate a list of considerations that serve as a guide to successful CPOE implementation [205]. Considerations were grouped into 9 categories: 1) motivation for implementation, 2) vision, leadership, and personnel, 3) costs, 4) integration of workflow and health care processes, 5) value to users, 6) project management and implementation staging, 7) technology-related issues, 8) training and support, and 9) learning, evaluation, and improvement. Lorenzi et al. [206] classified problems that present risks to health IT implementations into 4 categories: design, management, organization, and assessment. Design issues are primarily concerned with the properties of the system itself such as usability and system performance, but the workflow-related issues were also noted. Management issues revolve around the management of organizational change and the implementation process amid contextual and environmental changes, whereas organizational issues include the role, support, and leadership of the organization's management [206].

Change management is among the commonly cited issues that are crucial to the success of a health IT implementation project. A review paper published in the Journal of

the American Medical Informatics Association a decade ago is devoted to the issue of managing change in health IT implementations [207]. The issues discussed in the paper are still valid and are still critical to the project success in today's environment. Case studies from well-known health IT implementation projects facing significant challenges highlight the crucial role of change management. The University of Virginia Medical Center began implementation of a CPOE system in 1988, a project that was 3 years behind schedule, faced almost threefold cost overruns, and resulted in "a major confrontation between the medical staff and the hospital administration" [208]. Though design and usability issues were part of the reasons, the fact that the technology being introduced created a significant change in existing workflows and practices coupled with the leadership's failure to anticipate the magnitude of change resistance also contributed to the problem [208]. In another large-scale implementation of a CPOE system at the Cedars-Sinai Medical Center where physicians' use of the system was mandatory, problems led to temporary suspension of the system 4 months after go-live. The challenges and complexity related to management of change were cited as among the most important lessons learned [209].

Change management is a multi-faceted notion that involves a variety of issues. Nagle and Catford [210] suggest that practical approaches to managing change related to EHR adoption should include leadership and engagement, communication, process and workflow integration, education and training, and evaluation. Riley and Lorenzi [211] offer advice to minimize change resistance and gain physicians' acceptance of new system implementations, which include involvement of physician champions, providing

training and support, attention to the organizational climate, understanding of physicians' values, and creating a sense of ownership accomplished by communications and involvement of physicians in the project.

While there are many facets to the management of change, communications within the implementation team and among members of the organization is an aspect often noted. Communications deficiencies were referred to as among the most important causes of failures [207]. A number of case studies, research articles, and position papers emphasize that communications of project goals, plans, and progresses must be made throughout the organization [212-217]. Another issue that is key to successful implementation is a clear, shared vision that is communicated and understood throughout the organization [205,210,212,214,218,219].

Since health IT often changes how operations are performed, assessment of workflow compatibility and process redesign is another aspect of change management that shouldn't be overlooked. The shift or redistribution of power among different types of information system users that occurs when a new information system is implemented was evident in several studies [220-222]. This power shift, if inappropriately handled, often creates a resistance to change or a confrontation among users, neither of which is healthy for the implementation project. It is therefore imperative that workflow changes introduced by the new information systems are assessed, managed, and communicated [205,209,210,216,219,223,224].

User involvement is also among the most common recommendations of change management strategies toward successful IT adoption. The IS literature suggests that user involvement helps the systems implementation project for multiple reasons [225]. First, it allows the team to capture accurate and complete systems requirements, which are often not as complete or accurate in documentation. Second, it provides the expertise about the organization within which the system is to function, which is usually not present in the implementation team. Third, it helps avoid development of unacceptable or unimportant features. Furthermore, it promotes users' understanding of the system. Involving users also allows them to develop realistic expectations about what the system can and cannot do, provides an opportunity for negotiation and conflict resolution relating to systems design, creates a sense of user ownership, reduces change resistance, and helps commit users to the system [225]. The effect of user participation in developing the feelings of ownership toward a CPOE system is confirmed by a study by Paré et al [226]. The importance of involving and engaging users and promoting user ownership in health IT implementation is also underscored in many case studies, research papers, and review articles in the health informatics and health sciences literature [50,210,211,214,215,219-221,227-237]. Although engagement of physicians are critical to the success of the implementation, the importance of engaging non-physician stakeholders, such as nurses, pharmacists, management, and users in other departments is equally essential and should not be neglected [101,230,235,238].

Support from the organization's leadership for the IT implementation is also extremely important, according to the literature [205,214,218,219,227,230,232,237,239]. Such support includes not only the allocation of sufficient human and financial resources but also the visible, steady political support, active interest, and commitment to the project. It should send a clear signal to the entire organization that the project is vital to the organization's success, and that the management team is ready to provide additional support to the project when needed, which helps reduce the fear and feeling of uncertainty often associated with change resistance.

Health IT implementation is often a complicated process involving various users and departments. Such projects require coordination with involved parties, management of the project schedule and resources, and a process to help monitor the project's progress [227]. Project management is another practice that is frequently mentioned as vital to the success of health IT implementation projects [204,205,227,239]. In addition, before a new system is introduced into the work processes, user training is also repeatedly emphasized [205,210,211,215-218,220,233,235,237,239]. Adequate and timely training tailored to individual users' needs, skills, experience, and job requirements allows users to be familiar with the system and know how a certain procedure should be performed before hand. This helps reduce the disruption of the work processes once the system is in place, which could jeopardize the quality of patient care and the organization's productivity.

Finally, issues related to organizational cultures are also important for successful health IT implementation. Organizational learning, which is the culture in which an organization learns from its mistakes and uses its experience to improve how its work is performed, was noted in the expert consensus statement on considerations for a successful CPOE implementation [205], as well as at the 2006 AMIA workshop on health IT success and failure [204]. The innovativeness of an organization is also influential in determining the success of the implementation. Rogers noted that innovative organizations interested in new ideas of conducting operations lead them to be the first group to adopt an innovation [39]. Shortell et al. investigated the relationships among organizational cultures and the degree to which quality improvement processes were implemented in the organizations. The results indicated that organizations with developmental or innovative culture implemented quality improvement processes to a significantly higher degree compared to other culture types [240]. Since health IT is commonly implemented to improve the quality of care, this suggests that innovativeness might be associated with health IT adoption. Retchin and Wenzel made a similar argument that academic health centers usually possess the cultural readiness to change, which influences the implementation of EHR systems in these centers [237,241]. Lastly, the culture of innovation is cited as one of the aspects of readiness to CPOE adoption [242].

Based on the literature evidence, the researcher developed 11 survey items that belong to the cultural and managerial sophistication dimension. The items include communications of project plans and progresses, workflow considerations, management

support of IT projects, common visions, physician and non-physician user involvement, shared user commitment, project management, adequate training, organizational learning, and innovativeness. This list of managerial and cultural properties that facilitate IT adoption is not intended to be exhaustive or comprehensive, but instead to provide a number of exemplary items known to be associated with successful implementation, which will help guide implementers of health IT. The structure of the model allows addition of more items once the evidence supports their association with successful implementation.

Establishing the Instrument's Face and Content Validity

To establish the face and content validity of the modified instrument, interviews were conducted with 5 experts with backgrounds in medicine, nursing, pharmacy, and health informatics. Some of the experts were Thai and were familiar with the Thai health care system and health delivery. Details of the experts' background and areas of expertise are presented in Table 15.

**Table 15.** Background and areas of expertise of experts interviewed to establish face and content validity of the survey instrument.

| Expert | Familiarity with Thai Health Care System | Familiarity with U.S. Health Care System | Background and Areas of Expertise |
|---|---|---|---|
| A | | ✓ | Pharmacy, Medicine, Health Informatics |
| B | ✓ | | Medicine, Health Informatics |
| C | ✓ | | Pharmacy, Health Informatics |
| D | | ✓ | Medicine, Health Informatics |
| E | | ✓ | Nursing, Health Informatics |

The experts were asked to provide comments related to the instrument's face and content validity. Face validity is "a judgment by the scientific community that the indicator really measures the construct" [190]. It addresses whether, on the face of it, the definition and method of measurement seem to fit. To establish face validity, the experts were provided the definitions of the IT sophistication dimensions and were asked whether the questions and items in the survey address the corresponding dimensions of IT sophistication. Closely linked to the face validity, content validity ensures that the full content of a definition is represented in a measure [190]. The experts were asked to check the list of items in each of the dimensions and suggest any items pertinent to the dimensions that seem to be missing or any items that do not seem to represent the respective dimension.

Based on the expert interviews, a number of changes were made. The list of items related to the functional, structural, and cultural and managerial sophistication were made, and the item wording of some items was revised. Modifications of other items related to the hospital profile, IT management profile, and respondent's profile were also made based on expert comments. The survey was shortened, with some non-critical and redundant questions removed, because some experts were concerned about the survey length. The final survey instrument (provided in Appendix B) consists of 38 questions (some with multiple items) organized in 23 half-pages in the letter-sized booklet format. This survey was subsequently translated into the Thai version, resulting in a 21 half-paged A4-sized booklet (Appendix C), the translation of which was validated by two Thai experts. Table 16 identifies the questions in the instrument related to each dimension

of the IT sophistication construct.

**Table 16.** Questions in the survey instrument for the IT sophistication dimensions.

| Dimension | Questions in the Instrument | Total Number of Items |
|---|---|---|
| Cultural and Managerial Sophistication | Q6 | 11 |
| Structural Sophistication | | |
| Technological Sophistication | Q14 | 18 |
| Integration Sophistication | Q12-Q13 | 12 per question |
| Functional Sophistication | Q11 | 74 |

Each question number identifies a question in the original survey (Appendix B).

## Summary

The theoretical and methodological reviews of studies related to IT adoption have led to the selection of IT sophistication as the framework for the study of health IT adoption in Thai hospitals. This results in the proposed modification of the IT sophistication model and its survey instrument. This model conceptualizes IT adoption in hospitals as a construct consisting of the extent IT is part of a hospital's infrastructure, the extent clinical and administrative work processes are assisted by IT, and the extent facilitating management practices and organizational cultures are present in the hospital. It offers a holistic view of IT adoption that not only focuses on the technology but also the work processes and the managerial and cultural environment in which the technology is operated. By incorporating the managerial and cultural aspects into the IT sophistication construct, it emphasizes the importance of best practices and cultures to the successful adoption of IT. The resulting instrument, whose face and content validity has been established, offers a means to measure IT sophistication in hospitals. The instrument can be used for descriptive purposes simply to describe the state of health IT adoption in a particular setting, to compare the states of adoption across settings or geographic locations, or to track progress of adoption over time. Furthermore, it would allow the study of the multi-faceted relationships between organizational factors and IT adoption, and between IT adoption and clinical and organizational outcomes. It also provides a diagnostic tool that a hospital can use to balance the different dimensions of IT adoption and bring about the better quality and more efficient care health IT has much to offer.

# Appendix A

Literature Review Matrix for

the Methodological Review of Health IT Adoption

(Some studies may be grouped together.)

| Study | Purpose | IT Adoption Framework | Data Collection | Adoption-Related Variable | Level of Observation | Sample/Respondent (N = Sample Size) | Key Findings |
|---|---|---|---|---|---|---|---|
| Amaras-ingham et al. (2009) [8] | To examine the relationship between clinical information technologies and clinical and financial outcomes in a large number of hospitals | Clinical Information Technology Assessment Tool based on the automation concept | Self-administered paper-based survey | The degree to which clinical information processes in the hospital are fully computerized (automation; multi-item 5-point scales) | Individual | A random sample of physicians actively practicing in 72 general acute-care hospitals located within 10 geographically dispersed metropolitan statistical areas in Texas between December 1, 2005 and May 30, 2006 (N = 7,432) | 5 or more physician responses were received for 41 of 72 targeted hospitals (58%). A 10-point increase in the automation of notes and records was associated with a 15% decrease in the adjusted odds of fatal hospitalizations. Higher order entry scores were associated with decreases in the adjusted odds of death for myocardial infarction and coronary artery bypass graft procedures. Higher scores in decision support were associated with reduction in the odds of complications. More automation of test results, order entry, and decision support was also associated with lower costs for all hospital admissions. |
| AHA (2007) [16] | To assess the extent of health IT use in U.S. hospitals and identify barriers to adoption | Not mentioned | Self-administered mixed-mode (fax and Web-based) survey | EHR implementation status (scales) | Organization | All U.S. community hospitals from October - November 2006 (N = 4,936) | 1,543 (31%) hospitals responded to the survey. 68% reported fully or partially implemented EHRs in 2006. Fully implemented hospitals (11%) were more likely to be large, urban, and/or teaching hospitals. CPOE, lab order entry, and electronic alerts were used more than previous years. |

| Study | Purpose | IT Adoption Framework | Data Collection | Adoption-Related Variable | Level of Observation | Sample/Respondent (N = Sample Size) | Key Findings |
|---|---|---|---|---|---|---|---|
| Jha et al. (2009) [17] | To provide more precise estimates of EHR adoption among U.S. hospitals | Not mentioned | Self-administered paper-based survey | Presence of 32 clinical functions of an EHR system and whether they were fully implemented in all, some, or none of clinical units (binary) | Organization | Chief executive officers of all U.S. non-federal acute care hospitals which were members of the American Hospital Association in 2008 (N = 4,814) | 2952 usable responses were received (61%). Only 12% had electronic clinical notes, and CPOE implemented across all units in 17%. 1.5% had comprehensive EHRs in all clinical units and 7.6% had basic EHRs in at least one unit. |
| Jha et al. (2008) [18] | To estimate the state of health IT adoption and use in 7 industrialized nations | Not mentioned | Expert interviews | Point or range estimates of EHR adoption and health information exchange in each country | Country | 7 industrialized nations: U.S., Canada, U.K., Germany, the Netherlands, Australia, and New Zealand | U.K., the Netherlands, Australia, and New Zealand had nearly universal (> 90%) use of EHRs among practitioners, with Germany having moderate adoption (40-80%). U.S. and Canada had a minority of physicians who used EHRs consistently (10-30%). |
| Kijsana-yotin et al. [20] | To study the adoption of health IT in Thailand's community health centers | UTAUT | Self-administered paper-based survey | Number of computers available (count), presence of a local area network and Internet connectivity (binary), and IT use associated with activities in the community health centers (multi-item 4-point scale) | Organization | A random sample of regionally stratified community health centers in Thailand in 2005 (N = 1,607) | 1,323 community health centers responded to the survey (82%). Virtually all (except two) had at least one computer, with an average of 2 computers per center. 36% had a local area network, and less than half of all CHCs had Internet connectivity. Most rated high use of IT for providing care and routine reporting and use for management and administration, while there was moderate use of IT for information searching and collaboration. |

| Study | Purpose | IT Adoption Framework | Data Collection | Adoption-Related Variable | Level of Observation | Sample/Respondent (N = Sample Size) | Key Findings |
|---|---|---|---|---|---|---|---|
| Ash et al. (2004) [41] | To determine the availability of inpatient CPOE and the degree to which physicians use it | Not mentioned | Mixed-mode (self-administered paper-based and interviewer-administered telephone) survey | Availability of CPOE (scale), proportion of physicians using CPOE (participation), and proportion of orders entered through CPOE (saturation) (visual analog scales) | Organization | Contact persons of U.S. hospitals originally selected in random in a previous 1997 survey (N = 964), in 2002 | 110 (11%) mail surveys returned, with additional 516 surveys completed by phone (65% overall response rate). 84% reported not having CPOE. Physician use was required in 46%. Physician use was over 90% in 46% of hospitals with CPOE. |
| Hender-son et al. [43] | To evaluate the availability of computers to general practitioners and computer use for clinical functions | Not mentioned | Secondary data analysis using previously collected self-administered paper-based survey, supplemented with follow-up paper-based survey | The extent of use of a computerized medical record for patients (categorical) | Individual | Randomly selected general practitioners in Australia originally participated in the national Bettering the Evaluation and Care of Health (BEACH) survey in 2003-2004 (N = 1,319) | 11% of respondents did not use a computer at their practice. The majority used a computer at work for e-prescribing (95%), test ordering (82%), and care documentation (80%). Of those with available clinical software, 7% chose not to use it. About 33% kept all patient information in an electronic format. |
| Ash [50] | To identify factors associated with CPR implementation | The diffusion of innovations theory, the organizational behavior theory, innovation diffusion and infusion | Self-administered mixed-mode (paper-based and follow-up e-mail) survey | Extent of CPR use by clinicians (CPR diffusion; breadth), sophistication of CPR within organization (CPR infusion; depth) (4-point scales) | Organization | American Medical Informatics Association members affiliated with 67 U.S. institutions with accredited schools of medicine selected in random (N = 629) | 194 surveys were returned (31%). Organizational factors related to decision making and planning had a significant impact to CPR diffusion within the organizations. Innovation visibility was associated with CPR infusion. |

| Study | Purpose | IT Adoption Framework | Data Collection | Adoption-Related Variable | Level of Observation | Sample/Respondent (N = Sample Size) | Key Findings |
|---|---|---|---|---|---|---|---|
| Paré & Sicotte [68] | To develop and validate a survey instrument to measure IT sophistication in hospitals | Proposing the IT sophistication model | Self-administered paper-based survey | Technological, functional, and integration sophistication in each domain (multi-item scales and checklists) | Organization | Hospital information systems directors of medical centers in Canada's Quebec (N = 80) and Ontario (N = 106) | 74% of the surveys in Quebec and 54% of those in Ontario were returned (overall response rate of 62%). Overall results indicated a high-moderate level of functional sophistication, a somewhat low level of technological sophistication, and a lower level of integration sophistication. Validity and reliability of the instrument was confirmed. |
| Jaana et al. (2005) [70] | To measure IT sophistication in U.S. hospitals and compare with Canadian hospitals | IT sophistication | Self-administered paper-based survey | Technological, functional, and integration sophistication in each clinical subsection (multi-item scales and checklists) | Organization | Chief executive officers or appropriate persons responsible for IT activities of non-federal hospitals in Iowa from October to December 2002 (N = 116) | 74 hospitals completed the survey (63.7%). Hospitals in Iowa have more technologies but fewer computerized processes and integration of patient management activities than Canada. |
| Hart [72] | To evaluate the relationships between IT sophistication and clinical and financial outcomes of acute care hospitals | IT sophistication | Secondary data analysis using 2002 Dorenfest IHDS+ Database™ | Technological, functional, and integration sophistication in the patient management and clinical support domains (multi-item scales and checklists) | Organization | Texas acute care hospitals in 2002 (N = 175) | Small but significant relationships existed between IT sophistication and 3 out of 7 clinical care outcome measures: mortality, post-operative hemorrhage, and post-operative hip fracture rates. Significant positive relationships existed between IT sophistication and patient revenues. |

| Study | Purpose | IT Adoption Framework | Data Collection | Adoption-Related Variable | Level of Observation | Sample/Respondent (N = Sample Size) | Key Findings |
|---|---|---|---|---|---|---|---|
| Culler et al. [73] | To determine if differences exist between IT availability of urban and rural community hospitals | IT sophistication | Self-administered paper-based survey | Numbers of functional applications and technological devices available, based on technological and functional sophistication (counts derived from multi-item checklists) | Organization | Acute care community hospitals that were members of the Georgia Hospital Association's Partnership for Health and Accountability in 2003 (N = 130) | 71 hospitals completed the survey (55%). Overall, the responding hospitals had 59% of all functional applications and technological devices available. On average, hospitals had 64% of all possible functional applications surveyed, with patient management having the highest availability, followed by clinical support and patient care applications. Hospitals had 53% of technological devices on average, with clinical support devices having the highest availability, and patient care and patient management devices followed. |
| Alexand-er [75] | To describe the IT sophistication profile of nursing homes | IT sophistication | Self-administered mixed-mode (paper-based and Web-based) survey | Technological, functional, and integration sophistication (multi-item scales and checklists) | Organization | All nursing homes in Missouri from December 2006 to August 2007 (N = 491) | 199 surveys were returned (41%), yielding 188 usable ones. Most had low IT sophistication in clinical support activities. The highest sophistication is in administrative integration |

| Study | Purpose | IT Adoption Framework | Data Collection | Adoption-Related Variable | Level of Observation | Sample/Respondent (N = Sample Size) | Key Findings |
|---|---|---|---|---|---|---|---|
| Burke & Menache-mi [76] | To develop and validate a theoretically specified measure of IT capability | Proposing IT munificence construct based on the diffusion of innovations theory and the strategic contingency theory | Secondary data analysis using 1999 Dorenfest IHDS+ Database™ (Version 2) | Numbers of automated application systems in clinical, administration, and management functions, the number of shared automated applications available across the enterprise, numbers of linked information/ functions available to outside clinicians, the public, and external business organizations (counts) | Organization | Non-federal U.S. short-term acute care hospitals (N = 1,545) | On average, surveyed hospitals adopted 10.6 clinical applications, 13.5 administrative applications, and 5.0 strategic applications. The proposed IT munificence model fit the data well. |

| Study | Purpose | IT Adoption Framework | Data Collection | Adoption-Related Variable | Level of Observation | Sample/Respondent (N = Sample Size) | Key Findings |
|---|---|---|---|---|---|---|---|
| Weir et al. [100] | To identify important facilitating and impeding factors associated with implementation of an order entry application | Not mentioned | Self-administered paper-based survey | The proportion of physicians, nurse practitioners, and physician assistants entering most of their orders directly using the software, and the proportion of nurses directly using the software | Individual | Medical administration staff, administrators, support staff, users, and physicians of 6 hospitals with successful and unsuccessful implementation of the Order Entry/Results Reporting (OE/RR) 2.5 software from the Salt Lake City Information Service Center of the Veteran's Administration (N = 92) | 52 responses were received (57%). Available functionality was the most commonly mentioned factor. Hardware availability, physician involvement, administration support, and medical administration involvement were more often mentioned by successful hospitals than by less successful hospitals. |
| Lee et al. [101] | To evaluate user satisfaction, its correlates, and self-reported usage patterns on CPOE use in one hospital | Not mentioned | Self-administered paper-based survey | Self-reported use of each specific CPOE feature (binary) | Individual | Physician (N = 200) and nurse (N = 200) CPOE users from medical and surgical services at Brigham and Women's Hospital BWH) in Boston | The response rates were 56% for physicians and 47% for nurses. Users were generally satisfied with CPOE, with physicians more satisfied than nurses and medical staff more satisfied than surgical staff. Features such as off-floor ordering were most frequently used by physicians whereas "quick mode" ordering and personal order sets received little use. |

| Study | Purpose | IT Adoption Framework | Data Collection | Adoption-Related Variable | Level of Observation | Sample/Respondent (N = Sample Size) | Key Findings |
|---|---|---|---|---|---|---|---|
| Simić et al. [102] | To evaluate the diffusion of computer-based IT into health care institutions of the Republic of Serbia | Not mentioned | Self-administered paper-based survey | Number of computers (count), existence of computer networks (binary), type, stage of development, and duration of utilization of application software in use | Organization | Independent health care institutions in the Republic of Serbia, including hospitals, clinics, and pharmacies in 1994 (N = 238) | The overall response rate was 41%. 93% owned computers which were in use. Each had 6 personal computers and used two applications on average. One of the obligatory applications used was for accounting and billing. |
| Reeder et al. [103] | To profile characteristics of pharmaceutical services in non-federal acute care hospitals | Not mentioned | Self-administered paper-based survey (1996 ASHP national survey) | Whether the pharmacy was computerized (binary), and whether the system was used for inpatient or out patient services or both (categorical), and whether they can access information from other systems (binary) | Organization | A simple random sample of pharmacy directors of U.S. non-federal community hospitals in 1996 (N = 1,922) | 713 usable surveys were returned (37%). 92.7% had a computerized pharmacy system, with 65% had both inpatient and ambulatory systems. 72% were able to access information from other computer systems via the hospital network. |
| Ash et al. (1998) [104] | To determine the extent of availability and use of CPOE in U.S. hospitals | Not mentioned | Self-administered paper-based survey | Availability of CPOE (single-item scale), percentage of physicians using CPOE, and percentage of orders by physicians using a computer | Organization | A random sample of accredited U.S. hospitals (N = 1,000) | 324 responses were returned out of 983 eligible respondents (33%). About 66% did not have CPOE available, but many had it for use by non-physicians only. More than half of the hospitals with CPOE reported usage by under 10% of physicians and fewer than 10% of all orders entered by the system. |

| Study | Purpose | IT Adoption Framework | Data Collection | Adoption-Related Variable | Level of Observation | Sample/Respondent (N = Sample Size) | Key Findings |
|---|---|---|---|---|---|---|---|
| Bomba [105] | To investigate adoption of computerized medical records by general practitioners and understand their diffusion | Not mentioned | Self-administered paper-based survey | Present and possible future use of computerized medical records | Individual | General practitioners in Sweden and Australia selected in random (N = 600 in each country) | 302 (50%) and 293 (49%) responses were received from Sweden and Australia, respectively. There was a high rate (72%) of diffusion of computerized medical records among general practitioners in Sweden and a low rate (14%) of diffusion in Australia. |
| Hatcher [106] | To investigate the extent of information systems integration in the financial, medical, and administrative systems of hospitals | Not mentioned | Self-administered paper-based survey | Numbers of computer hardware, percentage of sources of software development, whether systems communicate with each other (counts) | Organization | Acute care hospitals in the U.S. taken randomly from the list in an American Hospital Association publication, from June 1997 to April 1998 (N = 813) | 115 hospitals responded to the survey (15%). An average hospital had 645 microcomputers and 1.7 mainframes, with 91% of the computers communicating |
| Ringold et al. (1999) [107] | To study pharmaceutical prescription and transcription processes in acute care hospitals | Not mentioned | Self-administered paper-based survey (1998 ASHP national survey) | Extent to which inpatient medication orders were entered directly into computers by physicians (scale), if the medication order reviews were undertaken manually, by computer, or both | Organization | A simple random sample of pharmacy directors at U.S. general and children's medical-surgical hospitals in 1998 (N = 1,067) | 548 surveys were returned (52%). Less than 10% of the hospitals had physicians enter inpatient medication orders directly, and 65% of these had less than 25% of orders entered directly by physicians. Most medication order reviews were done manually or by a combination of computer and manual processes. |

| Study | Purpose | IT Adoption Framework | Data Collection | Adoption-Related Variable | Level of Observation | Sample/Respondent (N = Sample Size) | Key Findings |
|---|---|---|---|---|---|---|---|
| Haruki et al. [108] | To describe the use of hospital information systems by Japan hospitals | Not mentioned | Self-administered paper-based survey | Use of information systems for specific functions in 4 categories: dedicated management systems, order entry systems for outpatients and inpatients, and reference systems and other applications (binary) | Organization | Managers of member hospitals of the Japan Hospital Association in 1996-1997 (N = 2,394) | 307 hospitals responded to the survey (13%). Many hospitals used dedicated management systems, particularly for patient registration and accounting, and those for personnel, food control, pharmacy, and financial departments. Order entry systems were well-developed in many hospitals. About half had patient databases containing basic patient information and clinical histories. |
| Ringold et al. (2000) [109] | To study pharmaceutical dispensing and administration processes in acute care hospitals | Not mentioned | Self-administered paper-based survey (1999 ASHP national survey) | Use of automated technology in certain dispensing procedures (multi-item binary variables), presence of a computer system within their hospital or health system, whether the pharmacy computer had access to various types of information through interfaces (binary) | Organization | A simple random sample of pharmacy directors at U.S. general and children's medical-surgical hospitals in 1999 (N = 1,067) | 539 surveys were returned (51%). 32% used automated storage and dispensing linked to the pharmacy computer. 91% reported that their hospital or health system had a computer system. 87% reported that the pharmacy computer had access to patient admission, discharge, and transfer data through an interface. 67% had electronic access to laboratory data. 50% to electronic order-entry data, 38% to automated medication dispensing unit data, 35% to EHRs, and 19% to outpatient affiliates. |

| Study | Purpose | IT Adoption Framework | Data Collection | Adoption-Related Variable | Level of Observation | Sample/Respondent (N = Sample Size) | Key Findings |
|---|---|---|---|---|---|---|---|
| Pedersen et al. (2000) [110] | To study pharmaceutical processes related to monitoring and patient education in acute care hospitals | Not mentioned | Self-administered paper-based survey (2000 ASHP national survey) | Computer access to lab data, and implementation of CPOE (binary) | Organization | A random sample of pharmacy directors at U.S. general and children's medical-surgical hospitals in 2000 (N = 1,063) | 525 surveys were returned (50%). About three fourths provided readily available computer access to lab data. 5% implemented a CPOE system, which helps promote medication therapy monitoring by pharmacists. |
| Parente & Dunbar [111] | To examine the relationship between clinical and financial information systems integration and hospital financial performance | Not mentioned | Secondary data analysis using the 1993 survey of hospitals developed by the Prospective Payment Assessment Commission | Whether the hospital had a clinical information system and whether the clinical and financial information systems were integrated (binary) | Organization | Hospitals participated in the 1993 survey that had 1993-1996 financial data in the Medicare Cost Report and Health Care Investment Analysts hospital summary database (N = 1,308) | Hospitals with integrated information systems had about 1-2% higher total margin and operating margin than those without integrated information systems. |
| Pedersen et al. (2001) [112] | To study pharmaceutical prescription and transcription processes in acute care hospitals | Not mentioned | Self-administered paper-based survey (2001 ASHP national survey) | Presence of CPOE (binary) and extent to which prescribers enter medication orders electronically (scale), presence of linkages that transfer data from CPOE to pharmacy computer system (binary) | Organization | A stratified random sample of pharmacy directors at U.S. general and children's medical-surgical hospitals in 2001, stratified by size (N = 1,091) | 535 surveys were returned (49%). Only 4.3% had CPOE, with larger hospitals using it more often than smaller ones. In large hospitals with 300 beds or more that used CPOE, 36% had 75% of medication orders entered through CPOE. Nearly three-fourths had information system linkages that transfer data from CPOE into the pharmacy computer system. |

| Study | Purpose | IT Adoption Framework | Data Collection | Adoption-Related Variable | Level of Observation | Sample/Respondent (N = Sample Size) | Key Findings |
|---|---|---|---|---|---|---|---|
| Johnson et al. [113] | To explore adoption of electronic information systems by medical group practices within a managed care environment | Not mentioned | Self-administered paper-based survey | Whether each of 16 types of computerized information systems was used within the organization (binary) | Organization | Group practices providing services for Blue Plus, a Minnesota managed care plan during 1995 (N = 155) | Completed surveys were received from 120 practices (77%). A majority had financial management systems, including billing and tracking of charges. Appointment scheduling was available in 78%, and electronic reminders were available in 38-43%. Pharmacy systems were available in 8-10% and computerized medical records in 13% of practices. |
| Commun-ity Clinics Initiative [114] | To provide a comprehensive picture of the information management capacity of California community health clinics | Not mentioned | Survey (mode unspecified) | Acquisition of practice management software, automation of various business, clinical, patient care, and population health functions (binary) | Organization | Community clinics that were part of the Community Clinics Initiative in California in June 2000-2001 (N > 500) | About 75% of the clinics responded to the survey. 54% purchased or upgraded their practice management software. Two-thirds had significant information management capacity in business operations and clinical administration, but few had systems to support patient care and population health. |
| Loomis et al. [115] | To explore differences in attitudes and beliefs about EHRs between users and non-users | Chasm theory of marketing | Self-administered paper-based survey | Use of computer-aided technology (binary) | Individual | Active members of the Indiana Academy of Family Physicians listed in the 2000-2001 membership database (N = 1,398) | 618 usable responses were returned (44%). 14% currently used an EHR. EHR users were more likely to practice in urban areas, in hospital-based practices, and see fewer patients. |
| Burke et al. [116] | To explore IT adoption and associated organizational and market factors | Not mentioned | Secondary data analysis using the 1999 Dorenfest IHDS+ Database™ (Version 2) | IT adoption scores obtained by dividing hospital's IT adoption for each function by the available IT identified in the database (range 0-1) | Organization | Non-federal hospitals that are part of integrated health care delivery networks in the U.S. (N = 3,220) | An average hospital adopted 75% of the total available IT applications. Early adopters predominantly adopted strategic IT, in contrast to administrative IT predominant in late adopters. |

| Study | Purpose | IT Adoption Framework | Data Collection | Adoption-Related Variable | Level of Observation | Sample/Respondent (N = Sample Size) | Key Findings |
|---|---|---|---|---|---|---|---|
| 2002 HIMSS/ Astra-Zeneca Clinician Wireless Survey [117] | To study the use of computers and IT in outpatient clinical settings | Not mentioned | Self-administered survey (mode unspecified) | Number of computers in office (count), presence of an Internet connection, use of handheld technology, an EHR system, and use of e-mail in the facility (binary) | Organization | Physicians, and practice managers and executives who were members of the Medical Group Management Association or American Medical Group Association in 2002 (N unspecified) | A total of 453 responses were received. Nearly all offices had at least one computer, and Internet connectivity and almost three-quarters had handheld technology in place. Almost three-quarters did not have an EHR system. |
| Pedersen (2003) [118] | To study pharmaceutical dispensing and administration processes in acute care hospitals | Not mentioned | Self-administered paper-based survey (2002 ASHP national survey) | Use of point-of-use dispensing device and bar codes for dose verification, use of bar codes for medication administration, and presence of computer-generated medication administration records (binary) | Organization | A stratified random sample of pharmacy directors at U.S. general and children's medical-surgical hospitals in 2002, stratified by size (N = 1,200) | 514 surveys were returned (47%). 8% used a robotic distribution system that automates the dispensing of inpatient unit doses within the centralized distribution system. 58% employed point-of-use dispensing devices in their decentralized distribution systems, while 10% used bar coding to verify doses before dispensing. 1.5% used bar coding for medication administration. Almost two thirds used computer-generated medication administration records. |
| Annual HIMSS Leader-ship Surveys [119,125, 139,152, 163,172] | Annual surveys conducted to report use of IT in health care providers and vendors and obtain opinions about priorities, barriers, and other IT-related information | Not mentioned | Self-administered Web-based survey | EHR implementation status (scale), currently used technologies (checklists) | Organization | Chief information officers at health care facilities across the U.S. (N = 1,500-3,000) | Response rates ranged from 7-20% and were not reported in some surveys. Results indicated increasing attention EHRs, on technologies that help reduce errors and promote safety such as CPOE, and security solutions. |

| Study | Purpose | IT Adoption Framework | Data Collection | Adoption-Related Variable | Level of Observation | Sample/Respondent (N = Sample Size) | Key Findings |
|---|---|---|---|---|---|---|---|
| Pallin et al. (2003) [120] | To describe acquisition and implementation of IT in emergency departments affiliated with a residency program | Not mentioned | Self-administered Web-based survey | Presence of each specific technology and whether it had been implemented fully (binary) | Organization | Program directors of all U.S. emergency medicine residencies in September 2000 (N = 121) | 93 responses were received (77%). A large number (> 75%) fully implemented registration, and lab results, followed by patient accounts, pathology and cardiology reports, radiography order entry, surgical reports/dictations, and patient tracking. 21% fully implemented clinical documentation, 20% fully implemented patient management software, and even fewer implemented medication order entry and error checking. |
| Bell et al. [121] | To determine differences in access to IT among physician offices located in high-minority low-income versus lower-minority higher-income neighborhoods | Not mentioned | Self-administered mixed-mode (paper-based and Web-based) survey | Availability of any computer, Web access, broadband Internet, practice Web page, and scheduling and billing systems in the office (binary) | Organization | Pediatrics, family medicine, and general practice offices in Orange County, California in 2001 (N = 307) | 141 responses were received (46%). 94% had a computer, 77% had Web access, 29% had broadband Internet access, and 53% used computerized scheduling and billing systems. Access to most technologies did not vary by neighborhood. |
| Schu-mock et al. [122] | To investigate the use of medication safety technologies in community hospitals | Not mentioned | Self-administered paper-based survey | Implementation status of medication safety technologies (categorical) | Organization | Pharmacy directors at hospitals that were members of Mercy Resource Management Incorporated, a group purchasing organization representing hospitals located across the U.S. in 2002 (N = 88) | 56 usable surveys were returned (64%). 89% had already implemented one or more types of technology listed. 80% had computer-generated or electronic medication administration records. 71% had an interface between pharmacy systems and laboratory results. CPOE was used in 11%, and PDAs were used by pharmacists in 27% of the hospitals. Bar-coding was used in 5% for dispensing and 2% for administration. |

| Study | Purpose | IT Adoption Framework | Data Collection | Adoption-Related Variable | Level of Observation | Sample/Respondent (N = Sample Size) | Key Findings |
|---|---|---|---|---|---|---|---|
| Andrews et al. [123] | To measure IT use in a primary care practice-based research network | Not mentioned | Self-administered paper-based survey | Current state of IT and practitioners' IT use (multi-item checklists, counts, and scales) | Individual | Primary care practitioners (N = 116) and office managers (N = 68) who were part of the Kentucky Ambulatory Network, a primary care practice-based research network | 46% of office managers and 51% of practitioners completed the survey. All but one had Internet access, with 43% using dial-up. Few (21%) practitioners used an electronic medical record. |
| 2004-2005 Medical Records Institute's Annual Surveys of Electronic Health Record Trend and Usage [124,135] | To describe the pattern of EHR usage among providers | Not mentioned | Self-administered Web-based survey | Presence of specific applications or functions of EHRs and use of wireless connectivity technology (checklists) | Individual | A sample of providers who responded to an e-mail invitation in two surveys conducted in 2004 and 2005 (N unspecified) | 436 and 280 responses were received in in 2004 and 2005, respectively. Administrative and financial functions of EHRs were present in a higher percentage than clinical functions. Patient demographics were available in about 60-70%, whereas physician order entry existed in less than 20%. Wireless network technology was used in 32% of respondents in 2004 and 46% in 2005. |
| Pedersen et al. (2004) [126] | To study pharmaceutical processes related to monitoring and patient education in acute care hospitals | Not mentioned | Self-administered paper-based survey (2003 ASHP national survey) | Computer access to lab data, and implementation of CPOE (binary) | Organization | A stratified random sample of pharmacy directors at U.S. general and children's medical-surgical hospitals in 2003, stratified by size (N = 1,173) | 552 surveys were returned (47%). 78% provided readily available computer access to lab data. 6.5% implemented a CPOE system, which helps promote medication therapy monitoring by pharmacists. |

| Study | Purpose | IT Adoption Framework | Data Collection | Adoption-Related Variable | Level of Observation | Sample/Respondent (N = Sample Size) | Key Findings |
|---|---|---|---|---|---|---|---|
| Parekh et al. [127] | To characterize the use and acceptance of the Internet and IT tools and evaluate concerns of online information | Not mentioned | Self-administered paper-based survey | Use of computer, Internet, e-mail, mobile phone, PDA (binary) | Individual | Residents in multiple specialties at a large U.S. academic medical center during their weekly conferences (N = 150) | 130 surveys returned (90%). Pervasive use of computer, Internet, and e-mail (96% or higher). Moderate use of mobile phone and PDA (54-68%). |
| Didham et al. [128] | To explore the current state of IT systems in general practice | Not mentioned | Self-administered paper-based survey | Number of computers (count), use of patient management system and specific features (binary) | Organization | All currently operating general practices in New Zealand in 2003 (N = 1,188) | 938 responses were returned (80%). A practice had on average 7.3 computers. Almost all practices (99%) used a specific patient management system. |
| Reed & Grossman [129] | To describe patterns of IT adoption among physicians | Not mentioned | Interviewer-administered telephone survey | Existence of IT support for 5 specific patient care functions (binary) | Individual | A sample of U.S. physicians involved in direct patient care in 2000-2001 who were not residents and fellows (N = 12,400) | The response rate was 59%. IT support for access to treatment guidelines was available in 53% of respondents. 41% had IT support for exchange of clinical data, 37% for access to patient notes, 24% for treatment reminder generation, and 11% for e-prescribing. |
| Chew et al. [130] | To identify strategies to facilitate Internet use by family physicians | Diffusion of innovations theory | Self-administered paper-based survey | Access, use, and interest in desktop computers, the Internet, and other technology (summated index based on binary outcomes) | Individual | Members of the local chapter of the American Academy of Family Physicians in a midsized metropolitan area in the Northeastern U.S. in spring 2002 (N = 91) | 58 physicians responded to the survey (63.7%). 93% had computers available at work, and 72% used them. 74% had Internet access at work and 90% had a computer with Internet access at home. 25% received e-mail communications from patients and 21% had replied to patients via e-mail. |

| Study | Purpose | IT Adoption Framework | Data Collection | Adoption-Related Variable | Level of Observation | Sample/Respondent (N = Sample Size) | Key Findings |
|---|---|---|---|---|---|---|---|
| Li et al. (2004) [131] | To assess the extent of diabetes care management processes adoption in physician organizations | Not mentioned | Interviewer-administered telephone survey | Whether there was a computerized problem list, physician progress notes, medication list, reminders and drug interaction information, lab results and radiology results (summated index) | Organization | U.S. physician organizations surveyed as part of the National Survey of Physician Organizations in 2001 (N = 1,590) | 1,104 organizations responded (70%). Among 987 organizations treating patients with diabetes, 48% used zero or one of the diabetes care management processes. 20% used two, and 32% used three or four processes. |
| Miller et al. [132] | To study physician use of IT and illustrate types of physician IT users | Not mentioned | Secondary data analysis using data from 2001 interviewer-administered telephone survey by Fulcrum Analytics and Deloitte Research | Use of EHR, work-related use of PDA and Internet (binary) | Individual | The original survey data were from a stratified random sample of practicing U.S. physicians, stratified by specialty (N = 23,492) | 1,200 interviews were completed in the original survey (response rate = 5.7%). 13% of respondents used EHRs. An additional 22% used PDA for work but did not use EHRs, and another 39% used Internet for work (but not an EHR or PDA). |
| Audet et al. [133] | To investigate use of EHRs, CPOE, CDSSs, and barriers to adoption | Not mentioned | Self-administered mixed-mode (paper-based and Web-based) survey | Use of specific IT tools (3-point scales) | Individual | A stratified random sample of U.S. physicians involved in direct care of adults and had been in practice at least 3 years post residency (N = 3,598) | 1,837 surveys were returned (53%). The most common use of IT was for billing, followed by electronic lab results viewing, EHRs, e-prescribing, and electronic alerts. |

| Study | Purpose | IT Adoption Framework | Data Collection | Adoption-Related Variable | Level of Observation | Sample/Respondent (N = Sample Size) | Key Findings |
|---|---|---|---|---|---|---|---|
| Gagnon et al. [134] | To explore the effect of hospitals' organizational characteristics on telehealth adoption | Not mentioned | Interviewer-administered telephone survey with qualitative in-depth interviews of actors in a representative subset | Total number of telehealth transmissions from 2000-2002 (counts), whether an equipment upgrade was planned, and whether equipment would be removed (binary) | Organization | Medical directors in hospitals involved in the Extended Telehealth Network of Quebec, Canada (N = 32) | All contacted hospitals participated in the study (100%). Telehealth programs were not isolated but rather located within larger health organizations. Adoption was associated with smaller and rural hospitals. |
| Warner et al. [136] | To assess the extent of pharmacy-related IT application utilization in Florida hospitals | Not mentioned | Self-administered paper-based survey | Implementation status of pharmacy information systems, pharmacy dispensing systems, CPR systems, bar-coded medication management, and CPOE systems (categorical) | Organization | Chief information officers of all acute care hospitals located in Florida in 2003 (N = 199) | 95 respondents completed the survey (48%). 85% reported using a pharmacy information system, and 64% currently used an automated pharmacy dispensing system. 31% had a fully operational CPR in at least one area of the hospital. |
| Terry [137] | To evaluate the use of computerized patient records | Not mentioned | Self-administered paper-based survey | Whether there exists a computerized patient record system in the respondent's practice (binary) | Individual | Office-based family physicians, internists, ob/gyns, and pediatricians randomly selected in August 2004 (N = 10,000) | 1,916 usable surveys were returned (19%). 15% reported using EHRs. Among those who used EHRs, about half had them for less than 2 years. 23% of respondents planned to acquire an EHR within the next 12 months. |

| Study | Purpose | IT Adoption Framework | Data Collection | Adoption-Related Variable | Level of Observation | Sample/Respondent (N = Sample Size) | Key Findings |
|---|---|---|---|---|---|---|---|
| Wang et al. [138] | To study adoption of health information systems by acute care hospitals and examine how hospital market, organizational, and financial factors influence HIS adoption | Diffusion of innovations theory | Secondary data analysis using IT data from the 1998 Dorenfest IHDS+ Database™ | Clinical, administrative, and strategic IT adoption measured by the number of applications reported for each category (counts) | Organization | Non-federal short-term acute care hospitals located in metropolitan statistical areas in the U.S., using 1998 data (N = 1,441) | Metropolitan size had a significant positive association with administrative and strategic systems adoption. Bed size, system affiliation, nongovernmental hospitals, case mix measures, total services, cash flow, and operating revenue per bed were associated with adoption of some categories of IT. |
| Pedersen et al. (2005) [140] | To study pharmaceutical prescription and transcription processes in acute care hospitals | Not mentioned | Self-administered paper-based survey (2004 ASHP national survey) | Presence of CPOE (binary) and extent to which prescribers enter medication orders electronically (scale), presence of integrated CDSS in CPOE, and presence of bidirectional interfaces that transfer data from CPOE to pharmacy computer system (binary) | Organization | A stratified random sample of pharmacy directors at U.S. general and children's medical-surgical hospitals in 2004, stratified by size (N = 1,183) | 493 surveys were returned (42%). Only 4.2% had CPOE, with larger hospitals using it more often than smaller ones. Overall, 61% of those with CPOE had 75% of medication orders entered through CPOE by prescribers. 74% of hospitals with CPOE had integrated CDSSs. Nearly three-fourths had information system linkages that transfer data from CPOE into the pharmacy computer system. |
| Burt & Hing [141] | To describe use of electronic clinical systems to support patient care in physician offices and hospital emergency and outpatient settings | Not mentioned | Interviewer-administered face-to-face survey (2001-2003 NAMCS) | Use of EHRs, electronic billing, CPOE (binary) | Organization | A multi-stage probability sample of non-federal office-based physicians in 2003 (N = 2,011) and non-federal general and short-stay hospitals in the U.S. in 2001-2002 (N = 817) | The response rates for physician and hospitals were 55% and 95%, respectively. 73% of physicians submitted claims electronically. EHRs were used more frequently in hospital settings (31% in EDs and 29% in OPDs) than in physician offices (17%). |

| Study | Purpose | IT Adoption Framework | Data Collection | Adoption-Related Variable | Level of Observation | Sample/Respondent (N = Sample Size) | Key Findings |
|---|---|---|---|---|---|---|---|
| Moylan et al. [142] | To better understand opportunities and challenges facing public hospitals in using EHR and related clinical applications | Not mentioned | Telephone and e-mail survey | Installation status of EHRs in the inpatient, emergency, and ambulatory settings of hospitals and physician office, presence of interfaces between EHR and other systems, installation status of other information systems (categorical) | Organization | Chief information officers or designees of members of the National Association of Public Hospitals and Health Systems, with a separate sample of the University HealthSystem Consortium members serving as a comparison group (N unspecified) | The response rate was 58%. Just over half of public hospitals and health systems had installed or were in the process of installing EHRs. Medical centers that served as the comparison group were more likely to have EHRs, PACS, and other technologies installed or in process. |
| Lorence & Churchill [143] | To determine the prevalence of CPR adoption and variation in adoption patterns | Not mentioned | Self-administered paper-based survey | Percentage of patient record information in computerized form and percentage of computerized records maintained in redundant paper form | Individual | U.S. health care information managers nationwide who were certified as Registered Health Information Administrators or Registered Health Information Technicians (N = 8,700) | 7,151 surveys returned (82%). A majority (52%) of respondents had < 25% of patient information in the computerized format. Regional and setting variations existed. Substantial duplication of CPRs and paper-based records existed in 70% of respondents. |
| Schect-man et al. [144] | To determine if physician experience with and attitude toward computers is associated with adoption of a voluntary ambulatory prescription writing expert system | Technology Acceptance Model and Information Technology Adoption Model | Self-administered paper-based survey of physician attitudes and behaviors, and system logs for system usage | Self-reported frequency of system use (scale) and actual use (system logs) of a computer-based prescription expert system | Individual | Physicians in an academic internal medicine residency training clinic (N = 94) | 84 surveys were received (89%). There was wide variability in system adoption and degree of usage. 72% of physicians reported predominant usage of the expert system six months after implementation. Self-reported and measured usage were strongly correlated. |

| Study | Purpose | IT Adoption Framework | Data Collection | Adoption-Related Variable | Level of Observation | Sample/Respondent (N = Sample Size) | Key Findings |
|---|---|---|---|---|---|---|---|
| Gans et al. [145] | To assess the current use of IT among medical group practices | Not mentioned | Self-administered mixed-mode (Web-based and paper-based) survey (2005 MGMA Survey) | Types of health records used (categorical), implementation status (scale), presence of EHR capabilities (binary) | Organization | A 50% stratified random sample of 34,490 U.S. group practices, stratified by regions and practice sizes in 2005 (exact N unspecified) | 2,879 responses were received, with the response rates ranging from 14% to 27% depending on practice size. 15% reported having EHRs, which varied by size. About 10-14% of the practices fully implemented EHRs, while 10-29% were in the process of implementation, again varying by size. Nearly all of those with EHR had recording and retrieval capabilities for basic information. Capabilities related to management of lab and imaging results and referral were less available, and those related to medication prescription and guideline adherence were least available. |
| AHA (2005) [146] | To assess the extent of IT use among hospitals and better understand barriers to further adoption | Not mentioned | Self-administered mixed-mode (fax and Web-based) survey | Implementation status of bar-coding, telemedicine, PDA, and various functions of EHRs (scales) | Organization | All U.S. community hospitals from April to June 2005 (N = 4,895) | 936 hospitals responded (19%). EHR functions most often used (ranging from 60%-75%) include lab result review, order entry and result review of lab, medications, and imaging studies, and access to patient demographics |
| Simon et al. (2005) [147] | To identify the characteristics of primary care medical groups that distinguish EHR adopters from non-adopters | Not mentioned | Secondary data analysis using data from the interviewer-administered (structured interviews) National Study of Physician Organizations | Whether the organization had an electronic database with patients' medical records and were progress notes contained in an EHR (binary) | Organization | Chief executive officers, presidents, or medical directors of U.S. physician organizations with 20 or more physicians nationwide from September 2000 to September 2001 (N = 1,104) | 738 eligible responses were used (67% response rate). 28% reported having an electronic database with patients' medical records. 13% stated that they had progress notes in an EHR. A combined total of 30% responded affirmatively to at least one of the two questions, representing EHR adopters |

| Study | Purpose | IT Adoption Framework | Data Collection | Adoption-Related Variable | Level of Observation | Sample/Respondent (N = Sample Size) | Key Findings |
|---|---|---|---|---|---|---|---|
| Cutler et al. [148] | To explore CPOE adoption and factors that could explain low CPOE implementation | Not mentioned | Secondary data analysis using previously collected self-administered paper-based survey | Implementation status of CPOE (scale) | Organization | Hospitals previously surveyed in the Leapfrog Group's Hospital Patient Safety Survey, Version 1 from 2002 to April 2003 in 22 selected geographic regions (N = 751) | CPOE implementation was related to hospital ownership and teaching status, but hospital profitability was not associated with CPOE implementation status. |
| Menache-mi et al. (2006) [149] | To investigate the current use of EHRs and PDAs among physicians and compare how they vary from family physicians to others | Not mentioned | Self-administered paper-based survey | Whether PDAs and EHRs were used routinely (binary), and functions used (multi-item checklists) | Individual | Physicians with an active license in Florida (N = 14,921) | 4,203 responses were received (28%). Family physicians reported higher rates of routine PDA use than other specialties, but the EHR use did not differ (23.3% vs. 23.8%). EHR use was associated with practice size, location, and age. |
| Ochieng & Hosoi [150] | To assess the effect of IT skills, status of computerization in the organizations, and attitudes on the desired IT diffusion status | The theory of reasoned action and the diffusion of innovations theory | Self-administered paper-based survey | Present status of computerization in each of the 16 clinical and administrative functions (binary) | Individual | Healthcare workers in 3 chosen hospitals in Japan between November 2003 and January 2004 (N = 390) | A total of 295 responses were returned overall (76%). IT skills of workers and present status of IT adoption influenced their attitudes, which in turn influenced the desired state of IT diffusion in their hospitals. |
| Poon et al. [151] | To estimate the current level of Health IT adoption in 8 key sectors and assess barriers to adoption | Not mentioned | Semi-structured interviews and expert panel discussion | Adoption of each target health IT application, including electronic results review, CPOE, e-prescribing, EHR, and communication tools (rating scales) | Organization | Informants knowledgeable about Boston and Denver's local IT adoption in each of 8 stakeholder groups in 2003 (N = 119) | Estimates from expert panel suggest widespread adoption of claims/eligibility checking, moderate adoption of electronic result viewing, and low adoption of other applications. Stand-alone hospitals and integrated delivery networks tend to have higher adoption of health IT compared to other sectors. |

| Study | Purpose | IT Adoption Framework | Data Collection | Adoption-Related Variable | Level of Observation | Sample/Respondent (N = Sample Size) | Key Findings |
|---|---|---|---|---|---|---|---|
| Pedersen (2006) [153] | To study pharmaceutical dispensing and administration processes in acute care hospitals | Not mentioned | Self-administered paper-based survey (2005 ASHP national survey) | Use of robot and automated dispensing cabinets, use of bar codes for medication administration (binary), types of medication administration records (categorical) | Organization | A stratified random sample of pharmacy directors at U.S. general and children's medical-surgical hospitals in 2005, stratified by size (N = 1,173) | 510 surveys were returned (44%). 15% used a robotic distribution system, while 58% of the hospitals employed automated dispensing cabinets. 9% used bar coding for medication administration. 55% used computer-generated medication administration records, while 21% used an electronic medication administration record system. |
| McInnes et al. [154] | To describe the use of computers for clinical purposes by general practitioners | Not mentioned | Self-administered paper-based survey | Adoption of technologies in practices (multi-item binary variables), use of EHR functions (scales) | Individual | A national stratified random sample of general practitioners in primary care settings in Australia in 2005, stratified by urban/rural status (N = 3,000) | 1,186 responses were received (40%). 87% used a computerized billing. 78% had computerized appointment scheduling. 90% used a clinical software package, 98% of which used it for prescribing, 88% for drug-drug interaction checking, 65% for recording a reason for prescribing, 85% to order lab tests, 78% to run recall systems, and 64% to record progress notes. Less than 20% of those who used a clinical package accessed computerized information during the consultation. |

| Study | Purpose | IT Adoption Framework | Data Collection | Adoption-Related Variable | Level of Observation | Sample/Respondent (N = Sample Size) | Key Findings |
|---|---|---|---|---|---|---|---|
| Anderson & Balas [155] | To evaluate the current level of IT use by primary care physicians | Not mentioned | Self-administered Web-based survey | Implementation status and implementation plans for financially-focused, clinically-focused, and patient-focused IT applications (categorical) | Individual | Primary care physicians in the U.S. (N = 31,743) | 2,145 responses were received (7.3%) , with a total of 1,665 surveys usable. About a quarter implemented EHRs and reported using point-of-care decision support tools. 23% communicated electronically with patients, and 1 in 5 utilized e-prescribing. Adoption varied by specialty. |
| Burt et al. [156] | To describe the use of EHRs among office-based physicians | Not mentioned | Interviewer-administered face-to-face survey (2005 NAMCS) | Whether full or partial EHRs were used (scales) and use of specific EHR features (binary) | Individual | A multi-stage probability sample of non-federal office-based physicians in the U.S. (N = 3,000) | 1,281 usable responses were obtained (67%). 24% of physicians reported using full (11%) or partial (13%) EHRs in office-based practice, a 32% increase since 2001. EHR use varied by practice characteristics but not physicians'. |
| Grant et al. [157] | To assess the current prevalence of non-EHR IT use by physicians and identify associated characteristics | Not mentioned | Self-administered paper-based survey | Frequencies of patient and clinician communications via e-mail, CDSS use in real-time patient management, continuing medical education, and online professional journal access (3-point scales) | Individual | A stratified random sample of U.S. physicians engaged in direct patient care (family practice, internal medicine, and pediatrics) and non-primary care (anesthesiology, general surgery, cardiology), stratified by specialty between November 2003 and June 2004 | 1,662 surveys were returned (58%). CDSS use and online professional access were used most frequently, with patient communication via e-mail used the lowest. 10% never used any of the inquired IT tools. |

| Study | Purpose | IT Adoption Framework | Data Collection | Adoption-Related Variable | Level of Observation | Sample/Respondent (N = Sample Size) | Key Findings |
|---|---|---|---|---|---|---|---|
| Schoen et al. [158] | To study the use of IT and clinical information systems in primary care practices in 7 countries | Not mentioned | Mixed-mode (paper-based and telephone) survey | Use of EHRs in practice and whether the EHRs have specific functions, use of lab order entry, e-prescribing, electronic access to lab results and patient records in practice (binary) | Individual | Primary care physicians in Australia, Canada, Germany, the Netherlands, New Zealand, U.K., and U.S. randomly selected in 2006 (N unspecified) | Response rates were not mentioned. Use of EHRs ranged from 23% in Canada to 28% in U.S. and 98% in the Netherlands. Routine use of lab order entry, e-prescribing, lab results access, and access to patient records varied widely, with New Zealand, the Netherlands, U.K., and Australia among leaders, and Canada and the U.S. lagged behind. |
| Furukawa et al. (2007) [159] | To investigate the relationships between revenue of physician practice and use of clinical IT | Not mentioned | Secondary data analysis using results of the 2001-2002 telephone-based Community Tracking Study (CTS) Physician Survey | Whether computers or other forms of IT were used for each of 5 applications: obtaining information about guidelines, formularies, accessing patient information, write prescription, and exchange data with other physicians (multiple binary variables) | Individual | U.S. physicians in physician-owned practices (N = 6,849) | Practice revenues were associated with physicians' use of IT in patient care. Above-average Medicaid revenue and capitation revenue was associated with higher overall IT use and use of some specific applications. |
| Pedersen et al. (2007) [160] | To study pharmaceutical processes related to monitoring and patient education in acute care hospitals | Not mentioned | Self-administered paper-based survey (2006 ASHP national survey) | Computer access to lab data, presence of electronic transfer of patient information between inpatient and outpatient settings, and implementation of CPOE (binary) | Organization | A stratified random sample of pharmacy directors at U.S. general and children's medical-surgical hospitals in 2006, stratified by size (N = 1,178) | 460 surveys were returned (39%). 87% provided readily available computer access to lab data. About 60% had electronic transfer of patient information between inpatient and outpatient settings. 7% implemented a CPOE system. |

| Study | Purpose | IT Adoption Framework | Data Collection | Adoption-Related Variable | Level of Observation | Sample/Respondent (N = Sample Size) | Key Findings |
|---|---|---|---|---|---|---|---|
| Simon et al. (2007) [161] | To examine physicians' actual use of EHR functions | Not mentioned | Mixed-mode (paper-based and telephone) survey | Whether the main practice had components of any EHR and presence of 10 functions in their EHR (binary), and the degree to which each function was used (3-point scales) | Organization | A stratified random sample of physicians practicing in Massachusetts in spring 2005, selecting 1 physician per practice (N = 1,884) | 1,345 surveys were completed (71%). 29% reported that their practice had adopted EHRs. Among these, 85% had the ability to view lab results, 84% documented visits electronically, 47% ordered lab tests electronically, and 45% transmitted prescriptions to a pharmacy electronically. Less than 50% used these functions most or all of the time. |
| Sequist et al. [162] | To evaluate EHR implementation within the Indian Health Service | Not mentioned | Self-administered mixed-mode (paper-based and electronic) survey | Availability and use of specific health IT functions before and after EHR implementation (multiple binary items) and extent of EHR use (scales) | Individual | Primary care clinicians practicing at 26 Indian Health Service health centers that implemented an EHR (N = 223) | 125 clinicians responded to the survey (56%). Clinicians had been using the Indian Health Service EHRs for a mean of 542 days at the time of the survey. 92% reported computer availability in their personal office, and 61% in the patient exam rooms. 78% reported using EHR with every patient encounter, while 5% never used it. |
| Amaras-ingham et al. (2007) [164] | To develop a measure that assesses automation and usability of an ICU's clinical information system and examine its impact on outcomes | Proposing the Clinical Information Technology Assessment Tool based on automation and usability concepts | Self-administered paper-based survey | The degree to which clinical information processes in the hospital are fully computerized (automation; multi-item 5-point scales) | Individual | Physician ICU directors of Michigan ICUs participating in the Keystone ICU Project (N = 19) | A total of 19 ICU directors completed the survey (100%). The researchers found that a 10-point increase in the clinical information technology score was associated with 4.6 fewer catheter related infections per 1,000 central line days for ICUs participating in the quality improvement intervention for 1 year. |

| Study | Purpose | IT Adoption Framework | Data Collection | Adoption-Related Variable | Level of Observation | Sample/Respondent (N = Sample Size) | Key Findings |
|---|---|---|---|---|---|---|---|
| Shields et al. [165] | To provide the first national assessment of current health IT capacity and EHR adoption rate among community health centers and identify key barriers to EHR adoption | Not mentioned | Mixed-mode (self-administered paper-based and electronic) survey | Use of EHRs (scale) and specific EHR functionalities (multi-item binary) | Organization | Executive directors or designated staff of community health centers that were federally funded as of July 2005 and reported data to the appropriate agency (N = 914) | 725 community health centers responded (80%). About a quarter reported having some EHR capacity. Among those having a full or partial EHR, only 13% had all functions deemed crucial to EHRs (demographics, medication and lab order entry, and lab results) |
| Kazley & Ozcan [166] | To assess the national prevalence of EHR adoption in acute care hospitals and identify organizational and environmental factors using a resource dependence theoretical perspective | Resource dependence theory | Secondary data analysis using 2004 HIMSS Analytics™ Database (Dorenfest IHDS+ Database™) | Automation of EHRs (binary) | Organization | All non-federal U.S. general and surgical acute care hospitals (N = 4,606) | 479 hospitals (10%) had automated EHR. Hospital EHR adoption was associated with environmental uncertainty, system affiliation type, size, and location. |
| Mojtabai [167] | To compare adoption of IT by psychiatrists and other medical providers | Not mentioned | Secondary data analysis using 2004-2005 Community Tracking Study (CTS) Physician Survey | Whether specific IT applications were adopted (multi-item binary variables) | Individual | Non-federal U.S. physicians surveyed in 2004-2005 (total N = 6,628; psychiatrists N = 367) | Overall, psychiatrists tended to use fewer IT applications compared to other medical providers. These differences were significant for clinical data exchange and imaging exchange with hospitals and laboratories, obtaining information about treatment alternatives or guidelines electronically, and generating reminders about preventive services. |

| Study | Purpose | IT Adoption Framework | Data Collection | Adoption-Related Variable | Level of Observation | Sample/Respondent (N = Sample Size) | Key Findings |
|---|---|---|---|---|---|---|---|
| Hing et al. [168] | To describe the use of EHRs in physician offices | Not mentioned | Interviewer-administered face-to-face survey (2006 NAMCS) | Whether full or partial EHRs were used (scales), and availability and use of specific EHR features (binary) | Individual | A multi-stage probability sample of non-federal office-based physicians in the U.S. (N = 3,350) | 1,311 eligible sampled physicians responded (64%). 29% of physicians reported using full (14.5%) or partial (14.7%) EHRs in office-based practice, a 22% increase since 2005. 12.4% reported having 4 features minimally necessary for a comprehensive EHR system. |
| Evans et al. [169] | To evaluate if practice characteristics were associated with variations in use of a Web-based clinical information system for diabetes | Not mentioned | Analysis of system logs on usage | Numbers of Web-based operations that occurred in the use of a clinical information system at each practice (counts) | Organization | General practices in Tayside, Scotland, that were part of a managed clinical network for diabetes care between 2001 and 2003 (N = 70) | Initially only a few practices made very frequent use of the system, and the use gradually became more evenly spread, particularly among nurse users. Only a small number of practices had frequent system use by GPs. |
| Lapinsky et al. [170] | To study the availability, implementation, and variability of information systems in the ICU setting | Not mentioned | Self-administered Web-based survey | Electronic access of ICU clinical data, availability of decision support tools, availability of PACS, use of order entry and medication administration systems, and use of wireless or mobile systems in the ICU (binary) | Organization | ICU directors of level 3 ICUs (those providing mechanical ventilation) in Ontario, Canada in 2006 (N = 73) | 50 responses were received (69%). 92% had electronic access to lab data and imaging reports. 76% used PACS, 46% used medication administration records, 26% used physician or nursing notes, and 22% used medication order entry. In 46% of the ICUs, wireless networks and mobile computing systems were used. |

| Study | Purpose | IT Adoption Framework | Data Collection | Adoption-Related Variable | Level of Observation | Sample/Respondent (N = Sample Size) | Key Findings |
|---|---|---|---|---|---|---|---|
| Simon et al. (2008) [171] | To determine the current state of EHR adoption and the degree to which physicians use EHR functionalities | Not mentioned | Mixed-mode (paper-based, telephone, fax, and electronic) survey | Use of computerized scheduling, billing, prescribing, and EHRs, the presence of EHR functionalities, and whether more than 50% of clinicians were actively using each (binary) | Organization | Medical and surgical practices in Massachusetts in 2005 selected in random (N = 1,977), stratified by location, hospital affiliation, specialty, and size | 847 surveys were returned (46%). 18% of practices reported having EHRs. Visit notes, lab test results, and medication lists were most common functionalities available within EHR systems. |
| Li et al. (2008) [173] | To examine the relationship between multihospital system affiliation and EHR adoption in hospitals | Not mentioned | Secondary data analysis using 2006 HIMSS Analytics™ Database (Dorenfest IHDS+ Database™) | EHR stage of adoption (a scale ranging from 0 to 3) | Organization | U.S. hospitals surveyed by HIMSS Analytics™ in as of August 2006 (N = 4,017) | The mean adoption level of EHRs varies between independent hospitals and those owned by a system for small hospitals. No significant effect of multihospital system membership on level of EHR adoption for medium and large hospitals was observed. |
| Pedersen et al. (2008) [174] | To study pharmaceutical prescription and transcription processes in acute care hospitals | Not mentioned | Self-administered paper-based survey (2007 ASHP national survey) | Presence of CPOE (binary) and extent to which prescribers enter medication orders electronically (scale), presence of integrated CDSS in CPOE, presence of one or more medical record components in electronic form, and presence of complete EHRs without paper charts (binary) | Organization | A stratified random sample of pharmacy directors at U.S. general and children's medical-surgical hospitals in 2007, stratified by size (N = 1,183) | 531 surveys were returned (42%). Only 5.1% had CPOE, with larger hospitals using it more often than smaller ones. 10% of hospitals had CPOE with integrated CDSSs. 41% had one or more components of the medical record in electronic form. Among these, only 9% had a complete EHR and did not use patient charts. |

| Study | Purpose | IT Adoption Framework | Data Collection | Adoption-Related Variable | Level of Observation | Sample/Respondent (N = Sample Size) | Key Findings |
|---|---|---|---|---|---|---|---|
| Furukawa et al. (2008) [175] | To assess the extent of health IT adoption for medication safety in U.S. hospitals | Not mentioned | Secondary data analysis using the 2006 HIMSS Analytics™ Database (Dorenfest IHDS+ Database™) | Adoption of health IT for medication safety (binary) and number of health IT applications live and operational in each hospital (counts) | Organization | U.S. non-federal acute care hospitals affiliated with integrated health care delivery systems in 2006 (N = 4,561) | There were significant variations in the rate of adoption of different types of health IT. Automated dispensing machines were most widely adopted. On average, about 2.24 out of 8 technologies studied were adopted per hospital |
| Rankin & White [176] | To obtain a snapshot of IT initiative implementation by Connecticut's acute care hospitals | Not mentioned | Self-administered mixed-mode (Web-based and paper-based) survey | Implementation status of CPOE, electronic medication administration, EHR, and wireless technology (categorical), and utilization of these technologies (scales) | Organization | Chief information officers of all acute care hospitals in Connecticut (N = 31) | 24 surveys were completed (77%). 46% had a CPOE system in place (29% with high utilization), and 29% were in the process of implementation. 56% had an electronic medication administration system in place (42% had high utilization), and an additional 25% in the process of implementation. 78% implemented an EHR system (63% had high utilization), and another 17% were in the process of implementing it. Wireless technology was used in 95%. |
| Des-Roches et al. [177] | To study physicians' adoption of outpatient EHRs, their satisfaction, perceived quality benefits, and perceived barriers to adoption | Not mentioned | Self-administered paper-based survey | Availability (binary) and use (scales) of features of EHRs | Individual | A random sample of U.S. physicians who provided direct patient care, excluding doctors of osteopathy, residents, physicians working in federal hospitals, and retired physicians (N = 5,000) | 2,758 completed surveys were returned out of 4,484 eligible respondents (62%). 4% of physicians reported having fully functional EHRs, with additional 13% reported having a basic system. |

| Study | Purpose | IT Adoption Framework | Data Collection | Adoption-Related Variable | Level of Observation | Sample/Respondent (N = Sample Size) | Key Findings |
|---|---|---|---|---|---|---|---|
| Chiang et al. [178] | To evaluate the current state of EHR use and user satisfaction by ophthalmologists | Not mentioned | Mixed-mode (self-administered Web-based and interviewer-administered telephone) survey | EHR implementation status (categorical) and use of various EHR features | Individual | American Academy of Ophthalmology members selected in random (N = 3,796) | 392 Web-based surveys were completed and 200 telephone surveys were conducted (overall response rate = 10%). 12% of the respondents had implemented an EHR, with another 7% in the process of implementation. 69% of those with an EHR in their practice were satisfied or extremely satisfied with their system. |
| Egger Halbeis et al. [179] | To examine adoption of anesthesia information management systems at academic anesthesia departments and explore motivations for and resistance to adoption | Not mentioned | Self-administered Web-based survey | Implementation status of anesthesia information management systems (categorical) and use of other technologies (composite index based on binary variables) | Organization | Academic anesthesia departments in the U.S. in late 2007 (N = 140) | 72 usable surveys were returned (51%). 28% had the system installed, with 17% currently implementing. 44% committed to the adoption and were in various stages of implementation/acquisition |

| Study | Purpose | IT Adoption Framework | Data Collection | Adoption-Related Variable | Level of Observation | Sample/Respondent (N = Sample Size) | Key Findings |
|---|---|---|---|---|---|---|---|
| Pedersen & Gumpper [180] | To explore the adoption and use of pharmacy informatics and technology within the medication-use process | Not mentioned | Self-administered Web-based survey (2007 ASHP national survey on informatics) | Presence of partial or complete EHRs, whether each profession had access to the EHRs, whether all clinical documentation was captured in EHRs, presence of CPOE and e-prescribing, whether CDSSs existed (binary), use of IT in medication reconciliation processes, and pharmacy computer integration (categorical) | Organization | Pharmacy directors of all U.S. hospitals, including specialty, federal, and Veterans Affairs hospitals in 2007 (N = 4,112) | 1,066 usable surveys were returned (26%). 43% had one or more components of the medical record in electronic form. 6% of all hospitals had a complete EHR system without paper charts. 100% of nurses, 99% of pharmacists, and 96% of physicians were routinely given access to EHRs. 40% of those with components of an EHR captured all clinical documentation in the EHR. 18% of hospitals had a CPOE system, among which 67% had CDSSs. 20% had e-prescribing, among which 44% had CDSSs. 10% used electronic medication reconciliation process, and another 42% used a combination of electronic and paper-based processes. In 51% of hospitals, the pharmacy system was part of a larger system suite, and another 35% had interfaces but not as part of a larger suite. |

| Study | Purpose | IT Adoption Framework | Data Collection | Adoption-Related Variable | Level of Observation | Sample/Respondent (N = Sample Size) | Key Findings |
|---|---|---|---|---|---|---|---|
| Jaana et al. (2009) [181] | To propose and validate a comprehensive IT capacities assessment tool in hospitals | Proposing a new IT capacities assessment tool based on IT sophistication | Self-administered paper-based survey | IT capacities in 8 dimensions: administrative, patient management, clinical support, and clinical systems, emerging technologies, administrative and clinical internal integration, and external integration (composite indexes based on multi-item scales) | Organization | Hospitals in Quebec (N = 92) and Ontario, Canada (N = 129) | Overall, 106 hospitals responded (52%). Functional and technological IT sophistication scores in the sample were 66.3 and 30.1 (out of 100), respectively. The integration score was 50.9, and the overall IT score was 56.3. The analysis demonstrated a good level of reliability and validity of the survey instrument. |
| Menache-mi et al. (2009) [182] | To study the adoption of health IT by children's hospitals and identify barriers and priorities related to health IT adoption | Not mentioned | Self-administered mixed-mode (paper-based and Web-based) survey | Current use of clinical and nonclinical health IT (multi-item binary variables) | Organization | Children hospitals that were members of the National Association of Children's Hospitals and Related Institutions in 2005 (N = 199) | 109 hospitals responded (55%). Common clinical applications were clinical scheduling (86%), transcription (85%), pharmacy information systems (82%), and laboratory information systems (81%). EHRs were present in 49%, CPOE in 40%, and CDSS in 36% of the hospitals. |
| Parente & Mc-Cullough [183] | To examine the effect of health IT on key patient safety indicators | Not mentioned | Secondary data analysis from unspecified source | Presence of EHRs, nurse chart applications, and PACS (binary) | Organization | A large, nationally representative sample of U.S. hospitals with Medicare inpatient data from 1999-2000 (N unspecified) | EHRs had a small positive effect on infection rates due to medical care, but not the rates of postoperative hemorrhage, and postoperative pulmonary embolism or deep vein thrombosis. Neither nurse chart applications or PACS had a relationship with any indicators. |

| Study | Purpose | IT Adoption Framework | Data Collection | Adoption-Related Variable | Level of Observation | Sample/Respondent (N = Sample Size) | Key Findings |
|---|---|---|---|---|---|---|---|
| Protti et al. [184] | To compare the adoption status of primary care physician offices between Andalucía, Spain and Denmark | Not mentioned | A qualitative study based on secondary data analysis and interviews | The degree of automation in primary care physician offices based on a novel scoring system of available data | Country | Data from each jurisdiction's centralized health care databases and interviews of local experts | The health systems in the two jurisdictions were similar in many aspects but there were significant differences that led to the rates of uptake of physician office computing, such as the fact that in Denmark, each physician office had individual patient records, whereas in Andalucía physicians share a common record. |
| Robinson et al. [185] | To study the role of financial incentives and quality improvement initiatives in accelerating adoption of clinical IT in large physician practices | Not mentioned | Interviewer-administered telephone survey | Whether each of 7 categories of electronic data and information technologies were actually used by a majority of physicians in the practice (a summated index based on binary outcomes) | Organization | Medical groups and independent practice associations in the U.S. with 20 or more physicians between March 2006 - March 2007 (N = 1,520) | 538 of 892 eligible organizations responded to the survey (60%). Most clinical IT categories were used to a higher extent by medical groups than independent practice associations. Those evaluated by external entities for pay-for-performance and public reporting purposes and those participating in quality improvement initiatives were associated with higher adoption. |
| Pedersen et al. (2009) [186] | To study pharmaceutical dispensing and administration processes in acute care hospitals | Not mentioned | Self-administered paper-based survey (2008 ASHP national survey) | Use of robot and automated dispensing cabinets, use of bar codes for medication administration (binary), types of medication administration records (categorical) | Organization | A stratified random sample of pharmacy directors at U.S. general and children's medical-surgical hospitals in 2008, stratified by size (N = 1,310) | 527 surveys were returned (40%). 10% used a robotic distribution system, while 83% of the hospitals employed automated dispensing cabinets. 25% used bar coding for medication administration. 47% used computer-generated medication administration records, while 37% used an electronic medication administration record system. |

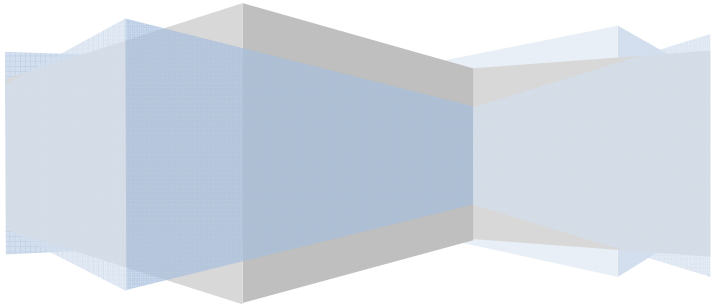
| Study | Purpose | IT Adoption Framework | Data Collection | Adoption-Related Variable | Level of Observation | Sample/Respondent (N = Sample Size) | Key Findings |
|---|---|---|---|---|---|---|---|
| Ludwick & Doucette [187] | To explore the relevance and impact of risks and factors on health IT adoption in the primary care context | Not mentioned | Semi-structured interviews | Type of health records system currently used (categorical), functions of the EHR system used (checklists) | Individual | Full-time physicians that are part of the local primary care network in Alberta, Canada, had significant EHR experience, and were an influencer in clinic decision making NN = 19) | Physicians reported that assessment and implementation of an EHR was limited by time constraints. This is complicated by the layout of the exam rooms, poor system user interfaces, computer skills, time pressure during patient encounters, and the fee-for-service model. |
| Pallin et al. (2009) [188] | To assess the state of acquisition and implementation of IT tools in emergency departments | Not mentioned | Self-administered paper-based survey | Availability of computerized medication order entry, order error checking, visit documentation, computerized documentations, lab results (binary) | Organization | All non-federal Massachusetts emergency departments in early 2006 (N = 74) | 61 EDs responded (82%). 15% reported full implementation of computerized medication ordering. Computerized documentation of current visit information was fully implemented in 41%. Electronic lab results were available in 90%. |
| Simon et al. (2009) [189] | To assess if the EHR usage gap is narrowing over time | Not mentioned | Self-administered paper-based survey | Whether the main practice had components of any EHR and presence of 10 functions in their EHR (binary), and the degree to which each function was used (3-point scales) | Individual | Physicians responding to the authors' 2005 statewide survey who were still practicing in Massachusetts (N = 1,146) and an additional random sample of newly licensed physicians in Massachusetts in 2006 (N = 628) | 910 (79%) completed surveys of physicians originally surveyed and 386 (72%) surveys of newly licensed physicians were returned. There was little change between 2005 and 2007 in the availability of nine of ten EHR features among practices with EHRs, except e-prescribing which increased from 45% to 71%. Use of EHR functions did not substantially change except use of e-prescribing which rose from 20% to 43%. |

AHA: American Hospital Association, ASHP: American Society of Health-System Pharmacists, CDSS: Clinical decision support system, CPOE: Computerized physician order entry, CPR: Computerized patient record, CTS: Community Tracking Study, EHR: Electronic health record, e-prescribing: electronic prescribing, HIMSS: Healthcare Information and Management Systems Society, ICU: Intensive care unit, IT: Information technology, MGMA: Medical Group Management Association, NAMCS: National Ambulatory Medical Care Survey, PACS: Picture archival and communication system, PDA: Personal digital assistant, UTAUT: Unified Theory of Acceptance and Use of Technology

# Appendix B

The Modified IT Sophistication Instrument

# Thai Hospitals' Adoption of Information Technology Survey (THAIS)





Thank you for your interest in this study. This questionnaire is designed for the person who is responsible for managing information systems in your hospital, such as a chief information officer, an IT manager or administrator, or someone in an equivalent position. If this is not you, we would appreciate your help in forwarding it to that person in your hospital. If there is no such a person, it is hoped that the hospital director or someone in a similar position could provide answers.

Please answer each of the following questions by selecting the choice that best fits your situation or opinion, or filling in the blanks. If you are not sure about certain questions, please feel free to ask one of your colleagues or refer to other data sources. If that is not possible, please provide the most appropriate answer to the best of your ability.

## Section 1: IT Management Profile

Q1. Is there an IT department at your hospital?

1 ❑ Yes

2 ❑ No

Q2. Are IT responsibilities in your hospital generally centralized in one unit or distributed across multiple departments?

1 ❑ Centralized

2 ❑ Distributed

3 ❑ There are no IT responsibilities in our hospital.

Q3. Is there a person with direct IT responsibilities on the senior management team (such as the executive committee or the hospital board) of your hospital?

1 ❑ Yes

2 ❑ No

Q4. Do you have a quality improvement initiative in your hospital?

1 ❑ Yes

2 ❑ No → Proceed to Q5

Skip to Q6

Q5. How much coordination exists between IT management and the quality improvement initiatives in your hospital?

1 ❑ High coordination

2 ❑ Moderate coordination

3 ❑ Some coordination

4 ❑ Little or no coordination

Q6. To what extent do you agree or disagree with each of the following statements? "N/A" represents a statement not applicable to your hospital's situation.

| STATEMENT | STRONGLY DISAGREE | | | | STRONGLY AGREE | |
|---|---|---|---|---|---|---|
| a. Our hospital is very open to new ways of conducting operations. | 1 | 2 | 3 | 4 | 5 | N/A |
| b. Our hospital sets a clear vision on what we wish to achieve with IT projects. | 1 | 2 | 3 | 4 | 5 | N/A |
| c. When a new technology is introduced, we communicate the goals, plans, and progresses to key stakeholders. | 1 | 2 | 3 | 4 | 5 | N/A |
| d. Those who will use IT are fully involved early in our IT projects. | 1 | 2 | 3 | 4 | 5 | N/A |
| e. Our top-level management fully supports the use of IT. | 1 | 2 | 3 | 4 | 5 | N/A |
| f. We have a multi-disciplinary team of users involved in our IT projects. | 1 | 2 | 3 | 4 | 5 | N/A |
| g. Before new IT is implemented in our hospital, the workflow changes required are seriously considered. | 1 | 2 | 3 | 4 | 5 | N/A |
| h. The majority of hospital employees are committed to achieving the envisioned organizational goals. | 1 | 2 | 3 | 4 | 5 | N/A |
| i. Before a new system is introduced, we adequately provide training to those who will use the system. | 1 | 2 | 3 | 4 | 5 | N/A |

| STATEMENT | STRONGLY DISAGREE | | | | STRONGLY AGREE | |
|---|---|---|---|---|---|---|
| j. When our hospital is conducting an IT project, we have a process in place to track its progress and manage it. | 1 | 2 | 3 | 4 | 5 | N/A |
| k. Our hospital learns from the past experience to improve its operations. | 1 | 2 | 3 | 4 | 5 | N/A |

## Section 2: IT Adoption and Use Profile

Q7. How many personal computers (including desktops and notebooks/laptops) does your hospital have in use?

|_____| Personal Computers

Q8. How many personal computers does your hospital have in use to support the front office (patient services) functions (including those supporting clinical work in outpatient and inpatient care, emergency room, laboratory, radiology/imaging, pharmacy, and patient billing)? An approximate figure is fine.

|_____| Personal Computers



Q9. To what extent does your hospital employ IT for front office (patient services) functions?

1 ❑ High
2 ❑ Moderate
3 ❑ Low
4 ❑ Not at all

Q10. To what extent does your hospital employ IT for back office (administrative) functions?

1 ❑ High
2 ❑ Moderate
3 ❑ Low
4 ❑ Not at all

Q11. For each of the following activities, how much is the activity assisted by computerized information systems in your hospital? If it varies across departments in your hospital, please indicate the average level in the entire hospital. "N/A" is not applicable (no such activity).

| ACTIVITY | TOTALLY MANUAL | | | | FULLY COMPUTERIZED | |
|---|---|---|---|---|---|---|
| Emergency Room (ER) | | | | | | |
| ER patient registration | 1 | 2 | 3 | 4 | 5 | N/A |
| Patient discharges from ER | 1 | 2 | 3 | 4 | 5 | N/A |
| ER patient referral to another facility | 1 | 2 | 3 | 4 | 5 | N/A |
| Patient flow management within ER | 1 | 2 | 3 | 4 | 5 | N/A |
| ER order entry | 1 | 2 | 3 | 4 | 5 | N/A |
| ER lab and imaging results reporting | 1 | 2 | 3 | 4 | 5 | N/A |
| ER clinical notes | 1 | 2 | 3 | 4 | 5 | N/A |
| Patient Management | | | | | | |
| General patient registration | 1 | 2 | 3 | 4 | 5 | N/A |
| Insurance eligibility verification | 1 | 2 | 3 | 4 | 5 | N/A |
| Outpatient appointment scheduling | 1 | 2 | 3 | 4 | 5 | N/A |
| Patient management within outpatient clinics | 1 | 2 | 3 | 4 | 5 | N/A |



| ACTIVITY | TOTALLY MANUAL | | | | FULLY COMPUTERIZED | |
|---|---|---|---|---|---|---|
| Inpatient admissions | 1 | 2 | 3 | 4 | 5 | N/A |
| Inpatient discharges | 1 | 2 | 3 | 4 | 5 | N/A |
| Patient transfers between wards within the hospital | 1 | 2 | 3 | 4 | 5 | N/A |
| Patient referral to another facility | 1 | 2 | 3 | 4 | 5 | N/A |
| Bed occupancy and availability check | 1 | 2 | 3 | 4 | 5 | N/A |
| Tracking and management of paper-based patient records | 1 | 2 | 3 | 4 | 5 | N/A |
| Inpatient Care | | | | | | |
| Inpatient medication order entry | 1 | 2 | 3 | 4 | 5 | N/A |
| Inpatient lab order entry | 1 | 2 | 3 | 4 | 5 | N/A |
| Inpatient imaging order entry | 1 | 2 | 3 | 4 | 5 | N/A |
| Inpatient lab results reporting | 1 | 2 | 3 | 4 | 5 | N/A |
| Inpatient imaging results reporting | 1 | 2 | 3 | 4 | 5 | N/A |
| Inpatient clinical notes | 1 | 2 | 3 | 4 | 5 | N/A |
| Discharge summary documentation | 1 | 2 | 3 | 4 | 5 | N/A |

| Activity | Totally Manual | | | | | Fully Computerized | |
|---|---|---|---|---|---|---|---|
| ICU/critical patient care | 1 | 2 | 3 | 4 | 5 | N/A | |
| Outpatient Care (Hospital Clinics) | | | | | | | |
| Outpatient medication order entry | 1 | 2 | 3 | 4 | 5 | N/A | |
| Outpatient lab order entry | 1 | 2 | 3 | 4 | 5 | N/A | |
| Outpatient imaging order entry | 1 | 2 | 3 | 4 | 5 | N/A | |
| Outpatient lab results reporting | 1 | 2 | 3 | 4 | 5 | N/A | |
| Outpatient imaging results reporting | 1 | 2 | 3 | 4 | 5 | N/A | |
| Outpatient clinical notes | 1 | 2 | 3 | 4 | 5 | N/A | |
| Nursing | | | | | | | |
| Care planning | 1 | 2 | 3 | 4 | 5 | N/A | |
| Reviewing and processing of physician orders | 1 | 2 | 3 | 4 | 5 | N/A | |
| Medication administration and documentation | 1 | 2 | 3 | 4 | 5 | N/A | |
| Documentation of nursing assessment | 1 | 2 | 3 | 4 | 5 | N/A | |
| Nurse charting | 1 | 2 | 3 | 4 | 5 | N/A | |
| End of shift reporting | 1 | 2 | 3 | 4 | 5 | N/A | |



| Activity | Totally Manual | | | | | Fully Computerized | |
|---|---|---|---|---|---|---|---|
| Surgery/Operating Room (OR) | | | | | | | |
| Patient management within operating rooms | 1 | 2 | 3 | 4 | 5 | N/A | |
| Operative report documentation | 1 | 2 | 3 | 4 | 5 | N/A | |
| Anesthetic note documentation | 1 | 2 | 3 | 4 | 5 | N/A | |
| Management of surgical materials and equipments | 1 | 2 | 3 | 4 | 5 | N/A | |
| Case service charging | 1 | 2 | 3 | 4 | 5 | N/A | |
| Surgery appointments and scheduling | 1 | 2 | 3 | 4 | 5 | N/A | |
| Laboratory | | | | | | | |
| Specimen handling | 1 | 2 | 3 | 4 | 5 | N/A | |
| Results capture from automated equipments | 1 | 2 | 3 | 4 | 5 | N/A | |
| Results entry for non-automated tests | 1 | 2 | 3 | 4 | 5 | N/A | |
| Results validation and confirmation | 1 | 2 | 3 | 4 | 5 | N/A | |
| Blood bank management | 1 | 2 | 3 | 4 | 5 | N/A | |
| Radiology and Imaging | | | | | | | |
| Imaging patient registration | 1 | 2 | 3 | 4 | 5 | N/A | |

| Activity | Totally Manual | | | | Fully Computerized | |
|---|---|---|---|---|---|---|
| Imaging appointments and scheduling | 1 | 2 | 3 | 4 | 5 | N/A |
| Image capture from imaging devices | 1 | 2 | 3 | 4 | 5 | N/A |
| Imaging reports entry | 1 | 2 | 3 | 4 | 5 | N/A |
| Image viewing by radiologists | 1 | 2 | 3 | 4 | 5 | N/A |
| Image viewing by other clinicians | 1 | 2 | 3 | 4 | 5 | N/A |
| Film tracking and management | 1 | 2 | 3 | 4 | 5 | N/A |
| Pharmacy | | | | | | |
| Pharmacist's review of medication orders | 1 | 2 | 3 | 4 | 5 | N/A |
| Outpatient medication dispensing | 1 | 2 | 3 | 4 | 5 | N/A |
| Outpatient pharmacy inventory control | 1 | 2 | 3 | 4 | 5 | N/A |
| Inpatient medication dispensing | 1 | 2 | 3 | 4 | 5 | N/A |
| Inpatient pharmacy inventory control | 1 | 2 | 3 | 4 | 5 | N/A |
| Clinical pharmaceutical care | 1 | 2 | 3 | 4 | 5 | N/A |



| Activity | Totally Manual | | | | Fully Computerized | |
|---|---|---|---|---|---|---|
| Public Health | | | | | | |
| Preventive care and community services | 1 | 2 | 3 | 4 | 5 | N/A |
| Public health reporting to government agencies | 1 | 2 | 3 | 4 | 5 | N/A |
| Finance | | | | | | |
| Billing and reimbursement | 1 | 2 | 3 | 4 | 5 | N/A |
| Accounting | 1 | 2 | 3 | 4 | 5 | N/A |
| Budgeting | 1 | 2 | 3 | 4 | 5 | N/A |
| Human Resource Management | | | | | | |
| Personnel records | 1 | 2 | 3 | 4 | 5 | N/A |
| Payroll and compensation | 1 | 2 | 3 | 4 | 5 | N/A |
| Staff workload management | 1 | 2 | 3 | 4 | 5 | N/A |
| Materials Management | | | | | | |
| Purchasing/procurement | 1 | 2 | 3 | 4 | 5 | N/A |
| Inventory management | 1 | 2 | 3 | 4 | 5 | N/A |
| Administration/Miscellaneous | | | | | | |
| Resource utilization | 1 | 2 | 3 | 4 | 5 | N/A |
| Project management | 1 | 2 | 3 | 4 | 5 | N/A |
| Internal communications | 1 | 2 | 3 | 4 | 5 | N/A |

Q12. An information system is sometimes linked (integrated) with other information systems, with data being shared or transferred between them. In other cases, an information system may be stand-alone and does not share or transfer data to other systems. For each of the following functions or settings, to what extent is its information systems linked to other systems within your hospital overall? "N/A" is not applicable (no such function or system).

| FUNCTION/SETTING | NOT LINKED | | | | HIGHLY LINKED | |
|---|---|---|---|---|---|---|
| a. ER | 1 | 2 | 3 | 4 | 5 | N/A |
| b. Patient registration, admissions, discharges, and transfers | 1 | 2 | 3 | 4 | 5 | N/A |
| c. Inpatient | 1 | 2 | 3 | 4 | 5 | N/A |
| d. Outpatient clinics | 1 | 2 | 3 | 4 | 5 | N/A |
| e. Nursing | 1 | 2 | 3 | 4 | 5 | N/A |
| f. Surgery/OR | 1 | 2 | 3 | 4 | 5 | N/A |
| g. Laboratory | 1 | 2 | 3 | 4 | 5 | N/A |
| h. Radiology/imaging | 1 | 2 | 3 | 4 | 5 | N/A |
| i. Pharmacy | 1 | 2 | 3 | 4 | 5 | N/A |
| j. Finance | 1 | 2 | 3 | 4 | 5 | N/A |
| k. Human resource management | 1 | 2 | 3 | 4 | 5 | N/A |
| l. Materials management | 1 | 2 | 3 | 4 | 5 | N/A |



Q13. For each of the following functions or settings, to what extent is its information systems linked to other systems outside your hospital overall (including linkages to government agencies and other hospitals)? "N/A" is not applicable (no such function or system).

| FUNCTION/SETTING | NOT LINKED | | | | HIGHLY LINKED | |
|---|---|---|---|---|---|---|
| a. ER | 1 | 2 | 3 | 4 | 5 | N/A |
| b. Patient registration, admissions, discharges, and transfers | 1 | 2 | 3 | 4 | 5 | N/A |
| c. Inpatient | 1 | 2 | 3 | 4 | 5 | N/A |
| d. Outpatient clinics | 1 | 2 | 3 | 4 | 5 | N/A |
| e. Nursing | 1 | 2 | 3 | 4 | 5 | N/A |
| f. Surgery/OR | 1 | 2 | 3 | 4 | 5 | N/A |
| g. Laboratory | 1 | 2 | 3 | 4 | 5 | N/A |
| h. Radiology/imaging | 1 | 2 | 3 | 4 | 5 | N/A |
| i. Pharmacy | 1 | 2 | 3 | 4 | 5 | N/A |
| j. Finance | 1 | 2 | 3 | 4 | 5 | N/A |
| k. Human resource management | 1 | 2 | 3 | 4 | 5 | N/A |
| l. Materials management | 1 | 2 | 3 | 4 | 5 | N/A |

Q14. For each of the following technologies, to what extent is it adopted in your hospital? If it varies across departments in your hospital, please indicate the average level among the applicable departments. "N/A" is not applicable (no activity supported by the technology).

| TECHNOLOGY | NOT ADOPTED | | | | EXTENSIVELY ADOPTED | |
|---|---|---|---|---|---|---|
| a. Internet access | 1 | 2 | 3 | 4 | 5 | N/A |
| b. Hospital Web site | 1 | 2 | 3 | 4 | 5 | N/A |
| c. Hospital intranet (internal Web site) | 1 | 2 | 3 | 4 | 5 | N/A |
| d. E-mail system | 1 | 2 | 3 | 4 | 5 | N/A |
| e. Local area network (LAN) | 1 | 2 | 3 | 4 | 5 | N/A |
| f. Wireless networks | 1 | 2 | 3 | 4 | 5 | N/A |
| g. Access to drug databases | 1 | 2 | 3 | 4 | 5 | N/A |
| h. Data warehouses | 1 | 2 | 3 | 4 | 5 | N/A |
| i. Computerized order entry | 1 | 2 | 3 | 4 | 5 | N/A |
| j. Electronic documentation of clinical care | 1 | 2 | 3 | 4 | 5 | N/A |
| k. Laboratory information system | 1 | 2 | 3 | 4 | 5 | N/A |
| l. Pharmacy information system | 1 | 2 | 3 | 4 | 5 | N/A |
| m. Picture archiving and communication system (PACS) | 1 | 2 | 3 | 4 | 5 | N/A |



| TECHNOLOGY | NOT ADOPTED | | | | EXTENSIVELY ADOPTED | |
|---|---|---|---|---|---|---|
| n. Radiology information system | 1 | 2 | 3 | 4 | 5 | N/A |
| o. Telemedicine (remote provision of medical services or consultation through IT) | 1 | 2 | 3 | 4 | 5 | N/A |
| p. Teleconferencing | 1 | 2 | 3 | 4 | 5 | N/A |
| q. Barcoding | 1 | 2 | 3 | 4 | 5 | N/A |
| r. Enterprise resource planning (ERP) system to manage finance, human resources, and materials | 1 | 2 | 3 | 4 | 5 | N/A |

Q15. In many cases, hospital staffs don't always use the existing computerized information systems when they perform their work even though the systems are available in the hospital. How often do your hospital staffs actually use the existing information systems on average?

1 ❑ 25% of the time or lower

2 ❑ Between 26 - 50% of the time

3 ❑ Between 51 - 75% of the time

4 ❑ 76% of the time or higher

5 ❑ Not applicable. No computerized information systems exist in our hospital.

## Section 3: Hospital Profile

Q16. How many inpatient beds does your hospital currently have?

|_____| Beds

Q17. How many physicians currently practice in your hospital?

|_____| Physicians

Q18. What is your hospital's current number of full-time equivalent (FTE) employees? If you do not know or cannot obtain the exact number, please provide the approximate number.

|_____| FTEs

Q19. What is your hospital's current number of full-time IT personnel (including IT managers, administrators, programmers, and other technical staffs)?

|_____| Full-Time IT Personnel

Q20. What percentage of your hospital's budget during the last fiscal year was spent on IT hardware, software, personnel, consulting, and outsourcing approximately?

|_____| Percent



Q21. Is your hospital a public or private hospital?

1 ❑ Public

2 ❑ Private → Proceed to Q22

Q22. Is your hospital part of a multi-hospital system that owns or manages more than one hospital?

1 ❑ Yes → Skip to Q25

2 ❑ No → Skip to Q25

Skip to Q23

Q23. Which of the following does your hospital belong to?

1 ❑ Ministry of Public Health → Proceed to Q24

2 ❑ A public university or college

3 ❑ Other governmental agencies

4 ❑ Our hospital is an independent public hospital.

Q24. Which of the following best describes your hospital's status?

1 ❑ A community hospital

2 ❑ A general hospital

3 ❑ A regional hospital

4 ❑ A specialty hospital or others

Skip to Q25

Q25. Is your hospital a teaching hospital primarily offering academic programs to medical students?

1 ❑ Yes

2 ❑ No → Proceed to Q26

Q26. Is your hospital affiliated with a medical school?

1 ❑ Yes

2 ❑ No

Skip to Q27

Q27. Which of the following best describes your hospital accreditation (HA) status?

1 ❑ Is currently not accredited and has no plan in place toward accreditation.

2 ❑ Is currently not accredited, has a plan in place, but has not made significant progress toward accreditation.

3 ❑ Is currently not accredited but has made significant progress toward accreditation.

4 ❑ Is currently accredited.

Q28. Please specify the percentage that your patient visits in the past 1 year use each of the following health insurance schemes on average.

| | |
|---|---|
| Civil Servant Medical Benefits Scheme | _____ Percent |
| Social Security Scheme | _____ Percent |
| Universal Coverage | _____ Percent |
| Other | _____ Percent |



## Section 4: Respondent's Information

Q29. What is your gender?

1 ❑ Male

2 ❑ Female

Q30. What is your current age?

|_____| Years

Q31. What is your highest level of education completed?

1 ❑ Lower than bachelor's degree

2 ❑ Bachelor's degree

3 ❑ Master's degree or higher

Q32. What is your primary professional background?

1 ❑ Business administration/management

2 ❑ Computer science, information science, or engineering

3 ❑ Medicine

4 ❑ Dentistry

5 ❑ Nursing

6 ❑ Pharmacy

7 ❑ Medical technology

8 ❑ Medical records or statistics

9 ❑ Public health

10 ❑ Other. Please specify |_____|

Q33. Which of the following best describes your formal IT training?

1 ❑ I had no formal training in an IT-related area.

2 ❑ I had a non-degree training in an IT-related area.

3 ❑ I received an academic degree in an IT-related field.

Q34. Which of the following best describes your formal clinical training?

1 ❑ I had no formal training in a clinical field.

2 ❑ I had a non-degree training in a clinical field.

3 ❑ I received an academic degree in a clinical field.

Q35. Which of the following best describes your formal business administration (BA)/management training?

1 ❑ I had no formal training in BA/management.

2 ❑ I had a non-degree training in BA/management.

3 ❑ I received an academic degree in BA/management.

Q36. How many years have you worked in <u>any</u> position in this hospital?

|_____| Years

Q37. How many years have you worked in the <u>current</u> position in this hospital?

|_____| Years



Q38. Which of the following best describes your role in the hospital? If you hold multiple roles, please check only the first option that matches you?

1 ❑ The director or senior executive of the hospital

2 ❑ A hospital executive who supervises hospital IT responsibilities

3 ❑ An IT manager or head of the hospital's IT unit or department

4 ❑ An IT specialist, system administrator, system analyst, programmer, or computer technician within the hospital

5 ❑ A hospital worker involved in IT projects without a formal executive or technical role

6 ❑ None of the above

Thank you very much for your participation in this study. Your responses are very important to future improvement of health informatics works in Thai hospitals. If you have additional comments, please use the space below.

If you would like to receive a copy of the study results, please include your address below. This information will be used only to deliver the results and will never be associated with your answers or revealed to someone outside the research team. It will be kept strictly confidential, and results will be reported only in an aggregate format, without revealing individual information about you or your hospital. Providing this information is optional.

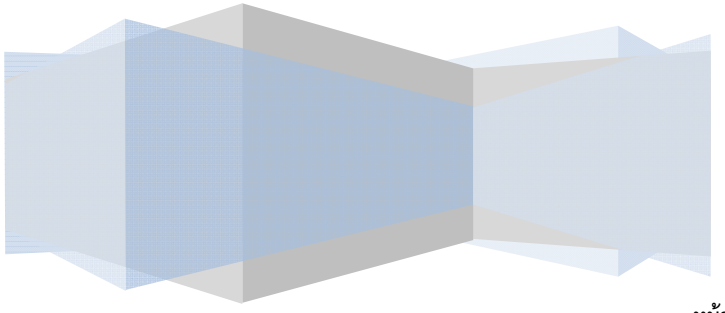
If you have any questions about this questionnaire, please call ..... at ..... or e-mail to ..... Please return the completed survey in the stamped return envelope to:

# Appendix C

The Thai Version of the IT Sophistication Instrument

# การสำรวจการใช้เทคโนโลยีสารสนเทศของโรงพยาบาลไทย

# Thai Hospitals' Adoption of Information Technology Survey (THAIS)





ผู้วิจัยขอขอบคุณท่านสำหรับความสนใจในงานวิจัยนี้ แบบสอบถามฉบับนี้ ถูกออกแบบเพื่อให้ผู้ที่มีหน้าที่บริหารจัดการระบบสารสนเทศของโรงพยาบาลของท่าน ซึ่งอาจเป็นผู้บริหารโรงพยาบาลที่มีหน้าที่ดูแลงานสารสนเทศ หัวหน้าหน่วยงานด้านสารสนเทศ หรือผู้ดูแลระบบสารสนเทศในโรงพยาบาล เป็นผู้ตอบ หากท่านไม่ได้มีบทบาทโดยตรงในการดูแลระบบสารสนเทศของโรงพยาบาล กรุณาส่งแบบสอบถามนี้ไปยังบุคคลดังกล่าวแทน ในกรณีที่ไม่มีผู้ที่มีบทบาทบริหารจัดการระบบสารสนเทศในโรงพยาบาลของท่าน ผู้ดำเนินการวิจัยหวังเป็นอย่างยิ่ง ว่าผู้อำนวยการโรงพยาบาลของท่าน จะสามารถสละเวลาในการตอบแบบสอบถามนี้ได้

กรุณาตอบคำถามแต่ละข้อโดยเลือกตัวเลือกที่ตรงกับสถานการณ์หรือความเห็นของท่านที่สุด หรือเติมคำตอบในช่องว่าง หากท่านไม่แน่ใจคำตอบของคำถามข้อใด ท่านสามารถสอบถามบุคลากรที่เกี่ยวข้องในโรงพยาบาลของท่านได้ หรือหากท่านไม่สามารถหาข้อมูลได้ โปรดพิจารณาเลือกหรือเติมคำตอบที่ท่านเห็นว่าเหมาะสมที่สุด

## ส่วนที่ 1: การบริหารจัดการงานสารสนเทศ

1. โรงพยาบาลของท่านมีหน่วยงานด้านสารสนเทศหรือไม่?

   1 ❑ มี
   2 ❑ ไม่มี

2. ภารกิจด้านสารสนเทศในโรงพยาบาลของท่าน อยู่ภายใต้ความรับผิดชอบของหน่วยงานใดหน่วยงานหนึ่งหรือกระจายไปตามหน่วยงานต่างๆ หลายหน่วยงาน?

   1 ❑ อยู่ภายใต้ความดูแลของหน่วยงานใดหน่วยงานหนึ่ง
   2 ❑ กระจายไปตามหน่วยงานต่างๆ หลายหน่วยงาน
   3 ❑ โรงพยาบาลของเราไม่มีภารกิจด้านเทคโนโลยีสารสนเทศ

3. ผู้บริหารจัดการงานสารสนเทศในโรงพยาบาลของท่าน เป็นส่วนหนึ่งของทีมผู้บริหาร หรือคณะกรรมการบริหาร ของโรงพยาบาลของท่านหรือไม่?

   1 ❑ เป็น
   2 ❑ ไม่เป็น

4. โรงพยาบาลของท่านมีโครงการพัฒนาคุณภาพหรือไม่?

1 ❑ มี
2 ❑ ไม่มี → ต่อข้อ 5

ข้ามไปข้อ 6

5. ผู้บริหารจัดการงานสารสนเทศ และทีมงานพัฒนาคุณภาพในโรงพยาบาลของท่าน มีการประสานงานกันมากน้อยเพียงใด?

1 ❑ มาก
2 ❑ ปานกลาง
3 ❑ น้อย
4 ❑ น้อยมากหรือไม่มี

6. ท่านเห็นด้วยหรือไม่เห็นด้วยกับข้อความแต่ละข้อต่อไปนี้มากน้อยเพียงใด? หากข้อความใดไม่เกี่ยวข้องกับสถานการณ์ในโรงพยาบาลของท่าน กรุณาเลือก "N/A" (Not Applicable)

| ข้อความ | ไม่เห็นด้วยอย่างยิ่ง | | | เห็นด้วยอย่างยิ่ง | | |
|---|---|---|---|---|---|---|
| ก. โรงพยาบาลของเราเปิดกว้างสำหรับแนวทางใหม่ๆ ในการปฏิบัติงาน | 1 | 2 | 3 | 4 | 5 | N/A |
| ข. โรงพยาบาลของเรามีการกำหนดวิสัยทัศน์ที่ชัดเจนสำหรับโครงการด้านสารสนเทศที่เราหวังจะไปให้ถึง | 1 | 2 | 3 | 4 | 5 | N/A |
| ค. เมื่อเรานำเทคโนโลยีใหม่ๆ เข้ามาในโรงพยาบาล เรามีการสื่อสารเป้าหมาย แผนงาน และความคืบหน้าของโครงการให้กับผู้ที่เกี่ยวข้อง | 1 | 2 | 3 | 4 | 5 | N/A |
| ง. ผู้ที่จะใช้เทคโนโลยีสารสนเทศมีส่วนร่วมในโครงการอย่างเต็มที่ตั้งแต่เนิ่นๆ | 1 | 2 | 3 | 4 | 5 | N/A |



| ข้อความ | ไม่เห็นด้วยอย่างยิ่ง | | | เห็นด้วยอย่างยิ่ง | | |
|---|---|---|---|---|---|---|
| จ. ผู้บริหารระดับสูงของเราสนับสนุนการใช้เทคโนโลยีสารสนเทศอย่างเต็มที่ | 1 | 2 | 3 | 4 | 5 | N/A |
| ฉ. ทีมผู้ใช้งานจากหลากหลายสาขามีส่วนร่วมในโครงการด้านสารสนเทศของเรา | 1 | 2 | 3 | 4 | 5 | N/A |
| ช. การเปลี่ยนแปลงของกระบวนการทำงาน (workflow) ได้รับการพิจารณาอย่างรอบคอบ ก่อนที่โรงพยาบาลของเราจะนำเทคโนโลยีสารสนเทศใหม่ๆ มาใช้ | 1 | 2 | 3 | 4 | 5 | N/A |
| ซ. บุคลากรส่วนใหญ่ของโรงพยาบาลมีความมุ่งมั่นที่จะให้โรงพยาบาลประสบความสำเร็จตามเป้าหมายที่วางไว้ | 1 | 2 | 3 | 4 | 5 | N/A |
| ฌ. โรงพยาบาลของเรามีการจัดการอบรมผู้ใช้งานระบบสารสนเทศใหม่อย่างเพียงพอก่อนที่ระบบจะถูกนำมาใช้ | 1 | 2 | 3 | 4 | 5 | N/A |
| ญ. โรงพยาบาลของเรามีกระบวนการติดตามและบริหารจัดการความคืบหน้าของโครงการเมื่อเราดำเนินโครงการด้านสารสนเทศ | 1 | 2 | 3 | 4 | 5 | N/A |
| ฎ. โรงพยาบาลของเราเรียนรู้จากประสบการณ์ในอดีตเพื่อปรับปรุงการปฏิบัติงาน | 1 | 2 | 3 | 4 | 5 | N/A |

## ส่วนที่ 2: การใช้งานเทคโนโลยีสารสนเทศ

7. โรงพยาบาลของท่านมีเครื่องคอมพิวเตอร์ส่วนบุคคล (รวมถึง desktops, notebooks และ laptops) สำหรับใช้งานจำนวนกี่เครื่อง?

   |_____| เครื่อง

8. โรงพยาบาลของท่านมีเครื่องคอมพิวเตอร์ส่วนบุคคลที่ใช้เพื่อสนับสนุนงานบริการผู้ป่วย (front office) จำนวนกี่เครื่อง (รวมถึงการสนับสนุนงานทางคลินิกเพื่อการดูแลผู้ป่วยนอก ผู้ป่วยใน ห้องฉุกเฉิน ห้องปฏิบัติการ แผนกรังสีวิทยา งานเภสัชกรรม และการเงินผู้ป่วย )? หากท่านไม่ทราบจำนวนที่แน่นอน กรุณาระบุจำนวนโดยประมาณ

   |_____| เครื่อง

9. โรงพยาบาลของท่านใช้เทคโนโลยีสารสนเทศเพื่อสนับสนุนงานบริการผู้ป่วย (front office) มากน้อยเพียงใด?

   1 ❑ มาก
   2 ❑ ปานกลาง
   3 ❑ น้อย
   4 ❑ ไม่ได้ใช้เลย

10. โรงพยาบาลของท่านใช้เทคโนโลยีสารสนเทศเพื่อสนับสนุนงานบริหาร (back office) มากน้อยเพียงใด?

    1 ❑ มาก
    2 ❑ ปานกลาง
    3 ❑ น้อย
    4 ❑ ไม่ได้ใช้เลย



11. ระบบคอมพิวเตอร์และเทคโนโลยีสารสนเทศได้ถูกนำมาใช้เพื่อสนับสนุนกิจกรรมแต่ละข้อต่อไปนี้มากน้อยเพียงใด? หากการใช้งานดังกล่าวแตกต่างกันในแต่ละหน่วยงาน โปรดระบุระดับการใช้งานโดยเฉลี่ยทั้งโรงพยาบาล และหากโรงพยาบาลของท่านไม่มีกิจกรรมใด กรุณาเลือก “N/A” (not applicable)

| กิจกรรม | ไม่ได้ถูกนำมาใช้ | | | | ถูกนำมาใช้อย่างเต็มที่ | |
|---|---|---|---|---|---|---|
| ห้องฉุกเฉิน | | | | | | |
| การลงทะเบียนผู้ป่วยฉุกเฉิน | 1 | 2 | 3 | 4 | 5 | N/A |
| การจำหน่ายผู้ป่วยออกจากห้องฉุกเฉิน | 1 | 2 | 3 | 4 | 5 | N/A |
| การส่งต่อผู้ป่วยฉุกเฉินไปยังสถานพยาบาลอื่น | 1 | 2 | 3 | 4 | 5 | N/A |
| การจัดการ flow ของผู้ป่วยภายในห้องฉุกเฉิน | 1 | 2 | 3 | 4 | 5 | N/A |
| การสั่งการรักษาภายในห้องฉุกเฉิน | 1 | 2 | 3 | 4 | 5 | N/A |
| การรายงานผลการตรวจทางห้องปฏิบัติการและรังสีวิทยาของผู้ป่วยฉุกเฉิน | 1 | 2 | 3 | 4 | 5 | N/A |
| การบันทึกประวัติการรักษาพยาบาลของผู้ป่วยฉุกเฉิน | 1 | 2 | 3 | 4 | 5 | N/A |
| การจัดการผู้ป่วย (Patient Management) | | | | | | |
| การลงทะเบียนผู้ป่วยทั่วไป | 1 | 2 | 3 | 4 | 5 | N/A |
| การตรวจสอบสิทธิค่ารักษาพยาบาล | 1 | 2 | 3 | 4 | 5 | N/A |
| การจัดการตารางนัดหมายผู้ป่วยนอก | 1 | 2 | 3 | 4 | 5 | N/A |
| การจัดการรายชื่อผู้ป่วย (patient management) ในแผนกผู้ป่วยนอก | 1 | 2 | 3 | 4 | 5 | N/A |

| กิจกรรม | ไม่ได้ถูกนำมาใช้ | | | | ถูกนำมาใช้อย่างเต็มที่ | |
|---|---|---|---|---|---|---|
| การรับผู้ป่วยไว้รักษาในโรงพยาบาล (admission) | 1 | 2 | 3 | 4 | 5 | N/A |
| การจำหน่ายผู้ป่วยในออกจากโรงพยาบาล | 1 | 2 | 3 | 4 | 5 | N/A |
| การย้ายผู้ป่วยในระหว่างหอ/ตึกผู้ป่วยภายในโรงพยาบาล | 1 | 2 | 3 | 4 | 5 | N/A |
| การส่งต่อผู้ป่วยไปยังสถานพยาบาลอื่น | 1 | 2 | 3 | 4 | 5 | N/A |
| การตรวจสอบการครองเตียงและจำนวนเตียงที่ว่าง | 1 | 2 | 3 | 4 | 5 | N/A |
| การติดตามและจัดการเวชระเบียนผู้ป่วยในรูปแบบกระดาษ | 1 | 2 | 3 | 4 | 5 | N/A |
| <u>การดูแลผู้ป่วยใน</u> | | | | | | |
| การสั่งยาผู้ป่วยใน | 1 | 2 | 3 | 4 | 5 | N/A |
| การสั่งการตรวจทางห้องปฏิบัติการของผู้ป่วยใน | 1 | 2 | 3 | 4 | 5 | N/A |
| การสั่งการตรวจทางรังสีวิทยาของผู้ป่วยใน | 1 | 2 | 3 | 4 | 5 | N/A |
| การรายงานผลการตรวจทางห้องปฏิบัติการของผู้ป่วยใน | 1 | 2 | 3 | 4 | 5 | N/A |
| การรายงานผลการตรวจทางรังสีวิทยาของผู้ป่วยใน | 1 | 2 | 3 | 4 | 5 | N/A |
| การบันทึกประวัติการรักษาพยาบาลของผู้ป่วยใน | 1 | 2 | 3 | 4 | 5 | N/A |
| การสรุปประวัติผู้ป่วยจำหน่าย (discharge summary) | 1 | 2 | 3 | 4 | 5 | N/A |
| การดูแลผู้ป่วยหนักใน ICU | 1 | 2 | 3 | 4 | 5 | N/A |



| กิจกรรม | ไม่ได้ถูกนำมาใช้ | | | | ถูกนำมาใช้อย่างเต็มที่ | |
|---|---|---|---|---|---|---|
| <u>การดูแลผู้ป่วยนอก</u> | | | | | | |
| การสั่งยาผู้ป่วยนอก | 1 | 2 | 3 | 4 | 5 | N/A |
| การสั่งการตรวจทางห้องปฏิบัติการของผู้ป่วยนอก | 1 | 2 | 3 | 4 | 5 | N/A |
| การสั่งการตรวจทางรังสีวิทยาของผู้ป่วยนอก | 1 | 2 | 3 | 4 | 5 | N/A |
| การรายงานผลการตรวจทางห้องปฏิบัติการของผู้ป่วยนอก | 1 | 2 | 3 | 4 | 5 | N/A |
| การรายงานผลการตรวจทางรังสีวิทยาของผู้ป่วยนอก | 1 | 2 | 3 | 4 | 5 | N/A |
| การบันทึกประวัติการรักษาพยาบาลของผู้ป่วยนอก | 1 | 2 | 3 | 4 | 5 | N/A |
| <u>การพยาบาล</u> | | | | | | |
| การวางแผนทางการพยาบาล (care planning) | 1 | 2 | 3 | 4 | 5 | N/A |
| การทบทวนและดำเนินการตามการสั่งการรักษาของแพทย์ | 1 | 2 | 3 | 4 | 5 | N/A |
| การให้ยาและบันทึกการให้ยาผู้ป่วย (medication administration) | 1 | 2 | 3 | 4 | 5 | N/A |
| การบันทึกการประเมินทางการพยาบาล (nursing assessment) | 1 | 2 | 3 | 4 | 5 | N/A |
| การบันทึกชาร์ตและ flowsheet ทางการพยาบาล | 1 | 2 | 3 | 4 | 5 | N/A |
| การส่งเวรพยาบาล | 1 | 2 | 3 | 4 | 5 | N/A |

| กิจกรรม | ไม่ได้ถูกนำมาใช้ | | | | ถูกนำมาใช้อย่างเต็มที่ | |
|---|---|---|---|---|---|---|
| <u>ห้องผ่าตัด</u> | | | | | | |
| การจัดการรายชื่อผู้ป่วย (patient management) ในห้องผ่าตัด | 1 | 2 | 3 | 4 | 5 | N/A |
| การบันทึกรายงานการผ่าตัด (operative note) | 1 | 2 | 3 | 4 | 5 | N/A |
| การบันทึกรายงานการดมยา/รายงานทางวิสัญญีวิทยา (anesthetic note) | 1 | 2 | 3 | 4 | 5 | N/A |
| การจัดการวัสดุอุปกรณ์ที่ใช้ผ่าตัด | 1 | 2 | 3 | 4 | 5 | N/A |
| การคิดราคาค่าผ่าตัด | 1 | 2 | 3 | 4 | 5 | N/A |
| การจัดตารางและการนัดผ่าตัด | 1 | 2 | 3 | 4 | 5 | N/A |
| <u>ห้องปฏิบัติการ</u> | | | | | | |
| การจัดการสิ่งส่งตรวจ (specimen) | 1 | 2 | 3 | 4 | 5 | N/A |
| การรับผลการตรวจทางห้องปฏิบัติการจากเครื่องตรวจอัตโนมัติ | 1 | 2 | 3 | 4 | 5 | N/A |
| การป้อนผลการตรวจทางห้องปฏิบัติการสำหรับการตรวจที่ไม่ได้ใช้เครื่องตรวจอัตโนมัติ | 1 | 2 | 3 | 4 | 5 | N/A |
| การตรวจสอบและยืนยันผลการตรวจทางห้องปฏิบัติการ | 1 | 2 | 3 | 4 | 5 | N/A |
| การจัดการคลังเลือด | 1 | 2 | 3 | 4 | 5 | N/A |



| กิจกรรม | ไม่ได้ถูกนำมาใช้ | | | | ถูกนำมาใช้อย่างเต็มที่ | |
|---|---|---|---|---|---|---|
| <u>รังสีวิทยา</u> | | | | | | |
| การลงทะเบียนผู้ป่วยรังสี | 1 | 2 | 3 | 4 | 5 | N/A |
| การจัดตารางและการนัดผู้ป่วยรังสี | 1 | 2 | 3 | 4 | 5 | N/A |
| การรับภาพทางรังสีวิทยาโดยตรงจากเครื่องเอกซเรย์ (แทนที่จะใช้ฟิล์มเอกซเรย์) | 1 | 2 | 3 | 4 | 5 | N/A |
| การบันทึกรายงานผลการตรวจทางรังสีวิทยา | 1 | 2 | 3 | 4 | 5 | N/A |
| การเรียกดูภาพทางรังสีวิทยาโดยรังสีแพทย์ | 1 | 2 | 3 | 4 | 5 | N/A |
| การเรียกดูภาพทางรังสีวิทยาโดยแพทย์และบุคลากรทางการแพทย์อื่น | 1 | 2 | 3 | 4 | 5 | N/A |
| การติดตามและจัดการฟิล์มเอกซเรย์ | 1 | 2 | 3 | 4 | 5 | N/A |
| <u>งานเภสัชกรรม</u> | | | | | | |
| การทบทวนการสั่งยาโดยเภสัชกร | 1 | 2 | 3 | 4 | 5 | N/A |
| การจ่ายยาผู้ป่วยนอก | 1 | 2 | 3 | 4 | 5 | N/A |
| การจัดการคลังยาและเวชภัณฑ์ผู้ป่วยนอก | 1 | 2 | 3 | 4 | 5 | N/A |
| การจ่ายยาผู้ป่วยใน | 1 | 2 | 3 | 4 | 5 | N/A |
| การจัดการคลังยาและเวชภัณฑ์ผู้ป่วยใน | 1 | 2 | 3 | 4 | 5 | N/A |
| การดำเนินงานเภสัชกรรมคลินิก | 1 | 2 | 3 | 4 | 5 | N/A |
| <u>งานด้านสาธารณสุข</u> | | | | | | |
| งานส่งเสริมสุขภาพและบริการปฐมภูมิ | 1 | 2 | 3 | 4 | 5 | N/A |
| การรายงานทางสาธารณสุขไปยังส่วนราชการที่เกี่ยวข้อง | 1 | 2 | 3 | 4 | 5 | N/A |

| กิจกรรม | ไม่ได้ถูกนำมาใช้ | | | | ถูกนำมาใช้อย่างเต็มที่ | |
|---|---|---|---|---|---|---|
| <u>งานการเงินการคลัง</u> | | | | | | |
| การเงินและการเบิกจ่ายค่ารักษาพยาบาล | 1 | 2 | 3 | 4 | 5 | N/A |
| การบัญชี | 1 | 2 | 3 | 4 | 5 | N/A |
| การบริหารจัดการและประเมินงบประมาณ | 1 | 2 | 3 | 4 | 5 | N/A |
| <u>งานบริหารทรัพยากรบุคคล</u> | | | | | | |
| ทะเบียนประวัติบุคลากร | 1 | 2 | 3 | 4 | 5 | N/A |
| การจ่ายเงินเดือนและค่าตอบแทน | 1 | 2 | 3 | 4 | 5 | N/A |
| การบริหารจัดการภาระงาน (workload) | 1 | 2 | 3 | 4 | 5 | N/A |
| <u>งานพัสดุ</u> | | | | | | |
| การจัดซื้อจัดจ้าง | 1 | 2 | 3 | 4 | 5 | N/A |
| การจัดการคลังพัสดุ | 1 | 2 | 3 | 4 | 5 | N/A |
| <u>งานบริหารทั่วไป</u> | | | | | | |
| การบริหารการใช้ทรัพยากร (Resource utilization) | 1 | 2 | 3 | 4 | 5 | N/A |
| การบริหารโครงการ (project management) | 1 | 2 | 3 | 4 | 5 | N/A |
| การสื่อสารภายในองค์กร | 1 | 2 | 3 | 4 | 5 | N/A |



12. ในบางครั้ง ระบบสารสนเทศหนึ่งจะมีการเชื่อมต่อกับระบบสารสนเทศอื่นๆ และมีการแลกเปลี่ยนหรือส่งต่อข้อมูลระหว่างกัน แต่ในบางกรณี ระบบสารสนเทศหนึ่งอาจไม่ได้แลกเปลี่ยนหรือส่งต่อข้อมูลกับระบบอื่น (stand-alone) ระบบสารสนเทศในภาพรวมของแต่ละระบบงานต่อไปนี้ มีการเชื่อมต่อกับระบบสารสนเทศอื่น<u>ภายในโรงพยาบาล</u>มากน้อยเพียงใด? หากโรงพยาบาลของท่านไม่มีระบบงานใด กรุณาเลือก “N/A” (not applicable)

| ระบบงาน | ไม่มีการเชื่อมต่อ | | | | เชื่อมต่ออย่างเต็มที่ | |
|---|---|---|---|---|---|---|
| ก. ห้องฉุกเฉิน | 1 | 2 | 3 | 4 | 5 | N/A |
| ข. การลงทะเบียนผู้ป่วย การรับผู้ป่วยไว้ในโรงพยาบาล การจำหน่าย และการส่งต่อผู้ป่วย | 1 | 2 | 3 | 4 | 5 | N/A |
| ค. ผู้ป่วยใน | 1 | 2 | 3 | 4 | 5 | N/A |
| ง. ผู้ป่วยนอก | 1 | 2 | 3 | 4 | 5 | N/A |
| จ. งานการพยาบาล | 1 | 2 | 3 | 4 | 5 | N/A |
| ฉ. ห้องผ่าตัด | 1 | 2 | 3 | 4 | 5 | N/A |
| ช. ห้องปฏิบัติการ | 1 | 2 | 3 | 4 | 5 | N/A |
| ซ. งานรังสีวิทยา | 1 | 2 | 3 | 4 | 5 | N/A |
| ฌ. งานเภสัชกรรม | 1 | 2 | 3 | 4 | 5 | N/A |
| ญ. งานการเงินการคลัง | 1 | 2 | 3 | 4 | 5 | N/A |
| ฎ. งานการเจ้าหน้าที่และการบริหารทรัพยากรบุคคล | 1 | 2 | 3 | 4 | 5 | N/A |
| ฏ. งานจัดซื้อและพัสดุ | 1 | 2 | 3 | 4 | 5 | N/A |

13. ระบบสารสนเทศในภาพรวมของแต่ละระบบงานต่อไปนี้ มีการเชื่อมต่อกับระบบสารสนเทศอื่น ภายนอกโรงพยาบาล (รวมถึงการเชื่อมต่อกับระบบสารสนเทศของส่วนราชการและสถานพยาบาลอื่น) มากน้อยเพียงใด? หากโรงพยาบาลของท่านไม่มีระบบงานใด กรุณาเลือก "N/A" (not applicable)

| ระบบงาน | ไม่มีการเชื่อมต่อ | | | | เชื่อมต่ออย่างเต็มที่ | |
|---|---|---|---|---|---|---|
| ก. ห้องฉุกเฉิน | 1 | 2 | 3 | 4 | 5 | N/A |
| ข. การลงทะเบียนผู้ป่วย การรับผู้ป่วยไว้ในโรงพยาบาล การจำหน่าย และการส่งต่อผู้ป่วย | 1 | 2 | 3 | 4 | 5 | N/A |
| ค. ผู้ป่วยใน | 1 | 2 | 3 | 4 | 5 | N/A |
| ง. ผู้ป่วยนอก | 1 | 2 | 3 | 4 | 5 | N/A |
| จ. งานการพยาบาล | 1 | 2 | 3 | 4 | 5 | N/A |
| ฉ. ห้องผ่าตัด | 1 | 2 | 3 | 4 | 5 | N/A |
| ช. ห้องปฏิบัติการ | 1 | 2 | 3 | 4 | 5 | N/A |
| ซ. งานรังสีวิทยา | 1 | 2 | 3 | 4 | 5 | N/A |
| ฌ. งานเภสัชกรรม | 1 | 2 | 3 | 4 | 5 | N/A |
| ญ. งานการเงินการคลัง | 1 | 2 | 3 | 4 | 5 | N/A |
| ฎ. งานการเจ้าหน้าที่และการบริหารทรัพยากรบุคคล | 1 | 2 | 3 | 4 | 5 | N/A |
| ฏ. งานจัดซื้อและพัสดุ | 1 | 2 | 3 | 4 | 5 | N/A |



14. โรงพยาบาลของท่านใช้เทคโนโลยีแต่ละอย่างต่อไปนี้มากน้อยเพียงใด? หากการใช้งานดังกล่าวแตกต่างกันในแต่ละหน่วยงาน โปรดระบุระดับการใช้งานโดยเฉลี่ยของหน่วยงานทั้งโรงพยาบาล และหากโรงพยาบาลของท่านไม่มีกิจกรรมที่สามารถนำเทคโนโลยีใดมาสนับสนุนได้ กรุณาเลือก "N/A" (not applicable)

| เทคโนโลยี | ไม่ถูกนำมาใช้ | | | | ถูกนำมาใช้อย่างเต็มที่ | |
|---|---|---|---|---|---|---|
| ก. การเข้าถึงอินเทอร์เน็ต | 1 | 2 | 3 | 4 | 5 | N/A |
| ข. เว็บไซต์ของโรงพยาบาล | 1 | 2 | 3 | 4 | 5 | N/A |
| ค. อินทราเน็ต (เว็บไซต์ภายใน) ของโรงพยาบาล | 1 | 2 | 3 | 4 | 5 | N/A |
| ง. ระบบ e-mail ขององค์กร | 1 | 2 | 3 | 4 | 5 | N/A |
| จ. ระบบเครือข่ายภายในโรงพยาบาล (Local area network/LAN) | 1 | 2 | 3 | 4 | 5 | N/A |
| ฉ. เครือข่ายไร้สาย (wireless networks) | 1 | 2 | 3 | 4 | 5 | N/A |
| ช. การเข้าถึงฐานข้อมูลยา (drug databases) | 1 | 2 | 3 | 4 | 5 | N/A |
| ซ. ระบบคลังข้อมูล (data warehouses) | 1 | 2 | 3 | 4 | 5 | N/A |
| ฌ. ระบบสั่งการรักษาผ่านคอมพิวเตอร์ (computerized order entry) | 1 | 2 | 3 | 4 | 5 | N/A |
| ญ. ระบบบันทึกประวัติการรักษาพยาบาลในรูปแบบอิเล็กทรอนิกส์ | 1 | 2 | 3 | 4 | 5 | N/A |
| ฎ. ระบบสารสนเทศห้องปฏิบัติการ (Laboratory information system) | 1 | 2 | 3 | 4 | 5 | N/A |
| ฏ. ระบบสารสนเทศทางเภสัชกรรม (Pharmacy information system) | 1 | 2 | 3 | 4 | 5 | N/A |
| ฐ. ระบบภาพทางรังสีวิทยา (Picture archiving and communication system/PACS) | 1 | 2 | 3 | 4 | 5 | N/A |

| เทคโนโลยี | ไม่ถูกนำมาใช้ | | | | ถูกนำมาใช้อย่างเต็มที่ | |
|---|---|---|---|---|---|---|
| ฑ. ระบบสารสนเทศทางรังสีวิทยา (Radiology information system) | 1 | 2 | 3 | 4 | 5 | N/A |
| ฒ. การให้บริการหรือคำปรึกษาทางการแพทย์ทางไกลโดยใช้เทคโนโลยีสารสนเทศ (telemedicine) | 1 | 2 | 3 | 4 | 5 | N/A |
| ณ. การประชุมทางไกล (teleconference) | 1 | 2 | 3 | 4 | 5 | N/A |
| ด. บาร์โค้ด (barcoding) | 1 | 2 | 3 | 4 | 5 | N/A |
| ต. ระบบบริหารทรัพยากร (งานคลังทรัพยากรบุคคล และพัสดุ) ขององค์กร (Enterprise resource planning/ERP) | 1 | 2 | 3 | 4 | 5 | N/A |

15. ในบางครั้ง บุคลากรในโรงพยาบาลไม่ได้ใช้ระบบคอมพิวเตอร์และเทคโนโลยีสารสนเทศที่มีอยู่ในการปฏิบัติงานเสมอไป แม้ว่าระบบดังกล่าวจะมีให้ใช้งานในโรงพยาบาล ก็ตาม โดยเฉลี่ยบุคลากรในโรงพยาบาลของท่าน ใช้งานระบบสารสนเทศที่มีอยู่มากน้อยเพียงใด?

1 ❑ ร้อยละ 25 ของงานทั้งหมดหรือน้อยกว่า
2 ❑ ร้อยละ 26 ถึง 50 ของงานทั้งหมด
3 ❑ ร้อยละ 51 ถึง 75% ของงานทั้งหมด
4 ❑ ร้อยละ 76% ของงานทั้งหมดหรือมากกว่า
5 ❑ โรงพยาบาลของเราไม่ใช้ระบบคอมพิวเตอร์และเทคโนโลยีสารสนเทศ



## ส่วนที่ 3: ข้อมูลทั่วไปของโรงพยาบาล

16. ปัจจุบันโรงพยาบาลของท่านมีเตียงรับผู้ป่วยในจำนวนกี่เตียง?

|_____| เตียง

17. ปัจจุบันโรงพยาบาลของท่านมีแพทย์ปฏิบัติงานจำนวนกี่คน?

|_____| คน

18. ปัจจุบันโรงพยาบาลของท่านมีบุคลากรที่ปฏิบัติงานเต็มเวลา (full-time) จำนวนกี่คน? หากท่านไม่ทราบจำนวนที่แน่นอน กรุณาระบุจำนวนโดยประมาณ

|_____| คน

19. ปัจจุบันโรงพยาบาลของท่านมีบุคลากรด้านเทคโนโลยีสารสนเทศ (รวมถึงผู้บริหารงานสารสนเทศ ผู้ดูแลระบบ โปรแกรมเมอร์ และบุคลากรทางเทคนิคอื่นๆ) ที่ปฏิบัติงานเต็มเวลา (full-time) จำนวนกี่คน?

|_____| คน

20. ในปีงบประมาณที่ผ่านมา โรงพยาบาลของท่าน ใช้งบประมาณเพื่อการจัดซื้อ/จัดจ้าง ฮาร์ดแวร์ ซอฟต์แวร์ บุคลากร ที่ปรึกษา และการจ้างงาน (outsourcing) ด้านเทคโนโลยีสารสนเทศเป็นจำนวนประมาณร้อยละเท่าใดของงบประมาณทั้งหมด?

ประมาณร้อยละ |_____| ของงบประมาณทั้งหมด

21. โรงพยาบาลของท่านเป็นโรงพยาบาลของรัฐหรือเอกชน?

1 ❑ โรงพยาบาลของรัฐ (รวมถึงรัฐวิสาหกิจ โรงพยาบาลในกำกับของรัฐ และองค์การมหาชน)
2 ❑ โรงพยาบาลเอกชน → ต่อข้อ 22

ข้ามไปข้อ 23

22. โรงพยาบาลของท่านเป็นส่วนหนึ่งของเครือข่ายโรงพยาบาลที่เป็นเจ้าของหรือเป็นผู้บริหารจัดการโรงพยาบาลมากกว่าหนึ่งแห่งใช่หรือไม่?

1 ❑ ใช่
2 ❑ ไม่ใช่ → ข้ามไปข้อ 25

23. โรงพยาบาลของท่านสังกัดหน่วยงานใด?

1 ❑ กระทรวงสาธารณสุข → ต่อข้อ 24
2 ❑ มหาวิทยาลัยหรือวิทยาลัยของรัฐ
3 ❑ ส่วนราชการ รัฐวิสาหกิจ หรือหน่วยงานอื่นของรัฐ
4 ❑ โรงพยาบาลของเราเป็นโรงพยาบาลของรัฐที่เป็นอิสระ ไม่ขึ้นอยู่กับหน่วยงานใด → ข้ามไปข้อ 25

24. ข้อใดต่อไปนี้ตรงกับสถานะของโรงพยาบาลของท่านมากที่สุด?

1 ❑ โรงพยาบาลชุมชน
2 ❑ โรงพยาบาลทั่วไป
3 ❑ โรงพยาบาลศูนย์
4 ❑ โรงพยาบาลเฉพาะทางหรือโรงพยาบาลประเภทอื่น

25. โรงพยาบาลของท่านเป็นโรงเรียนแพทย์ที่เปิดรับนักศึกษาแพทย์โดยตรงใช่หรือไม่?

1 ❑ ใช่
2 ❑ ไม่ใช่ → ต่อข้อ 26

26. โรงพยาบาลของท่านเป็นสถาบันสมทบของโรงเรียนแพทย์ใช่หรือไม่?

1 ❑ ใช่
2 ❑ ไม่ใช่

ข้ามไปข้อ 27



27. ข้อใดต่อไปนี้ตรงกับสถานภาพการรับรองคุณภาพโรงพยาบาล (hospital accreditation/HA) ของโรงพยาบาลของท่านในปัจจุบันมากที่สุด?

1 ❑ ยังไม่ได้รับการรับรอง และไม่มีแผนที่จะรับการตรวจรับรอง
2 ❑ ยังไม่ได้รับการรับรอง มีแผนที่จะรับการตรวจรับรอง แต่ยังไม่มีความคืบหน้าอย่างมีนัยสำคัญ
3 ❑ ยังไม่ได้รับการรับรอง แต่มีความคืบหน้าอย่างมีนัยสำคัญเพื่อรองรับการตรวจรับรอง
4 ❑ ผ่านการรับรองแล้ว

28. โปรดระบุร้อยละของผู้รับบริการ (patient visits) ในโรงพยาบาลของท่าน ใน 1 ปีที่ผ่านมาที่ใช้สิทธิค่ารักษาพยาบาลแต่ละอย่างต่อไปนี้โดยประมาณ

สิทธิข้าราชการ ร้อยละ _____

ประกันสังคม ร้อยละ_____

UC/ประกันสุขภาพถ้วนหน้า ร้อยละ_____

อื่นๆ ร้อยละ_____

## ส่วนที่ 4: ข้อมูลทั่วไปของผู้ตอบแบบสอบถาม

29. โปรดระบุเพศของท่าน

1 ❑ ชาย
2 ❑ หญิง

30. ท่านมีอายุเท่าใด

|_____| ปี

31. ท่านจบการศึกษาขั้นสูงสุดระดับใด?

1 ❑ ต่ำกว่าปริญญาตรี
2 ❑ ปริญญาตรี
3 ❑ ปริญญาโทหรือสูงกว่า

32. ข้อใดต่อไปนี้ตรงกับวิชาชีพหลักของท่านมากที่สุด?

1 ❑ บริหารธุรกิจหรือการจัดการ (business administration/management)
2 ❑ วิทยาการคอมพิวเตอร์ สารสนเทศศาสตร์ หรือวิศวกรรมศาสตร์
3 ❑ แพทยศาสตร์
4 ❑ ทันตแพทยศาสตร์
5 ❑ พยาบาลศาสตร์
6 ❑ เภสัชศาสตร์
7 ❑ เทคนิคการแพทย์
8 ❑ เวชระเบียนหรือสถิติ
9 ❑ สาธารณสุขศาสตร์
10 ❑ อื่นๆ โปรดระบุ |_____|

33. ข้อใดต่อไปนี้ตรงกับการรับการศึกษาอบรมด้านเทคโนโลยีสารสนเทศของท่านมากที่สุด?

1 ❑ ไม่เคยได้รับการศึกษาอบรมด้านเทคโนโลยีสารสนเทศเลย
2 ❑ เคยได้รับการอบรม แต่ไม่เคยได้รับปริญญาในสาขาที่เกี่ยวข้องกับเทคโนโลยีสารสนเทศ
3 ❑ เคยได้รับปริญญาในสาขาที่เกี่ยวข้องกับเทคโนโลยีสารสนเทศ

34. ข้อใดต่อไปนี้ตรงกับการรับการศึกษาอบรมในสาขาวิชาชีพทางคลินิกของท่านมากที่สุด? (สาขาวิชาชีพทางคลินิก รวมถึงสาขาวิชาทางแพทยศาสตร์ ทันตแพทยศาสตร์ พยาบาลศาสตร์ เภสัชศาสตร์ เทคนิคการแพทย์ กายภาพบำบัด เป็นต้น)

1 ❑ ไม่เคยได้รับการศึกษาอบรมในสาขาวิชาชีพทางคลินิก
2 ❑ เคยได้รับการอบรม แต่ไม่เคยได้รับปริญญาในสาขาวิชาชีพทางคลินิก
3 ❑ เคยได้รับปริญญาในสาขาวิชาชีพทางคลินิก



35. ข้อใดต่อไปนี้ตรงกับการรับการศึกษาอบรมด้านบริหารธุรกิจหรือการจัดการ (business administration/management) ของท่านมากที่สุด?

1 ❑ ไม่เคยได้รับการศึกษาอบรมด้านการบริหารธุรกิจหรือการบริหารจัดการ
2 ❑ เคยได้รับการอบรม แต่ไม่เคยได้รับปริญญาด้านการบริหารธุรกิจหรือการบริหารจัดการ
3 ❑ เคยได้รับปริญญาด้านการบริหารธุรกิจหรือการบริหารจัดการ

36. ท่านปฏิบัติงานในโรงพยาบาลแห่งนี้ (ไม่ว่าในตำแหน่งใด) มาแล้วทั้งหมดเป็นเวลากี่ปี?

|_____| ปี

37. ท่านปฏิบัติงานในตำแหน่งปัจจุบันในโรงพยาบาลแห่งนี้มาแล้วเป็นเวลากี่ปี?

|_____| ปี

38. ข้อใดต่อไปนี้ตรงกับบทบาทของท่านในโรงพยาบาลมากที่สุด? หากท่านมีหลายบทบาท กรุณาเลือกเฉพาะตัวเลือกแรกที่ตรงกับท่าน

1 ❑ ผู้อำนวยการหรือผู้บริหารระดับสูงของโรงพยาบาล
2 ❑ ผู้บริหารโรงพยาบาลที่กำกับดูแลงานด้านสารสนเทศของโรงพยาบาล
3 ❑ ผู้จัดการหรือหัวหน้าหน่วยงานด้านเทคโนโลยีสารสนเทศของโรงพยาบาล
4 ❑ ผู้เชี่ยวชาญด้านเทคโนโลยีสารสนเทศ ผู้ดูแลระบบ นักวิเคราะห์ระบบ โปรแกรมเมอร์ นักวิชาการคอมพิวเตอร์ หรือบุคลากรทางเทคนิคในโรงพยาบาล
5 ❑ บุคลากรในโรงพยาบาลที่มีส่วนร่วมในโครงการทางเทคโนโลยีสารสนเทศแต่ไม่ได้มีบทบาททางบริหารหรือทางเทคนิคอย่างเป็นทางการ
6 ❑ ไม่มีข้อใดข้างต้นตรงกับบทบาทของท่าน

ผู้วิจัยขอขอบพระคุณท่านเป็นอย่างสูงที่ได้กรุณาสละเวลาในการตอบแบบสอบถามนี้ คำตอบของท่านมีคุณค่าและสำคัญอย่างยิ่งต่อการพัฒนางานด้านเวชสารสนเทศในโรงพยาบาลของประเทศในอนาคต หากท่านมีความเห็นเพิ่มเติมในเรื่องใด ท่านสามารถแสดงความเห็นดังกล่าวได้ในช่องว่างข้างล่างนี้

_____
_____
_____
_____

หากท่านประสงค์จะได้รับผลการวิจัยนี้ กรุณาระบุที่อยู่ของท่านในช่องว่างข้างล่างนี้ ข้อมูลนี้จะถูกนำมาใช้เพื่อส่งผลการวิจัยเท่านั้น ผู้วิจัยจะไม่นำมาใช้ในการวิเคราะห์คำตอบของท่านในแบบสอบถาม หรือเปิดเผยกับบุคคลอื่นนอกคณะผู้วิจัย และคำตอบของท่านจะถูกรักษาเป็นความลับ การรายงานผลการศึกษาจะเป็นการรายงานในระดับผลรวม ไม่มีการเปิดเผยข้อมูลเฉพาะของท่านหรือโรงพยาบาลของท่าน ท่านอาจเลือกที่จะกรอกที่อยู่ของท่านในช่องว่างข้างล่างนี้หรือไม่ก็ได้

_____
_____
_____
_____
_____
_____

หากท่านมีข้อสงสัยเกี่ยวกับแบบสอบถามนี้ ท่านสามารถติดต่อ .....
ได้ที่หมายเลขโทรศัพท์ ..... หรือทาง e-mail ที่ .....
กรุณาส่งแบบสอบถามที่ตอบเสร็จแล้วในซองที่ผนึกตราไปรษณียากรแล้วซึ่งทางผู้วิจัยได้แนบมาพร้อมกับแบบสอบถามนี้ แล้วส่งไปที่:

## References


1. Institute of Medicine, Committee on Quality of Health Care in America. To err is human: building a safer health system. Kohn LT, Corrigan JM, Donaldson MS, editors. Washington, DC: National Academy Press; 2000. 287 p.

2. Institute of Medicine, Committee on Quality of Health Care in America. Crossing the quality chasm: a new health system for the 21st century. Washington, DC: National Academy Press; 2001. 337 p.

3. Organizing for America [Internet]. Washington, DC: Democratic National Committee, Organizing for America; [cited 2009 Mar 28]. Barack Obama and Joe Biden: the change we need | health care; [cited 2009 Mar 28]; [about 4 pages]. Available from: http://www.barackobama.com/issues/healthcare/

4. American Recovery and Reinvestment Act of 2009, Pub. L. 111-5, H.R. 1.

5. AMIA [Internet]. Bethesda (MD): American Medical Informatics Association; c2008. Letter to AMIA members from Don Eugene Detmer summarizing AMIA's activities on HR1; 2009 Feb 23 [cited 2009 Mar 28]; 3 p. Available from: http://www.amia.org/files/shared/MemberLetter_2-23-09_r.pdf

6. Chaudhry B, Wang J, Wu S, Maglione M, Mojica W, Roth E, Morton SC, Shekelle PG. Systematic review: impact of health information technology on quality, efficiency, and costs of medical care. Ann Intern Med. 2006 May;144(10):742-52.

7. Bates DW, Gawande AA. Improving safety with information technology. N Engl J Med. 2003 Jun;348(25):2526-34.

8. Amarasingham R, Plantinga L, Diener-West M, Gaskin DJ, Powe NR. Clinical information technologies and inpatient outcomes. Arch Intern Med. 2009 Jan;169(2):108-14.

9. Wang SJ, Middleton B, Prosser LA, Bardon CG, Spurr CD, Carchidi PJ, Kittler AF, Goldszer RC, Fairchild DG, Sussman AJ, Kuperman GJ, Bates DW. A cost-benefit analysis of electronic medical records in primary care. Am J Med. 2003 Apr;114(5):397-403.

10. Hillestad R, Bigelow J, Bower A, Girosi F, Meili R, Scoville R, Taylor R. Can electronic medical record systems transform health care? Potential health benefits, savings, and costs. Health Aff (Millwood). 2005 Sep-Oct;24(5):1103-17.

11. Walker J, Pan E, Johnston D, Adler-Milstein J, Bates DW, Middleton B. The value of health care information exchange and interoperability. Health Aff (Millwood). 2005 Jan;Suppl Web Exclusives:W5-10-W5-18.

12. Sidorov J. It ain't necessarily so: the electronic health record and the unlikely prospect of reducing health care costs. Health Aff (Millwood). 2006 Jul-Aug;25(4): 1079-85.

13. Himmelstein DU, Woolhandler S. Hope and hype: predicting the impact of electronic medical records. Health Aff (Millwood). 2005 Sep-Out;24(5):1121-3.

14. Jha AK, Ferris TG, Donelan K, DesRoches C, Shields A, Rosenbaum S, Blumenthal D. How common are electronic health records in the United States? A summary of the evidence. Health Aff (Millwood). 2006 Nov-Dec;25(6):w496-507.

15. Blumenthal D, DesRoches C, Donelan K, Ferris T, Jha A, Kaushal R, Rao S, Rosenbaum S. Health information technology in the United States: the information base for progress [Internet]. Princeton (NJ): Robert Wood Johnson Foundation; 2006 [cited 2009 Mar 29]. 81 p. Available from: http://www.rwjf.org/files/publications/ other/EHRReport0609.pdf

16. Continued progress: hospital use of information technology [Internet]. Chicago (IL): American Hospital Association; 2007 Feb [cited 2009 Mar 29]. 20 p. Available from: http://www.aha.org/aha/content/2007/pdf/070227-continuedprogress.pdf

17. Jha AK, DesRoches CM, Campbell EG, Donelan K, Rao SR, Ferris TG, Shields A, Rosenbaum S, Blumenthal D. Use of electronic health records in U.S. hospitals. N Engl J Med. 2009 Apr 16;360(16):1628-38.

18. Jha AK, Doolan D, Grandt D, Scott T, Bates DW. The use of health information technology in seven nations. Int J Med Inform. 2008 Dec;77(12):848-54.

19. Protti D. Comparison of information technology in general practice in 10 countries. Healthc Q. 2007;10(2):107-16.

20. Kijsanayotin B, Pannarunothai S, Speedie S. Penetration and adoption of health information technology (IT) in Thailand's community health centers (CHCs): a national survey. Stud Health Technol Inform. 2007;129(Pt 2):1154-8.

21. Pongpirul K, Sriratana S. Computerized information system in hospitals in Thailand: a national survey. J Health Sci. 2005 Sep-Oct;14(5):830-9. Thai.

22. Jha AK, Blumenthal D. International adoption of electronic health records. In: Blumenthal D, DesRoches C, Foubister V, editors. Health information technology in the United States: where we stand, 2008 [Internet]. Princeton (NJ): Robert Wood Johnson Foundation; 2008 [cited 2009 Jun 26]. p. 104-142. Available from: http://www.rwjf.org/files/research/3297.31831.hitreport.pdf

23. Chiasson M, Reddy M, Kaplan B, Davidson E. Expanding multi-disciplinary approaches to healthcare information technologies: what does information systems offer medical informatics? Int J Med Inform. 2007 Jun;76 Suppl 1:S89-97.

24. DeLone WH, McLean ER. Information systems success: the quest for the dependent variable. Inform Syst Res. 1992 Mar;3(1):60-95.

25. Shannon CE, Weaver W. The mathematical theory of communication. Urbana (IL): University of Illinois Press; 1949. 117 p.

26. Mason RO. Measuring information output: a communication systems approach. Inform Manage. 1978;1(5):219-34.

27. DeLone WH, McLean ER. The Delone and McLean model of information systems success: a ten-year update. J Manage Inform Syst. 2003 Spring;19(4):9-30.

28. Van Der Meijden MJ, Tange HJ, Troost J, Hasman A. Determinants of success of inpatient clinical information systems: a literature review. J Am Med Inform Assoc. 2003 May-Jun;10(3):235-43.

29. Fishbein M, Ajzen I. Belief, attitude, intention and behavior: an introduction to theory and research. Reading (MA): Addison-Wesley; 1975. 578 p.

30. Davis FD. Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Quart. 1989 Sep;13(3):319-40.

31. Ajzen I. The theory of planned behavior. Organ Behav Hum Dec. 1991;50(2): 179-211.

32. Bandura A. Social foundations of thought and action: a social cognitive theory. Englewood Cliffs (NJ): Prentice-Hall; 1986. 617 p.

33. Yarbrough AK, Smith TB. Technology acceptance among physicians: a new take on TAM. Med Care Res Rev. 2007 Dec;64(6):650-72.

34. Dixon DR. The behavioral side of information technology. Int J Med Inform. 1999 Dec;56(1-3):117-23.

35. Venkatesh V, Morris MG, Davis GB, Davis FD. User acceptance of information technology: toward a unified view. MIS Quart. 2003 Sep;27(3):425-78.

36. Chen CC, Wu J, Crandall RE. Obstacles to the adoption of radio frequency identification technology in the emergency rooms of hospitals. Int J Electron Healthc. 2007;3(2):193-207.

37. Duyck P, Pynoo B, Devolder P, Voet T, Adang L, Vercruysse J. User acceptance of a picture archiving and communication system. Applying the unified theory of acceptance and use of technology in a radiological setting. Methods Inf Med. 2008;47(2):149-56.

38. Kijsanayotin B, Pannarunothai S, Speedie SM. Factors influencing health information technology adoption in Thailand's community health centers: applying the UTAUT model. Int J Med Inform. 2009 Jun;78(6):404-16.

39. Rogers EM. Diffusion of innovations. 5th ed. New York: Free Press; 2003. 551 p.

40. Davidson SM, Heineke J. Toward an effective strategy for the diffusion and use of clinical information systems. J Am Med Inform Assoc. 2007 May-Jun;14(3): 361-367.

41. Ash JS, Gorman PN, Seshadri V, Hersh WR. Computerized physician order entry in U.S. hospitals: results of a 2002 survey. J Am Med Inform Assoc. 2004 Mar-Apr;11(2):95-99.

42. Ward MM, Jaana M, Bahensky JA, Vartak S, Wakefield DS. Clinical information system availability and use in urban and rural hospitals. J Med Syst. 2006 Dec;30(6):429-438.

43. Henderson J, Britt H, Miller G. Extent and utilisation of computerisation in Australian general practice. Med J Aust. 2006 Jul;185(2):84-7.

44. Leonard KJ, Sittig DF. Improving information technology adoption and implementation through the identification of appropriate benefits: creating IMPROVE-IT. J Med Internet Res. 2007 May;9(2):e9.

45. Zmud RW, Apple LE. Measuring technology incorporation/infusion. J Prod Innov Manag. 1992;9(2):148-55.

46. Kraemer KL. The politics of model implementation. Syst Object Solut. 1981;1(4): 161-71.

47. Kwon TH, Zmud RW. Unifying the fragmented streams of information systems implementation research. In: Boland RJ Jr, Hirschheim RA, editors. Critical issues in information systems research. New York: John Wiley; 1987. p. 227-51.

48. Munson D, Pelz DC. Innovating in organizations: a conceptual framework. Ann Arbor (MI): University of Michigan; 1982. 106 p.

49. Yin RK. Changing urban bureaucracies. Lexington (MA): Lexington Books; 1979. 395 p.

50. Ash JS. Factors affecting the diffusion of the computer-based patient record. Proc AMIA Annu Fall Symp. 1997:682-6.

51. Churchill NC, Kempster JH, Uretsky M. Computer based information systems for management: a survey. New York: National Association of Accountants; 1969. 167 p.

52. Greiner LE. Evolution and revolution as organizations grow. Harvard Bus Rev. 1972 Jul-Aug;50(4):37-46.

53. Nolan RL. Managing the computer resource: a stage hypothesis. Commun ACM. 1973 Jul;16(7):399-405.

54. Nolan RL. Plight of the EDP manager. Harvard Bus Rev. 1973 May-Jun;51(3): 143-52.

55. Gibson CF, Nolan RL. Behavioral and organizational issues in the stages of managing the computer resource. In: Nolan RL, editor. Managing the data resource function. St. Paul (MN): West Publishing Company; 1974. p. 63-86.

56. Gibson CF, Nolan RL. Managing the four stages of EDP growth. Harvard Bus Rev. 1974 Jan-Feb;52(1):76-88.

57. Nolan RL. Thoughts about the fifth stage. Database. 1975 Fall;7(2):4-10.

58. Nolan RL. Controlling the cost of data services. Harvard Bus Rev. 1977 Jul-Aug; 55(4):114-24.

59. Nolan RL. Management accounting and control of data processing. New York: National Association of Accountants; 1977. 192 p.

60. Nolan RL. Organizational response and information technology. AFIPS Conf P. 1978;47:517-24.

61. Nolan RL. Managing the crises in data processing. Harvard Bus Rev. 1979 Mar-Apr;57(2):115-26.

62. Benbasat I, Dexter AS, Drury DH, Goldstein RC. A critique of the stage hypothesis: theory and empirical evidence. Commun ACM. 1984 May;27(5):476-85.

63. Benbasat I, Dexter AS, Mantha RW. Impact of organizational maturity on information system skill needs. MIS Quart. 1980 Mar;4(1):21-34.

64. Saunders CS, Keller RT. A study of maturity of the information system function, task characteristics and interdepartmental communications: the importance of information system-organizational fit. Proc Int Conf Inf Syst. 1983:111-24.

65. Gupta YP, Karimi J, Smoers TM. Alignment of a firm's competitive strategy and information technology management sophistication: the missing link. IEEE T Eng Manage. 1997 Nov;44(4):399-413.

66. Cheney PH, Dickson GW. Organizational characteristics and information systems: an exploratory investigation. Acad Manage J. 1982;25(1):170-84.

67. Raymond L, Paré G. Measurement of information technology sophistication in small manufacturing business. Inf Resour Manag J. 1992 Spring;5(2):4-16.

68. Paré G, Sicotte C. Information technology sophistication in health care: an instrument validation study among Canadian hospitals. Int J Med Inform. 2001 Oct;63(3):205-223.

69. Paré G, Sicotte C. IT sophistication in hospitals: a field study in Quebec. Medinfo. 2001;10(Pt 2):1185-1189.

70. Jaana M, Ward MM, Paré G, Wakefield DS. Clinical information technology in hospitals: a comparison between the state of Iowa and two provinces in Canada. Int J Med Inform. 2005 Sep;74(9):719-731.

71. Jaana M, Ward MM, Paré G, Sicotte C. Antecedents of clinical information technology sophistication in hospitals. Health Care Manage Rev. 2006 Oct-Dec;31(4):289-299.

72. Hart VA. Information technology sophistication and outcomes of acute care hospitals in Texas [dissertation]. Arlington (TX): The University of Texas at Arlington; 2006 Aug. 150 p.

73. Culler SD, Atherly A, Walczak S, Davis A, Hawley JN, Rask KJ, Naylor V, Thorpe KE. Urban-rural differences in the availability of hospital information technology applications: a survey of Georgia hospitals. J Rural Health. 2006 Summer;22(3): 242-7.

74. Culler SD, Hawley JN, Naylor V, Rask KJ. Is the availability of hospital IT applications associated with a hospital's risk adjusted incidence rate for patient safety indicators: results from 66 Georgia hospitals. J Med Syst. 2007 Oct;31(5): 319-27.

75. Alexander GL. A state profile of IT sophistication in nursing homes. AMIA Annu Symp Proc. 2008 Nov:1-5.

76. Burke DE, Menachemi N. Opening the black box: measuring hospital information technology capability. Health Care Manage Rev. 2004 Jul-Sep;29(3):210-7.

77. Bharadwaj AS. A resource-based perspective on information technology capability and firm performance: an empirical investigation. MIS Quart. 2000 Mar;24(1): 169-96.

78. Tippins MJ, Sohi RS. IT competency and firm performance: is organizational learning a missing link? Strategic Manage J. 2003;24(8):745-61.

79. Bharadwaj AS, Sambamurthy V, Zmud RW. IT capabilities: theoretical perspectives and empirical operationalization. Proc 20th Int Conf Inf Syst. 1999:378-85.

80. Khatri N. Building IT capability in health-care organizations. Health Serv Manage Res. 2006 May;19(2):73-79.

81. PubMed [Internet]. Bethesda (MD): National Library of Medicine (US). [1950] - [cited 2009 Jun 9]. Available from http://pubmed.gov/.

82. Garrard J. Health sciences literature review made easy: the Matrix Method. 2nd ed. Sudbury (MA): Jones & Bartlett; 2007. 199 p.

83. Google [Internet]. Mountain View (CA): Google Inc. c2008 - [cited 2008 Jun 1]. Available from http://www.google.com/.

84. Google Scholar [Internet]. Mountain View (CA): Google Inc. c2008 - [cited 2008 Jun 1]. Available from http://scholar.google.com/.

85. Ash J. Organizational factors that influence information technology diffusion in academic health sciences centers. J Am Med Inform Assoc. 1997 Mar-Apr;4(2): 102-11.

86. Burke D, Menachemi N, Brooks RG. Diffusion of information technology supporting the Institute of Medicine's quality chasm care aims. J Healthc Qual. 2005 Jan-Feb;27(1):24-32, 39.

87. Brooks RG, Menachemi N, Burke D, Clawson A. Patient safety-related information technology utilization in urban and rural hospitals. J Med Syst. 2005 Apr;29(2): 103-9.

88. Menachemi N, Burke D, Clawson A, Brooks RG. Information technologies in Florida's rural hospitals: does system affiliation matter? J Rural Health. 2005 Summer;21(3):263-8.

89. Burt CW, Sisk JE. Which physicians and practices are using electronic medical records? Health Aff (Millwood). 2005 Sep-Oct;24(5):1334-43.

90. Burke D, Menachemi N, Brooks R. Health care CIOs: assessing their fit in the organizational hierarchy and their influence on information technology capability. Health Care Manag (Frederick). 2006 Apr-Jun;25(2):167-72.

91. Menachemi N, Brooks RG. EHR and other IT adoption among physicians: results of a large-scale statewide analysis. J Healthc Inf Manag. 2006 Summer;20(3):79-87.

92. Simon SR, Kaushal R, Cleary PD, Jenter CA, Volk LA, Poon EG, Orav EJ, Lo HG, Williams DH, Bates DW. Correlates of electronic health record adoption in office practices: a statewide survey. J Am Med Inform Assoc. 2007 Jan-Feb;14(1):110-7.

93. Menachemi N, Brooks RG, Simpson L. The relationship between pediatric volume and information technology adoption in hospitals. Qual Manag Health Care. 2007 Apr-Jun;16(2):146-52.

94. Menachemi N, Saunders C, Chukmaitov A, Matthews MC, Brooks RG. Hospital adoption of information technologies and improved patient safety: a study of 98 hospitals in Florida. J Healthc Manag. 2007 Nov-Dec;52(6):398-409.

95. Simon SR, Kaushal R, Jenter CA, Volk LA, Burdick E, Poon EG, Tumolo AZ, Tripathi M, Bates DW. Readiness for electronic health records: comparison of characteristics of practices in a collaborative with the remainder of Massachusetts. Inform Prim Care. 2008;16(2):129-37.

96. Burke D, Randeree E, Menahcemi N, Brooks RG. Hospital financial performance: does IT governance make a difference? Health Care Manag (Frederick). 2008 Jan-Mar;27(1):71-8.

97. Menachemi N, Chukmaitov A, Saunders C, Brooks RG. Hospital quality of care: does information technology matter? The relationship between information technology adoption and quality of care. Health Care Manage Rev. 2008 Jan-Mar;33(1):51-9.

98. Hikmet N, Bhattacherjee A, Menachemi N, Kayhan VO, Brooks RG. The role of organizational factors in the adoption of healthcare information technology in Florida hospitals. Health Care Manag Sci. 2008 Mar;11(1):1-9.

99. Menachemi N, Struchen-Shellhorn W, Brooks RG, Simpson L. Influence of pay-for-performance programs on information technology use among child health providers: the devil is in the details. Pediatrics. 2009 Jan;123 Suppl 2:S92-6.

100. Weir C, Lincoln M, Roscoe D, Turner C, Moreshead G. Dimensions associated with successful implementation of a hospital based integrated order entry system. Proc Annu Symp Comput Appl Med Care. 1994:653-7.

101. Lee F, Teich JM, Spurr CD, Bates DW. Implementation of physician order entry: user satisfaction and self-reported usage patterns. J Am Med Inform Assoc. 1996 Jan-Feb;3(1):42-55.

102. Simić S, Marinković J, Bjegović V, Stanisavljević D. The diffusion of computer-based information technology into health institutions of Republic of Serbia (FR Yugoslavia). J Med Syst. 1996 Aug;20(4):207-14.

103. Reeder CE, Dickson M, Kozma CM, Santell JP. ASHP national survey of pharmacy practice in acute care settings--1996. Am J Health Syst Pharm. 1997 Mar 15;54(6): 653-69.

104. Ash JS, Gorman PN, Hersh WR. Physician order entry in U.S. hospitals. Proc AMIA Symp. 1998:235-9.

105. Bomba D. A comparative study of computerised medical records usage among general practitioners in Australia and Sweden. Stud Health Technol Inform. 1998; 52 Pt 1:55-9.

106. Hatcher M. Information systems' approaches and designs and facility information: survey of acute care hospitals in the United States. J Med Syst. 1998 Dec;22(6): 389-396.

107. Ringold DJ, Santell JP, Schneider PJ, Arenberg S. ASHP national survey of pharmacy practice in acute care settings: prescribing and transcribing--1998. Am J Health Syst Pharm. 1999 Jan 15;56(2):142-57.

108. Haruki Y, Ogushi Y, Okada Y, Kimura M, Kumamoto I, Sekita Y. Status and perspective of hospital information systems in Japan. Methods Inf Med. 1999 Sep;38(3):200-6.

109. Ringold DJ, Santell JP, Schneider PJ. ASHP national survey of pharmacy practice in acute care settings: dispensing and administration--1999. Am J Health Syst Pharm. 2000 Oct 1;57(19):1759-75.

110. Pedersen CA, Schneider PJ, Santell JP, Kelly EJ. ASHP national survey of pharmacy practice in acute care settings: monitoring, patient education, and wellness--2000. Am J Health Syst Pharm. 2000 Dec 1;57(23):2171-87.

111. Parente ST, Dunbar JL. Is health information technology investment related to the financial performance of US hospitals? An exploratory analysis. Int J Healthcare Technology and Management. 2001;3(1):48-58.

112. Pedersen CA, Schneider PJ, Santell JP. ASHP national survey of pharmacy practice in hospital settings: prescribing and transcribing--2001. Am J Health Syst Pharm. 2001 Dec 1;58(23):2251-66.

113. Johnson CE, Kralewski JE, Lemak CH, Côté MJ, Deane J. The adoption of computer-based information systems by medical groups in a managed care environment. J Ambul Care Manage. 2002 Jan;25(1):40-51.

114. Wiring California's health care safety net: how community health centers are using information technology to improve their services [Internet]. Oakland (CA): Blueprint Research & Design, Inc.; 2002 Feb 14 [cited 2009 Jun 19]. 8 p. Available from: http://blueprintrd.com/text/cci_report.pdf

115. Loomis GA, Ries JS, Saywell RM,Jr, Thakker NR. If electronic medical records are so great, why aren't family physicians using them? J Fam Pract. 2002 Jul;51(7): 636-41.

116. Burke DE, Wang BB, Wan TT, Diana ML. Exploring hospitals' adoption of information technology. J Med Syst. 2002 Aug;26(4):349-355.

117. 2002 HIMSS/AstraZeneca Clinician Survey [Internet]. Chicago (IL): Healthcare Information and Management Systems Society; 2002 Nov 4 [cited 2009 Jun 19]. 18 p. Available from: http://www.himss.org/content/files/surveyresults/Final%20 Final%20Report.pdf

118. Pedersen CA, Schneider PJ, Scheckelhoff DJ. ASHP national survey of pharmacy practice in hospital settings: dispensing and administration--2002. Am J Health Syst Pharm. 2003 Jan 1;60(1):52-68.

119. 14th Annual HIMSS Leadership Survey - healthcare chief information officer results: healthcare CIO survey final report [Internet]. Chicago (IL): Healthcare Information and Management Systems Society; 2003 Feb 10 [cited 2008 Jul 10]. 32 p. Available from: http://www.himss.org/2003survey/docs/Healthcare_CIO_final_ report.pdf Sponsored by Superior Consultant Company, Inc.

120. Pallin D, Lahman M, Baumlin K. Information technology in emergency medicine residency-affiliated emergency departments. Acad Emerg Med. 2003 Aug;10(8): 848-52.

121. Bell DS, Daly DM, Robinson P. Is there a digital divide among physicians? A geographic analysis of information technology in Southern California physician offices. J Am Med Inform Assoc. 2003 Sep-Oct;10(5):484-93.

122. Schumock GT, Nair VP, Finley JM, Lewis RK. Penetration of medication safety technology in community hospitals. J Med Syst. 2003 Dec;27(6):531-41.

123. Andrews JE, Pearce KA, Sydney C, Ireson C, Love M. Current state of information technology use in a US primary care practice-based research network. Inform Prim Care. 2004;12(1):11-18.

124. Medical Records Institute. Medical Records Institute's Sixth Annual Survey of Electronic Health Record Trends and Usage for 2004 [Internet]. Edison (NJ): The Provider's Edge; 2004 [cited 2009 Jun 25]. 21 p. Available from: http://www.providersedge.com/ehdocs/ehr_articles/Survey_of_EHR_Trends_and_ Usage_for_2004.pdf

125. 15th Annual HIMSS Leadership Survey - healthcare CIO results: final report [Internet]. Chicago (IL): Healthcare Information and Management Systems Society; 2004 Feb 23 [cited 2008 Jul 10]. 29 p. Available from: http://www.himss.org/2004survey/docs/Healthcare_CIO_final_report.pdf Sponsored by Superior Consultant Company, Inc.

126. Pedersen CA, Schneider PJ, Scheckelhoff DJ. ASHP national survey of pharmacy practice in hospital settings: monitoring and patient education--2003. Am J Health Syst Pharm. 2004 Mar 1;61(5):457-71.

127. Parekh SG, Nazarian DG, Lim CK. Adoption of information technology by resident physicians. Clin Orthop Relat Res. 2004 Apr;(421):107-111.

128. Didham R, Martin I, Wood R, Harrison K. Information technology systems in general practice medicine in New Zealand. N Z Med J. 2004 Jul 23;117(1198):U977.

129. Reed MC, Grossman JM. Limited information technology for patient care in physician offices. Issue Brief Cent Stud Health Syst Change. 2004 Sep;(89):1-6.

130. Chew F, Grant W, Tote R. Doctors on-line: using diffusion of innovations theory to understand internet use. Fam Med. 2004 Oct;36(9):645-50.

131. Li R, Simon J, Bodenheimer T, Gillies RR, Casalino L, Schmittdiel J, Shortell SM. Organizational factors affecting the adoption of diabetes care management processes in physician organizations. Diabetes Care. 2004 Oct;27(10):2312-6.

132. Miller RH, Hillman JM, Given RS. Physician use of IT: results from the Deloitte Research Survey. J Healthc Inf Manag. 2004 Winter;18(1):72-80.

133. Audet AM, Doty MM, Peugh J, Shamasdin J, Zapert K, Schoenbaum S. Information technologies: when will they make it into physicians' black bags? MedGenMed. 2004 Dec 6;6(4):2.

134. Gagnon MP, Lamothe L, Fortin JP, Cloutier A, Godin G, Gagné C, Reinharz D. Telehealth adoption in hospitals: an organisational perspective. J Health Organ Manag. 2005;19(1):32-56.

135. Medical Records Institute. Medical Records Institute's Seventh Annual Survey of Electronic Health Record Trends and Usage for 2005 [Internet]. Lisbon (Portugal): European Health Telematics Observatory; c2005 [cited 2009 Jun 25]. 30 p. Available from: http://www.ehto.org/2006/US%20Medical%20Records%20Institute%20-%20Results%20of%20the%20EHR%20global%20survey%20in%202005.pdf

136. Warner A, Menachemi N, Brooks RG. Information technologies relevant to pharmacy practice in hospitals: result of a statewide survey. Hosp Pharm. 2005;40(3):233-9.

137. Terry K. Exclusive survey: doctors and EHRs. Med Econ. 2005 Jan 21;82(2):72-4, 77-8, 80-4.

138. Wang BB, Wan TT, Burke DE, Bazzoli GJ, Lin BY. Factors influencing health information system adoption in American hospitals. Health Care Manage Rev. 2005 Jan-Mar;30(1):44-51.

139. 16th Annual HIMSS Leadership Survey - healthcare CIO results: final report [Internet]. Chicago (IL): Healthcare Information and Management Systems Society; 2005 Feb 14 [cited 2008 Jul 10]. 28 p. Available from: http://www.himss.org/2005survey/docs/Healthcare_CIO_finalreport.pdf Sponsored by Superior Consultant Company/ACS Healthcare Solutions.

140. Pedersen CA, Schneider PJ, Scheckelhoff DJ. ASHP national survey of pharmacy practice in hospital settings: prescribing and transcribing--2004. Am J Health Syst Pharm. 2005 Feb 15;62(4):378-90.

141. Burt CW, Hing E. Use of computerized clinical support systems in medical settings: United States, 2001-03. Adv Data. 2005 Mar 2;(353):1-8.

142. Moylan C, Sickler D, Carrier B, Cromwell J. NAPH health information technology source book: findings from the 2004 Electronic Medical Record Survey [Internet]. Washington, DC: National Association of Public Hospitals and Health Systems; 2005 May [cited 2009 Jun 25]. 70 p. Available from: http://www.naph.org/Publications/naphhealthinformationtechnologysourcebook.aspx

143. Lorence DP, Churchill R. Clinical knowledge management using computerized patient record systems: is the current infrastructure adequate? IEEE Trans Inf Technol Biomed. 2005 Jun;9(2):283-288.

144. Schectman JM, Schorling JB, Nadkarni MM, Voss JD. Determinants of physician use of an ambulatory prescription expert system. Int J Med Inform. 2005 Sep;74(9): 711-7.

145. Gans D, Kralewski J, Hammons T, Dowd B. Medical groups' adoption of electronic health records and information systems. Health Aff (Millwood). 2005 Sep-Oct; 24(5):1323-33.

146. Forward momentum: hospital use of information technology [Internet]. Chicago (IL): American Hospital Association; 2005 Oct [cited 2009 Jun 18]. 13 p. Available from: http://www.aha.org/aha/content/2005/pdf/FINALNonEmbITSurvey105.pdf

147. Simon JS, Rundall TG, Shortell SM. Drivers of electronic medical record adoption among medical groups. Jt Comm J Qual Patient Saf. 2005 Nov;31(11):631-9.

148. Cutler DM, Feldman NE, Horwitz JR. U.S. adoption of computerized physician order entry systems. Health Aff (Millwood). 2005 Nov-Dec;24(6):1654-63.

149. Menachemi N, Perkins RM, van Durme DJ, Brooks RG. Examining the adoption of electronic health records and personal digital assistants by family physicians in Florida. Inform Prim Care. 2006;14(1):1-9.

150. Ochieng OG, Hosoi R. Factors influencing diffusion of electronic medical records: a case study in three healthcare institutions in Japan. HIM J. 2006;34(4):120-9.

151. Poon EG, Jha AK, Christino M, Honour MM, Fernandopulle R, Middleton B, Newhouse J, Leape L, Bates DW, Blumenthal D, Kaushal R. Assessing the level of healthcare information technology adoption in the United States: a snapshot. BMC Med Inform Decis Mak. 2006 Jan 5;6:1.

152. 17th Annual HIMSS Leadership Survey: CIO results final report [Internet]. Chicago (IL): Healthcare Information and Management Systems Society; 2006 Feb 13 [cited 2008 Jul 10]. 27 p. Available from: http://www.himss.org/2006survey/docs/ Healthcare_CIO_finalreport.pdf Sponsored by ACS Healthcare Solutions.

153. Pedersen CA, Schneider PJ, Scheckelhoff DJ. ASHP national survey of pharmacy practice in hospital settings: dispensing and administration--2005. Am J Health Syst Pharm. 2006 Feb 15;63(4):327-45.

154. McInnes DK, Saltman DC, Kidd MR. General practitioners' use of computers for prescribing and electronic health records: results from a national survey. Med J Aust. 2006 Jul 17;185(2):88-91.

155. Anderson JG, Balas EA. Computerization of primary care in the United States. Int J Healthc Inform Syst Informat. 2006 Jul-Sep;1(3):1-23.

156. Burt CW, Hing E, Woodwell D. Electronic medical record use by office-based physicians: United States, 2005 [Internet]. Hyattsville (MD): Centers for Disease Control and Prevention, National Center for Health Statistics; 2006 Aug [reviewed 2008 Jul 17; cited 2008 Aug 16]. [about 6 screens]. Available from: http://www.cdc.gov/nchs/products/pubs/pubd/hestats/electronic/electronic.htm

157. Grant RW, Campbell EG, Gruen RL, Ferris TG, Blumenthal D. Prevalence of basic information technology use by U.S. physicians. J Gen Intern Med. 2006 Nov;21(11): 1150-5.

158. Schoen C, Osborn R, Huynh PT, Doty M, Puegh J, Zapert K. On the front lines of care: primary care doctors' office systems, experiences, and views in seven countries. Health Aff (Millwood). 2006 Nov-Dec;25(6):w555-71.

159. Furukawa MF, Ketcham JD, Rimsza ME. Physician practice revenues and use of information technology in patient care. Med Care. 2007 Feb;45(2):168-76.

160. Pedersen CA, Schneider PJ, Scheckelhoff DJ. ASHP national survey of pharmacy practice in hospital settings: monitoring and patient education--2006. Am J Health Syst Pharm. 2007 Mar 1;64(5):507-20.

161. Simon SR, Kaushal R, Cleary PD, Jenter CA, Volk LA, Orav EJ, Burdick E, Poon EG, Bates DW. Physicians and electronic health records: a statewide survey. Arch Intern Med. 2007 Mar 12;167(5):507-12.

162. Sequist TD, Cullen T, Hays H, Taualii MM, Simon SR, Bates DW. Implementation and use of an electronic health record within the Indian Health Service. J Am Med Inform Assoc. 2007 Mar-Apr;14(2):191-7.

163. 18th Annual HIMSS Leadership Survey: CIO results final report [Internet]. Chicago (IL): Healthcare Information and Management Systems Society; 2007 Apr 10 [cited 2008 Jul 10]. 27 p. Available from: http://www.himss.org/2007survey/DOCS/ 18thAnnualLeadershipSurvey.pdf

164. Amarasingham R, Pronovost PJ, Diener-West M, Goeschel C, Dorman T, Thiemann DR, Powe NR. Measuring clinical information technology in the ICU setting: application in a quality improvement collaborative. J Am Med Inform Assoc. 2007 May-Jun;14(3):288-94.

165. Shields AE, Shin P, Leu MG, Levy DE, Betancourt RM, Hawkins D, Proser M. Adoption of health information technology in community health centers: results of a national survey. Health Aff (Millwood). 2007 Sep-Oct;26(5):1373-83.

166. Kazley AS, Ozcan YA. Organizational and environmental determinants of hospital EMR adoption: a national study. J Med Syst. 2007 Oct;31(5):375-84.

167. Mojtabai R. Datapoints: use of information technology by psychiatrists and other medical providers. Psychiatr Serv. 2007 Oct;58(10);1261.

168. Hing ES, Burt CW, Woodwell DA. Electronic medical record use by office-based physicians and their practices: United States, 2006. Adv Data. 2007 Oct 26;(393): 1-7.

169. Evans JM, Guthrie B, Pagliari C, Greene A, Morris AD, Cunningham S, Donnan PT. Do general practice characteristics influence uptake of an information technology (IT) innovation in primary care? Inform Prim Care. 2008;16(1):3-8.

170. Lapinsky SE, Holt D, Hallett D, Abdolell M, Adhikari NK. Survey of information technology in intensive care units in Ontario, Canada. BMC Med Inform Decis Mak. 2008 Jan 24;8:5.

171. Simon SR, McCarthy ML, Kaushal R, Jenter CA, Volk LA, Poon EG, Yee KC, Orav EJ, Williams DH, Bates DW. Electronic health records: which practices have them, and how are clinicians using them? J Eval Clin Pract. 2008 Feb;14(1):43-7.

172. 19th Annual HIMSS Leadership Survey: CIO results final report [Internet]. Chicago (IL): Healthcare Information and Management Systems Society; 2008 Feb 25 [cited 2008 Jul 10]. 30 p. Available from: http://www.himss.org/2008survey/DOCS/ 19thAnnualLeadershipSurveyFINAL.pdf Sponsored by Cisco.

173. Li P, Bahensky JA, Jaana M, Ward MM. Role of multihospital system membership in electronic medical record adoption. Health Care Manage Rev. 2008 Apr-Jun; 33(2):169-77.

174. Pedersen CA, Schneider PJ, Scheckelhoff DJ. ASHP national survey of pharmacy practice in hospital settings: prescribing and transcribing--2007. Am J Health Syst Pharm. 2008 May 1;65(9):827-43.

175. Furukawa MF, Raghu TS, Spaulding TJ, Vinze A. Adoption of health information technology for medication safety in U.S. hospitals, 2006. Health Aff (Millwood). 2008 May-Jun;27(3):865-75.

176. Rankin SB, White BA. Healthcare IT and Connecticut's acute-care hospitals: an analysis of trends, barriers, impacts, and perspectives. J Healthc Inf Manag. 2008 Summer;22(3);57-63.

177. DesRoches CM, Campbell EG, Rao SR, Donelan K, Ferris TG, Jha A, Kaushal R, Levy DE, Rosenbaum S, Shields AE, Blumenthal D. Electronic health records in ambulatory care--a national survey of physicians. N Engl J Med. 2008 Jul 3;359(1):50-60.

178. Chiang MF, Boland MV, Margolis JW, Lum F, Abramoff MD, Hildebrand PL. Adoption and perceptions of electronic health record systems by ophthalmologists: an American Academy of Ophthalmology Survey. Ophthalmology. 2008 Sep;115(9):1591-7.

179. Egger Halbeis CB, Epstein RH, Macario A, Pearl RG, Grunwald Z. Adoption of anesthesia information management systems by academic departments in the United States. Anesth Analg. 2008 Oct;107(4):1323-9.

180. Pedersen CA, Gumpper KF. ASHP national survey on informatics: assessment of the adoption and use of pharmacy informatics in U.S. hospitals--2007. Am J Health Syst Pharm. 2008 Dec 1;65(23):2244-64.

181. Jaana M, Paré G, Sicotte C. Information technology capacities assessment tool in hospitals: instrument development and validation. Int J Technol Assess Health Care. 2009 Jan;25(1):97-106.

182. Menachemi N, Brooks RG, Schwalenstocker E, Simpson L. Use of health information technology by children's hospitals in the United States. Pediatrics. 2009 Jan;123 Suppl 2:S80-4.

183. Parente ST, McCullough JS. Health information technology and patient safety: evidence from panel data. Health Aff (Millwood). 2009 Mar-Apr;28(2):357-60.

184. Protti D, Johansen I, Perez-Torres F. Comparing the application of health information technology in primary care in Denmark and Andalucía, Spain. Int J Med Inform. 2009 Apr;78(4):270-83.

185. Robinson JC, Casalino LP, Gillies RR, Rittenhouse DR, Shortell SS, Fernandes-Taylor S. Financial incentives, quality improvement programs, and the adoption of clinical information technology. Med Care. 2009 Apr;47(4):411-7.

186. Pedersen CA, Schneider PJ, Scheckelhoff DJ. ASHP national survey of pharmacy practice in hospital settings: dispensing and administration--2008. Am J Health Syst Pharm. 2009 May 15;66(10):926-46.

187. Ludwick DA, Doucette J. Primary care physicians' experience with electronic medical records: barriers to implementation in a fee-for-service environment. Int J Telemed Appl. 2009;2009:853524.

188. Pallin DJ, Sullivan AF, Auerbach BS, Camargo CA Jr. Adoption of information technology in Massachusetts emergency departments. J Emerg Med. Epub 2009 Feb 18.

189. Simon SR, Soran CS, Kaushal R, Jenter CA, Volk LA, Burdick E, Cleary PD, Orav EJ, Poon EG, Bates DW. Physicians' use of key functions in electronic health records from 2005 to 2007: a statewide survey. J Am Med Inform Assoc. 2009 Jul-Aug;16(4):465-470.

190. Neuman WL. Social research methods: qualitative and quantitative approaches. 6th ed. Boston: Allyn & Bacon; c2006. 592 p.

191. Friedman CP, Wyatt JC. Evaluation methods in biomedical informatics. 2nd ed. New York: Springer; c2006. 386 p.

192. Moore DS, McCabe GP. Introduction to the practice of statistics. 4th ed. New York: W.H. Freeman & Co.; 2003. 828 p.

193. Dorenfest SI. The Dorenfest 3000+ database: knowledge produces results. Dimens Health Serv. 1990 Apr;67(3):22-4.

194. HIMSS finalizes sale and acquires Dorenfest IHDS+ Database™ as HIMSS Analytics expands its market research efforts [Internet]. Chicago (IL): Healthcare Information and Management Systems Society; 2004 Jul 16 [cited 2009 July 4]. 3 p. Available from: http://www.dorenfest.com/doc/dorenfestSale.pdf

195. Dillman DA. Mail and Internet surveys: the Tailored Design Method. 2nd ed. Hoboken (NJ):John Wiley & Sons; 2007. 523 p.

196. Institute of Medicine, Board on Health Care Services, Committee on Data Standards for Patient Safety. Key Capabilities of an electronic health record system: letter report [Internet]. Washington, DC: National Academy of Sciences; 2003 [cited 2009 July 2]. 31 p. Available from: http://www.nap.edu/catalog/10781.html

197. Garets D, Davis M. Electronic medical records vs. electronic health records: yes, there is a difference. A HIMSS Analytics™ white paper [Internet]. Chicago (IL): HIMSS Analytics; 2006 Jan 26 [cited 2009 July 2]. 14 p. Available from: https://himssanalytics.org/docs/WP_EMR_EHR.pdf

198. Kaelber DC, Bates DW. Health information exchange and patient safety. J Biomed Inform. 2007 Dec;40(6 Suppl):S40-5.

199. Khoja S, Scott RE, Casebeer AL, Mohsin M, Ishaq AF, Gilani S. e-Health readiness assessment tools for healthcare institutions in developing countries. Telemed J E Health. 2007 Aug;13(4):425-31.

200. Lorenzi NM, Smith JB, Conner SR, Campion TR. The Success Factor Profile for clinical computer innovation. Stud Health Technol Inform. 2004;107(Pt 2):1077-80.

201. Jennett P, Jackson A, Healy T, Ho K, Kazanjian A, Woollard R, Haydt S, Bates J. A study of a rural community's readiness for telehealth. J Telemed Telecare. 2003;9(5):259-63.

202. Snyder-Halpern R. Indicators of organizational readiness for clinical information technology/systems innovation: a Delphi study. Int J Med Inform. 2001 Oct;63(3):179-204.

203. Snyder RA, Fields WL. Measuring hospital readiness for information technology (IT) innovation: a multisite study of the Organizational Information Technology Innovation Readiness Scale. J Nurs Meas. 2006 Spring-Summer;14(1):45-55.

204. Kaplan B, Harris-Salamone KD. Health IT success and failure: recommendations from the literature and an AMIA workshop. J Am Med Inform Assoc. 2009 May-Jun;16(3):291-9.

205. Ash JS, Stavri PZ, Kuperman GJ. A consensus statement on considerations for a successful CPOE implementation. J Am Med Inform Assoc. 2003 May-Jun;10(3):229-34.

206. Lorenzi NM, Novak LL, Weiss JB, Gadd CS, Unertl KM. Crossing the implementation chasm: a proposal for bold action. J Am Med Inform Assoc. 2008 May-Jun;15(3):290-6.

207. Lorenzi NM, Riley RT. Managing change: an overview. J Am Med Inform Assoc. 2000 Mar-Apr;7(2):116-24.

208. Massaro TA. Introducing physician order entry at a major academic medical center: I. Impact on organizational culture and behavior. Acad Med. 1993 Jan;68(1):20-5.

209. Langberg ML. Challenges to implementing CPOE: a case study of a work in progress at Cedars-Sinai. Mod Physician. 2003 Feb;7(2):21-2.

210. Nagle LM, Catford P. Toward a model of successful electronic health record adoption. Healthc Q. 2008;11(3):84-91.

211. Riley RT, Lorenzi NM. Gaining physician acceptance of information technology systems. Med Interface. 1995 Nov;8(11):78-80, 82-3.

212. Prijatelj V. Success factors of hospital information system implementation: what must go right? Stud Health Technol Inform. 1999;68:197-200.

213. Ash JS, Lyman J, Carpenter J, Fournier L. A diffusion of innovations model of physician order entry. Proc. AMIA Symp. 2001:22-6.

214. Dykstra R. Computerized physician order entry and communication: reciprocal impacts. Proc AMIA Symp. 2002:230-4.

215. Carr D, Howells A, Chang M, Hirji N, English A. An integrated approach to stakeholder engagement. Healthc Q. 2009;12 Spec No Ontario:62-70.

216. Kraus S, Barber TR, Briggs B, Kall G, Vernon TR, Moran B, Waggoner DM. Implementing computerized physician order management at a community hospital. Jt Comm J Qual Patient Saf. 2008 Feb;34(2):74-84.

217. Ash JS, Bates DW. Factors and forces affecting EHR system adoption: report of a 2004 ACMI discussion. J Am Med Inform Assoc. 2005 Jan-Feb;12(1):8-12.

218. Community Clinics Initiative. Celebrating technology advances in California's community clinics and health centers: Community Clinics Initiative, a joint project of Tides and The California Endowment 1999-2006 [Internet]. San Francisco (CA): Community Clinics Initiative; 2006 [cited 2008 Aug 17]. 40 p. Available from: http://www.communityclinics.org/files/887_file_Getting_to_the_Sun_ Commemorative_Book.pdf

219. Poon EG, Blumenthal D, Jaggi T, Honour MM, Bates DW, Kaushal R. Overcoming barriers to adopting and implementing computerized physician order entry systems in U.S. hospitals. Health Aff (Millwood). 2004 Jul-Aug;23(4):184-90.

220. Ash JS, Gorman PN, Lavelle M, Payne TH, Massaro TA, Frantz GL, Lyman JA. A Cross-site qualitative study of physician order entry. J Am Med Inform Assoc. 2003 Mar-Apr;10(2):188-200.

221. Lapointe L, Rivard S. Clinical information systems: understanding and preventing their premature demise. Healthc Q. 2005;8(2):92-100.

222. Campbell EM, Sittig DF, Ash JS, Guappone KP, Dykstra RH. Types of unintended consequences related to computerized provider order entry. J Am Med Inform Assoc. 2006 Sep-Oct;13(5):547-56.

223. Lee J, Cain C, Young S, Chockley N, Burstin H. The adoption gap: health information technology in small physician practices. Understanding office workflow can help realize the promise of technology. Health Aff (Millwood). 2005 Sep-Oct;24(5):1364-6.

224. Geyer S. Physicians: the key to IT success. Trustee. 2004 Feb;57(2):6-10, 1.

225. Ives B, Olson MH. User involvement and MIS success: a review of research. Manage Sci. 1984 May;30(5):586-603.

226. Paré G, Sicotte C, Jacques H. The effects of creating psychological ownership on physicians' acceptance of clinical information systems. J Am Med Inform Assoc. 2006 Mar-Apr;13(2):197-205.

227. Bernstein ML, McCreless T, Côté MJ. Five constants of information technology adoption in healthcare. Hosp Top. 2007 Winter;85(1):17-25.

228. Javitt JC. How to succeed in health information technology. Health Aff (Millwood). 2004 Jan-Jun;Suppl Web Exclusives:W4-321-4.

229. Scalise D. MDs + IT. Facilitating physician adoption. Hosp Health Netw. 2003 Apr;77(4):41-6, 1.

230. Metzger J, Fortin J. Computerized physician order entry in community hospitals: lessons from the field [Internet]. Oakland (CA): California HealthCare Foundation and First Consulting Group; 2003 Jun [cited 2008 Jul 23]. 51 p. Available from: http://www.chcf.org/documents/hospitals/CPOECommHospCorrected.pdf

231. Wyatt JC. Hospital information management: the need for clinical leadership. BMJ. 1995 Jul 15;311(6998):175-8.

232. Ash JS, Stavri PZ, Dykstra R, Fournier L. Implementing computerized physician order entry: the importance of special people. Int J Med Inform. 2003 Mar; 69(2-3):235-50.

233. Terry AL, Thorpe CF, Giles G, Brown JB, Harris SB, Reid GJ, Thind A, Stewart M. Implementing electronic health records: key factors in primary care. Can Fam Physician. 2008 May;54(5):730-6.

234. Chiang MF, Starren JB. Software engineering risk factors in the implementation of a small electronic medical record system: the problem of scalability. Proc AMIA Symp. 2002:145-9.

235. Weir C, Lincoln M, Roscoe D, Moreshead G. Successful implementation of an integrated physician order entry application: a systems perspective. Proc Annu Symp Comput Appl Med Care. 1995:790-4.

236. Ahmad A, Teater P, Bentley TD, Kuehn L, Kumar RR, Thomas A, Mekhjian HS. Key attributes of a successful physician order entry system implementation in a multi-hospital environment. J Am Med Inform Assoc. 2002 Jan-Feb;9(1):16-24.

237. Studer M. The effect of organizational factors on the effectiveness of EMR system implementation--what have we learned? Healthc Q. 2005;8(4):92-8.

238. Courtney KL, Alexander GL, Demiris G. Information technology from novice to expert: implementation implications. J Nurs Manag. 2008 Sep;16(16):692-9.

239. Leatt P, Shea C, Studer M, Wang V. IT solutions for patient safety--best practices for successful implementation in healthcare. Healthc Q. 2006;9(1):94-104.

240. Shortell SM, O'Brien JL, Carman JM, Foster RW, Hughes EF, Boerstler H, O'Connor EJ. Assessing the impact of continuous quality improvement/total quality management: concept versus implementation. Health Serv Res. 1995 Jun;30(2): 377-401.

241. Retchin SM, Wenzel RP. Electronic medical record systems at academic health centers: advantages and implementation issues. Acad Med. 1999 May;74(5):493-8.

242. Stablein D, Welebob E, Johnson E, Metzger J, Burgess R, Classen DC. Understanding hospital readiness for computerized physician order entry. Jt Comm J Qual Saf. 2003 Jul;29(7):336-44.