The Impact of Health Information Technology on Inpatient Medical Errors in US Hospitals

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Abstract

Background

In today's complex and high risk healthcare environment the race to implement health information technology (health IT) in the care delivery system is becoming more prevalent in United States hospitals but the science to support its safe and effective use is contradictory at best. Since the 1999 Institute of Medicine Report, *To Err is Human, Building a Safer Health System;* there has been an increasingly intensive focus on the prevention of medical errors and the improvement of hospital safety and quality. In more recent years information technology has been identified as having the potential to reduce and prevent a wide range of issues, including medical errors, thus increasing patient safety, improving the quality of care, and reducing costs. Many hospitals and provides have integrated health IT into the patient care process, usually in the form of decision support systems, electronic health records, provider order entry systems, and the like. However, not all providers, clinicians, and researchers are in agreement on the impact these computerized systems have on safety, quality, and patient outcomes. With contradicting results in the literature and gaps in the evidence of the safe and effective use of health IT there is much to be learned in this area.

This research project aims to quantify the impact of health IT on hospitals in the United States by investigating inpatient medical claims data, specifically medical errors and mortality rates and how they are impacted by health IT implementation data. The stage of

health IT implementation from year to year will be evaluated for its impact on the number of medical errors and mortality rates.

Methods

To address the study objectives data from two datasets, the HIMSS Analytics datasets, provided by the Healthcare Information Management and Systems Society (HIMSS) and the Healthcare Cost and Utilization Project's (HCUP) National Inpatient Sample (NIS) datasets provided by the Agency for Healthcare Research and Quality (AHRQ), were aggregated to form the analysis dataset. To accurately match the hospitals in each dataset the hospital's Medicare ID code was used. Once the datasets were matched, the study outcomes, number of medical errors and mortality rates, were drawn from the HCUP data and the health IT stages was derived from the HIMSS data. The International Classification of Disease version 9 (ICD-9) codes were used to identify medical errors from the HCUP data.

To address the primary and secondary objectives, both SAS and SPSS were utilized for data manipulation, data cleaning, and analysis. As part of the analysis descriptive statistics on hospital characteristics were assessed to determine the characteristics of hospitals at different stages of health IT implementation. Additionally, analysis of variance (ANOVA) was performed to determine the effects of health IT on medical errors and mortality rates. Finally multiple regression analysis was performed to determine if health IT stage is a predictor of medical errors and mortality rates.

Results

More than 530 hospitals were assessed for each of the four study years (2008, 2009, 2010, and 2011). Overall, US hospitals in three of the four years assessed support a significant difference in the mean number of medical errors between health IT stages within each year and for mortality rates all four years demonstrated the a significant amount of the variation in the model could be explained by health IT stage. Additionally, it was demonstrated that Stage 7 and Stage 0 were significantly different indicating that health IT stage can be a predictor for medical errors and mortality rates in three of the four years assessed.

Conclusion

This study demonstrates that there is an affect on quality of care, measured by medical errors and mortality rates, as it relates to the implementation of health IT. While the results are able to demonstrate this relationship between stages of health IT, further research is needed to assess health IT's affects on hospital outcomes in greater detail. Additionally, the hospital characteristics associated with hospitals at various levels of health IT provides insight into the available resources for implementation of technology in the clinical setting.

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1. Chapter I - Introduction

1.1 Background

In today's complex and high risk healthcare environment the introduction and implementation of health information technology (health IT) in hospitals and other care delivery settings has become an essential tool for managing the large amount of health and clinical information that is becoming available. Not only is there a need to manage individual patient data but also to use integrated systems to manage population health and the increasing body of knowledge available in the field. While the introduction and use of health IT in medicine is essential and unavoidable for patient care, the informatics community has little evidence to support the claims made by policy makers, who are pushing the widespread implementation of health IT. Additionally, the current body of knowledge available is not consistent and is often contradictory. The enactment of The Health Information Technology for Economic and Clinical Health (HITECH) Act has given the public a false sense of security in believing that these systems will improve patient safety, increase efficiency and reduce costs as they are made widely available in hospitals and patient care settings in the US.

The introduction of computers into the medical profession has occurred at a steady pace, though still unmatched by other industries including aviation and automotive. In the 1940's the first digital computers were introduced with great expectations.[1] Within several decades the first personal computers appeared in the 1970's and soon followed the ability for hospitals and other clinical care settings to make workstations available along with other advancements in computing specifically targeted to physicians and clinicians.[1] In the 1980's the Veterans Administration began creating individual health records through their in-house system, the Veterans Health Information Systems and Technology Architecture (VistA) based of the Massachusetts General Hospital Utility Multi-Programming System (MUMPS) and establishing one of the first integrated electronic medical record systems. In the early 1990's the internet and World Wide Web came into play[1] as we began to see the beginnings of information sharing and data integration. With the introduction of smartphones and tables, the wide range of applications, hardware, and software now available to clinicians is staggering and continues to grow.

In 1998, the Institute of Medicine (IOM) initiated the Quality of Health in America project which was tasked with developing an approach to improve health care quality.[2] In 1999 the IOM released groundbreaking information on medical errors and safety in the United States health care system. *To Err is Human: Building a Safer Health System* was the first in a series of publications released by the Institute on the topic. The report is infamous for reporting that medical errors had the potential to be one of the top ten causes of death in the US, killing some 44,000 – 98,000 Americans per year, with some estimating the number to be even higher. Between 1999 and 2011 the IOM continued to release a number of publications addressing the issues surrounding medical errors, patient, safety, quality of care, and health information technology. In these reports the institute makes recommendations for how to move forward with policies at the government and industry levels and provides insight into what patients can do to protect themselves. However, despite the uptick in research and public awareness of these issues there have not been reports demonstrating a significant decline in the number of medical errors. In fact, much of the available research provides a conflicting view of how to deal with the issue and what effects different solutions actually have on patient outcomes. Several recent studies suggest that the rate of medical errors occurring among hospitalized inpatients is still very high.[3,4] To add to the already complicated topic, some research and many resent policy decisions have pointed to the integration of information systems technology into the care process to solve the safety and quality issues plaguing healthcare. While some see health IT as the "holy grail" for fixing these problems the introduction of health IT into the clinical workflow may in fact be causing new types of errors to occur[5]. This has lead to concerns over the strong push by congress and the White House to implement health IT in the care delivery process. To this end, the IOM released a 2011 publication, *Health IT and Patient Safety: Building Safer Systems for Better Care,* to address head on the issues surrounding the safe and effective use of health IT in the delivery of patient care. Many investigators have followed the lead of the Institute, researching and publishing on these same topics. However, as the most recent IOM report indicates, there still remains a sizable gap in the available literature on the affects health IT has on patient outcomes. The report also sheds light on the lack of information regarding the degree of harm caused by health IT and that many factors contribute to the effective use of health IT in the clinical setting; including, the diversity of available health IT products on the market, how implementation effects clinical workflow, and the importance of managing and preparing for the integration of new systems into the care setting, to name a few.

It is also clear from the IOM's 2011 report and the review of current literature that the effects of health IT on patient outcomes are blurred with no strong evidence to support or dismiss its capabilities. Some researchers have demonstrated improvements in patient care while others have shown harm and even death due to improper use of health IT systems.[6,7] Some of the benefits include the reduction of some types of medication errors and when properly implemented some report improvements in patient safety and workflow[8]. On the other side of the argument health IT can also add complexity to the effective treatment of patients with the introduction of poor human-computer interaction, improper dosing calculations, and presentation of the wrong data at the wrong time[9]. The research community has and is continuing to conduct research in this area to determine how health IT impacts the quality and safety of patient care; however, many studies are conducted in a single hospital or delivery care system, which make the results difficult to generalize. There is also a lack of large-scale studies and studies that focus on more than just one medical condition or health IT application.

In addition to the efforts being made by the IOM to address these issues there are several leaders in the field that have taken a home grown approach to building and implementing health IT systems in their networks, hospitals, and hospital systems. Kaiser Permanente, the largest health maintenance organization (HMO) in the US, was among the first to develop and implement a health IT system. Their goal was to integrate over 10,000 doctors and care givers in 19 states. [10] Kaiser spent an estimated $1 billion on implementing their health IT system between 2000 and 2005 to achieve this goal.[10]

Other institutes including, Brigham and Women's Hospital/ Partners Health Care, Regenstrief Institute, and the LDS Hospital / Intermountain Health Care, have also developed their own homegrown electronic health record (EHR) systems and with much more success than organizations and hospitals who have chosen to purchase systems from outside vendors.[11] This success is primarily attributed to the fact that health IT systems are most successful when they are developed for the specific environment and clinical workflow of that institution, which is difficult to do with a customizable "off the shelf" product. Also many of the doctors, nurses, clinicians, and administrative staff have unique insight as the end-users of most of these products and their ideas and input are often solicited at the development phase which can be crucial not only to how the systems work once operational but also increases workplace moral and "buy in" for the system which many organizations with third party venders struggle to overcome and many times over look.[11]

Much of the early spending and implementation of information technology in US hospitals had been on administrative claims and financial systems but this trend has drastically changed to focus on clinical implementations in hospitals and outpatient settings.[10] These early initiatives and the demonstration of the many benefits information technology has had in other industries lead to the general, but unproven, belief that health IT would have a major impact on patient outcomes by providing high quality and safe health care while also cutting medical costs. In 2004, this led President George W. Bush, through executive order, to establish the position of National Coordinator for Health Information Technology. In 2005, the Office of the National Coordinator for Health Information Technology (ONC) was established within the Office of the Secretary at Health and Human Services (HHS). Between 2005 and 2007 the ONC for Health IT awarded contracts to develop standards for health information exchange, develop a Nationwide Health Information Network, and establish standards for product certification and certain ambulatory products.[12]

In 2009 Congress and the Obama administration gave the adoption of electronic health and medical records a boost by authorizing incentive payments to hospitals and providers under the HITECH act as part of the American Recovery and Reinvestment Act (ARRA), with the overarching goal to promote the adoption and meaningful use of health IT. These incentives can be realized by providers when they safely and effectively implement electronic health and medical records to improve the delivery and quality of healthcare in predetermined, specified ways by following the "meaningful use" objectives laid out by the act. These provider payments will be made through the Center for Medicare and Medicaid Services (CMS), who will also have a joint role in the development of the meaningful use objectives along with the Department of Health and Human Services (DHHS). With this new plan coming into play the landscape of health IT adoption is expected to change dramatically. However, the lack of evidence to support the effective use of health IT makes these efforts worrisome because the potential of this technology to help or harm individuals has not been demonstrated. With the cost of health IT implementation estimated at some $8 billion a year the potential cost savings associated with the use of health IT is estimate to be $77 billion (http://www.rand.org/pubs/research_briefs/RB9136/index1.html), however these savings have yet to be realized.

It is clear that the policies currently in place have set the standard for health IT implementation; however, the data and research are a long way from supporting it. This research project aims to quantify the impact of health IT on hospitals in the United States by studying the number of medical errors reported through a nationwide claims database. Additionally, it will look at mortality rates as another quality indicator. Hospital implementation of health IT will be measured by the accessibility of specifically identified computerized applications and systems that have been implemented in each hospital. Other measures will include the investigation of hospital demographics characteristics and the ability of stage health IT to predict the prevalence of medical errors and mortality rate. This investigation is spurred by the lack of a “big picture” perspective on the impact of health IT in US hospitals as much of the available research is conducted with smaller datasets and/or data from a single hospital or healthcare provider.

1.2 Objectives and Research Questions

Objectives:

1. To assess the variations in hospital demographic characteristics at each stage of health IT implementation.
2. To assess prevalence of medical errors and mortality rates within each stage of health IT for each year of data provided.
3. To determine the effects of health IT implementation on hospital quality of care using medical error and mortality rates.
4. To determine if health IT stage is a predictor for prevalence of medical errors and mortality rates in US hospitals.

Outcomes:

1. The primary outcomes are the prevalence of medical errors and mortality rates in a given year, based on ICD-9 discharge codes.
2. Hospital region, location, bed size, teaching status, and ownership status in combination with stages of health IT implementation (for an investigation into hospital demographic characteristics).

This study aims to answer several questions, which are listed below:

1. What are the demographic characteristics of hospitals at each stage of health IT implementation?
2. Does the stage of health IT implemented at a hospital have an effect on quality, as measured by the medical error and mortality rates?
3. How does the stage of health IT implemented in US hospitals change over time?
4. What hospital characteristics (including health IT implementation stage) are predictors for medical errors?
5. What hospital characteristics (including health IT implementation stage) are predictors for mortality rate?

1.2 Hypothesis

The goal of this research project is to determine how the use and implementation of health IT in hospitals in the United States impacts the quality of care as measured by medical errors and mortality rates. This study hypothesizes that the use of health IT in US hospitals will not have a significant impact on medical error and mortality rates.

2. Chapter II - Review of the Literature

2.1 Overview

Much of the available literature on the use of health IT to prevent medical errors and increase patient safety is contradictory, with studies both in support of health IT's abilities and those that do not support. Some research illustrates the benefits and importance of using health IT in the improvement of quality care and the decrease of errors. However, still others provide compelling evidence about the drawbacks of these systems and provide cautionary tales of the disastrous effects of their implementation into the healthcare process. Therefore, it is unclear if the implementation of health IT will have a profound beneficial affect on a patient's quality of care as many authors, institutions, and the US government believe will be the case.

A literature review was conducted as part of this project to gain a closer look at the current state of health IT in US hospitals. For this review the following criteria were established:

- No restriction on the timeframe for publications
- Limited to human subjects
- Limited to the English language

A variety of search terms were used to search the Medline, Cochrane, and Ovid databases. From the search 1,085 articles and other sources were initially selected.

Through a title review these were narrowed down to 135 articles. The abstracts of the 135 articles were then reviewed for exclusion or inclusion based on relevance. A list of search terms is provided in Appendix A. In addition to the articles selected from the title and abstract review a more thorough review of the references listed in the selected articles was also completed and selections made for addition to the literature review.

Since the 1999 IOM Report, *To Err is Human: Building a Safer Health System,* there has been an increasingly intense focus on the prevention of medical errors and the improvement of healthcare quality.[2] Also of importance is the number of deaths and injuries from errors that go unreported. In recent years information systems have been identified as having the potential to reduce and prevent a wide range of medical errors. [11,13] Many hospitals and provides have jumped on the preverbal "bandwagon" to bring health IT, usually in the form of decision support systems, electronic health records, provider order entry systems, electronic medication dispensing and the like, to their hospitals and practices. However, not all providers, clinicians, and researchers are in agreement on the impact these computerized systems have on healthcare outcomes and quality improvement and with good reason [11,13-15]. A report released by the IOM, *Preventing Medication Errors: Quality Chasm Series*, highlights that while much research has been conducted since the first report much of the available data indicates that medical errors remain a persistent issue with it estimated that more than 1.5 million preventable adverse events occur annually. [16] The lasts IOM report released in 2011, *Health IT and Patient Safety: Building Safer Systems for Better Care*, highlights that while many healthcare institutions have turned to health IT to improve safety this has not proven to be the fail safe remedy for better safety and quality in patient care they had hoped for. In fact some research has shown that health IT provides no improvement to patient care and can even cause new problems for clinical workflow, leading to new risks and unforeseen issues. Because of this the IOM has called for the government and health IT systems vendors to be more transparent about product performance, establish a standard format and requirement for reporting errors, and allow systems to be openly reviewed and tested and results released to the public from independent groups. [13] This report and other initiatives, in addition to other recommendations made by the IOM, aim to get the implementation of health IT on track to allow the full potential of these systems to be realized.

2.2 Health Information Technology

2.2.1 Definition

The term health information technology (health IT), as used in the literature, industry, and elsewhere is a broad term that has a variety of meanings and includes a number of information systems. Both the Agency for Healthcare Research and Quality (AHRQ) and the Office of the National Coordinator for Health Information Technology define health information technology as "*The application of information processing involving both computer hardware and software that deals with the storage, retrieval, sharing, and use of health care information, data, and knowledge for communication and decision* *making.*"

(http://healthit.hhs.gov/portal/server.pt/community/health_it_hhs_gov__glossary/1256)

Therefore, health IT is not a single product; it encompasses a technical system of computers and software that operate in the context of a larger system. While this is the context in which health IT will be defined for this study the more distinct definition of electronic health and medical records is also significant as the data used in this study to assess health IT in US hospitals primarily encompasses the various stages of electronic medical record (EMR) development. The Office of the National Coordinator for Health Information Technology defines electronic health records (EHR) as "*A real-time patient health record with access to evidence-based decision support tools that can be used to aid clinicians in decision making. The EHR can automate and streamline a clinician's workflow, ensuring that all clinical information is communicated. It can also prevent delays in response that result in gaps in care. The EHR can also support the collection of data for uses other than clinical care, such as billing, quality management, outcome reporting, and public health disease surveillance and reporting*." AHRQ has a similar definition for EHRs and also includes a definition for electronic medical records (EMR) as "*A computer-based patient medical record. An EMR facilitates access of patient data by clinical staff at any given location; accurate and complete claims processing by insurance companies; building automated checks for drug and allergy interactions; clinical notes; prescriptions; scheduling; sending to and viewing by labs; The term has become expanded to include systems which keep track of other relevant medical* *information. The practice management system is the medical office functions which support and surround the electronic medical record."* These definitions encompass how health IT and EMRs will be defined for this study. More precisely, the data available from the HIMSS Analytics dataset provides detailed information on the types of information technology systems currently implemented in US hospitals. This method for categorizing hospitals will be used as the bases for establishing a model for health IT stage to describe and categorize each hospital provided in the database for this study, allowing for the matching of health IT stage and number of medical errors for analysis. For example hospitals will be categorized based on the availability of a clinical data repository, information systems applications in ancillary departments, and the implementation of computerized practitioner order entry systems (CPOE), in addition to the implementation of other heath IT systems. Each stage will demonstrate an increase in the technology implemented, such that the lower stages will have the least amount of health IT implemented and the higher stages will have the greatest amount implemented).

2.2.2 Current State of Health IT

Currently there is not enough data available in the literature to properly assess the safety of health IT systems in US hospitals [15,17-19]. By assessing how health IT has affected patient outcomes in hospitals in the US this will provide a first look at what is happening on a national level. There are many factors that contribute to health IT's effect on patient outcomes including human computer interaction, system design, and implementation into the clinical workflow. An article by Harrington, et al (2011) highlights the inconsistencies in the literature and contributes to the realization that some systems, such as EMRs, may be increasing the number of some types of errors and introducing new and unexpected risks to patients.[14]

Longhurst, et al (2010) presents compelling evidence to support the implementation of a CPOE systems in an article that demonstrated a 20 percent decrease in the mean monthly adjusted mortality rate in an academic children's hospital.[20] This data indicates that the hospital potentially experienced 36 fewer deaths in an 18 month period following the implantation of the CPOE system[20]. To the contrary Han, et al (2005) presents the negative and fatal impact a CPOE system had on the pediatric critical care department at the Children's Hospital of Pittsburgh (CHP). [7] The study compared specific data points prior to and following the implementation of a CPOE system and determined that the rate of fatalities increased from 2.80 percent, prior to system implementation, to 6.57 percent after implementation. While these results have their limitations, specifically the data was collected at a single institution and was collected over a relatively short time frame (18 months), making it difficult to generalize the results, this research demonstrates the potential consequences of system implementation and it positive and negative results. Along with the hard data presented here the study also highlights a common theme seen among the majority of researchers, that the implementation of health IT requires effective planning and management, as it will disrupt clinical workflow. This and other common observations, including the time it takes to train and learn a new system (learning curve), time away from patients, the alteration of communication, and provider-provider and provider-patient interaction, are echoed by other researchers. [9,15,21] Other research demonstrates the variability in system implementation by products meant to accomplish the same goal but have a wide range of effects on safety. [22]

An article in strong support of this current study is Zhou, et al's (2009) [15] which investigates the impact of EHRs on quality of care in the ambulatory care setting. Similarly, this research is looking at how the implementation of EMRs and other types of health IT impact the quality and safety of healthcare and also how the stage of health IT implemented affects these outcomes. This study demonstrates that the implementation of an EMR alone will not have an impact on improving healthcare quality and safety. This is the case not only at the time of and shortly after implementation of the technology but also for usage of the system over time. [15]

Other researchers report on the interruption in workflow from the implementation of health IT systems causing delays in patient care and critical treatment. [9] For some patients the time it takes to receive treatment can be a matter of life or death and an EMR can be a catalyst in improving this time to care or inhibiting it and causing fatalities. Others report that while healthcare information systems reduce some types of errors they can cause new types of errors.[5,23] This is compounded by the intricacies needed at all stages of implementation of new systems and the involvement and support of clinicians and hospital staff that will be using the systems. Still many researches praise these systems for significantly reducing the rates of medical errors in specific departments and/or with the use of certain types of systems. [6,8,24] Some of the most successfully implemented systems have an extended planning period to evaluate and assess how to incorporate a complicated technology into an already complicated health system. [10] With the variations in current research on the use of health IT in hospitals the literature leaves many unanswered questions on the impact, implementation, quality improvements, and use of health IT.

2.3 Medical Errors

2.3.1 Definition

Wikipedia defines medical errors as "*a preventable adverse effect of care, whether or not it is evident or harmful to the patient. This might include an inaccurate or incomplete diagnosis or treatment of a disease, injury, syndrome, behavior, infection, or other ailment*." The IOM defines medical errors as "*the failure of a planned action to be completed as intended or the use of a wrong plan to achieve an aim*."[2] These events are usually unintended by the healthcare provider and can often go undetected, with little or no harm done to the patient. In these cases medical complications usually go undetected and subsequently unreported, leading to the idea that the true number of medical errors is much higher than that reported in the 1999 IOM report and shedding light on reasons for the difficulty in the ability to truly quantify the number of errors that occur. Some events however, cause serious harm to the patient and can result in death. The available literature describes several ways to capture and quantify medical errors, including medical chart review, International Classification of Disease version 9 (ICD-9) codes, the Agency for Healthcare Research and Quality (AHRQ) patient safety indicators (PSI), provider reported events (i.e. through a surveillance system), or any combination of these methods.

Naessens, et al provides an investigation into the use of several types of error detection methods and the benefits and drawbacks of each.[25] For this study the aim is to understand and investigate errors that occur while patients are hospitalized to be able to assess how the number of errors has been impacted by the implementation of different stages of health IT. One suggested and widely used error detection measure is the AHRQ PSI indicators. Research has been conducted on the validity of this method [25] and it has been used to conduct a variety of analysis.[26] While this method, like any, has its benefits it was not selected for this study because it may include conditions that were present in patients upon admission. Another method, provider reported events, has been shown to be unreliable[25] and the probability that all occurring events are recorded and reported is not likely. The use of medical chart review to detect errors was not selected for this study because of the need for several reviewers to participate in the process as well as someone with a clinical background. Another issue sited regarding the use of this method is the introduction of variability and bias from the reviewers. [27]

Kanter, et al defines medical errors as the ICD-9 codes used to record complications of surgical and medical care.[27] For this study medical errors are similarly defined as medical and surgical complications recorded at the time of patient discharge with one of the ICD-9 codes that represent complications. These codes will be drawn from the

Healthcare Cost and Utilization Project's (HCUP) Nationwide Inpatient Sample (NIS) dataset available through the AHRQ. ICD-9 discharge codes are structured such that there is a set of codes from code 996.xx through codes 999.xx that represent medical errors that occurred and were reported as part of a patient's discharge summary.[25] A detailed list of the ICD-9 codes used in this study and the corresponding definitions are provided in Appendix B and will be used to assess the frequency of medical errors. In addition to the 996.xx-999.xx codes several additional codes representing medical and surgical complications will also be used. These include the following:

- 995.2 – medication adverse effect NEC, correct substance properly administered
- 995.22 – Anesthesia, complication or reaction NEC, due to correct substance,
  properly administered
- 995.23 – insulin complication
- 995.27 – injection drug reaction
- 995.29 – adverse effect other drug, medicinal and biological substance

2.3.2 Current State

The issues, inconsistencies, and uncertainty surrounding the safety of health IT and its effects on patient outcomes gained enough attention by the IOM that they formed a committee and published their latest report to highlight these issues and bring recommendations to the forefront.[13] There is still a long way to go to establish benchmarks for this area, develop standards and investigate the true impact of health IT on patient safety and quality of care. This study will provide a first step in determining the effect of medical errors.

3. Chapter III - Methods

3.1 Data Source

The data sources used for this study include the Nationwide Inpatient Sample (NIS) part of the Healthcare Cost and Utilization Project (HCUP) from the Agency for Healthcare Research and Quality and the Dorenfest Analytics data from the Health Information and Management Systems Society (HIMSS).

To determine and quantify the impact of different stages of health IT on medical errors and mortality the available data from both the HIMSS Analytics and HCUP datasets will be aggregated using unique Medicare hospital identifiers. This is the unique ID used by CMS to identify US hospitals. This ID will be added to the HCUP dataset, based on other unique hospital identifiers, to facilitate matching hospitals with the HIMSS dataset. Due to the nature of the HCUP dataset and the methods used to match hospitals, it is anticipated that some hospitals will be dropped from the study analysis. More information on the limitations of the two datasets is provided in the sections below.

In the section below on Hospital Demographic Characteristics a detailed description of the demographic characteristics investigated for the study is provided. These will be used to classify hospitals and determine the demographic characteristics of hospitals at different stages of health IT implementation.

Additionally, the HIMSS dataset defines 'Hospital' as a freestanding hospital, single hospital health system, or IDS/RHA; while the HCUP dataset only includes freestanding acute-care hospitals in its definition. For this study the HCUP definition was used and in both datasets "Hospital" was defined as freestanding acute-care facilities.

3.1.1 HIMSS Analytics

One dataset, the Dorenfest Complete Integrated HEALTHCARE DELIVERY SYSTEM PLUS (IHDS+) DATABASE™ is available through the HIMSS Foundation (http://www.himss.org/foundation/histdata_about.asp) and contains information on more than 35,000 healthcare facilities in the United States, of which more than 5,000 are hospitals. At the time of this study data was available from 1986 to 2011, and included the complete Dorenfest 3000+Databases™, the Dorenfest Integrated Healthcare Delivery System Databases™ (1986 – 2003) and the HIMSS Analytics™ database (2004 – 2011). The combined databases are available free of change on the provided website and require registration and justification for the research being conducted to gain six months of access to the data. Along with each database, which can be downloaded from the website once access is granted in Microsoft Access, a *Table Descriptions* document is provided which describes the data contained in each table of the database. Additionally, a series of Microsoft Excel spreadsheets are provided which contain the metadata. A copy of the 2008 *Table Descriptions* document is provided in Appendix D. Additional documentation includes the *Element List by Table*, which is essentially a data dictionary, and additional spreadsheets that act as the codebook for each provided data element. The

Element List is provided in Appendix E. For this study data was acquired from 1986 – 2011.

This is a rich dataset with a plethora of information on the health IT capabilities of US hospitals, including but not limited to financial data, wireless capabilities, and projected spending for the coming year. This depth of data and the information provided within will be used to determine the stage of implementation of health IT at each hospital. This will be done by classifying each hospital into a stage of health IT similar to that provided in the eight stages of the HIMSS US EMR Adoption Model.

Within this dataset are 34,978 healthcare delivery institutions of which 7,764 represent inpatient hospitals, single hospital health systems, and Integrated Delivery System/Regional Health Authority (IDS/RHA). These numbers are in line with the number of hospitals operating in the US in 2008, additional years have been provided in Table 2.

While HIMSS reports on the percent of hospitals at each stage in the EMR Adoption Model in the US the specific hospitals meeting these stages are not provided. This information must be derived from the information provided on each hospitals use of health IT.

The key data elements use for this study from the HIMSS database are provided in Table 1 below. A detailed description of all data tables and elements is provided in Appendix D and E, respectively.

Table 1. Key HIMSS Data Elements

Table	Data Element	Description
AutoIdentification	**DepartmentId**	Identification number of the department type
AutoIdentification	**HAEntityId**	Identification number associated with surveyed entity. Unique within survey year.
AutoIdentification	**InUseFlag**	Yes = the hospital utilizes bar coding, RFID or bar coding/RFID
AutoIdentification	**SurveyId**	Identification number assigned to survey
AutoIdentification	**Type**	Type of autoidentification (see tab AT-AutoID Type)
HAEntity	**Address1**	Entity's Street Address
HAEntity	**Address2**	Additional Address Info if Necessary
HAEntity	**City**	City where the Entity is located
HAEntity	**FreeStanding**	Yes = the sub-acute care facility is not housed in another facility
HAEntity	**HAEntityId**	Identification number associated with surveyed entity. Unique within survey year.
HAEntity	**HAEntityType**	Description of surveyed entity type (See tab M-Facility Types)
HAEntity	**HAEntityTypeId**	Unique identification number associated with surveyed entity type
HAEntity	**IsImaging**	Yes = the ambulatory facilities provides imaging services (sometimes in addition to the primary service offered)

HAEntity	**MedicareNumber**	Medicare identification number
HAEntity	**Name**	Entity's Name
HAEntity	**NofBeds**	Number of Licensed Beds
HAEntity	**NofStaffedBeds**	Number of Beds that can be operated at present staffing levels
HAEntity	**OwnershipStatus**	Ownership Status; Owned, Managed, Leased, or Affiliated
HAEntity	**ParentId**	identification number of the IDS and Independent Health System that the facilities and data centers are associated
HAEntity	**ProfitStatus**	Not for Profit or Profit
HAEntity	**SameISSystem**	Yes = the sub-acute care facility uses the same software platform as a hospital in the health care system
HAEntity	**ServicePopulation**	Size of Population served by entity
HAEntity	**State**	State where entity is located
HAEntity	**SurveyId**	Identification number assigned to survey
HAEntity	**Type**	Description of the entities primary service provided (see tab N-Facility Descriptions)
HAEntity	**UniqueId**	Fixed unique identifier for the entity. This number will not change from year to year.
HAEntity	**Zip**	Entity's Postal Zip Code
HAEntityApplication	**AppId**	Record identification number
HAEntityApplication	**Application**	Software application name (See tab P-Application List)
HAEntityApplication	**ApplicationId**	Unique identification number for application
HAEntityApplication	**Category**	The category the software application is associated with (See table P-Application List)
HAEntityApplication	**CategoryId**	Unique identification number for

		application category
HAEntityApplication	**ContractYear**	The year the software was contracted
HAEntityApplication	**HAEntityId**	Identification number associated with surveyed entity. Unique within survey year.
HAEntityApplication	**Status**	Indicates the status of an application (See Q-Automation Status)
HAEntityApplication	**SurveyId**	Identification number assigned to survey

Similar to the HCUP data, the included hospitals vary from year to year as do the included variables. To avoid the challenges of analyzing data from years with different variables, years that provided data with the same variables were used (2008, 2009, 2010, and 2011). The HIMSS EMR Adoption Model, illustrated in Figure 1, provides the descriptions by which each hospital is rated based on the type and degree of health IT implemented. As part of this study each hospital in the analysis dataset was assessed and assigned a stage based on the information provided in the HIMSS dataset and using hospital descriptions similar to the EMR Adoption Model. One advantage to using this method is that the HIMSS datasets provide data from hospitals in all 50 US states, Washington DC and Puerto Rico, for each year unlike the HCUP data which states vary from year to year. Also these hospitals are identified by name and address along with other pertinent demographic information. Table 2 provides information on the number of hospitals and states that participated in the survey by year.

Table 2. HIMSS Analytics Data Summary

HIMSS Analytics Data Summary						
Year	2011	2010	2009	2008	2007	2006
# of Hospitals	5339	5283	5,237	5,168	5,073	4,048
# US States (in dataset)*	52	52	52	52	52	52
HIMSS Analytics Data Summary con't						
Year	2005	2004	2003	2002	2001	2000
# of Hospitals	4,010	4,018	4,005	4,023	4,029	4,045
# US States (in dataset)*	52	52	52	52	52	52

*# of states includes Washington, DC and Puerto Rico

The **EMR Adoption Model**SM (EMRAM) uses an 8-stage scale to identify the specific hospital health IT capabilities implemented and scores hospitals based on their progress in achieving a 100 percent paperless system (HIMSS Analytics website: http://www.himssanalytics.org/home/index.aspx).

HIMSS uses an algorithm to score each hospital based on their stage of health IT. Each stage represents an increasing level of health IT implementation. Figure 1 below provides an overview of this scale and a brief description of the health IT capabilities in each stage. Appendix C, obtained from the HIMSS Analytics website, provides a more detailed description of each stages capability within US hospitals.

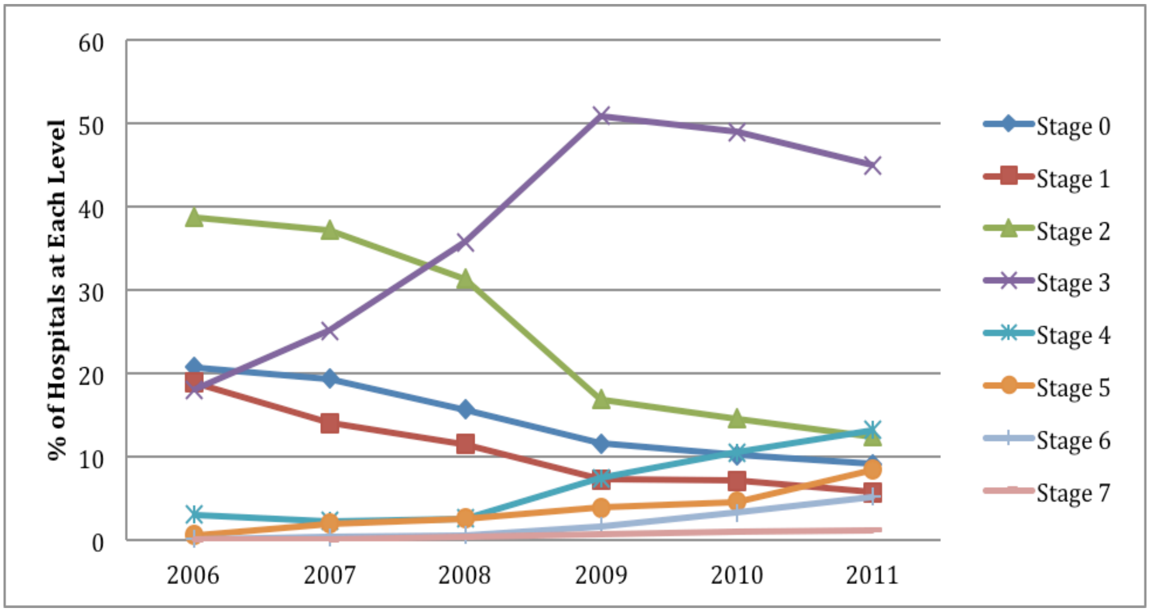
Figure 1. HIMSS EMR Adoption Model

EMR Adoption ModelSM	
Stage	**Cumulative Capabilities**
Stage 7	Complete EMR; CCD transactions to share data; Data warehousing; Data continuity with ED, ambulatory, OP

Stage 6	Physician documentation (structured templates), full CDSS (variance & compliance), full R-PACS
Stage 5	Closed loop medication administration
Stage 4	CPOE, Clinical Decision Support (clinical protocols)
Stage 3	Nursing/clinical documentation (flow sheets), CDSS (error checking), PACS available outside Radiology
Stage 2	CDR, Controlled Medical Vocabulary, CDS, may have Document Imaging; HIE capable
Stage 1	Ancillaries - Lab, Rad, Pharmacy - All Installed
Stage 0	All Three Ancillaries Not Installed
Data from HIMSS Analytics™ Database © 2011	

Data has been obtained for years 1986 – 2011; however for preliminary analysis, as provided in Figure 2 below, only data from years 2006 to 2011 were used in an effort to better match the two datasets. Figure 2 provides a look at the trends seen in health IT from the available years. It shows the gradual decrease in the number of hospitals in Stages 0, 1, and 2 and an increase in Stages 4, 5, 6, and 7. Stage 3 shows the most growth until 2009 when it starts to decline, which could indicate that hospitals are continuing to make improvements in their health IT systems as they move closer to implementation of "meaningful use" requirements. Other possible indications for these trends could be that hospitals are moving out of the start-up phases of health IT implementation and moving into the more advanced stages. This may be a result of the newly available funds and incentives becoming available. Alternatively, this could indicate a decline in the number of hospitals with the resources to incorporate information technology into their healthcare spending plans.

Figure 2. Trends in HIMSS 8 Health IT Stages



For the purposes of this study, health IT stages, to categorize each hospital in the database, were identified from the available data in the **HAEntityApplication** and **AutoIdentification** tables of the HIMSS datasets. Data elements were used independently and in combination to identify hospital entities that reached a specific stage of health IT. The variables and how they were interpreted to identify hospital stages for each hospital are identified in Table 3 below. A complete list of all codes available from the variables provided in Table 3 is provided in Appendix E. It is also important to note that the stages build on each other such that, for a hospital to achieve each stage of health IT it must first achieve the preceding stage or stages. For example, to achieve stage

3 a hospital must have achieved stages 0, 1, and 2 in addition to achieving the required codes for stage 3. This also requires the stages to be mutually exclusive; therefore, a hospital cannot be categorized to more than one stage in a given year.

Table 3. Definition of Health IT Stages

Stage	Label	Table	Variables	Code #	Code Description
0	No Ancillaries	**N/A**	**None of the below variables**	N/A	N/A
1	Ancillaries	**HAEntityApplication**	**ApplicationId**	71	Laboratory Information System
				78	Pharmacy Management System
				19	Radiology Information System
2	Clinical Data Repository (CDR)	**HAEntityApplication**	**ApplicationId**	31	Clinical Data Repository
3	Electronic Medication Administration Record (EMAR)	**HAEntityApplication**	**ApplicationId**	79	Electronic Medication Administration Record
4	Computerized Practitioner Order Entry (CPOE)	**HAEntityApplication**	**ApplicationId**	34	Computerized Practitioner Order Entry
5	Medication Administration	**AutoIdentification**	**InUseFlag**	1	Bar Coding, RFID or Bar Coding/RFID

6	Structured Templates	**HAEntityApplication**	**ApplicationId**	38	Physician Documentation
7	Full EMR	**HAEntityApplication**	**ApplicationId**	100	Case Mix Management
				101	Data Warehousing/ Mining - Clinical
				102	Outcomes and Quality Management

3.1.2 HCUP

The other dataset used in this study is the Healthcare Cost and Utilization Project's (HCUP) Nationwide Inpatient Sample (NIS) dataset provided by AHRQ (http://www.hcup-us.ahrq.gov/nisoverview.jsp). This dataset provides detailed hospital discharge level data and captures much of the information provided to government authorities, such as the Center for Medicare and Medicaid Services. The information provided for a discharge is in the form of ICD-9 codes, along with many other variables, to describe the diagnoses received by patients while hospitalized. The datasets also provide information on hospitals nationwide which submitted their data to AHRQ. This includes demographic information on most hospitals participating in the HCUP data submission.

The data for this study was purchased for a minimal fee and contains information on more than eight million hospital stays per year in over 1,000 US hospitals (about a 20%

stratified sample). At the time this study was conducted data was available from 1988 to 2011 and included information on inpatient stays including healthcare outcomes of interest (e.g. ICD-9 codes and mortality rate). This database also provides hospital level demographic information including bed size, region, control, location, teaching status, and ownership status for more than 40 states between 2008 and 2011 (42 in 2008; 44 in 2009; 45 in 2010; 46 in 2011). Table 6 below includes data on the years included in this study as well as additional years.

To date this study has acquired data from the following years; 1992, 1994, 1996, 1998, 2000, 2002, 2004, 2006, 2007, 2008, 2009, 2010, and 2011. Upon request and payment, the datasets were delivered as sets of CD-ROMs that contained fixed-width ASCII formatted data files and a README text file. To load and review the data, the SAS and SPSS load programs were obtained from the HCUP website (NIS SAS load programs: https://www.hcup-us.ahrq.gov/db/nation/nis/nissasloadprog.jsp; NIS SPSS load programs: https://www.hcup-us.ahrq.gov/db/nation/nis/nisspssloadprog.jsp). Once the data was loaded it was manipulated with both SAS and SPSS and analyzed using SAS. Along with the CD-ROMs came a bounded and written overview and description of the data along with Tables and Listings representing some basic statistics and a Data Elements Table, which provided the metadata and code lists for each of the four included ASCII files; *Core Files, Hospital Weights Files, Disease Severity Measures Files, and Diagnosis and Procedure Groups Files*. Appendix F provides a copy of the 2011 Data Elements document. The NIS database was selected over other databases provided by

AHRQ (i.e. SID, KID, NEDS, and others) because the purpose of this study is to analyze in-patient hospital data on a national level. A hospitals state ID was used to help match this dataset with the HIMSS dataset, along with other hospital characteristics, but the analysis was not comparing hospitals between states and therefore the SID (Statewide Inpatient Sample) would not have been appropriate for this study. Additionally, the KID datasets (Kids Inpatient Database) provided information only on inpatient stays for children and was therefore out of scope, as this study was not focused on analyzing data only from children. Likewise, other datasets focused on providing data at the state level or specifically from emergency departments, both of which did not meet the criteria for this study.

This data also contains the primary end points, number of medical errors and mortality rates. For this study medical errors were defined as the ICD-9 codes used to record complications of surgical and medical care ranging from 996 to 999 and several additional codes 995.2, 995.22, 995.23, 995.27, 995.29, which also represent errors. These ICD-9 codes were provided as primary and secondary diagnosis codes. For all years assessed in this study the primary or principle diagnosis code is provided by the DX1 variable. In the 2008 dataset the secondary diagnosis codes are provided by variables DX2 thru DX15. In the 2009, 2010, and 2011 datasets the secondary diagnosis codes are provided by variables DX2 thru DX25. This difference in the datasets allow for additional discharge codes to be recorded in several years. Mortality rate in all four datasets was defined by the variable DIED and provides information on whether a patient died during hospitalization or did not die. A full list of the data elements used in this study is provided in Table 4.

Table 4. Key HCUP – NIS Data Elements

Table	Data Element	Description
CORE	**DX1-DX15** (for 2008) **AND** **DX1-DX25** (for 2009, 2010, 2011)	Diagnoses, principal (DX1) and secondary (DX2-15 OR 25) (ICD-9-CM)
CORE	**DIED**	Indicates in-hospital death: (0) did not die during hospitalization, (1) died during hospitalization
CORE	**HOSPID**	HCUP hospital number
CORE	**HOSPST**	State postal code for the hospital
HospWeights	**HOSPID**	HCUP hospital number
HospWeights	**HOSPNAME**	Hospital name from AHA Annual Survey Database (not available for all states)
HospWeights	**HOSPADDR**	Hospital address from AHA Annual Survey Database
HospWeights	**HOSPCITY**	Hospital city from AHA Annual Survey Database
HospWeights	**HOSPST**	Hospital state from AHA Annual Survey Database
HospWeights	**HOSPZIP**	Hospital zip code from AHA Annual Survey Database
HospWeights	**HOSP_BEDSIZE**	Bed size of hospital
HospWeights	**HOSP_CONTROL**	Control/ownership of hospital: (0) government or private, collapsed category, (1) government, nonfederal, public, (2) private, non-profit, voluntary, (3) private, invest-own, (4) private,

		collapsed category
HospWeights	**HOSP_LOCATION**	Location: (0) rural, (1) urban
HospWeights	**HOSP_LOCTEACH**	Location/teaching status of hospital: (1) rural, (2) urban non-teaching, (3) urban teaching
HospWeights	**HOSP_REGION**	Region of hospital: (1) Northeast, (2) Midwest, (3) South, (4) West
HospWeights	**HOSP_TEACH**	Teaching status of hospital: (0) non-teaching, (1) teaching
HospWeights	**NIS_STRATUM**	Stratum used to sample hospitals; includes geographic region, control, location/teaching status, and bed size

While this dataset offers a rich source of information for research purposes there are a few limitations. One of these limitations is that each year of data available in the datasets can vary based on the hospitals that contributed data in that year, the variables requested and those provided by the hospitals (i.e. not all hospitals contribute discharge data every year, so the included hospitals can vary by year). This means that the included variables and some of the codes used to categorize the variables have changed and evolved over the years. Also when hospitals submit data to be included in the dataset some variables are missing, i.e. hospital name and address, or other demographic information are commonly missing for some hospitals. However, the variables selected for use in aggregating the HCUP and HIMSS datasets are available in all years and for all hospitals in the HCUP datasets. Table 5 provides information on the number of hospitals and states that participated in the survey by year.

Table 5. HCUP, NIS Data Summary

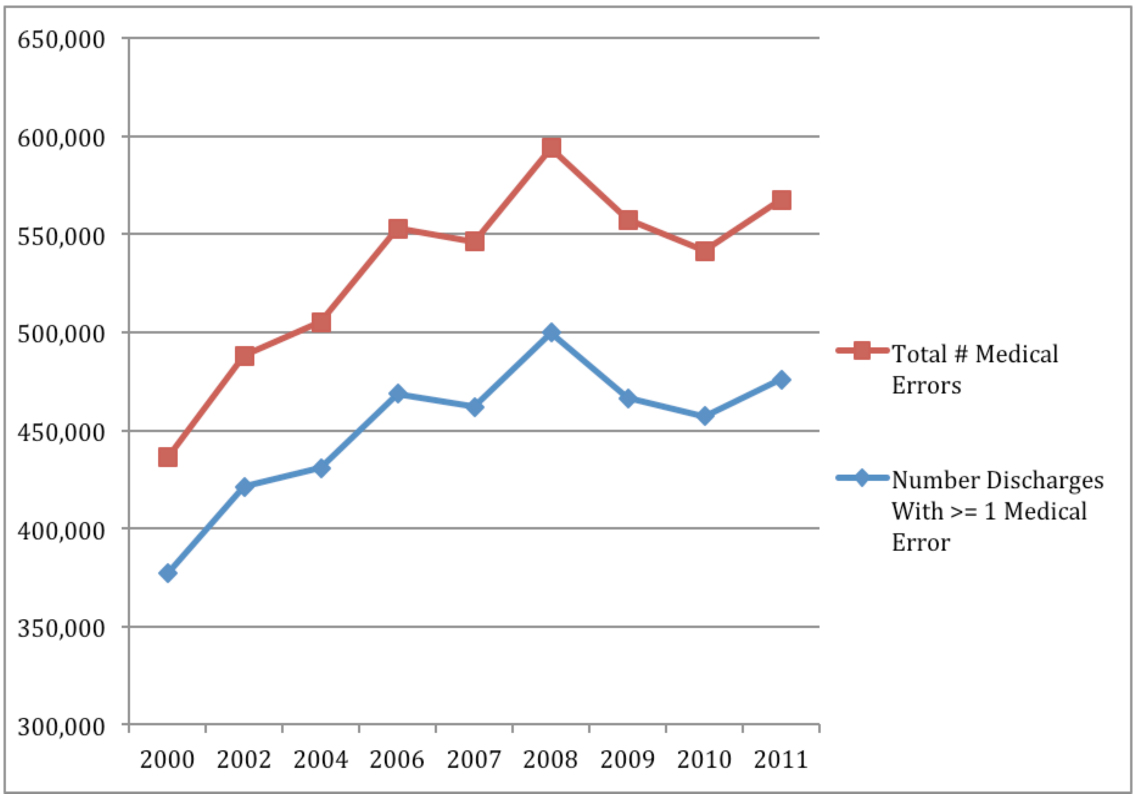
Year	2011	2010	2009	2008	2007	2006
# of Hospitals	1,049	1,051	1,050	1,056	1,044	1,045
# US States	46	45	44	42	40	38
Number Discharges (in millions)	8.024	7.800	7.811	8.158	8.043	8.075

Table 5. HCUP, NIS Data Summary, con't

Year	2005	2004	2003	2002	2001	2000
# of Hospitals	1,054	1,004	994	995	986	994
# US States	37	37	37	35	33	28
Number Discharges (in millions)	7.995	8.005	7.978	7.854	7.453	7.451

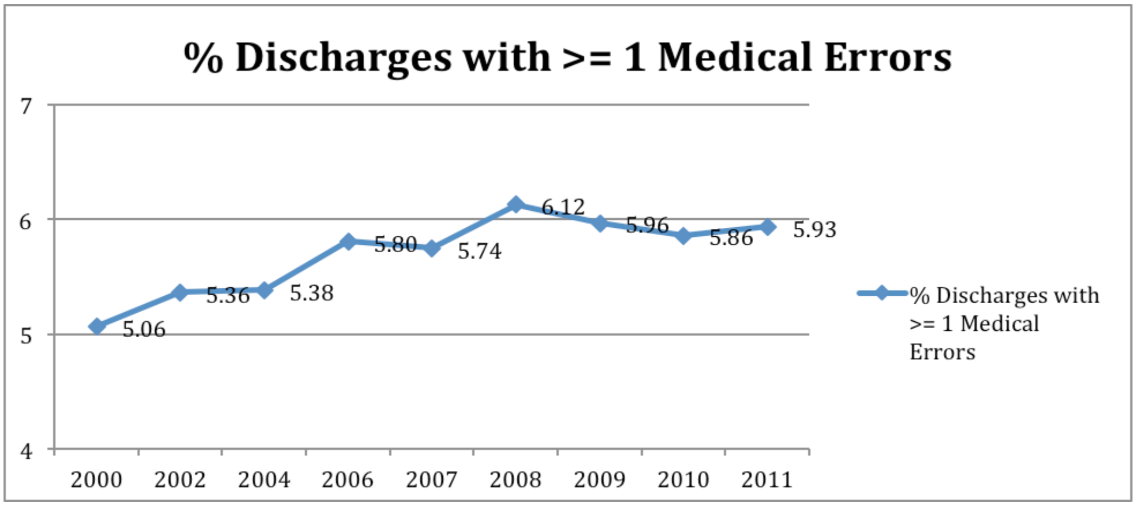
While data was obtained for all years described in Table 5 above only data from years 2011, 2010, 2009, 2008, 2007, 2006, 2004, 2002, and 2000 were used for the preliminary analysis in an effort to match them with the data available from the HIMSS dataset. Figure 3 provides a brief look at the trends seen from 2000 to 2011 in the number of medical errors reported in the HCUP datasets. This is in line with the IOM Report that indicates the number of medical errors has not significantly declined. The decrease in errors between 2008 and 2010 could be a result of the boost in funding hospitals received from the HITECH act. However, the benefits realized from this funding were not steady and an increase in errors is seen 2011.

Figure 3. Number of Medical Errors



Additionally, Figure 4 provides a look at the percent of discharges with at least one medical error to show further evidence of the upward and downward trends in the number of medical errors and to demonstrate that a significant portion of hospital discharges have medical errors.

Figure 4. Percent of Discharges with ≥ 1 Medical Error



3.2 Procedures

While the two data sources analyzed for this study are available to the public for use in research related activities there are a number of processes and procedures that must be completed to obtain the datasets. The details of this procedure for each of the databases are described in detail below. The databases for several years were obtained from each source for inclusion in the analysis and the procedures described are applicable to each of the years of data obtained from that source.

3.2.1 HCUP

The first step in obtaining the databases for 2008 through 2011 entails a review of the AHRQ website which provided a detailed description of the data resources and tools offered by the government organization (http://www.ahrq.gov/research/data/hcup/index.html). More specifically the webpage provided a link to and description of the National Inpatient Samples (NIS), which was purchased and used for this study. The NIS webpage provided details on the data elements available in the database as well as information on how to use and obtain the data, what the hardware and software requirements are, and frequently asked questions (http://www.hcup-us.ahrq.gov/nisoverview.jsp). The website provided a link to the HCUP Central Distributer and the application tool kit that provided the documentation needed to request access to the data.

As part of the application process the requester was required to review and sign a data use agreement and complete an online data use agreement training course, which required proof of completion of the course by obtaining a course certificate. This certificate, along with the application request for the data, was mailed to Social and Scientific Systems, the central distributer for AHRQ's HCUP data. Included in the request was also a payment for each database requested. The data, which was available at a reduced price for students with proof of good academic standing, was available at a cost of $50 for years 2007 – 2011 and $20 for all other years from 1992 – 2006.

Once the application tool kit was mailed to and received by the central distributor, the request was processed and once approved the data was mailed to the requestor in the form of CDs (three for each year) for each year requested and a notebook which provided relevant information on what data is provided, how to access and extract the data, a list of data elements and other pertinent information on how to make the best use of the data. There was also detailed information on which states did not provide data for that given year.

3.2.2 HIMSS

The process for accessing the data provided by the Dorenfest Institute for H.I.T. Research and Education from the HIMSS Foundation has some of the same components required to access the HCUP data. These primarily include the review and agreement to abide by the HIMSS Foundation data use agreement. As part of the data use agreement the foundation required the inclusion of the following citation at the bottom of each page in which the data source is cited; “Dorenfest Institute for H.I.T. Research and Education, HIMSS Foundation, Chicago, Illinois, 2005.” This citation has been added to each page of this document.

In addition to the data use agreement the requester was also required to complete an online application where information about the requester and the research being conducted with the requested data was required. Once the online application was completed and submitted a designated individual at the foundation reviewed it for approval. Once approval was granted an email was sent to the requester with a link to access the available databases along with a unique username and password. Once access was granted the requested has access to all the available data for a period of six months from the time the request is approved. After the six month access period the request's access to the data was disabled.

3.3 Data Extraction, Cleaning, and Restructuring

This section describes how the data from all sources was decompressed, extracted, cleaned and restructured to create the analytic database for the study. The analytic database was the database used to conduct the descriptive analysis, analysis of variance, and multiple regression. Additionally, SAS, SPSS, and MS ACCESS were used to complete the extraction, cleaning, and restructuring process described in detail below.

3.3.1 – HCUP

As described above the HCUP data was received in the form of three CDs for each year being studied. These CDs consisted of ASCII files for the NIS Severity and Diagnosis Pr Groups, Core and Hospital, and HCUP Hospital Cost-to-Change Ratio. The data was then extracted into SPSS using the SPSS load files provided on the HCUP website (SAS load programs: http://www.hcup-us.ahrq.gov/db/nation/nis/nissasloadprog.jsp; SPSS load programs: http://www.hcup-us.ahrq.gov/db/nation/nis/nisspssloadprog.jsp). Once uploaded the Core and Hospital datasets were modified based on the following inclusion criteria:

- >= 1 claim(s) for a medical error (see Appendix B for list of ICD-9-CM diagnosis codes), of interest. (Note: for the Core dataset only)
- >=1 hospital ID (*HOSPID*) (Note: for the Hospital dataset only)

Once the study dataset has been created, Medicare ID codes for each unique hospital record were added to the Hospital dataset to facilitate joining this data with data from the HIMSS database. The addition of the Medicare ID codes was accomplished by joining the HIMSS *HAEntity* database with the HCUP Hospital database using variables for the state, zip code, and address as the primary joining keys. This method matched more than half of the hospitals from the HCUP dataset to the hospitals in the HIMSS dataset. The remaining hospitals were manually matched based on hospital state, zip code, address and name. During the review and quality check process, and Medicare ID codes were manually added to a file with the complete HCUP Hospital demographic information. Additionally, any corrections that needed to be made to the file were done so during the review process. The reviewed file was uploaded into SAS and joined again with the corresponding hospital demographic data from the HIMSS database using the Medicare ID as the primary join key.

The Core dataset and the Hospital dataset were then extracted into SAS format where the datasets were joined using the key variable *HOSPID* to create the final HCUP dataset. Once the two NIS files were joined several new variables were created to facilitate the analysis process. These variables included total number of medical errors in a hospital and total number of discharges with at least one error. This process for data extraction of the HCUP-NIS datasets was completed for each year of data analyzed for this study (2011, 2010, 2009, and 2008).

3.3.2 – HIMSS

Once the HIMSS data was downloaded from the designated website, as described above, specific datasets (*HAEntityApplication* and *AutoIdentification*) were exported from Access 2000 files into SPSS. Once in SPSS these two datasets were restructured from having multiple records (or rows) per hospital into having a single record for each unique hospital. This was accomplished by using the *HAEntityID* variable, which is unique for each hospital in a given year. The restructuring allowed the hospitals to be more easily compared between stages and allow the data to be joined with the hospital demographic dataset from HCUP.

Upon completing the data restructure of both the *HAEntityApplication* and the *AutoIdentification* datasets the two were joined with the *HAEntity* dataset. At this stage the data was coded and each hospital assigned a health IT stage based on the variables and stages identified in Table 3 above.

For the HIMSS dataset one inclusion criteria was applied to create the final database. All facilities included in the final data were required to be hospitals based on a code of *1 - Hospital* from the *HAEntityIDTypeID* variable.

3.4 Merging Databases

Once the HIMSS and HCUP datasets had been extracted, cleaned, and restructured, the two datasets were joined using a data step and FULL JOIN in SAS. The variables *MedicareNumber* and *MedicareNumberHC* (the unique Medicare ID code assigned to each hospital in the HIMSS and HCUP datasets, respectfully) were used to join the two datasets. Joining the two datasets created the final analysis dataset that was used in the statistical analysis to address the study objectives.

Additionally, Tables 6 and 7 below illustrate the attrition rates for both the HIMSS and HCUP datasets. Both provide the total number of hospitals from the raw data and follow the reduction in numbers as the data was cleaned, modified, and joined together to form the analysis dataset.

Table 6. HIMSS Hospital Dataset Attrition Rates

Year	Total Facilities	Total # of Hospitals	# with Medicare ID	# Matched with HCUP
2008	34,978	5,168	4,477	580
2009	36,026	5,237	4,839	561
2010	37,713	5,283	4,898	584
2011	39,051	5,339	4,906	532

Table 7. HCUP Hospital Dataset Attrition Rates

Year	Total	# with Name and Zip Codes	# with Medicare ID	# Matched with HIMSS
2008	1,056	623	610	580
2009	1,050	575	564	561
2010	1,051	595	588	584
2011	1,049	601	569	532

4. Chapter IV – Statistical Analysis

4.1 Introduction

This section describes the analysis conducted to evaluate and answer the study objectives and analyzes the combined data from both the HIMSS and HCUP datasets. Details on the descriptive statistics, analysis of variance to compare health IT stages, and multiple regression to determine hospital predictors for errors and mortality rates are provided in the sections below.

4.2 Hospital Descriptive Statistics

As part of the descriptive statistics details on the breakdown of hospital characteristics from each year of data are provided for this study. These characteristics are presented for the HCUP datasets prior to joining with the HIMSS dataset and by stage of health IT for each year of data assessed. These hospital characteristics include:

- **Region** (Northwest, Midwest, South, West)
- **Bed Size** (small, medium, large)
- **Teaching Status** (Teaching, Non-teaching)
- **Location** (Urban, Rural)

- **Ownership or Control** (Government or private; Government, non-federal, public; Private, non-profit, voluntary; Private, invest-owned; and Private, collapsed)

The data in these two databases provide an opportunity to describe the demographic characteristics of hospitals at different health IT stages. The hospital characteristics, used for this portion of the analysis are described in greater detail below.

Region

Both the HCUP and HIMSS Analytics datasets provide the state in which the hospital is located. These are provided in the standard two letter state abbreviation (i.e. CA, NY, LA). This allowed the hospitals to be match in the joining process. Regions, based on the HCUP categorization, are broken down into the following:

- Northeast Region – Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont

- Midwest Region – Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin

- South Region – Alabama, Arkansas, Delaware, District of Columbia, Florida, George, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia

- West Region - Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Washington, and Wyoming

The data provided by the HCUP datasets includes a large sampling of hospitals; however, not all US states are represented in each year that data is provided. Table 6 above provides summary information on the number of states submitting data to the NIS each year. This demonstrates that while increasingly more hospitals have been submitting data not all states submit data for this dataset. Additionally, some hospitals have contributed data in one year but not in subsequent years. To further add to even if a state submits data it may not contain the information needed to identify the hospital for matching with the HIMSS dataset (i.e. there is no address, zip code, or hospital name).

Bed Size

While the initial intent for the study was to utilize bed size as a key variable to map the two datasets for creating the analysis dataset, the differences in bed size between regions, location, and teaching status varies greatly. Additionally, resent research suggests this is not a reliable way to classify hospitals when conducting research.[28] Therefore, bed size was included in the analysis as a hospital characteristic. For this study the HCUP definition for hospital bed size was used. According to the HCUP datasets bed size was classified into the following three categories based on the number of beds in a hospital:

- Small – 1 to 199 beds
- Medium – 200 to 499 beds

- Large – more than 500 beds

Teaching Status

In the HCUP database teaching status is provided as two categories, *Non-Teaching* and *Teaching*. The HCUP definition for teaching status was used for this study because the HIMSS datasets do not provide codes for these categories. According to HCUP these two categories of hospital differ based on financial incentives and what their respective missions entail. Additionally, an HCUP hospital is considered teaching is it meets any of the three criteria below:

- Residency training approval by the Accreditation Council for Graduate Medical Education,
- Member in the Council of Teaching Hospitals (COTH), or
- A ratio of full-time equivalent interns and residents to beds of .25 or higher.

Location

In the HCUP database location is provided as also provided as two categories, either *Urban* or *Rural*; however, the HIMSS database does not provide a designation for the hospital location. Therefore, the HCUP definition was used when conducting analysis on the combined dataset. This definition is based on the Core Based Statistical Area (CBSA) codes provided by 2000 US Census data. Specifically, hospitals classified as Metropolitan or Division according to the CBSA was coded as Urban in the HCUP dataset. Likewise, hospitals classified as Micropolitan or Rural according to the CBSA were coded as Rural in the HCUP data.

In general the differences between urban and rural hospitals are in the manner they receive government payments and in the size of the hospitals. Generally rural hospitals tend to be smaller than urban hospitals and offer fewer clinical services.

Ownership

A hospitals ownership status (or control) was also defined by the HCUP database and categorized into the following categories:

- Government or private,
- Government, non-federal, public,
- Private, non-profit, voluntary,
- Private, investor-owned, and
- Private, collapsed.

The various hospital ownership categories generally differ in several areas including how they handle sources of funding, responses to government policies and regulations, and their missions.

4.3 Analysis of Variance

To address the primary objective of this study; which is to assess quality of care over time by determining if the increased implantation of health IT over a 4-year period affects the rate of reported medical errors, a one-way between groups analysis of variance (ANOVA) model was conducted. This analysis helped to determine if there is a statistically significant difference in the mean number of medical errors at various stages of health IT implementation. Specifically, the ANOVA tested whether the means of the stages of health IT were equal and determine if there was a significant difference between the number of error and deaths in each stage.

This type of analysis was selected because there are more than two health IT stages that were compared, therefore ruling out the use of a t-test for analysis, and the study used the same group of hospitals to measure differences in the mean number of medical errors from year to year, where data is available, for this part of the study. The same type of analysis was used to answer the secondary objective by using mortality rates as the dependent variable to evaluate the effect each stage of health IT has on mortality rates in each year. While this type of analysis will indicate if there is a difference between the stages of health IT in terms of the specified outcomes, it will not provide information on where the differences are.

Either *proc GLM* or *proc ANOVA* can be used to perform the ANOVA using SAS if the level of each factor has the same number of observations. In these datasets the number of observations in each health IT stage is not the same they are unbalanced. Therefore, the *proc GLM* procedure was used, as this procedure is able to analyze unbalanced data where the ANOVA procedure is only able to handle balanced datasets.

The ANOVA procedure is broken down into two steps. This first step is calculating the overall difference between the means of the health IT stages using the sum of squares (SS):

$$\mathbf{SS\ (between) = n \sum (x_{\cdot k} - x_{\cdot\cdot})^2}$$

The second step is to calculate the variability within the different stages of health IT. This is done by calculating the degree of freedom:

$$\mathbf{df\ (between) = k - 1}$$

In addition to between groups ANOVA analysis the effect size was also calculated to determine the strength of the association between the different stages of heath IT and the mean number of medical errors. ETA, a common formula for calculating effect size was used:

ETA squared = sum of squares between-groups/ total sum of squares

Additionally, if hospitals with specific characteristics that seem to affect the outcome of the analysis were detected a two-way between groups ANOVA was conducted to further explore this (these) relationship(s).

4.4 Multiple Regression

To address the fourth objective, which is to determine what health IT stages are predictors of medical errors and hospital deaths, a multiple regression model was used. The number of medical errors (or hospital deaths) was the continuous dependent variable and the hospitals health IT stage, which is categorical, was the independent variable. Because the independent variable is categorical, dummy variables were used which translated into the use of class statements for the regression model in SAS. The health IT stage variable has eight stages ranging from 0-7 with the lowest being stage 0 and the highest being stage 7. These health IT stages included in the model were those used in other analysis for this study and are described in detail in section 3.1.1 above. For the purposes of this study and analysis all health IT stages will be evaluated against Stage 0. The mean for Stage 0 will also represent the intercept for the model.

Using a multiple regression model allowed for the health IT stages to be assessed as a whole and also provide the effect of each individual stage and its ability to predict medical errors or mortality rates. This also provides insight into which of the eight health IT stages are the best predictor of medical errors and mortality rate in US hospitals. Specifically, a general linear model (GLM) was used to analyze the predictive ability of the health IT stages.

Multiple Regression Equation:

$$Y_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \ldots + \beta_p X_{ip} + \epsilon_i .$$

In this equaltion β_0 represents the constant. β_p represents the coefficient for the eight independent variables that make up health IT stage. Lastly, ϵ represents the error value in the multiple regression model.

Additionally, to assess the ability of the these same health IT stages to predict mortality rates logistic regression was used because mortality rate is a dichotomous variable, unlike assessing the mean number of medical errors which is a continuous variable. The regression analysis provided results that measure the likelihood that the created model will describe a real relationship between the variables as opposed to a random relationship. The output also tests the null hypotheses, that the independent variable reliably predicts the dependent variable, using p-values and an alpha level of 0.05.

Samples Size

An important component of conducting the multiple regression analysis was to ensure an adequate number of hospitals for the sample population. However, due to the limited number of hospitals that were retained once the HCUP and HIMSS datasets were combined, all available hospitals from the combined dataset were included in the analysis. The attrition rates and total number of hospitals used in the study for each of the four years is provided in Tables 6 and 7 above.

Dummy Variables

Because the independent variable used to represent health IT stages is not dichotomous (there are eight codes associated with the variable), dummy variables were created prior to analysis to ensure reliable and accurate results. The dummy variable were created by assigning reference values for each of the eight health IT stage codes such that each code becomes it own dichotomous (0/1) variable that can be assessed as part of the model. The reference value used for health IT stage was Stage 0, the lowest stage, to allow the study is determine if the increased use of information technology has an effect on medical errors and mortality rates. Therefore, using the lowest level allowed all other levels to be assessed against Stage 0.

To conduct both the ANOVA and multiple regression analyses SAS 9.0 and SPSS (PASW) 18 were used. The years of data utilized for this research included 2008, 2009, 2010, and 2011 and were utilized to assess and answer the study objectives. Every effort was made to obtain and incorporate the latest observations in the study. This was accomplished by using the most recent data available at the time of the study where both datasets were available.

5. Chapter V – Results

5.1 Introduction

This section provides the study results from completing a review of the hospital demographic characteristics for HIMSS and HCUP alone as well as the characteristics of the analysis dataset combined data for HIMSS and HCUP). Additionally, the results from the analysis of variance and the multiple regression are both presented here.

5.2 HIMSS Hospital Characteristics

The descriptive characteristics presented for the hospitals in the HIMSS data are included in Table 8 below. The data in this table and used for analysis in this project includes only those organizations identified as hospitals according to the HIMSS dataset. Other types of facilities, such as sub-acute care, ambulatory, home health, data centers were excluded from the study. This data includes the hospital region, bed size, and teaching status from each year (2008, 2009, 2010, and 2011) of data analyzed for this project. This data shows minimal change from year to year in the number of hospitals providing data for the four HIMSS datasets. There are small increases from year to year in the number of hospitals included indicating that there was an increase in the number of hospitals providing data each year it was collected. This data also shows stability across all four years used for analysis with little change in the number of hospitals in each region, bed size, and teaching status sub-category. It is important to note that several hospitals (194 in 2008; 197 in 2009; 208 in 2010; and 208 in 2011) are missing hospital Region data.

Table 8. HIMSS-Dorenfest, Hospital Descriptive Characteristics, by Year

Year	2008	2009	2010	2011
Number of Hospitals	5168	5237	5283	5339
Region				
Northeast	710 (13.7)	696 (13.3)	692 (13.1)	691 (12.9)
Midwest	1303 (25.2)	1319 (25.2)	1329 (25.2)	1349 (25.3)
South	1986 (38.4)	2025 (38.7)	2049 (38.8)	2085 (39.1)
West	975 (18.9)	1000 (19.1)	1005 (19.0)	1006 (18.8)
Bed Size				
Small	3582 (69.3)	3645 (69.6)	3689 (69.8)	3746 (70.2)
Medium	1262 (24.4)	1264 (24.1)	1257 (23.8)	1250 (23.4)
Large	324 (6.3)	328 (6.3)	337 (6.4)	343 (6.4)
Teaching Status				
Teaching	4871 (94.3)	4941 (94.4)	5060 (95.8)	5119 (95.9)
Non-Teaching	297 (5.8)	296 (5.7)	223 (4.2)	220 (4.1)

5.3 HCUP Hospital Characteristics

The descriptive characteristics presented for the hospitals in the HCUP data are included in Table 9 below. All organizations in the HCUP database are identified as hospital entities and therefore all where included in the study. This data includes the hospital region, bed size, teaching status, location, and ownership status from each year of data analyzed for this project. Similar to the HIMSS dataset, the HCUP data shows minimal change over the four years of hospital data presented. There are small variations from year to year in several of the sub-categories and in the number of hospitals in each year, indicating that there is little variation in hospital characteristics over time. This also shows the data has remained stable across all four years used for analysis. It is important to note that several hospitals are missing data from each year used in the analysis. Specifically, there are 3 hospitals missing from the 2008 data; 15 hospitals missing from 2009; 11 hospitals missing from 2010; and 10 hospitals missing from the 2011 HCUP dataset.

Table 9. HCUP, Hospital Descriptive Characteristics, by Year

Year	2008	2009	2010	2011
Number of Hospitals	1056	1050	1051	1049
Region				
Northeast	132 (12.5)	129 (12.3)	131 (12.5)	129 (12.3)
Midwest	306 (29.0)	306 (29.1)	306 (29.1)	306 (29.2)
South	420 (39.8)	418 (39.8)	418 (39.8)	417 (39.8)
West	198 (18.8)	197 (18.8)	196 (18.7)	197 (18.8)
Bed Size				
Small	478 (45.3)	474 (45.1)	479 (45.9)	487 (46.4)
Medium	254 (24.1)	248 (23.6)	243 (23.1)	249 (23.7)
Large	321 (30.4)	313 (29.8)	318 (30.3)	303 (28.9)
Teaching Status				
Teaching	184 (17.4)	176 (16.8)	183 (17.4)	182 (17.4)
Non-Teaching	869 (82.3)	859 (81.8)	857 (81.5)	857 (81.7)
Location				
Rural	416 (39.4)	414 (39.4)	413 (39.3)	414 (39.5)
Urban	637 (60.3)	621 (59.1)	627 (59.7)	625 (59.6)
Ownership				
Governm	368 (34.9)	355 (33.8)	364 (34.6)	361 (34.4)

ent or Private				
Government, non-federal, public	191 (18.1)	187 (17.8)	182 (17.3)	179 (17.1)
Private, non-profit, voluntary	194 (18.4)	190 (18.1)	187 (17.8)	192 (18.3)
Private, investor-own	168 (15.9)	170 (16.2)	173 (16.5)	171 (16.3)
Private, collapsed	132 (12.5)	133 (12.7)	134 (12.8)	136 (13.0)

5.4 Hospital Characteristics for Analysis Data Set

The analysis dataset includes hospitals matched from both the HCUP and HIMSS datasets. Hospitals from each dataset and each year of data were matched based on Medicare ID code. The data for this portion of the analysis only includes those hospitals at are present in both the HCUP and HIMSS datasets and have a matching Medicare ID code.

Table 10, below provides data by year on the total number of hospitals matched along with data on hospital region, bed size, teaching status, location, and ownership. The table shows a slight decrease in the number of hospitals between 2008 and 2011 while 2009 and 2010 are more closely related in the total number of hospitals in the dataset for the at year. Additionally, the available data from each year is evenly distributed within each subgroup of hospital characteristics.

Within each year there is a relatively even distribution among hospitals in each of the four regions with a range of 20% to 31%. Similarly bed size has an even distribution between small and large hospitals with about 37% of hospitals being small and 34% being large. There is a slightly lower distribution of medium size hospitals with an average of about 28% across all years. Within teaching status, from year-to-year, there are significantly more non-teaching hospitals (~78%) in the analysis data sets than teaching hospitals (~22%). Additionally, there are more urban hospitals (~65%) than rural hospitals (~34%) in each year of data provided over all four years. Lastly, within each year more than 40% of hospitals had government or privately held ownership compared to other ownership models.

Table 10. Analysis Data Set, Hospital Descriptive Characteristics, by Year

Year	2008	2009	2010	2011
Number of Hospitals	580	561	584	532
Region				
Northeast	120 (21.7)	122 (21.8)	119 (20.4)	118 (22.2)
Midwest	150 (25.9)	126 (22.5)	131 (22.4)	113 (21.2)
South	136 (23.5)	139 (24.8)	162 (27.7)	153 (28.8)
West	174 (30.0)	174 (31.0)	172 (29.5)	148 (27.8)
Bed Size				
Small	213 (36.7)	206 (36.7)	230 (39.4)	198 (37.2)
Medium	162 (27.9)	159 (28.3)	156 (26.7)	154 (29.0)
Large	205 (35.3)	196 (34.3)	198 (33.9)	180 (33.8)
Teaching Status				

Teaching	126 (21.7)	121 (21.6)	130 (22.3)	115 (21.6)
Non-Teaching	454 (78.3)	440 (78.4)	454 (77.7)	417 (78.4)
Location				
Rural	203 (35.0)	194 (34.6)	205 (35.1)	185 (34.8)
Urban	377 (65.0)	367 (65.4)	379 (64.9)	347 (65.2)
Ownership				
Government or Private	246 (42.4)	238 (42.4)	240 (41.1)	227 (42.7)
Government, non-federal, public	84 (14.5)	77 (13.7)	86 (14.7)	77 (14.5)
Private, non-profit, voluntary	107 (18.5)	116 (20.7)	116 (19.9)	113 (21.2)
Private, investor-own	61 (10.5)	59 (10.5)	71 (12.2)	59 (11.1)
Private, collapsed	82 (14.1)	71 (12.7)	71 (12.2)	56 (10.5)

5.4.1 Hospital Characteristics 2008

Hospital characteristics from the 2008 analysis dataset categorized by health IT stage were assessed and the results are presented in Table 11. This table shows data for hospital region, bed size, teaching status, location, and ownership for 2008 and includes matched hospitals from both the HCUP and HIMSS datasets. There are three hospitals in the 2008 dataset that did not have sufficient data to be categorized into one of the eight health IT stages.

The distribution of data in each subcategory is similar to that of the distribution of data among total hospitals in each stage with a greater distribution of hospitals in the early stages of health IT implementation, Stages 1 (23.4%), 2 (38%), and 3 (19.4%), and fewer hospitals in the later stages of health IT implementation, Stages 4 (1%), 5 (3.6%), and 6 (0.5%). Stage 0 has a lower overall distribution of hospitals at 2.8% while Stage 7 has an average distribution at 11.3%. There is a similar distribution across all eight stages for region, bed size, teaching status, location, and ownership status. Specifically, the distribution shows a higher percentage of hospitals between Stages 1, 2, and 3 and a smaller percentage in Stages 4, 5, and 6 in all subcategories similar to the total distribution of hospitals. This distribution could indicate that hospitals adopting health IT systems are still in the early stages of implementation.

Table 11. Analysis Data Set, Hospital Descriptive Characteristics, for 2008 by Stage

Health IT Stage	Stage 0	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6	Stage 7	Total
Number of Hospitals (Percent)	16 (2.8)	135 (23.4)	219 (38.0)	112 (19.4)	6 (1.0)	21 (3.6)	3 (0.5)	65 (11.3)	577
Region									
Northeast	1 (6.3)	22 (16.3)	48 (21.9)	21 (18.8)	3 (50.0)	8 (38.1)	0 (0.0)	16 (24.6)	119 (20.6)
Midwest	6 (37.5)	33 (24.4)	65 (29.7)	27 (24.1)	0 (0.0)	2 (9.5)	1 (33.3)	15 (23.1)	149 (25.8)
South	3 (18.8)	25 (18.5)	45 (20.6)	40 (35.7)	1 (16.7)	9 (42.9)	0 (0.0)	13 (20.0)	136 (23.6)
West	6 (37.5)	55 (40.7)	61 (27.9)	24 (21.4)	2 (33.3)	2 (9.5)	2 (66.7)	21 (32.3)	173 (30.0)
Bed Size									
Small	8 (50.0)	58 (43.0)	82 (37.4)	36 (32.1)	6 (100.0)	3 (14.3)	0 (0.0)	18 (27.7)	211 (36.6)
Medium	7 (43.8)	38 (28.2)	57 (26.0)	33 (29.5)	0 (0.0)	5 (23.8)	3 (100.0)	18 (27.7)	161 (27.9)
Large	1 (6.3)	39 (28.9)	80 (36.5)	43 (38.4)	0 (0.0)	13 (61.9)	0 (0.0)	29 (44.6)	205 (35.5)

Teaching Status									
Teaching	2 (12.5)	14 (10.8)	44 (20.1)	26 (23.2)	0 (0.0)	8 (38.1)	1 (33.3)	30 (46.2)	125 (21.7)
Non-Teaching	14 (87.5)	121 (89.6)	175 (79.9)	86 (76.8)	6 (100.0)	13 (61.9)	2 (66.7)	35 (53.9)	452 (78.3)
Location									
Rural	6 (37.5)	67 (49.6)	90 (41.1)	27 (24.1)	0 (0.0)	4 (19.1)	2 (66.7)	5 (7.7)	201 (34.8)
Urban	10 (62.5)	68 (50.4)	129 (58.9)	85 (75.9)	6 (100.0)	17 (81.0)	1 (33.3)	60 (92.3)	376 (65.2)
Ownership									
Government or Private	5 (31.3)	39 (28.9)	91 (41.6)	50 (44.7)	3 (50.0)	13 (61.9)	1 (33.3)	43 (66.2)	245 (42.5)
Government, non-federal, public	1 (6.3)	28 (20.7)	33 (15.1)	14 (12.5)	0 (0.0)	2 (9.5)	2 (66.7)	3 (4.6)	83 (14.4)
Private, non-profit, voluntary	5 (31.3)	24 (17.8)	38 (17.4)	24 (21.4)	0 (0.0)	2 (9.5)	0 (0.0)	14 (21.5)	107 (18.5)
Private, investor-own	2 (12.5)	14 (10.4)	18 (8.2)	15 (13.4)	3 (50.0)	4 (19.1)	0 (0.0)	5 (7.7)	61 (10.6)
Private, collapsed	3 (18.8)	30 (22.2)	39 (17.8)	9 (8.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	81 (14.0)

Tables 12 and 13 below provide information on the number of errors (per discharge and total) as well as the number of patients deaths reported during 2008. Overall the prevalence of discharges with at least one error where stable over each stage with several outliers from the total occurring in Stages 3 (mean=696), 4 (mean=68), 5 (mean=1134), and 7 (mean=1248). Some of the variation in Stage 4 can be attributed to the small number of hospitals, six, in that stage for year 2008.

There is significant variation in the mean number of errors reported for all hospitals and in each stage. This could possibly be because each patient discharge with an error can have more than one error for a single patient discharge report. This could also be an early indicator that as the health IT stage increases new or more errors arise as indicated by the increase in mean number of errors reported with progression of health IT stage.

There is also little variation between total mean patient deaths and mean patient deaths in each stage. Similarly, Stage 4 varies from the total and the other stages with a mean of 59, which is significantly lower than the total mean for patient deaths, 192.

Table 12. Analysis Data Set, Hospital Descriptive Characteristics, Total for 2008

Total				
Variable	**N**	**Mean**	**Median**	**Standard Deviation**
Discharges with at least 1 error	580	598.9551724	240.5	1014.66
Total Errors	580	714.8810345	279.5	1244.98
Patient Deaths	580	192.2068966	106	235.779848

Table 13. Analysis Data Set, Hospital Descriptive Characteristics by Stage, for 2008

Stage 0				
Variable	**N**	**Mean**	**Median**	**Standard Deviation**
Discharges with at least 1 error	16	329.5625	104	499.6653505
Total Errors	16	393.875	118	611.6869434
Patient Deaths	16	131.9375	48	176.1868208
Stage 1				
Discharges with at	135	315.5777778	105	471.1995722

least 1 error				
Total Errors	135	371.2074074	121	565.1724885
Patient Deaths	135	121.3037037	57	145.9102809
Stage 2				
Discharges with at least 1 error	219	522.6575342	205	959.67002
Total Errors	219	626.2328767	234	1197.71
Patient Deaths	219	169.5479452	89	211.0969846
Stage 3				
Discharges with at least 1 error	112	696.0803571	371.5	1051.93
Total Errors	112	824.9642857	439	1261.5
Patient Deaths	112	228.6071429	129	252.8553109
Stage 4				
Discharges with at least 1 error	6	67.5	53.5	64.5003876
Total Errors	6	81.3333333	63.5	77.644489
Patient Deaths	6	58.6666667	35.5	62.908399
Stage 5				
Discharges with at least 1 error	21	1133.81	906	945.2857039
Total Errors	21	1356.43	1099	1149.33
Patient Deaths	21	359.9047619	245	311.6706442
Stage 6				
Discharges with at least 1 error	3	351	19	591.5716356
Total Errors	3	393	21	662.592635
Patient Deaths	3	131.3333333	11	215.3887957
Stage 7				
Discharges with at least 1 error	65	1248.05	816	1630.32
Total Errors	65	1503.52	930	2011.23
Patient Deaths	65	328.7230769	269	328.3387403

5.4.2 Hospital Characteristics 2009

Hospital characteristics from the 2009 analysis dataset categorized by health IT stage were assessed and the results are presented in Table 14. This table shows data for hospital region, bed size, teaching status, location, and ownership for 2009 and includes matched hospitals from both the HCUP and HIMSS datasets. There are two hospitals in the 2009 dataset that did not have sufficient data to be categorized into one of the eight health IT stages.

The greatest distribution of hospitals in the 2009 data set is in Stages 2 (31.8%) and 3 (26.3%) with the smallest distribution in Stages 0 (3.2%), 4 (1.1%) and 5 (5.2%). Within the subcategories for Region the majority of stages are evenly distributed with the exception of Stage 0 and for some subcategories Stages 3 and 4. The subcategories for Bed Size are also evenly distributed across health IT implementation stages with the exception of Stage 4 which shows a greater variation in all three categories, small, medium, and large. This could possible be due to overall low number of hospitals in Stage 4 (6 hospitals) for the 2009 dataset. Similarly, Teaching Status and Location are evenly distributed among the various stages with the exception of Stage 4, which has a significantly different distribution of hospitals. This could primarily be due to the small number of hospitals Stage 4 has in the data set with only a 1.1% distribution from six hospitals. A similar trend is also seen within the Ownership subcategory as the distribution of Stage 4 varies significantly from the other stages.

Table 14. Analysis Data Set, Hospital Descriptive Characteristics, for 2009

Health IT Stage	Stage 0	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6	Stage 7	Total
Number of Hospitals (percent)	18 (3.2)	90 (16.1)	178 (31.8)	147 (26.3)	6 (1.1)	29 (5.2)	45 (8.1)	46 (8.2)	559
Region									

Northeast	0 (0.0)	11 (12.2)	43 (24.2)	24 (16.3)	2 (33.3)	10 (34.5)	14 (31.1)	17 (37.0)	121 (21.7)
Midwest	10 (55.6)	21 (23.3)	40 (22.5)	25 (17.0)	1 (16.7)	6 (20.7)	11 (24.4)	12 (26.1)	126 (22.5)
South	2 (11.1)	17 (18.9)	44 (24.7)	55 (37.4)	0 (0.0)	7 (24.1)	7 (15.6)	6 (13.0)	138 (24.7)
West	6 (33.3)	41 (45.6)	51 (28.7)	43 (29.3)	3 (50.0)	6 (20.7)	13 (28.9)	11 (23.9)	174 (31.1)
Bed Size									
Small	7 (38.9)	42 (46.7)	74 (41.6)	47 (32.0)	5 (83.3)	10 (34.5)	11 (24.4)	10 (21.7)	206 (36.9)
Medium	5 (27.8)	25 (27.8)	49 (27.5)	42 (28.6)	0 (0.0)	9 (31.0)	12 (26.7)	16 (34.8)	158 (28.3)
Large	6 (33.3)	23 (25.6)	55 (30.9)	58 (39.5)	1 (16.7)	10 (34.5)	22 (48.9)	20 (43.5)	195 (34.9)
Teaching Status									
Teaching	1 (5.6)	14 (15.6)	32 (18.0)	24 (16.3)	0 (0.0)	10 (34.5)	21 (46.7)	19 (41.3)	121 (21.7)
Non-Teaching	17 (94.4)	76 (84.4)	146 (82.0)	123 (83.7)	6 (100.0)	19 (65.5)	24 (53.3)	27 (58.7)	438 (78.4)
Location									
Rural	12 (66.7)	43 (47.8)	75 (42.1)	42 (28.6)	0 (0.0)	5 (17.2)	5 (11.1)	11 (23.9)	193 (34.5)
Urban	6 (33.3)	47 (52.2)	103 (57.9)	105 (71.4)	6 (100.0)	24 (82.8)	40 (88.9)	35 (76.1)	366 (65.5)
Ownership									
Government or Private	3 (16.7)	30 (33.3)	69 (38.8)	57 (38.8)	3 (50.0)	13 (44.8)	30 (66.7)	32 (69.6)	237 (42.4)
Government, non-federal, public	3 (16.7)	24 (26.7)	25 (14.0)	13 (8.8)	0 (0.0)	5 (17.2)	3 (6.7)	4 (8.7)	77 (13.8)
Private, non-profit, voluntary	3 (16.7)	16 (17.8)	42 (23.6)	32 (21.8)	0 (0.0)	8 (27.6)	7 (15.6)	7 (15.2)	115 (20.6)
Private, investor-own	1 (5.6)	5 (5.6)	15 (8.4)	31 (21.1)	3 (50.0)	1 (3.5)	3 (6.7)	0 (0.0)	59 (10.6)
Private, collapsed	8 (44.4)	15 (16.7)	27 (15.2)	14 (9.5)	0 (0.0)	2 (4.4)	2 (4.4)	3 (6.5)	71 (12.7)

Tables 15 and 16 below provide information on the number of errors (per discharge and total) as well as the number of patients deaths reported during 2009. Overall the prevalence of discharges with at least one error where stable over each stage with several outliers from the total occurring in Stages 5 (mean=822), 6 (mean=930), and 7 (mean=920). It is unclear from the raw data why these stages exhibit a greater prevalence of discharges with at least one error; however, this could be due to an increase in errors as hospitals achieve a higher stage of health IT implementation. This can be further supported by an increase in the total number of errors.

There is also significant variation in the mean number of total errors reported for all hospitals and in Stage 0 in addition to Stages 5, 6, and 7 as mentioned above. Some of the variation in total number of errors could be attributed to the possibility that a single patient's discharge can have more than one error.

There is also greater variation between total mean patient deaths (mean=180) and mean patient deaths in Stages 5 (mean=247), 6 (mean=258), and 7 (mean=268). Additionally, Stage 0 varies from the total and other stages with a mean of 97, which is lower than the total mean for patient deaths.

Table 15. Analysis Data Set, Hospital Descriptive Characteristics, Total for 2009

2009 - Total				
Variable	N	Mean	Median	Standard Deviation
Discharges with at least 1 error	561	556.5597148	208	822.7489639
Total Errors	561	665.0392157	249	1006.73
Patient Deaths	561	180.0802139	96	217.5722597

Table 16. Analysis Data Set, Hospital Descriptive Characteristics by Stage, for 2009

Variable	N	Mean	Median	Standard Deviation
Stage 0				
Discharges with at least 1 error	18	208.9444444	60.5	430.2529314
Total Errors	18	248.5555556	66.5	530.1095583
Patient Deaths	18	97	31	186.6440462
Stage 1				
Discharges with at least 1 error	90	417.9111111	68.5	665.3963024
Total Errors	90	494.3444444	79	795.4742089
Patient Deaths	90	124.8888889	30.5	182.7375747
Stage 2				
Discharges with at least 1 error	178	421.4831461	167.5	633.5555592
Total Errors	178	503.0505618	199	766.9920062
Patient Deaths	178	153.6235955	78	196.1776806
Stage 3				
Discharges with at least 1 error	147	576.0952381	245	903.2775506
Total Errors	147	681.7346939	294	1077.8
Patient Deaths	147	193.0952381	123	235.0865866
Stage 4				
Discharges with at least 1 error	6	338.5	145.5	548.5255691
Total Errors	6	410.6666667	197.5	637.3079842
Patient Deaths	6	136.8333333	93	140.9942079
Stage 5				
Discharges with at least 1 error	29	822.0689655	408	906.1479669
Total Errors	29	973.8275862	497	1082.91
Patient Deaths	29	247	123	246.4667465
Stage 6				
Discharges with at least 1 error	45	930.4222222	598	1145.35
Total Errors	45	1114.09	693	1401.59
Patient Deaths	45	257.7333333	228	218.9472124
Stage 7				
Discharges with at least 1 error	46	919.9565217	689	963.8480276

Total Errors	46	1135.28	801	1316.26
Patient Deaths	46	268.2173913	197	249.8199274

5.4.3 Hospital Characteristics 2010

Hospital characteristics from the 2010 analysis dataset categorized by health IT stage were assessed and the results are presented in Table 17. As with previous years data, this table shows data for hospital region, bed size, teaching status, location, and ownership for 2010 and includes matched hospitals from both the HCUP and HIMSS datasets. All hospitals in the 2010 dataset had sufficient data to be categorized into one of the eight health IT stages.

As in pervious years (i.e. 2009) there are a small number of hospitals in Stage 4, which has fours hospitals. This low number of hospitals could explain much of the variation seen in the subcategories for many hospital characteristics represented in Table 17 below. The distribution of data in Region appears to be somewhat uniform with the exception of Stage 4, as mentioned above and Stage 5. There is a similar distribution across health IT stages, with the exception of Stage 4 and 5, for Bed Size, Teaching Status, Location, and Ownership Status. This distribution could indicate that hospitals at all stages of health IT adoption exhibit similar characteristics with no specific subcategory representing the overwhelming majority of hospitals in any stage.

Table 17. Analysis Data Set, Hospital Descriptive Characteristics, for 2010

Health IT Stage	Stage 0	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6	Stage 7	Total
Number of Hospitals (percent)	19 (3.25)	85 (14.6)	159 (27.2)	179 (30.7)	4 (0.7)	28 (4.8)	35 (6.0)	75 (12.8)	584
Region									
Northeast	0 (0.0)	12 (14.1)	36 (22.6)	30 (16.8)	0 (0.0)	12 (42.9)	9 (25.7)	20 (26.7)	119 (20.4)
Midwest	6 (31.6)	18 (21.2)	36 (22.6)	37 (20.7)	1 (25.0)	2 (7.1)	11 (31.4)	20 (26.7)	131 (22.4)
South	3 (15.8)	22 (25.9)	45 (28.3)	67 (37.4)	1 (25.0)	4 (14.3)	6 (17.1)	14 (18.7)	162 (27.7)
West	10 (52.6)	33 (38.8)	42 (26.4)	45 (25.1)	2 (50.0)	10 (35.7)	9 (25.7)	21 (28.0)	172 (29.5)
Bed Size									
Small	10 (52.6)	48 (56.5)	69 (43.4)	52 (29.1)	4 (100.0)	8 (28.6)	15 (42.9)	24 (32.0)	230 (39.4)
Medium	7 (36.8)	19 (22.4)	32 (20.1)	63 (35.2)	0 (0.0)	10 (35.7)	5 (14.3)	20 (26.7)	156 (26.7)
Large	2 (10.5)	18 (21.2)	58 (36.5)	64 (35.8)	0 (0.0)	10 (35.7)	15 (42.9)	31 (41.3)	198 (33.9)
Teaching Status									
Teaching	2 (10.5)	9 (10.6)	25 (15.7)	32 (17.9)	0 (0.0)	10 (35.7)	14 (40.0)	38 (50.7)	130 (22.3)
Non-Teaching	17 (89.5)	76 (89.4)	134 (84.3)	147 (82.1)	4 (100.0)	18 (64.3)	21 (60.0)	37 (49.3)	454 (77.7)
Location									
Rural	7 (36.8)	40 (47.1)	73 (45.9)	54 (30.2)	0 (0.0)	6 (21.4)	9 (25.7)	16 (21.3)	205 (35.1)
Urban	12 (63.2)	45 (52.9)	86 (54.1)	125 (69.8)	4 (100.0)	22 (78.6)	26 (74.3)	59 (78.7)	379 (64.9)
Ownership									
Government or Private	5 (26.3)	22 (25.9)	60 (37.7)	69 (38.6)	1 (25.0)	16 (57.1)	19 (54.3)	48 (64.0)	240 (41.1)
Government, non-federal, public	2 (10.5)	21 (24.7)	33 (20.8)	20 (11.2)	0 (0.0)	3 (8.6)	3 (8.6)	4 (5.3)	86 (14.7)
Private, non-profit, voluntary	4 (21.1)	14 (16.5)	26 (16.4)	45 (25.1)	1 (25.0)	6 (21.4)	6 (17.1)	14 (18.7)	116 (19.9)
Private, investor-own	5 (26.3)	13 (15.3)	19 (12.0)	27 (15.1)	2 (50.0)	3 (10.7)	2 (5.7)	0 (0.0)	71 (12.2)
Private, collapsed	3 (15.8)	15 (17.7)	21 (13.2)	18 (10.1)	0 (0.0)	0 (0.0)	5 (14.3)	9 (12.0)	71 (12.2)

Tables 18 and 19 below provide information on the number of errors (per discharge and total) as well as the number of patients deaths reported during 2010. These table show that overall the prevalence of discharges with at least one error where variable over each stage with the mean ranging from 167 in Stage 4 to a mean of 992 in Stage 7. Stages 2 (mean=407), 3 (mean=512), and 5 (mean=658) demonstrate a mean that is more inline with the mean of the total hospital population (mean=523) in this year. Some of the variation in Stage 4 can be attributed to the small number of hospitals, four, in that stage for year 2010. However it is unclear why there is variation in other stages and why there is such diverse variation between each health IT stage.

Similarly, there is significant variation in the mean number of errors reported for hospitals at each stage. This could possibly be because of the variation in the number of hospitals categorized into each stage based on the raw data. This could also be an indicator of how health IT implementation affects or lacks an affect on medical errors.

Among patient deaths there is some variation between total mean patient deaths and mean patient deaths in each health IT stage. Stages 0 and 7 show more variation from the total and the other stages with a mean of 85 and 290, respectively. These are significantly lower and higher than the total mean for patient deaths, 173.

Table 18. Analysis Data Set, Hospital Descriptive Characteristics, Total for 2010

2010 - Total				
Variable	**N**	**Mean**	**Median**	**Standard Deviation**
Discharges with at	584	523.390411	218	777.6565348

least 1 error				
Total Errors	584	621.3921233	255.5	953.8506965
Patient Deaths	584	172.5547945	87	211.7872336

Table 19. Analysis Data Set, Hospital Descriptive Characteristics by Stage, for 2010

Stage 0				
Variable	**N**	**Mean**	**Median**	**Standard Deviation**
Discharges with at least 1 error	19	250.2631579	76	360.5142688
Total Errors	19	296.1052632	92	427.6382031
Patient Deaths	19	85.1052632	24	135.8033279
Stage 1				
Discharges with at least 1 error	85	301.0352941	62	528.9060689
Total Errors	85	354.9294118	69	629.2744459
Patient Deaths	85	102.0352941	26	160.5248421
Stage 2				
Discharges with at least 1 error	159	406.5974843	138	825.0812551
Total Errors	159	486.2578616	159	1029.78
Patient Deaths	159	135.6603774	75	168.6449281
Stage 3				
Discharges with at least 1 error	179	511.9664804	310	588.6952236
Total Errors	179	597.8715084	361	697.7763399
Patient Deaths	179	189.5139665	122	212.8621265
Stage 4				
Discharges with at least 1 error	4	167.25	147	108.4938554
Total Errors	4	212	190.5	132.0378734
Patient Deaths	4	114	38.5	162.1912451
Stage 5				
Discharges with at least 1 error	28	657.7142857	591.5	664.0393148
Total Errors	28	770.8214286	681	778.5947005
Patient Deaths	28	214.75	152.5	218.1285087
Stage 6				
Discharges with at	35	730.1714286	264	896.4988595

least 1 error				
Total Errors	35	866.0857143	306	1079.75
Patient Deaths	35	192.8857143	114	227.0028208
Stage 7				
Discharges with at least 1 error	75	991.8	660	1111.61
Total Errors	75	1200.27	749	1395.12
Patient Deaths	75	290.2533333	242	285.3596163

5.4.4 Hospital Characteristics 2011

Hospital characteristics from the 2011 analysis dataset categorized by health IT stage were assessed and the results are presented in Table 20 below. This table shows data for hospital region, bed size, teaching status, location, and ownership for 2011 and includes matched hospitals from both the HCUP and HIMSS datasets. There are two hospitals in the 2011 dataset that did not have sufficient data to be categorized into one of the eight health IT stages.

The 2011 data demonstrates the largest distribution of hospitals in the Stages 2 (20.1%), 3 (21.4%), and 7 (20.3%) and the smallest distributions in the Stages 0 (3.4%) and 4 (0.4%). Within subcategories for Region the majority of stages are evenly distributed with outliers following the same distribution patterns as the overall percentage of hospitals. The subcategories for Bed Size are also evenly distributed across the eight health IT implementation stages with the exception of Stage 4 which shows a greater variation in all three categories, small, medium, and large. This could possible be due to overall low number of hospitals in Stage 4 for the 2011 dataset and that these two hospitals are both categorized as *Small*. Teaching Status and Location are more heavily weighted in one of the two subcategories with total number of non-teaching (78.4%) and total number of urban (65.2%) hospitals capturing the larger proportion of hospitals in the dataset, respectively. Within the health IT stages teaching status is evenly distributed with the exception of Stage 4, which has a significantly different distribution of hospitals. This could primarily be due to the small number of hospitals Stage 4 has in the data set with only a 0.4% distribution from two hospitals. A similar trend is also seen within the Ownership subcategory as the distribution of Stage 4 varies significantly from the other stages.

Table 20. Analysis Data Set, Hospital Descriptive Characteristics, for 2011

Health IT Stage	Stage 0	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6	Stage 7	Total
Number of Hospitals (percent)	18 (3.4)	78 (14.7)	107 (20.1)	114 (21.4)	2 (0.4)	55 (10.3)	50 (9.4)	108 (20.3)	532
Region									
Northeast	5 (27.8)	11 (14.1)	30 (28.0)	16 (14.0)	1 (50.0)	18 (32.7)	10 (20)	27 (25.0)	118 (22.2)
Midwest	4 (22.2)	14 (18.0)	21 (19.6)	28 (24.6)	0 (0.0)	11 (20.0)	9 (18.0)	26 (24.1)	113 (21.2)
South	4 (22.2)	23 (29.5)	30 (28.0)	44 (38.6)	0 (0.0)	9 (16.4)	14 (28.0)	29 (26.9)	153 (28.8)
West	5 (27.8)	30 (38.5)	26 (24.3)	26 (22.8)	1 (50.0)	17 (34.0)	17 (34.0)	26 (24.1)	148 (27.8)
Bed Size									
Small	6 (33.3)	38 (48.7)	50 (46.7)	34 (29.8)	2 (100.0)	15 (27.3)	18 (36.0)	35 (32.4)	198 (37.2)
Medium	7 (38.9)	21 (26.9)	27 (25.2)	37 (32.5)	0 (0.0)	15 (27.3)	11 (22.0)	36 (33.3)	154 (29.0)
Large	5 (27.8)	19 (24.4)	30 (28.0)	43 (37.7)	0 (0.0)	25 (45.5)	21 (42.0)	37 (34.3)	180 (33.8)
Teaching Status									

Teaching	4 (22.2)	13 (16.7)	17 (15.9)	11 (9.7)	0 (0.0)	17 (30.9)	14 (28.0)	39 (36.1)	115 (21.6)
Non-Teaching	14 (77.8)	65 (83.3)	90 (84.1)	103 (90.4)	2 (100.0)	38 (69.1)	36 (72.0)	69 (63.9)	417 (78.4)
Location									
Rural	7 (38.9)	37 (47.4)	42 (39.3)	50 (43.9)	0 (0.0)	13 (23.6)	12 (24.0)	24 (22.2)	185 (34.8)
Urban	11 (61.1)	41 (52.6)	65 (60.8)	64 (56.1)	2 (100.0)	42 (76.4)	38 (76.0)	84 (77.8)	347 (65.2)
Ownership									
Government or Private	9 (50.0)	23 (29.5)	48 (44.9)	33 (29.0)	1 (50.0)	34 (61.8)	22 (44.0)	57 (52.8)	227 (42.7)
Government, non-federal, public	5 (27.8)	19 (24.4)	14 (13.1)	13 (11.4)	0 (0.0)	5 (9.1)	6 (12.0)	15 (13.9)	77 (14.5)
Private, non-profit, voluntary	1 (5.6)	20 (25.6)	20 (18.7)	29 (25.4)	0 (0.0)	8 (14.6)	15 (30.0)	20 (18.5)	113 (21.2)
Private, investor-own	0 (0.0)	6 (7.7)	15 (14.0)	24 (21.1)	1 (50.0)	3 (5.5)	4 (8.0)	6 (5.6)	59 (11.1)
Private, collapsed	3 (16.7)	10 (12.8)	10 (9.4)	15 (13.2)	0 (0.0)	5 (9.1)	3 (6.0)	10 (9.3)	56 (10.5)

Tables 21 and 22 below provide information on the number of errors (per discharge and total) as well as the number of patients deaths reported during 2011. Overall the prevalence of discharges with at least one error where stable over each stage with several outliers from the total occurring in Stages 4 (mean=144) and 6 (mean=808). It is unclear from the raw data why these stages exhibit a significantly different prevalence of discharges with at least one error for the total; however, this could be due to an increase in errors as hospitals achieve a higher stage of health IT implementation. This observation can be further supported by the increase in mean number of errors in the higher stages.

There is also significant variation in the mean number of total errors reported for all hospitals from the total (mean=656) to that reported in Stages 4 (mean=159), 5(mean=820), 6 (mean=985), and 7 (mean=893). There is also little variation between total mean patient deaths (mean=178) and mean patient deaths in each stage. Stage 2 (mean=123) and Stage 7 (mean=242) demonstrate the lower and higher outliers, respectively, from the total for this dataset.

Table 21. Analysis Data Set, Hospital Descriptive Characteristics, Total for 2011

2011 - Total				
Variable	**N**	**Mean**	**Median**	**Standard Deviation**
Discharges with at least 1 error	532	549.4661654	262	864.5204176
Total Errors	532	655.5620301	301.5	1062.56
Patient Deaths	532	178.0018797	102	217.7491732

Table 22. Analysis Data Set, Hospital Descriptive Characteristics by Stage, for 2011

Stage 0				
Variable	**N**	**Mean**	**Median**	**Standard Deviation**
Discharges with at least 1 error	18	546.7777778	196	819.6615913
Total Errors	18	642.8333333	227.5	972.9975062
Patient Deaths	18	182.6666667	109	220.3377087
Stage 1				
Discharges with at least 1 error	78	383.0384615	64.5	607.3049351
Total Errors	78	451.1923077	74	725.882196

Patient Deaths	78	139.9230769	46	184.9109136
Stage 2				
Discharges with at least 1 error	107	342.6728972	123	548.6238663
Total Errors	107	404.4205607	142	657.0225871
Patient Deaths	107	123.1401869	62	158.4257131
Stage 3				
Discharges with at least 1 error	114	496.0263158	266.5	721.8414316
Total Errors	114	592.9210526	301.5	891.2997683
Patient Deaths	114	158.4561404	91	193.3465933
Stage 4				
Discharges with at least 1 error	2	129.5	129.5	77.0746391
Total Errors	2	159	159	101.8233765
Patient Deaths	2	143.5	143.5	58.6898628
Stage 5				
Discharges with at least 1 error	55	687.8181818	426	858.9219145
Total Errors	55	820.0545455	519	1050.73
Patient Deaths	55	224.8	163	228.0162762
Stage 6				
Discharges with at least 1 error	50	808.08	350.5	1208.7
Total Errors	50	985.16	393	1548.69
Patient Deaths	50	209.1	103	215.730865
Stage 7				
Discharges with at least 1 error	108	748.9907407	504	1138.62
Total Errors	108	893.0555556	598.5	1388.24
Patient Deaths	108	242.1203704	163	284.3033695

5.5 Results from Analysis of Variance

This section presents results from the one-way between groups analysis of variance (ANOVA) for the combined (HCUP and HIMSS) analysis data set by year. As detailed in section 4.3 above ANOVA was chosen to determine the statistically significant variables associated with medical errors and support the analysis for the primary objective, to assess quality of care by determining if the increased implantation of health IT over a 4 year period affects the rate of reported medical errors. Specifically, this will determine if there is a statistically significant difference in the mean number of medical errors (and hospital deaths) based on the stage of health IT implemented. This was accomplished by testing whether the mean of each of the eight health IT stages was equal.

5.5.1 ANOVA Results for 2008

The class level information in the SAS procedures used several categorical variables including, but not limited to, *health IT stage, hospital region, hospital location, hospital teaching status, hospital bed size*. Most of the cases include data for all analyzed variables; however, there were three cases in the dataset that did not have complete information. This allowed for 577 of the 580 read observations to be used in the analysis of the 2008 datasets.

Using Number of Medical Errors

For this part of the study analysis, the variable for total hospital errors (*Hosp_err_tot*) was used as the dependent variable in the GLM model. The results from analyzing the 2008 analysis dataset are provided in Table 23, below. Based on an alpha level of 0.05 for acceptance of a Type 1 error, the model p-value of <0.0001 indicates that the null hypothesis, that the model does not explain the variation in the total number of hospital errors, should be rejected. Therefore, it can be concluded that this model explains a statistically significant portion of the variance in total number of errors and it can be concluded that the medical error rates are significantly different for the different stages of health IT.

To determine the amount of variation explained by the model the R-square value is evaluated. For this model of the 2008 data, approximately 47% of the total variation can be explained by the model. Additionally, the grand mean for total number of hospital errors is 717.

As a default, SAS outputs both the Type I (sequential) and Type III (partial) sums of squares for evaluation as part of the analysis model and the results of both are provided in the tables below. As shown in the Type I results the health IT stages variable is on it's own intercept (as it is the first variable in the model) and shows that a statistically significant portion of the variance in the model is explained by health IT stage (p-value = <0.0001). As additional variables are added to the model and sequentially build on each other (i.e. Region, Location, Teaching Status, Bed Size, and Ownership Control, in that order), the p-values remain statistically significant at <0.0001 or 0.0001 for Region, Location, Teaching Status, and Bed Size, indicating that a significant portion of the variance can be explained by these individual variables given that there are other factors in the model. This is maintained until Ownership Control, the last factor in the model, is added which then causes the model to lose its statistical significance with a p-value = 0.2547.

Based on the results proved below from comparing the mean number of errors for each stage of health IT it can be concluded that the mean number of medical errors for the different stages of health IT are significantly different. This can be determined by the Tukey analysis included to determine which stages of health IT are significant and which are not. Based on this health IT stages 7 (Full Electronic Medical Record), 6 (Clinical Decision Support System), 5 (Medication Administration), 3 (Electronic Medication Administration Record), 2 (Clinical Data Repository), 1 (Ancillaries), and 0 (No Ancillaries) are not significantly different from each other. Also health IT stages 6 (CDSS), 4 (Computerized Practitioner Order Entry), 3 (EMAR), 2 (CDR), 1 (Ancillaries), and 0 (No Ancillaries) are not significantly different from each other; however, health IT stages 7 (Full EMR) and 5 (Medication Administration) are significantly different from health IT stage 4 (CPOE).

Table 23. ANOVA 2008 Analytic Data; Medical Errors

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	18	417155724.7	23175318	26.98	<.0001
Error	558	479294934.9	858951.5		
Corrected Total	576	896450659.6			

R-Square	Coeff Var	Root MSE	Hosp_err_tot Mean
0.465342	129.2203	926.7964	717.2218

Source	DF	Type I SS	Mean Square	F Value	Pr > F
health_IT_stage	7	72458404	10351200.6	12.05	<.0001
HOSP_REGION	3	17706043.4	5902014.5	6.87	0.0001
HOSP_LOCATION	1	59592632.6	59592632.6	69.38	<.0001
HOSP_TEACH	1	138662341.9	138662341.9	161.43	<.0001
HOSP_BEDSIZE	2	124140380.6	62070190.3	72.26	<.0001
HOSP_CONTROL	4	4595922.1	1148980.5	1.34	0.2547

Source	DF	Type III SS	Mean Square	F Value	Pr > F
health_IT_stage	7	5862233.7	837462	0.97	0.4485
HOSP_REGION	3	4167271.1	1389090.4	1.62	0.1843
HOSP_LOCATION	1	17723700.6	17723700.6	20.63	<.0001
HOSP_TEACH	1	78963873	78963873	91.93	<.0001
HOSP_BEDSIZE	2	126017866.3	63008933.1	73.36	<.0001
HOSP_CONTROL	4	4595922.1	1148980.5	1.34	0.2547

Alpha	0.05
Error Degrees of Freedom	558
Error Mean Square	858951.5
Critical Value of Studentized Range	4.30269
Minimum Significant Difference	1133.5
Harmonic Mean of Cell Sizes	12.37613

Means with the same letter are not significantly different.				
Tukey Grouping		Mean	N	health_IT_stage
	A	1503.5	65	7
	A	1356.4	21	5
B	A	825	112	3
B	A	626.2	219	2
B	A	393.9	16	0
B	A	393	3	6
B	A	371.2	135	1
B		81.3	6	4

Using Total Number of Hospital Deaths

For this part of the study analysis, the variable for total hospital deaths (*died_tot*) was used as the dependent variable in the GLM model. The results from analyzing the number of total deaths in the 2008 analysis dataset are provided in Table 24, below. Based on an alpha level of 0.05 for acceptance of a Type 1 error, the model p-value of <0.0001 indicates that the null hypothesis, that the model does not explain the variation in the total number of hospital deaths, should be rejected. Therefore, it can be concluded that this model explains a statistically significant portion of the variance in total number of deaths and it can be concluded that the death rate is significantly different for the different stages of health IT.

To determine the amount of variation explained by the model the R-square value is evaluated. For this model of the 2008 data, approximately 60% of the total variation can be explained by the model. Additionally, the grand mean for total number of hospital deaths is 192.

As a default, SAS outputs both the Type I (sequential) and Type III (partial) sums of squares for evaluation as part of the analysis model and the results of both are provided in the tables below. As shown in the Type I results the health IT stages variable is on it's own intercept (as it is the first variable in the model) and shows that a statistically significant portion of the variance in the model is explained by health IT stage (p-value =

<0.0001). As additional variables are added to the model and sequentially build on each other (i.e. Region, Location, Teaching Status, Bed Size, and Ownership Control, in that order), the p-values remain statistically significant at <0.0001 for Region, Location, Teaching Status, and Bed Size, indicating that a significant portion of the variance can be explained by these individual variables given that there are other factors in the model. This is maintained until Ownership Control, the last factor in the model, is added which then causes the model to lose its statistical significance with a p-value = 0.0565.

Table 24. ANOVA 2008 Analytic Data; Total Deaths

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	18	19055449.43	1058636.08	45.63	<.0001
Error	558	12947046.98	23202.59		
Corrected Total	576	32002496.41			

R-Square	Coeff Var	Root MSE	Died_total Mean
0.595436	79.25742	152.324	192.1889

Source	DF	Type I SS	Mean Square	F Value	Pr > F
health_IT_stage	7	2917709.138	416815.591	17.96	<.0001
HOSP_REGION	3	1588356.218	529452.073	22.82	<.0001
HOSP_LOCATION	1	3357237.644	3357237.644	144.69	<.0001
HOSP_TEACH	1	3980326.069	3980326.069	171.55	<.0001
HOSP_BEDSIZE	2	6997222.268	3498611.134	150.79	<.0001
HOSP_CONTROL	4	214598.09	53649.523	2.31	0.0565

Source	DF	Type III SS	Mean Square	F Value	Pr > F
health_IT_stage	7	141351.155	20193.022	0.87	0.5297

HOSP_REGION	3	519527.571	173175.857	7.46	<.0001
HOSP_LOCATION	1	1421642.25	1421642.25	61.27	<.0001
HOSP_TEACH	1	2609964.614	2609964.614	112.49	<.0001
HOSP_BEDSIZE	2	6997485.644	3498742.822	150.79	<.0001
HOSP_CONTROL	4	214598.09	53649.523	2.31	0.0565

5.5.2 ANOVA Results for 2009

The class level information in the SAS procedure used several categorical variables including, but not limited to, *health IT stage, hospital region, hospital location, hospital teaching status, hospital bed size*. Most of the cases include data for all analyzed variables; however, there were two cases in the dataset that did not have complete information. This allowed for 559 of the 561 read observations to be used in the analysis of the 2009 datasets.

Using Number of Medical Errors

For this part of the analysis, the variable for total hospital errors (*Hosp_err_tot*) was used as the dependent variable in the GLM model. The results from analyzing the 2009 analysis dataset are provided in Table 25, below. Based on an alpha level of 0.05 for acceptance of a Type 1 error, the model p-value of <0.0001 indicates that the null hypothesis, that the model does not explain the variation in the total number of hospital errors, should be rejected. Therefore, it can be concluded that this model explains a statistically significant portion of the variance in total number of errors and it can be concluded that the medical error rates are significantly different for the different stages of health IT.

To determine the amount of variation explained by the model the R-square value is evaluated. For this model of the 2009 data, approximately 54% of the total variation can be explained by the model. Additionally, the grand mean for total number of hospital errors is 665.

The results of both the Type I and Type III sums of squares are provided in the tables below. As shown in the Type I results the health IT stages variable is on it's own intercept (as it is the first variable in the model) and shows that a statistically significant portion of the variance in the model is explained by health IT stage (p-value = <0.0001). As additional variables are added to the model and sequentially build on each other (i.e. Region, Location, Teaching Status, Bed Size, and Ownership Control, in that order), the p-values remain statistically significant at <0.0001 for Region, Location, Teaching Status, and Bed Size, indicating that a significant portion of the variance can be explained by these individual variables given that there are other factors in the model. This is maintained until Ownership Control, the last factor added to the model, is added which then causes the model to lose its statistical significance with a p-value = 0.4155.

In addition, based on the results proved below from comparing the mean number of errors for each stage of health IT it can be concluded that the mean number of medical errors for the different stages of health IT are significantly different. This is determined by the Tukey analysis included to determine which stages of health IT are significant and which are not. Based on this, health IT stages 7 (Full Electronic Medical Record), 6 (Clinical Decision Support System), 5 (Medication Administration), and 3 (Electronic Medication Administration Record) are not significantly different from each other. Health IT stages 5 (Medication Administration), 3 (EMAR), 2 (Clinical Data Repository), 1 (Ancillaries), and 4 (Computerized Practitioner Order Entry), and are also not significantly different from each other. Additionally, other health IT stages that are not significantly different from each other including 4 (CPOE), 3 (EMAR), 2 (CDR), 1 (Ancillaries), and 0 (No Ancillaries). Health IT stages that are considered significantly different include 7 (Full EMR) and 6 (CDSS) with 2 (CDR), 1 (Ancillaries), and 4 (CPOE); also of a significant difference is health IT stage 5 (Medication Administration) with 0 (No Ancillaries). Lastly health IT stages 7 (Full EMR), 6 (CDSS), and 5 (Medication Administration) are significantly different than health IT stages 0 (No Ancillaries), 1 (Ancillaries), 2 (CDR), and 4 (CPOE).

Table 25. ANOVA 2009 Analytic Data; Medical Errors

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	18	306012849.2	17000713.8	35.18	<.0001
Error	540	260930450.3	483204.5		
Corrected Total	558	566943299.5			

R-Square	Coeff Var	Root MSE	Hosp_err_tot Mean

0.539759	104.5166	695.1292	665.0894

Source	DF	Type I SS	Mean Square	F Value	Pr > F
health_IT_stage	7	32855679.1	4693668.4	9.71	<.0001
HOSP_REGION	3	10618373.4	3539457.8	7.32	<.0001
HOSP_LOCATION	1	61323534.2	61323534.2	126.91	<.0001
HOSP_TEACH	1	102463254.8	102463254.8	212.05	<.0001
HOSP_BEDSIZE	2	96849373.5	48424686.7	100.22	<.0001
HOSP_CONTROL	4	1902634.2	475658.6	0.98	0.4155

Source	DF	Type III SS	Mean Square	F Value	Pr > F
health_IT_stage	7	1867865.57	266837.94	0.55	0.7947
HOSP_REGION	3	2136059.87	712019.96	1.47	0.2208
HOSP_LOCATION	1	11221439.45	11221439.45	23.22	<.0001
HOSP_TEACH	1	52144902.73	52144902.73	107.91	<.0001
HOSP_BEDSIZE	2	95595820.03	47797910.02	98.92	<.0001
HOSP_CONTROL	4	1902634.22	475658.55	0.98	0.4155

Alpha	0.05
Error Degrees of Freedom	540
Error Mean Square	483204.5
Critical Value of Studentized Range	4.30324
Minimum Significant Difference	602.17
Harmonic Mean of Cell Sizes	24.67627

Means with the same letter are not significantly different.					
Tukey Grouping			Mean	N	health_IT_stage
	A		1135.3	46	7
	A		1114.1	45	6
B	A		973.8	29	5

B	A	C	681.7	147	3
B		C	503.1	178	2
B		C	494.3	90	1
B		C	410.7	6	4
		C	248.6	18	0

Using Total Number of Hospital Deaths

For this part of the study analysis, the variable for total hospital deaths (*died_tot*) was used as the dependent variable in the GLM model. The results from analyzing the number of total deaths in the 2009 analysis dataset are provided in Table 26, below. Based on an alpha level of 0.05 for acceptance of a Type 1 error, the model p-value of <0.0001 indicates that the null hypothesis, that the model does not explain the variation in the total number of hospital deaths, should be rejected. Therefore, it can be concluded that this model explains a statistically significant portion of the variance in total number of hospital deaths and it can be concluded that the death rate is significantly different for the different stages of health IT.

To determine the amount of variation explained by the model the R-square value is evaluated. For this model of the 2009 data, approximately 61% of the total variation can be explained by the model.

As shown in the Type I sums of squares results the health IT stages variable is on it's own intercept and shows that a statistically significant portion of the variance in the model is explained by health IT stage (p-value = <0.0001). As additional variables are added to the model and sequentially build on each other (i.e. Region, Location, Teaching Status, Bed Size, and Ownership Control, in that order), the p-values remain statistically significant at <0.0001 for Region, Location, Teaching Status, and Bed Size, indicating that a significant portion of the variance can be explained by these individual variables given that there are other factors in the model. This is maintained until Ownership Control, the last factor in the model, is added which then causes the model to lose its statistical significance with a p-value = 0.5922.

Table 26. ANOVA 2009 Analytic Data; Total Deaths

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	18	16206674.92	900370.83	47.32	<.0001
Error	540	10273928.62	19025.79		
Corrected Total	558	26480603.54			

R-Square	Coeff Var	Root MSE	Died_total Mean
0.612021	76.61783	137.934	180.0286

Source	DF	Type I SS	Mean Square	F Value	Pr > F
health_IT_stage	7	1317656.746	188236.678	9.89	<.0001
HOSP_REGION	3	1536370.259	512123.42	26.92	<.0001
HOSP_LOCATIO N	1	3528409.308	3528409.308	185.45	<.0001
HOSP_TEACH	1	3870359.474	3870359.474	203.43	<.0001
HOSP_BEDSIZE	2	5900611.589	2950305.795	155.07	<.0001
HOSP_CONTRO L	4	53267.544	13316.886	0.7	0.5922

Source	DF	Type III SS	Mean Square	F Value	Pr > F
health_IT_stage	7	71227.371	10175.339	0.53	0.8083

HOSP_REGION	3	291413.737	97137.912	5.11	0.0017
HOSP_LOCATIO N	1	1058842.632	1058842.632	55.65	<.0001
HOSP_TEACH	1	2170564.538	2170564.538	114.09	<.0001
HOSP_BEDSIZE	2	5868482.538	2934241.269	154.22	<.0001
HOSP_CONTRO L	4	53267.544	13316.886	0.7	0.5922

5.5.3 ANOVA Results for 2010

The class level information in the SAS procedure used several categorical variables including, but not limited to, *health IT stage, hospital region, hospital location, hospital teaching status, hospital bed size*. All cases include data for all analyzed variables; allowing for 584 observations to be read and used in the analysis of the 2010 dataset.

Using Number of Medical Errors

For this part of the analysis, the variable for total hospital errors (*Hosp_err_tot*) was used as the dependent variable in the GLM model. The results from analyzing the 2010 analysis dataset are provided in Table 27, below. Based on an alpha level of 0.05 for acceptance of a Type 1 error, the model p-value of <0.0001 indicates that the null hypothesis, that the model does not explain the variation in the total number of hospital errors, should be rejected. Therefore, it can be concluded that this model explains a statistically significant portion of the variance in total number of errors and it can be concluded that the medical error rates are significantly different for the different stages of health IT.

To determine the amount of variation explained by the model the R-square value is evaluated. For this model of the 2010 data, approximately 54% of the total variation can be explained by the model. Additionally, the grand mean for total number of hospital errors is 621.

The results of both the Type I and Type III sums of squares are provided in the tables below. As shown in the Type I results the health IT stages variable is on it's own intercept (as it is the first variable in the model) and shows that a statistically significant portion of the variance in the model is explained by health IT stage (p-value = <0.0001). As additional variables are added to the model and sequentially build on each other (i.e. Region, Location, Teaching Status, Bed Size, and Ownership Control, in that order), the p-values remain statistically significant at <0.0001 for Region, Location, Teaching Status, and Bed Size, indicating that a significant portion of the variance can be explained by these individual variables given that there are other factors in the model. This is maintained until Ownership Control, the last factor added to the model, is added which then causes the model to lose its statistical significance with a p-value = 0.3951.

Additionally, based on the results proved below from comparing the mean number of errors for each stage of health IT it can be concluded that the mean number of medical errors for the different stages of health IT are significantly different. This is determined by the Tukey analysis used to determine which stages of health IT are significantly different and which are not. Based on this analysis, health IT stages 7 (Full Electronic Medical Record), 6 (Clinical Decision Support System), 5 (Medication Administration), and 3 (Electronic Medication Administration Record) are not significantly different from each other. Health IT stages 6 (CDSS), 5 (Medication Administration), 3 (EMAR), 2 (Clinical Data Repository), 1 (Ancillaries), and 0 (No Ancillaries) are also not significantly different from each other. Additionally, other health IT stages that are not significantly different from each other including 5 (Medication Administration), 3 (EMAR), 2 (CDR), 1 (Ancillaries), 0 (No Ancillaries), and 4 (Computerized Practitioner Order Entry). Health IT stages that are considered significantly different from each other include 7 (Full EMR) with 2 (CDR), 1 (Ancillaries), and 0 (No Ancillaries); also of a significant difference is health IT stage 6 (CDSS) with stage 4 (CPOE). Lastly health IT stages 5 (Medication Administration) with 0 (No Ancillaries). Lastly health IT stages 7 (Full EMR) and 6 (CDSS) are significantly different than health IT stages 0 (No Ancillaries), 1 (Ancillaries), 2 (CDR), and 4 (CPOE).

Table 27. ANOVA 2010 Analytic Data; Medical Errors

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	18	285534728.5	15863040.5	36.6	<.0001
Error	565	244896832.7	433445.7		
Corrected Total	583	530431561.2			

R-Square	Coeff Var	Root MSE	Hosp_err_tot Mean
0.538306	105.9502	658.3659	621.3921

Source	DF	Type I SS	Mean Square	F Value	Pr > F

health_IT_stage	7	39571615.85	5653087.98	13.04	<.0001
HOSP_REGION	3	13897198.47	4632399.49	10.69	<.0001
HOSP_LOCATION	1	51996565.66	51996565.66	119.96	<.0001
HOSP_TEACH	1	81992847.72	81992847.72	189.17	<.0001
HOSP_BEDSIZE	2	96304117.64	48152058.82	111.09	<.0001
HOSP_CONTROL	4	1772383.11	443095.78	1.02	0.3951

Source	DF	Type III SS	Mean Square	F Value	Pr > F
health_IT_stage	7	3521244.18	503034.88	1.16	0.3237
HOSP_REGION	3	4219841.85	1406613.95	3.25	0.0217
HOSP_LOCATION	1	10138444.82	10138444.82	23.39	<.0001
HOSP_TEACH	1	39706231.08	39706231.08	91.61	<.0001
HOSP_BEDSIZE	2	95043780.3	47521890.15	109.64	<.0001
HOSP_CONTROL	4	1772383.11	443095.78	1.02	0.3951

Alpha	0.05
Error Degrees of Freedom	565
Error Mean Square	433445.7
Critical Value of Studentized Range	4.30249
Minimum Significant Difference	636.46
Harmonic Mean of Cell Sizes	19.80731

Means with the same letter are not significantly different.					
Tukey Grouping			Mean	N	health_IT_stage
	A		1200.3	75	7
B	A		866.1	35	6
B	A	C	770.8	28	5
B	A	C	597.9	179	3
B		C	486.3	159	2
B		C	354.9	85	1

B		C	296.1	19	0
		C	212	4	4

Using Total Number of Hospital Deaths

In this analysis, the variable for total hospital deaths (*died_tot*) was used as the dependent variable in the GLM model. The results from analyzing the number of total deaths in the 2010 analysis dataset are provided in Table 28, below. Based on an alpha level of 0.05 for acceptance of a Type 1 error, the model p-value of <0.0001 indicates that the null hypothesis, that the model does not explain the variation in the total number of hospital deaths, should be rejected. Therefore, it can be concluded that this model explains a statistically significant portion of the variance in total number of deaths and it can be concluded that the death rate is significantly different for the different stages of health IT.

To determine the amount of variation explained by the model the R-square value is evaluated. For this model of the 2010 data, approximately 61% of the total variation can be explained by the model. Additionally, the grand mean for total number of hospital deaths is 172.6.

As shown in the Type I sums of squares results, the health IT stages variable is on it's own intercept (as it is the first variable in the model) and shows that a statistically significant portion of the variance in the model is explained by health IT stage (p-value = <0.0001). As additional variables are added to the model and sequentially build on each other (i.e. Region, Location, Teaching Status, Bed Size, and Ownership Control, in that order), the p-values at each level remain statistically significant at <0.0001 for Region, Location, Teaching Status, and Bed Size, indicating that a significant portion of the variance can be explained by these individual variables given that there are other factors in the model. This is maintained until Ownership Control is added to the model which then causes it to lose its statistical significance with a p-value = 0.4607.

Table 28. ANOVA 2010 Analytic Data; Total Deaths

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	18	16065520.61	892528.92	50.01	<.0001
Error	565	10084263.64	17848.25		
Corrected Total	583	26149784.25			

R-Square	Coeff Var	Root MSE	Died_total Mean
0.614365	77.42315	133.5974	172.5548

Source	DF	Type I SS	Mean Square	F Value	Pr > F
health_IT_stage	7	1952924.208	278989.173	15.63	<.0001
HOSP_REGION	3	1716631.194	572210.398	32.06	<.0001
HOSP_LOCATION	1	2737630.76	2737630.76	153.38	<.0001
HOSP_TEACH	1	3965082.253	3965082.253	222.16	<.0001
HOSP_BEDSIZE	2	5628648.28	2814324.14	157.68	<.0001
HOSP_CONTROL	4	64603.912	16150.978	0.9	0.4607

Source	DF	Type III SS	Mean Square	F Value	Pr > F
health_IT_stage	7	185647.128	26521.018	1.49	0.1695
HOSP_REGION	3	468723.098	156241.033	8.75	<.0001
HOSP_LOCATION	1	676646.307	676646.307	37.91	<.0001
HOSP_TEACH	1	2247876.058	2247876.058	125.94	<.0001
HOSP_BEDSIZE	2	5525340.546	2762670.273	154.79	<.0001
HOSP_CONTROL	4	64603.912	16150.978	0.9	0.4607

5.5.4 ANOVA Results for 2011

The class level information in the SAS procedure used several categorical variables including, but not limited to, *health IT stage, hospital region, hospital location, hospital teaching status, hospital bed size*. All cases include data for all analyzed variables; allowing for all 532 observations to be read and used in the analysis of the 2011 dataset.

Using Total Number of Medical Errors

For this part of the study analysis, the variable for total hospital errors (*Hosp_err_tot*) was used as the dependent variable in the GLM model. The results from analyzing the 2011 analysis dataset are provided in Table 29, below. Based on an alpha level of 0.05 for acceptance of a Type 1 error, the p-value of <0.0001 indicates that the null hypothesis (that the model does not explain the variation in the total number of hospital errors) should be rejected. Therefore, it can be concluded that this model explains a statistically significant portion of the variance in total number of errors and it can be concluded that the medical error rates are significantly different for the different stages of health IT.

To determine the amount of variation explained by the model the R-square value is evaluated. For this model of the 2011 data, approximately 48% of the total variation can be explained by the model. Additionally, the grand mean for total number of hospital errors is 656.

As a default, SAS outputs both the Type I (sequential) and Type III (partial) sums of squares for evaluation as part of the analysis and the results of both are provided in the tables below. As shown in the Type I results the health IT stages variable is on it's own intercept (as it is the first variable in the model) and shows that a statistically significant portion of the variance in the model is explained by health IT stage (p-value = <0.0001). As additional variables are added to the model and sequentially build on each other (i.e. Region, Location, Teaching Status, Bed Size, and Ownership Control, in that order), the p-values remain statistically significant at <0.0001 or 0.0003 for Region, Location, Teaching Status, and Bed Size, indicating that a significant portion of the variance can be explained by these individual variables given that there are other factors in the model. This is maintained until Ownership Control, the last variable in the model, is added which then causes the model to lose its statistical significance with a p-value = 0.1957.

Based on the results proved below from comparing the mean number of errors for each stage of health IT it can be concluded that the mean number of medical errors for the different stages of health IT are not significantly different. This can be determined by the Tukey analysis included to determine which stages of health IT are significant and which are not. Based on this, none of the eight health IT stages is significantly different from each other.

Table 29. ANOVA 2011 Analytic Data; Medical Errors

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	18	288623320.5	16034628.9	26.46	<.0001
Error	513	310895308.5	606033.7		
Corrected Total	531	599518629			

R-Square	Coeff Var	Root MSE	Hosp_err_tot Mean

0.481425	118.7503	778.4817	655.562

Source	DF	Type I SS	Mean Square	F Value	Pr > F
health_IT_stage	7	23961382.75	3423054.68	5.65	<.0001
HOSP_REGION	3	11597807.99	3865936	6.38	0.0003
HOSP_LOCATION	1	65018788.02	65018788.02	107.29	<.0001
HOSP_TEACH	1	91103829.96	91103829.96	150.33	<.0001
HOSP_BEDSIZE	2	93262602.1	46631301.05	76.95	<.0001
HOSP_CONTROL	4	3678909.65	919727.41	1.52	0.1957

Source	DF	Type III SS	Mean Square	F Value	Pr > F
health_IT_stage	7	2851895.16	407413.59	0.67	0.6956
HOSP_REGION	3	5589003.57	1863001.19	3.07	0.0274
HOSP_LOCATION	1	16135591.66	16135591.66	26.62	<.0001
HOSP_TEACH	1	44552942.26	44552942.26	73.52	<.0001
HOSP_BEDSIZE	2	93474888.99	46737444.5	77.12	<.0001
HOSP_CONTROL	4	3678909.65	919727.41	1.52	0.1957

Alpha	0.05
Error Degrees of Freedom	513
Error Mean Square	606033.7
Critical Value of Studentized Range	4.30413
Minimum Significant Difference	943.22
Harmonic Mean of Cell Sizes	12.61959

Means with the same letter are not significantly different.			
Tukey Grouping	Mean	N	health_IT_stage
A	985.2	50	6
A	893.1	108	7
A	820.1	55	5

A	642.8	18	0
A	592.9	114	3
A	451.2	78	1
A	404.4	107	2
A	159	2	4

Using Total Number of Hospital Deaths

For this part of the study analysis, the variable for total hospital deaths (*died_tot*) was used as the dependent variable in the GLM model. The results from analyzing the number of total deaths in the 2011 analysis dataset are provided in Table 30, below. Based on an alpha level of 0.05 for acceptance of a Type 1 error, the model p-value of <0.0001 indicates that the null hypothesis, that the model does not explain the variation in the total number of hospital deaths, should be rejected. Therefore, it can be concluded that this model explains a statistically significant portion of the variance in total number of deaths and it can be concluded that the death rate is significantly different for the different stages of health IT.

To determine the amount of variation explained by the model the R-square value is evaluated. For this model of the 2011 data, approximately 61% of the total variation can be explained by the model. Additionally, the grand mean for total number of hospital deaths is 178.

As a default, SAS outputs both the Type I (sequential) and Type III (partial) sums of squares for evaluation as part of the analysis model and the results of both are provided in the tables below. As shown in the Type I results the health IT stages variable is on it's own intercept (as it is the first variable in the model) and shows that a statistically significant portion of the variance in the model is explained by health IT stage (p-value = <0.0001). As additional variables are added to the model and sequentially build on each other (i.e. Region, Location, Teaching Status, Bed Size, and Ownership Control, in that order), the p-values remain statistically significant at <0.0001 for Region, Location, Teaching Status, and Bed Size, indicating that a significant portion of the variance can be explained by these individual variables given that there are other factors in the model. This is maintained until Ownership Control, the last factor in the model, is added which then causes the model to lose its statistical significance with a p-value = 0.149.

Table 30. ANOVA 2011 Analytic Data; Total Deaths

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	18	15388382.23	854910.12	44.8	<.0001
Error	513	9788824.76	19081.53		
Corrected Total	531	25177207			

R-Square	Coeff Var	Root MSE	Died_total Mean
0.611203	77.60362	138.1359	178.0019

Source	DF	Type I SS	Mean Square	F Value	Pr > F
health_IT_stage	7	1094289.047	156327.007	8.19	<.0001
HOSP_REGION	3	1476564.691	492188.23	25.79	<.0001
HOSP_LOCATION	1	3423528.232	3423528.232	179.42	<.0001
HOSP_TEACH	1	3325112.002	3325112.002	174.26	<.0001
HOSP_BEDSIZE	2	5939255.347	2969627.674	155.63	<.0001
HOSP_CONTROL	4	129632.915	32408.229	1.7	0.149

Source	DF	Type III SS	Mean Square	F Value	Pr > F
health_IT_stage	7	116425.876	16632.268	0.87	0.5287
HOSP_REGION	3	444243.809	148081.27	7.76	<.0001
HOSP_LOCATION	1	1056162.921	1056162.921	55.35	<.0001
HOSP_TEACH	1	1810883.804	1810883.804	94.9	<.0001
HOSP_BEDSIZE	2	5916546.795	2958273.398	155.03	<.0001
HOSP_CONTROL	4	129632.915	32408.229	1.7	0.149

5.5.5 ANOVA Results Overview

Overall for years 2008, 2009, and 2010 the analysis provided results to support a significant difference in the mean number of medical errors between health IT stages within each year. For 2011 there was not significant difference in the mean number of medical errors between health IT stages reported from the Tukey analysis. There was a significant amount of the variation in the model that could be explained by health IT stage for 2011. For years 2008, 2009, and 2010 it was also reported that a significant amount of the variation in the model could be explained by health IT stage alone as well as with other factors (i.e. Region, Location, Teaching Status, and Bed Size) and health IT stage when combined.

Additional analysis was conducted using hospital death rates. This analysis generated results similar to those provided from analyzing the total number of medical errors. In all years a significant amount of the variation in the model could be explained by health IT stage. Similarly for all years analyzed (2008, 2009, 2010, and 2011), when assessing health IT stage along with other hospital characteristics (i.e. Region, Location, Teaching

Status, Bed Size, and Ownership Control) a significant potion of variation in each model was statistically significant as represented by a p-value of <0.0001. This remained true of all variables with the exception of Ownership Control. This variable, which was the last factor, added to the model, was analyzed with the other hospital characteristics and returned results that were not statistically significant.

5.6 Results from Multiple Linear Regression

This section provides results from the multiple linear regression for the combined (HCUP and HIMSS) analysis datasets. These results are presented by year for 2008, 2009, 2010, and 2011. As detailed in section 4.4 above a multiple linear regression was selected to determine which health IT implementation stages are predictors of medical errors and hospital deaths. More specifically, this will provide insight regarding which health IT stage(s) is more likely to be a predictor for medical errors and death. For this analysis total number of medical errors was the dependent variable for the first assessment and total number of hospital deaths was the dependent variable for the second assessment. The independent variable for both assessments was health IT stage, which is one of several hospital characteristics. This regression analysis supports the fourth objective in the study, to determine if health IT stages or death rates are predictors for medical errors.

5.6.1 Multiple Linear Regression Results for 2008

Most of the cases for the 2008 dataset include data for all analyzed variables; however, there were three cases in the dataset that did not have complete information and therefore could not be included in the analysis. Therefore, 577 of the 580 read observations were used in the analysis of the 2008 datasets.

Using Total Number of Medical Errors

The first set of results, in Table 31, in the regression output provides the results for the F-value and p-value. The F-value measures the likelihood that the model, as a whole, describes a random relationship as opposed to a real relationship. This value is based on the p-value and its ability to test the null hypotheses, which answers the question of whether the independent variable reliably predicts the dependent variable. Because the p-value (<0.0001) is less than the alpha level (0.05), it can be assumed that the independent variable, health IT stage, can predict total hospital errors (dependent variable).

For this year the mean number of medical errors is reported as 717, as indicated by the Dependent Mean in the table below, and the coefficient of variation is 168. R-square is the proportion of variance in the total medical errors (dependent variable) which can be predicted from the independent variable (Health IT stage). Based on the results provided below the model explains only 8% of the variance in total number of medical errors, indicating that there is a weak association between the dependent and independent variables. This weak association could indicate that other hospital characteristics such as

Region, Bed Size, Location, or Teaching Status, which are not included in the model, could explain more of the variation than health IT stage.

The last table from the regression analysis provides information on the parameter estimates for each health IT stage. For these results health IT stage 0 was omitted from the model and therefore the Intercept represents the mean for this group. Additionally, omitting stage 0 from the model allows all other health IT stages to be compared against it. Overall the health IT stages differ in the number of medical errors. Specifically, health IT Stage 5 and Stage 7 are significantly different from Stage 0.

Table 31. Multiple Linear Regression 2008 Analytic Data, Medical Errors

Analysis of Variance					
Source	**DF**	**Sum of Squares**	**Mean Square**	**F Value**	**Pr > F**
Model	7	72458404	10351201	7.15	<.0001
Error	569	823992256	1448141		
Corrected Total	576	896450660			

Root MSE	1203.38732	**R-Square**	0.0808
Dependent Mean	717.22184	**Adj R-Sq**	0.0695
Coeff Var	167.78453		

Parameter Estimates					
Variable	**DF**	**Parameter Estimate**	**Standard Error**	**t Value**	**Pr > |t|**
Intercept	1	393.875	300.84683	1.31	0.191
health_IT_stage_1	1	-22.66759	318.17572	-0.07	0.9432
health_IT_stage_2	1	232.35788	311.64296	0.75	0.4562
health_IT_stage_3	1	431.08929	321.61879	1.34	0.1807

health_IT_stage_4	1	-312.54167	576.07782	-0.54	0.5877
health_IT_stage_5	1	962.55357	399.33434	2.41	0.0163
health_IT_stage_6	1	-0.875	757.11459	0	0.9991
health_IT_stage_7	1	1109.64808	335.83911	3.3	0.001

Using Total Number of Hospital Deaths

In this analysis which examines health IT stage and its relationship to total number of patient deaths, the p-value of <0.0001 is less than the alpha level of 0.05. Therefore, it can be assumed that the independent variable, health IT stage, can predict total number of hospital deaths (dependent variable).

For this year the mean number of hospital deaths is reported as 192, as indicated by the Dependent Mean in the table below, and the coefficient of variation is 118. R-square is the proportion of variance in total number of hospital deaths (dependent variable) which can be predicted from the independent variable (Health IT stage). Based on the results provided below the model explains only 9% of the variance in total number of hospital deaths, indicating that there is a weak association between the dependent and independent variables. As with the analysis on medical errors described above, this weak association could indicate that other hospital characteristics such as Region, Bed Size, Location, or Teaching Status, which are not included in the model, could explain more of the variation than health IT stage.

The last section in Table 32 provides information on the parameter estimates for each health IT stage. For these results health IT stage 0 was omitted from the model and therefore the Intercept represents the mean for this group. Additionally, omitting stage 0 from the model allows all other health IT stages to be compared against it. Overall the health IT stages differ in the number of medical errors. Specifically, health IT Stage 5 and Stage 7 are significantly different from Stage 0.

Table 32. Multiple Linear Regression 2008 Analytic Data, Total Deaths

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	7	2917709	416816	8.15	<.0001
Error	569	29084787	51116		
Corrected Total	576	32002496			

Root MSE	226.08764	R-Square	0.0912
Dependent Mean	192.18891	Adj R-Sq	0.08
Coeff Var	117.63823		

Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	131.9375	56.52191	2.33	0.0199
health_IT_stage_1	1	-10.6338	59.77759	-0.18	0.8589
health_IT_stage_2	1	37.61045	58.55024	0.64	0.5209
health_IT_stage_3	1	96.66964	60.42446	1.6	0.1102
health_IT_stage_4	1	-73.27083	108.23122	-0.68	0.4987
health_IT_stage_5	1	227.96726	75.02535	3.04	0.0025
health_IT_stage_6	1	-0.60417	142.24368	0	0.9966
health_IT_stage_7	1	196.78558	63.09612	3.12	0.0019

5.6.2 Multiple Linear Regression Results for 2009

Most of the cases for the 2009 dataset include data for all analyzed variables; however, there were two cases in the dataset that did not have complete information and therefore could not be included in the analysis. Therefore, 557 of the 559 read observations were used in the analysis of the 2009 datasets.

Using Total Number of Medical Errors

The first set of results, in Table 33 in the regression output, provides the results for the F-value and p-value. The F-value, which is based on the p-value and its ability to test the null hypotheses, answers the question of whether the independent variable reliably predicts the dependent variable. Because the p-value (<0.0001) is less than the alpha level (0.05), it can be assumed that the independent variable, health IT stage, can predict total hospital errors (dependent variable).

For this year the mean number of medical errors is reported as 665, as indicated by the Dependent Mean in the table below, and the coefficient of variation is 148. Based on the results provided below for R-square the model explains about 6% of the variance in total number of medical errors, indicating that there is a weak association between the dependent and independent variables. This weak association could indicate that other hospital characteristics can explain more of the variation in the model than health IT stage.

The last table from the regression analysis provides information on the parameter estimates for each health IT stage. For these results health IT stage 0 was omitted from the model and therefore the Intercept represents the mean for this group. Additionally, omitting stage 0 from the model allows all other health IT stages to be compared against it. Overall health IT stages differ in the number of medical errors. Specifically, health IT Stages 5, 6, and 7 are significantly different from Stage 0.

Table 33. Multiple Linear Regression 2009 Analytic Data, Medical Errors

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	7	32855679	4693668	4.84	<.0001
Error	551	534087620	969306		
Corrected Total	558	566943300			

Root MSE	984.53341	R-Square	0.058
Dependent Mean	665.08945	Adj R-Sq	0.046
Coeff Var	148.03023		

Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	248.55556	232.05675	1.07	0.2846
health_IT_stage_1	1	245.78889	254.20543	0.97	0.334

health_IT_stage_2	1	254.49501	243.50744	1.05	0.2964
health_IT_stage_3	1	433.17914	245.85413	1.76	0.0786
health_IT_stage_4	1	162.11111	464.1135	0.35	0.727
health_IT_stage_5	1	725.27203	295.42288	2.46	0.0144
health_IT_stage_6	1	865.53333	274.57325	3.15	0.0017
health_IT_stage_7	1	886.72705	273.71921	3.24	0.0013

Using Total Number of Hospital Deaths

In this analysis which examines health IT stage and its relationship to total number of patient deaths the p-value of <0.0002 is less than the alpha level of 0.05. Therefore, it can be assumed that the independent variable, health IT stage, can predict total number of hospital deaths (dependent variable).

For this year the mean number of hospital deaths is reported as 180, as indicated by the Dependent Mean in the table below, and the coefficient of variation is 119. R-square is the proportion of variance in total number of hospital deaths (dependent variable) which can be predicted from the independent variable (Health IT stage). Based on the results provided below for R-square the model explains only 5% of the variance in total number of hospital deaths, indicating that there is a weak association between number of hospital deaths and health IT stage. As with the analysis on medical errors described above, this weak association could indicate that other hospital characteristics such as Region, Bed Size, Location, or Teaching Status, could explain more of the variation than health IT stage.

For the results from the parameter estimates health IT stage 0 was omitted from the model and therefore the Intercept represents the mean for this group. Additionally, omitting stage 0 from the model allows all other health IT stages to be compared against it. Overall the health IT stages differ in the number of medical errors. Specifically, health IT Stages 5, 6 and 7 are significantly different from Stage 0.

Table 34. Multiple Linear Regression 2009 Analytic Data, Total Deaths

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	7	1317657	188237	4.12	0.0002
Error	551	25162947	45668		
Corrected Total	558	26480604			

Root MSE	213.70021	R-Square	0.0498
Dependent Mean	180.02862	Adj R-Sq	0.0377
Coeff Var	118.70346		

Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	97	50.36962	1.93	0.0546
health_IT_stage_1	1	27.88889	55.17716	0.51	0.6135
health_IT_stage_2	1	56.6236	52.85508	1.07	0.2845
health_IT_stage_3	1	96.09524	53.36445	1.8	0.0723
health_IT_stage_4	1	39.83333	100.73925	0.4	0.6927
health_IT_stage_5	1	150	64.12371	2.34	0.0197
health_IT_stage_6	1	160.73333	59.59814	2.7	0.0072
health_IT_stage_7	1	171.21739	59.41277	2.88	0.0041

5.6.3 Multiple Linear Regression Results for 2010

All cases for the 2010 dataset included data for all analyzed variables. Therefore, all 584 of the read observations were used in the analysis.

Using Total Number of Medical Errors

The first set of results in Table 35 of the regression output provides the results for the F-value and p-value. The F-value measures the likelihood that the model, as a whole, describes a random relationship as opposed to a real relationship. This value is based on the p-value and its ability to test the null hypotheses, which answers the question of whether the independent variable reliably predicts the dependent variable. Because the p-value (<0.0001) is less than the alpha level (0.05), it can be assumed that the independent variable, health IT stage, can predict total hospital errors (dependent variable).

For this year the mean number of medical errors is reported as 621, as indicated by the Dependent Mean in the table below, and the coefficient of variation is 149. R-square is the proportion of variance in the total medical errors (dependent variable) which can be predicted from the independent variable (Health IT stage). Based on the results provided below the model explains only 7% of the variance in total number of medical errors, indicating that there is a weak association between the dependent and independent variables. This weak association could indicate that other hospital characteristics such as Region, Bed Size, Location, or Teaching Status, which are not included in the model, could explain more of the variation than health IT stage.

The last table from the regression analysis provides information on the parameter estimates for each health IT stage. For these results health IT stage 0 was omitted from the model and therefore the Intercept represents the mean for this group. Additionally, omitting stage 0 from the model allows all other health IT stages to be compared against it. Overall the health IT stages differ in the number of medical errors. Specifically, health IT Stage 6 and Stage 7 are significantly different from Stage 0.

Table 35. Multiple Linear Regression 2010 Analytic Data, Medical Errors

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	7	39571616	5653088	6.63	<.0001
Error	576	490859945	852187		
Corrected Total	583	530431561			

Root MSE	923.13997	R-Square	0.0746
Dependent Mean	621.39212	Adj R-Sq	0.0634
Coeff Var	148.55997		

Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	296.10526	211.78283	1.4	0.1626
health_IT_stage_1	1	58.82415	234.2599	0.25	0.8018
health_IT_stage_2	1	190.1526	224.07953	0.85	0.3965
health_IT_stage_3	1	301.76625	222.73929	1.35	0.176
health_IT_stage_4	1	-84.10526	507.8374	-0.17	0.8685
health_IT_stage_5	1	474.71617	274.38519	1.73	0.0841

health_IT_stage_6	1	569.98045	263.05927	2.17	0.0307
health_IT_stage_7	1	904.1614	237.0959	3.81	0.0002

Using Total Number of Hospital Deaths

In this analysis, presented in Table 36, examines health IT stage and its relationship to total number of patient deaths the p-value of <0.0001 is less than the alpha level of 0.05. Therefore, it can be assumed that the independent variable, health IT stage, can predict total number of hospital deaths (dependent variable).

For this year the mean number of hospital deaths is reported as 173 and the coefficient of variation is 119. R-square is the proportion of variance in total number of hospital deaths (dependent variable) which can be predicted from the independent variable (Health IT stage). Based on the results provided below for R-square the model explains only 8% of the variance in total number of hospital deaths, indicating that there is a weak association between number of hospital deaths and health IT stage. As with the analysis on medical errors described above, this weak association could indicate that other hospital characteristics such as Region, Bed Size, Location, or Teaching Status, could explain more of the variation than health IT stage.

For the results from the parameter estimates health IT stage 0 was omitted from the model and therefore the Intercept represents the mean for this group. Additionally, omitting stage 0 from the model allows all other health IT stages to be compared against it. Overall the health IT stages differ in the number of medical errors. Specifically, health IT Stages 3, 5 and 7 are significantly different from Stage 0.

Table 36. Multiple Linear Regression 2010 Analytic Data, Total Deaths

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	7	1952924	278989	6.64	<.0001
Error	576	24196860	42008		
Corrected Total	583	26149784			

Root MSE	204.9596	R-Square	0.0747
Dependent Mean	172.55479	Adj R-Sq	0.0634
Coeff Var	118.77943		

Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	85.10526	47.02096	1.81	0.0708
health_IT_stage_1	1	16.93003	52.01142	0.33	0.7449
health_IT_stage_2	1	50.55511	49.75112	1.02	0.31
health_IT_stage_3	1	104.4087	49.45356	2.11	0.0352
health_IT_stage_4	1	28.89474	112.75229	0.26	0.7978
health_IT_stage_5	1	129.64474	60.92021	2.13	0.0338
health_IT_stage_6	1	107.78045	58.40558	1.85	0.0655
health_IT_stage_7	1	205.14807	52.64108	3.9	0.0001

5.6.4 Multiple Linear Regression Results for 2011

All cases for the 2011 dataset included data for all analyzed variables. Therefore, all 532 of the read observations were used in the analysis.

Using Total Number of Medical Errors

The first set of results, presented in Table 37, in the regression output provides the results for the F-value and p-value. The F-value measures the likelihood that the model, as a whole, describes a random relationship as opposed to a real relationship. This value is based on the p-value and its ability to test the null hypotheses, which answers the question of whether the independent variable reliably predicts the dependent variable. Because the p-value (<0.0031) is less than the alpha level (0.05), it can be assumed that the independent variable, health IT stage, can predict total hospital errors (dependent variable).

For this year the mean number of medical errors is reported as 656, as indicated by the Dependent Mean in the table below, and the coefficient of variation is 160. R-square is the proportion of variance in the total medical errors (dependent variable) which can be predicted from the independent variable (Health IT stage). Based on the results provided below the model explains only 4% of the variance in total number of medical errors, indicating that there is a weak association between the dependent and independent variables. This weak association could indicate that other hospital characteristics such as Region, Bed Size, Location, or Teaching Status, which are not included in the model, could explain more of the variation than health IT stage.

The last table from the regression analysis provides information on the parameter estimates for each health IT stage. For these results health IT stage 0 was omitted from the model and therefore the Intercept represents the mean for this group. Additionally, omitting stage 0 from the model allows all other health IT stages to be compared against it. These results show there is no significant different between Stage 0 and any of the other seven stages.

Table 37. Multiple Linear Regression 2011 Analytic Data, Medical Errors

Analysis of Variance					
Source	**DF**	**Sum of Squares**	**Mean Square**	**F Value**	**Pr > F**
Model	7	23961383	3423055	3.12	0.0031
Error	524	575557246	1098392		
Corrected Total	531	599518629			

Root MSE	1048.04184	**R-Square**	0.04
Dependent Mean	655.56203	**Adj R-Sq**	0.0271
Coeff Var	159.86921		

Parameter Estimates					
Variable	**DF**	**Parameter Estimate**	**Standard Error**	**t Value**	**Pr > |t|**

Intercept	1	642.83333	247.02583	2.6	0.0095
health_IT_stage_1	1	-191.64103	274.05055	-0.7	0.4847
health_IT_stage_2	1	-238.41277	266.99645	-0.89	0.3723
health_IT_stage_3	1	-49.91228	265.81342	-0.19	0.8511
health_IT_stage_4	1	-483.83333	781.16426	-0.62	0.5359
health_IT_stage_5	1	177.22121	284.59185	0.62	0.5337
health_IT_stage_6	1	342.32667	288.07915	1.19	0.2353
health_IT_stage_7	1	250.22222	266.81839	0.94	0.3488

Using Total Number of Hospital Deaths

In this analysis, in Table 38, which examines health IT stage and its relationship to total number of patient deaths the p-value of <0.0015 is less than the alpha level of 0.05. Therefore, it can be assumed that the independent variable, health IT stage, can predict total number of hospital deaths (dependent variable).

For this year the mean number of hospital deaths is reported as 178 and the coefficient of variation is 120. R-square is the proportion of variance in total number of hospital deaths (dependent variable) which can be predicted from the independent variable (Health IT stage). Based on the results provided below for R-square the model explains only 4% of the variance in total number of hospital deaths, indicating that there is a weak association between number of hospital deaths and health IT stage. As with the analysis on medical errors described above, this weak association could indicate that other hospital characteristics such as Region, Bed Size, Location, or Teaching Status, could explain more of the variation than health IT stage.

For the results from the parameter estimates health IT stage 0 was omitted from the model and therefore the Intercept represents the mean for this group. Additionally, omitting stage 0 from the model allows all other health IT stages to be compared against it. These results show there is no significant different between Stage 0 and any of the other seven stages.

Table 38. Multiple Linear Regression 2011 Analytic Data, Total Deaths

Analysis of Variance					
Source	**DF**	**Sum of Squares**	**Mean Square**	**F Value**	**Pr > F**
Model	7	1094289	156327	3.4	0.0015
Error	524	24082918	45960		
Corrected Total	531	25177207			

Root MSE	214.38229	**R-Square**	0.0435
Dependent Mean	178.00188	**Adj R-Sq**	0.0307
Coeff Var	120.43822		

Parameter Estimates					
Variable	**DF**	**Parameter Estimate**	**Standard Error**	**t Value**	**Pr > |t|**
Intercept	1	182.66667	50.53039	3.61	0.0003
health_IT_stage_1	1	-42.74359	56.05844	-0.76	0.4461
health_IT_stage_2	1	-59.52648	54.61548	-1.09	0.2762
health_IT_stage_3	1	-24.21053	54.37349	-0.45	0.6563
health_IT_stage_4	1	-39.16667	159.79113	-0.25	0.8065
health_IT_stage_5	1	42.13333	58.21471	0.72	0.4695
health_IT_stage_6	1	26.43333	58.92806	0.45	0.6539
health_IT_stage_7	1	59.4537	54.57906	1.09	0.2765

5.6.5 Multiple Regression Results Overview

Overall for years 2008, 2009, and 2010 the analysis provided results to support a significant difference in the number of medical errors between different health IT stages. Specifically, all three years showed a significant difference between stage 7, the highest stage of health IT implementation and stage 0, the lowest stage. Other stages that showed a significant difference from stage 0 were stage 5, which was significant in the 2008 and 2009 datasets, and stage 6, which was significant in the 2009 and 2010 datasets. The 2011 dataset was the only year that did not show a significant difference between any of the health IT stages and stage 0.

The trends in the analysis of medical errors are similar to that of the analysis of hospital death rates. Overall for years 2008, 2009, and 2010 the analysis provided results to support a significant difference in the number of hospital deaths between different health IT stages. Specifically, all three years showed a significant difference between stage 5 and stage 0 and between stage 7 and stage 0, the highest and lowest stages. Additionally, in 2009 there was a significant difference between stage 6 and stage 0 and in 2010 there was a significant difference between stage 3 and stage 0. The 2011 dataset was the only year analyzed that did not show a significant difference between any of the health IT stages and stage 0.

6. Chapter VI – Discussion

6.1 Hospital Descriptive Characteristics

As detailed in the descriptive hospital characteristics sections above, there are several characteristics that describe what types of US hospitals are at the various stages of health IT implementation. These characteristics were reviewed by year from 2008 to 2011 data from the analysis datasets which combined data from both the HCUP and HIMSS datasets. Descriptive characteristics included hospital information for the following items:

- Region
  - Northeast,
  - Midwest,
  - South, and
  - West
- Bed Size
  - Small,
  - Medium, and
  - Large
- Teaching Status
  - Teaching and
  - Non-Teaching
- Location
  - Urban and
  - Rural
- Ownership

- Government or Private;
- Government, non-federal, public;
- Private, non-profit, voluntary;
- Private, investor-own; and
- Private, collapsed

For 2008 the dataset contained 580 matched hospitals. In 2009, 561 hospitals were successfully matched and in 2010 and 2011, 584 and 532 hospitals respectively, were matched to form the analysis datasets for each year. In 2008 health IT stage 1 (23.4%), stage 2 (38%), and stage 3 (19.4%) had the highest percentage of hospitals available for analysis. All other health IT stages each represented less than 12% of hospitals. For the descriptive characteristics, Region and Bed Size both had a relatively even distribution of hospitals among the subgroups for each. For Teaching Status the majority of hospitals were classified as Non-Teaching (78.3%). Likewise, for Location the majority of hospitals were classified as Urban (65.2%) and within in Ownership the largest majority of hospitals were Government or Privately owned (42.5%). Additionally, the mean number of errors per discharge and the number of patient deaths were highest for stages 5 (1133.81 and 359.9, respectively) and 7 (1248.05 and 328.7, respectively). In reviewing this initial evaluation of hospital characteristics as they relate to error rates, patient deaths, and health IT stage there is a clear trend indicating that higher stages of health IT have hospitals with more quality control issues than hospitals at lower stages. This is not however, the case for stage 6 which has levels of errors and deaths that are more inline with the rates of other lower stages of health IT. Additional, analysis, which is discussed in other sections of this study, were conducted to determine if these variations in the data are significant or just happen by chance. It is also important to note that the stages with the highest level of issues do not represent the majority of hospitals in the dataset. This indicates that there is a need to further explore the data, as the volume of hospitals cannot solely explain the differences among stages.

Similar results were obtained for subsequent years (2009, 2010, and 2011) which also warrant additional analysis to explore the statistical significance of the differences between health IT stages. Data from the 2009 dataset show that health IT stage 2 (31.8%) and stage 3 (26.3%) had the highest percentage of hospitals available for analysis. Stage 1 also had 16.1% of total hospitals while all other health IT stages each represented less than 8.5% of hospitals. In reviewing the descriptive characteristics, similar to the 2008 dataset, Region and Bed Size both had a relatively even distribution of hospitals among the subgroups for each. For Teaching Status the majority of hospitals were classified as Non-Teaching (78.4%). Likewise, for Location the majority of hospitals were classified as Urban (65.5%) and within in Ownership the largest majority of hospitals were Government or Privately owned (42.4%). These are all similar to the results seen for the 2008 dataset. Additionally, the mean number of errors per discharge and the number of patient deaths were highest for stages 5 (822.1 and 247, respectively), 6 (903.4 and 257.7), and 7 (920 and 268.2, respectively). In reviewing this initial evaluation of hospital characteristics as they relate to 2009 error rates, patient deaths, and health IT stage there is a clear trend indicating that hospitals with more quality control issues tend to have implemented a higher stage of health IT than hospitals at lower stages. Additional, analysis, which is discussed in other sections of this study, were conducted to determine if these variations in the data are significant or occurred by chance. It is also important to note that stages with the most issues do not represent the majority of hospitals in the dataset. This indicates that the data is most likely not artificially inflated due to these hospitals representing the majority of the data in the this dataset and therefore further exploration of the data is needed.

For 2010 the dataset contained 584 matched hospitals of which 27.2% were at health IT stage 2, 30.7% were at stage 3, 14.6% were at stage 1 and 12.8% were at stage 7. These four stages had the highest percentage of hospitals available for analysis. All other health IT stages each represented less than 6.0% of hospitals. For the descriptive characteristics, Region and Bed Size both had a relatively even distribution of hospitals between both subgroups. For Teaching Status the majority of hospitals were classified as Non-Teaching (77.7%). Likewise, for Location the majority of hospitals were classified as Urban (64.9%) and within in Ownership the largest majority of hospitals were Government or Privately owned (41.1%). Additionally, the mean number of patient deaths weas highest for stages 5 (214.8) and 7 (290.3). Stages 3 and also had higher than expected patient deaths at 189.5 and 192.9, respectively. For the mean number of errors per discharge the health IT stages with the highest means were stages 5 (657.7), 6 (730.2), and 7 (991.8). This initial evaluation of hospital characteristics for 2010 related to error rates, patient deaths, and health IT stage demonstrates a clear trend indicating that higher stages of health IT have hospitals with more quality control issues than hospitals at lower stages, Additional analysis, which is discussed in other sections of this study, were conducted to determine if these variations in the data are significant or just happen by chance. It is also important to note that the stages with the most issues do not represent the majority of hospitals in the dataset. This indicates that there is a need to further explore the data, as the volume of hospitals cannot solely explain the differences among stages.

In the last year (2011) evaluated for hospital characteristics 532 hospitals were assessed. Data from this dataset show that health IT stage 2 (20.1%), stage 3 (21.4%), and stage 7 (20.3%) had the highest percentage of hospitals available for analysis. Stage 1 also had 14.7% of total hospitals while all other health IT stages each represented less than 10% of hospitals. Similar to the descriptive characteristics for other years, Region and Bed Size both had a relatively even distribution of hospitals among the subgroups for each. For Teaching Status 78.4% of hospitals were classified as Non-Teaching. For Location 65.2% of hospitals, the majority, were classified as Urban and within in Ownership the largest majority of hospitals was Government or Privately owned at 42.7%. These are all similar to the results seen for the 2008, 2009, and 2010 datasets. In additional to these hospital characteristics, the mean number of errors per discharge and the number of patient deaths were highest for stages 5 (687.8 and 224.8, respectively), 6 (808.1 and 209.1), and 7 (749 and 242.1, respectively). Additionally, stage 0 demonstrated a higher than expected mean number of patient deaths at 182.7 and mean number of errors per discharge at 546.8 than other assessed years. It is unclear in this initial evaluation why there is a high number of errors and deaths in stage 0 but this could be an indication that as hospitals stager and delay or fail to implement health IT systems in their hospitals patient care and quality suffer. However, additional analysis is needed to determine what is causing the variation in the data for this stage. Additionally, in reviewing other hospital characteristics results for error rates, patient deaths, and health IT stage there is a trend, with the exception of stage 0 data, indicating that hospitals with more quality control issues tend to have implemented a higher stage of health IT than hospitals at lower stages. Additional, analysis, which is discussed in other sections of this study, were conducted to determine if these variations in the data are significant or occurred by chance.

6.2 Analysis of Variance

To address the study objective of determining if the quality of care, using death rate and number of medical errors, at US hospitals is affected by the stage of health IT implemented at that facility an analysis of variance was conducted for each of the fours years assess in the study. Two separate analysis were conducted, one using number of medical errors and another using mortality rate. A significant difference in the mean number of medical errors between health IT stages was supported by the analysis in all analyzed years (2008, 2009, and 2010) except 2011. Additionally, the model used for this study showed that a significant amount of the variation in the model could be explained by health IT stage. Furthermore, as additional factors (i.e. Region, Location, Teaching Status, Bed Size and Ownership/Control) were added to the models in the 2008, 2009, and 2010 datasets the model maintained its significance. These results provide an important first step in determining how the implementation of health IT systems impacts hospital errors rates and ultimately quality of care. However, it falls short of identifying were the variation in the models occurs and in identifying which stages of health IT demonstrate the greatest impact. Additional analysis was conducted as part of this study to further understand these effects; however, a more detailed analysis is needed to determine the health IT stage or stages that provided the greatest improvements in quality of care.

As part of the ANOVA analysis, additional evaluation was conducted on hospital mortality rates. Similar to the analysis using medical errors, a significant amount of the variation in the models for years 2008, 2009, and 2010 could be explained by health IT stage. Additional the year 2011 model could also account for significant variation in the model. Additionally, when assessing health IT stage along side the other hospital characteristics (i.e. Region, Location, Teaching Status, Bed Size, and Ownership/Control) the results were statistically significant, as represented by a p-value <0.0001, for all factors with the exception of Ownership/Control, which was not statistically significant. This analysis of hospital mortality rate and health IT stage falls short in the same areas as the analysis on medical errors. In the conduct of future analysis to assess quality of care mortality rate should also be taken into consideration.

In reviewing the results of these two analyses it is important to mention that both the ANOVA analysis using mortality rate and the analysis using medial errors yield similar results further validating the models. These results also support what the results suggest, that there is a strong correlation between the stage of health IT implemented at a hospital and the quality of care that facility provides. Additional analysis could provide more detailed information on which health IT stages demonstrate the greatest affects on quality of care and provide information on the stage(s) hospital should seek to attain to provides the greatest quality of care to their patients.

6.3 Multiple Regression Analysis

As part of this study a multiple regression analysis was conducted to determine if the health IT stage of a hospital facility is a predictor for quality of care based on mortality rate and number of medical errors, which is one of the study objectives. This analysis was conduced for all four years of data assessed in this study. Overall for years 2008, 2009, and 2010 the analysis provided results to support a significant difference in the number of medical errors between different health IT stages. More specifically, these years showed a significant difference between stage 7, the highest stage of health IT implementation and stage 0, the lowest stage of implementation. In addition to the difference between stages 7 and 0 there was also a significant difference seen between stage 0 and stage 5 in the 2008 and 2009 datasets and a significant difference between stage 6 and stage 0 in the 2009 and 2010 datasets. The 2011 dataset did not show a significant difference between any of the health IT stages and stage 0. It is unclear from the data why there was no significant difference between stage 0 and the other health IT stages for the 2011 dataset. Analysis of subsequent years could provide insight for these results indicating if additional years (i.e. 2012, 2013, 2014) produce the same or similar results or if the analysis produces very different results that more inline with those seen in the 2008, 2009, and 2010 datasets. If the former this could indicate that hospitals are not benefiting from the implemented technology over the years. However, if the latter is the case this could mean that the 2011 dataset is simply an outlier in the presented results.

The multiple regression analysis of mortality rates is similar to those seen in the analysis of medical errors. Like the analysis with medical errors the overall results for years 2008, 2009, and 2010 are different than the results of the analysis for year 2011. In years 2008, 2009, and 2010 the analysis provided results to support a significant difference in the hospital mortality rates between different health IT stages. Specifically, all three years showed a significant difference between stage 5 and stage 0 and between stage 7 and stage 0, the highest and lowest stages. Additionally, in 2009 there was a significant difference between stage 6 and stage 0 and in 2010 there was a significant difference between stage 3 and stage 0. Again, similar to the analysis of medical errors, the 2011 dataset was the only year analyzed that did not show a significant difference between any of the health IT stages and stage 0 when assessing mortality rates.

6.4 Limitations

With uncertainties about the effect of health IT on patient outcomes and medical errors the aim is for the results of this study to provide evidence to confirm or refute the effects of implementation of health IT systems in US hospitals. The literature is clear about the conflicting results seen after health IT is implemented in hospitals but only on a small scale (e.g. a single hospital or hospital system). A broad view of health IT's impact (i.e. on a national level) would provide additional evidence to support the successful implementation electronic systems in hospitals. Additionally, the literature shows that while the implementation of health IT systems resolves some medication prescribing issues its integration into the clinical workflow has the potential to introduce new types of errors. This is an area that deserves further exploration because the type of errors caused by these systems remains difficult to study.

In conducting this study every effort has been made to utilize the data in the best possible manner to yield the best results. However, there are limitations to the data that must be considered in interpreting the results of the study, one being the selection of the chosen datasets. The HCUP database is comprised of discharge level data and includes ICD-9 codes from administrative data. Some reviewers may indicate that the use of other reporting methods to assess the number of medical errors is more appropriate such as self-report, chart review, or medical error surveillance systems. However, while these other methods for capturing the primary outcome may also provide reliable data, it is not possible at this time to utilize this data on a national level. This is primarily due to the lack of access to and existence of a national system that maintains this level of information on errors. Additionally, the definition of medical errors may be of issue, again in part because of the alternative means of defining and assessing errors as there is no universal definition for capturing and assessing medical errors. There is evidence in the literature to support the use of ICD-9 codes from the HCUP datasets to define medical errors, which has been utilized for this study. [29] There is a clear need for a better way to record and assess medical errors on a large scale. This could also be making the number of errors reported using ICD-9 codes artificially low because many errors could go unreported or are recorded using a different method that does not include the use of ICD-9 codes.

Another possible limitation with the study design may lie with the true generalizability of the study results. The intent of using two national databases is to provide results that have a broader implication for hospitals in the US. This is especially important because much of the research to date provides information on a single hospital or hospital system, making the results difficult to generalize. Because the datasets used in this study represent a subset of US hospitals it is not possible to generalize these results to all US hospitals.

For this study specific health IT products are not identified and even the various types of systems are not analyzed individually (i.e. CPOE, bar-code, etc). Since many products are customized for the specific needs of that particular hospital or hospital department the results may not provide the desired insight medical and management professionals need to make informed decisions about the implementation of health IT systems in their facilities.

Additionally, hospital quality plays an important role in the number of medical errors and deaths in a hospital, which could impact the rate of medical errors from year to year. Add to this the possibility that the implementation of health IT could improve, or diminish the overall quality of a hospital and therefore affect patient outcomes (i.e. the rate of errors and mortality rates). Furthermore, the implementation or lack of health IT in a particular hospital may not have a significant affect because it is of high quality regardless of the stage of heath IT that has been implemented. For analysis purposes hospital quality may be a confounding variable affecting the stage of health IT implementation and the rate of medical errors and or mortality. To control for this, every attempt was made to acquire data points that can be linked to the study database with Medicare Provider identification codes. Information providing score cards for individual hospitals could help to create a more robust dataset from which to analyze how hospital quality scores impact the implementation of health IT. However, obtaining this level of hospital quality information was out of scope for this study and was not included. However, future research may be conducted to obtain this data for additional analysis.

Another significant limitation to using observational data is the lack of information on how and if the implemented health IT tools are being used. There is also a lack of data to determine if the technology is being used correctly. The literature has reported numerous cases of misuse and underutilization of technology in the healthcare setting[30-33]. The best way to address this gap in the data would be to collect additional data, most likely in the form of hospital and/or provider surveys, on how they utilize health IT in their hospitals. However, due to financial constraints this is outside the scope of the current study, as it would require a nationwide survey of healthcare providers from each state utilized in the study. Nevertheless, this would provide invaluable information and insight into how health IT is utilized and how it correlates with the stages of health IT implementation and the rate of medical errors assessed for this study. The extent of health IT use will also have an effect on clinical workflow, which according to the IOM's 2011 report, is a major contributing factor in the safe and effective use of information technology in patient care and safety.

Another contributing factor to the use of health IT in US hospitals are the variations in hospital demographics, which could make it difficult to generalize results. In the preceding section on Hospital Demographic Characteristics, the differences in hospital facilities were investigated. Specifically, this study looked at hospital region, location, teaching status, bed size, and other demographic characteristics. Descriptive statistics were provided for hospitals in each of these categories. The analysis of these hospital characteristics was controlled for in the regression and ANOVA models utilized as part of this study.

Lastly, in addition to being limited to hospitals in the HCUP and HIMSS datasets it was further limited to the US hospitals that could be match between these two datasets. This limited the number of hospitals that could be included in the analysis because hospitals that appeared in one dataset but not in the other or those that could not be matched with a Medicare ID were not included in the analysis models. When assessing hospital demographic characteristics both results of the full HIMSS and HCUP data are provided as well as the combined more limited datasets from each year.

6.5 Future Research

While combining these databases produces a robust dataset to conduct many different types of analysis this study focused on data available for hospitals deaths and medical errors to determine how they are impacted by health IT stage. However, there are other types of research that can be conducted using this same dataset that may be of interest in furthering the research on how health IT impacts hospital quality and outcomes. An important factor would be the impact of the cost of health IT implementation on hospital quality outcomes. This type of analysis could be done as a next step to complement the current study and increase the body of knowledge in this area. One important component would be to assess the data to determine if there is an association between the amounts spent on health IT and the number of medical errors and/or hospital deaths.

Additionally, as mentioned in the sections above assessing hospital quality as an independent factor that can be controlled for in the model is also out of scope for the current study. However, controlling for hospital quality could have a significant impact on the results for assessing the effects of health IT systems have various outcomes. Adding quality metrics to the analysis could also provide insight on why some of the health IT stages demonstrated differences and other did not and/or why some analyzed years had varying results.

7. Chapter VII – Summary and Conclusions

At the start this research study set out to assess several objects. These objectives included:

1. To assess the variations in hospital demographic characteristics at each stage of health IT implementation
2. To assess prevalence of medical errors and mortality rates within each stage of health IT for each year of data provided.
3. To determine the effects of health IT implementation on hospital quality of care using medical error and mortality rates.
4. To determine if health IT stage is a predictor for prevalence of medical errors and/or mortality rates in US hospitals.

After completing this the analysis and reviewing the results it is evident that there is a significant difference in the number of medical errors and the mortality rates at hospitals implementing different stages of health IT systems. Additionally, health IT stages does seem to be a predictor for both medical errors and mortality rate when comparing stages 7 and 0 for most years in the analyzed datasets. There was also evidence that a significant portion of the variation seen in several of the models can be attributed to health IT stage suggesting that the different stages have an impact on the model and therefore could be having a significant impact on the quality of care within the studies facilities. While these results address the study objectives it is important to note that this is only scratching the surface and that much more research is needed to fully understand the impact health IT systems have on the quality of care in US hospitals. The descriptive statistics describing the types of hospitals in the datasets are also reviewed and the characteristics of hospitals are different stages provide insight into what type of hospitals are currently implementing various stages of health IT systems.

This research attempts to shed light on the impact health IT systems have on US hospitals and the quality of the care they deliver. However, there are many factors that affect hospital quality and ultimately patient outcome. Much more research needs to be conducted in this area to assess all possible causes for how health IT systems affect medical errors and the quality of care. Additional research would also provide more specific details to support the results of this study.

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Appendix A

List of Literature Search Terms

Appendix A

List of Search Terms

- Health information technology and medical errors
- Medical errors
- Adverse medical errors and adverse medical reactions
- Hospital reported medical errors
- Patient safety and health information technology
- Reducing medical errors and preventing medical errors
- Hospital and medical error and health information technology
- Health information technology and prevent medical errors
- Adverse medical error and health information technology and hospital and national
- health information technology and HCUP
- medical errors and HCUP
- Detecting medical errors with ICD-9 codes
- ICD-9 and medical errors
- health information technology and ICD-9 code

Appendix B

ICD-9 Medical Error Analysis Codes

Appendix B
ICD-9 Medical Error Analysis Codes

Medical Term	ICD-9 code
Unspecified adverse effect of unspecified drug	995.20
Unspecified adverse effect of anesthesia	995.22
Unspecified adverse effect of insulin	995.23
Other drug allergy	995.27
Unspecified adverse effect of other drug	995.29
Complications peculiar to certain specified procedures	**996**
Mechanical complication of cardiac device implant and graft	996.0
Mechanical complication of unspecified cardiac device, implant, and graft	996.00
Mechanical complication due to cardiac pacemaker (electrode)	996.01
Mechanical complication due to heart valve prosthesis	996.02
Mechanical complication due to coronary bypass graft	996.03
Mechanical complication of automatic implantable cardiac defibrillator	996.04
Other mechanical complication of cardiac device, implant, and graft	996.09
Mechanical complication of other vascular device, implant, and graft	996.1
Mechanical complication of nervous system device, implant, and graft	996.2
Mechanical complication of genitourinary device implant and graft	996.3
Mechanical complication of unspecified genitourinary device, implant, and graft	996.30
Mechanical complication due to urethral (indwelling) catheter	996.31
Mechanical complication due to intrauterine contraceptive device	996.32
Other mechanical complication of genitourinary device, implant, and graft	996.39
Mechanical complication of internal orthopedic device implant and graft	996.4
Unspecified mechanical complication of internal orthopedic device, implant, and graft	996.40
Mechanical loosening of prosthetic joint	996.41

Dislocation of prosthetic joint	996.42
Broken prosthetic joint implant	996.43
Peri-prosthetic fracture around prosthetic joint	996.44
Peri-prosthetic osteolysis	996.45
Articular bearing surface wear of prosthetic joint convert	996.46
Other mechanical complication of prosthetic joint implant	996.47
Other mechanical complication of other internal orthopedic device, implant, and graft	996.49
Mechanical complication of other specified prosthetic device implant and graft	996.5
Mechanical complication due to corneal graft	996.51
Mechanical complication due to graft of other tissue, not elsewhere classified	996.52
Mechanical complication due to ocular lens prosthesis	996.53
Mechanical complication due to breast prosthesis	996.54
Mechanical complication due to artificial skin graft and decellularized allodermis	996.55
Mechanical complication due to peritoneal dialysis catheter	996.56
Mechanical complication due to insulin pump	996.57
Mechanical complication due to other implant and internal device, not elsewhere classified	996.59
Infection and inflammatory reaction due to internal prosthetic device implant and graft	996.6
Infection and inflammatory reaction due to unspecified device, implant, and graft	996.60
Infection and inflammatory reaction due to cardiac device, implant, and graft	996.61
Infection and inflammatory reaction due to other vascular device, implant, and graft	996.62
Infection and inflammatory reaction due to nervous system device, implant, and graft	996.63
Infection and inflammatory reaction due to indwelling urinary catheter	996.64
Infection and inflammatory reaction due to other genitourinary device, implant, and graft	996.65
Infection and inflammatory reaction due to internal joint prosthesis	996.66
Infection and inflammatory reaction due to other internal orthopedic device, implant, and graft	996.67
Infection and inflammatory reaction due to peritoneal dialysis catheter	996.68
Infection and inflammatory reaction due to other internal prosthetic device, implant, and graft	996.69

Other complications due to internal prosthetic device, implant, and graft	996.7
Other complications due to unspecified device, implant, and graft	996.70
Other complications due to heart valve prosthesis	996.71
Other complications due to other cardiac device, implant, and graft	996.72
Other complications due to renal dialysis device, implant, and graft	996.73
Other complications due to other vascular device, implant, and graft	996.74
Other complications due to nervous system device, implant, and graft	996.75
Other complications due to genitourinary device, implant, and graft	996.76
Other complications due to internal joint prosthesis	996.77
Other complications due to other internal orthopedic device, implant, and graft	996.78
Other complications due to other internal prosthetic device, implant, and graft	996.79
Complications of transplanted organ	996.8
… unspecified	996.80
Complications of transplanted kidney	996.81
Complications of transplanted liver	996.82
Complications of transplanted heart	996.83
Complications of transplanted lung	996.84
Complications of transplanted bone marrow	996.85
Complications of transplanted pancreas	996.86
Complications of transplanted intestine	996.87
… stem cell	996.88
Complications of other specified transplanted organ	996.89
Complications of reattached extremity or body part	996.9
Complications of unspecified reattached extremity	996.90
Complications of reattached forearm	996.91
Complications of reattached hand	996.92
Complications of reattached finger(s)	996.93
Complications of reattached upper extremity, other and unspecified	996.94
Complication of reattached foot and toe(s)	996.95
Complication of reattached lower extremity, other and unspecified	996.96
Complication of other specified reattached body part	996.99

Complications affecting specified body system not elsewhere classified	**997**
Nervous system complications	997.0
Nervous system complication, unspecified	997.00
Central nervous system complication	997.01
Iatrogenic cerebrovascular infarction or hemorrhage	997.02
Other nervous system complications	997.09
Cardiac complications, not elsewhere classified	997.1
Peripheral vascular complications, not elsewhere classified	997.2
Respiratory complications not elsewhere classified	997.3
Ventilator associated pneumonia	997.31
Postprocedural aspiration pneumonia	997.32
Other respiratory complications	997.39
Digestive system complications not elsewhere classified	997.4
Retained cholelithiasis following cholecystectomy	997.41
Other digestive system complications	997.49
Urinary complications, not elsewhere classified	997.5
Amputation stump complication	997.6
Unspecified complication of amputation stump	997.60
Neuroma of amputation stump	997.61
Infection (chronic) of amputation stump	997.62
Other amputation stump complication	997.69
Vascular complications of other vessels	997.7
Vascular complications of mesenteric artery	997.71
Vascular complications of renal artery	997.72
Vascular complications of other vessels	997.79
Complications affecting other specified body systems not elsewhere classified	997.9
Complications affecting other specified body systems, not elsewhere classified, hypertension	997.91
Complications affecting other specified body systems, not elsewhere classified	997.99
Other complications of procedures not elsewhere classified	**998**
Postoperative shock not elsewhere classified	998.0
Postoperative shock, unspecified	998.00
Postoperative shock, cardiogenic	998.01
Postoperative shock, septic	998.02
Postoperative shock, other	998.09
Hemorrhage or hematoma complicating a procedure not elsewhere classified	998.1
Hemorrhage complicating a procedure	998.11
Hematoma complicating a procedure	998.12

Seroma complicating a procedure	998.13
Accidental puncture or laceration during a procedure, not elsewhere classified	998.2
Disruption of operation wound	998.3
Disruption of wound, unspecified	998.30
Disruption of internal operation (surgical) wound	998.31
Disruption of external operation (surgical) wound	998.32
Disruption of traumatic injury wound repair	998.33
Foreign body accidentally left during a procedure	998.4
Postoperative infection not elsewhere classified	998.5
Infected postoperative seroma	998.51
Other postoperative infection	998.59
Persistent postoperative fistula	998.6
Acute reaction to foreign substance accidentally left during a procedure	998.7
Other specified complications of procedures not elsewhere classified	998.8
Emphysema (subcutaneous) (surgical) resulting from procedure	998.81
Cataract fragments in eye following cataract surgery	998.82
Non-healing surgical wound	998.83
Other specified complications of procedures not elsewhere classified	998.89
Unspecified complication of procedure, not elsewhere classified	998.9
Complications of medical care not elsewhere classified	**999**
Generalized vaccinia as a complication of medical care, not elsewhere classified	999.0
Air embolism as a complication of medical care, not elsewhere classified	999.1
Other vascular complications of medical care, not elsewhere classified	999.2
Other infection due to medical care not elsewhere classified	999.3
Other and unspecified infection due to central venous catheter	999.31
Bloodstream infection due to central venous catheter	999.32
Local infection due to central venous catheter	999.33
Acute infection following transfusion, infusion, or injection of blood and blood products	999.34
Infection following other infusion, injection, transfusion, or vaccination	999.39
Anaphylactic reaction to serum	999.4
Anaphylactic reaction due to administration of	999.41

blood and blood products	
Anaphylactic reaction due to vaccination	999.42
Anaphylactic reaction due to other serum	999.49
Other serum reaction not elsewhere classified	999.5
Other serum reaction due to administration of blood and blood products	999.51
Other serum reaction due to vaccination	999.52
Other serum reaction	999.59
ABO incompatibility reaction due to transfusion of blood or blood products	999.6
ABO incompatibility reaction, unspecified	999.60
ABO incompatibility with hemolytic transfusion reaction not specified as acute or delayed	999.61
ABO incompatibility with acute hemolytic transfusion reaction	999.62
ABO incompatibility with delayed hemolytic transfusion reaction	999.63
Other ABO incompatibility reaction	999.69
Rh incompatibility reaction not elsewhere classified	999.7
Rh incompatibility reaction, unspecified	999.70
Rh incompatibility with hemolytic transfusion reaction not specified as acute or delayed	999.71
Rh incompatibility with acute hemolytic transfusion reaction	999.72
Rh incompatibility with delayed hemolytic transfusion reaction	999.73
Other Rh incompatibility reaction	999.74
Non-ABO incompatibility reaction, unspecified	999.75
Non-ABO incompatibility with hemolytic transfusion reaction not specified as acute or delayed	999.76
Non-ABO incompatibility with acute hemolytic transfusion reaction	999.77
Non-ABO incompatibility with delayed hemolytic transfusion reaction	999.78
Other non-ABO incompatibility reaction	999.79
Other and unspecified transfusion reaction not elsewhere classified	999.8
Transfusion reaction, unspecified	999.80
Extravasation of vesicant chemotherapy	999.81
Extravasation of other vesicant agent	999.82
Hemolytic transfusion reaction, incompatibility unspecified	999.83
Acute hemolytic transfusion reaction, incompatibility unspecified	999.84
Delayed hemolytic transfusion reaction,	999.85

incompatibility unspecified	
Other infusion reaction	999.88
Other transfusion reaction	999.89
Other and unspecified complications of medical care, not elsewhere classified	999.9

Source: Codes obtained from http://www.icd9data.com/

Appendix C

U.S. Electronic Medical Record Adoption Model

HIMSS

HIMSS ANALYTICS

U.S. EMR Adoption Model℠ Trends

Understanding the level of electronic medical record (EMR) capabilities in hospitals is a challenge in the US healthcare IT market today. HIMSS Analytics has created an EMR Adoption Model that identifies the levels of electronic medical record (EMR) capabilities ranging from limited ancillary department systems through a paperless EMR environment. HIMSS Analytics has developed a methodology and algorithms to automatically score more than 5,200 U.S. and approximately 700 Canadian hospitals in our database relative to their IT-enabled clinical transformation status, to provide peer comparisons for hospital organizations as they strategize their path to a complete EMR and participation in an electronic health record (EHR). The stages of the model are as follows:

US EMR Adoption Model℠

Stage	Cumulative Capabilities
Stage 7	Complete EMR; CCD transactions to share data; Data warehousing; Data continuity with ED, ambulatory, OP
Stage 6	Physician documentation (structured templates), full CDSS (variance & compliance), full R-PACS
Stage 5	Closed loop medication administration
Stage 4	CPOE, Clinical Decision Support (clinical protocols)
Stage 3	Nursing/clinical documentation (flow sheets), CDSS (error checking), PACS available outside Radiology
Stage 2	CDR, Controlled Medical Vocabulary, CDS, may have Document Imaging; HIE capable
Stage 1	Ancillaries - Lab, Rad, Pharmacy - All Installed
Stage 0	All Three Ancillaries Not Installed

Stage 0: The organization has not installed all of the three key ancillary department systems (laboratory, pharmacy, and radiology).

Stage 1: All three major ancillary clinical systems are installed (i.e., pharmacy, laboratory, and radiology).

Stage 2: Major ancillary clinical systems feed data to a clinical data repository (CDR) that provides physician access for reviewing all orders and results. The CDR contains a controlled medical vocabulary, and the clinical decision support/rules engine (CDS) for rudimentary conflict checking. Information from document imaging systems may be linked to the CDR at this stage. The hospital may be health information exchange (HIE) capable at this stage and can share whatever information it has in the CDR with other patient care stakeholders.

Stage 3: Nursing/clinical documentation (e.g. vital signs, flow sheets, nursing notes, eMAR is required and is implemented and integrated with the CDR for at least one inpatient service in the hospital; care plan charting is scored with extra points. The Electronic Medication Administration Record application (EMAR) is implemented. The first level of clinical decision support is implemented to conduct error checking with order entry (i.e., drug/drug, drug/ food, drug/lab conflict checking normally found in the pharmacy information system). Medical image access from picture archive and communication systems (PACS) is available for access by physicians outside the Radiology department via the organization's intranet.

Stage 4: Computerized Practitioner Order Entry (CPOE) for use by any clinician licensed to create orders is added to the nursing and CDR environment along with the second level of clinical decision support capabilities related to evidence based medicine protocols. If one inpatient service area has implemented CPOE with physicians entering orders and completed the previous stages, then this stage has been achieved.

Stage 5: The closed loop medication administration with bar coded unit dose medications environment is fully implemented. The eMAR and bar coding or other auto identification technology, such as radio frequency identification (RFID), are implemented and integrated with CPOE and pharmacy to maximize point of care patient safety processes for medication administration. The "five rights" of medication administration are verified at the bedside with scanning of the bar code on the unit does medication and the patient ID.

Stage 6: Full physician documentation with structured templates and discrete data is implemented for at least one inpatient care service area for progress notes, consult notes, discharge summaries or problem list & diagnosis list maintenance. Level three of clinical decision support provides guidance for all clinician activities related to protocols and outcomes in the form of variance and compliance alerts. A full complement of radiology PACS systems provides medical images to physicians via an intranet and displaces all film-based images. Cardiology PACS and document imaging are scored with extra points.

Stage 7: The hospital no longer uses paper charts to deliver and manage patient care and has a mixture of discrete data, document images, and medical images within its EMR environment. Data warehousing is being used to analyze patterns of clinical data to improve quality of care and patient safety and care delivery efficiency. Clinical information can be readily shared via standardized electronic transactions (i.e. CCD) with all entities that are authorized to treat the patient, or a health information exchange (i.e., other non-associated hospitals, ambulatory clinics, sub-acute environments, employers, payers and patients in a data sharing environment). The hospital demonstrates summary data continuity for all hospital services (e.g. inpatient, outpatient, ED, and with any owned or managed ambulatory clinics).

Appendix D

2008 HIMSS Analytics Database

Table Descriptions

Table Descriptions

Table Name	Description	Links	New in 2008
AcuteInfo	This table contains statistic and summary information about the hospitals (acute care facilities) in the database.	This table links to the other tables by the HAEntityID	
AppVendorPlan	This table contains a list of the vendors under consideration for purchase for the applications tracked.	This table links to the HAEntityApplicationPlan table by AppID	
AutoIdentification	High level information about the use of bar coding and RFID by department	This table links to the other tables by the	Yes
AutoIdentificationProduct	This table provides information about the vendors and products used for printing and scanning technology for bar coding in	This table links to the other tables by the HAEntityID	Yes
BiometricTechnology	This table contains information on the status of Biometric technology at the hospitals.	This table links to the other tables by the	
Computer	This table contains information on the use of computers such as handheld devices, desktops, laptops and PC Blades.	This table links to the other tables by the HAEntityID	
Connectivity	This table contains information on the status of the hospitals connectivity.	This table links to the other tables by the	
Contact	This table is a duplicate free list of the contacts at all the facilities in the database.	This table links to the HAEntityContact table by ContactID	
ContactSource	This table is a code table for the functions a contact fills.	This tables links to the HAEntityContact table by HAEntityContactSourc	
ContactType	This table is a code table for the type of contact an individual fills such as Key Personnel, HIPPA Security, Steering	This table links to the HAEntityContact table by TypeID	
DataCenterFacility	This table establishes the link between data centers and the facilities they service.	This table links to the HAEntity table either by ParentID (data center's HAEntityID) or	
DecisionType	This table provides information on the types of decisions facilities can make without parent involvement.	This table links to the other tables by the HAEntityID	
DisasterRecoveryPlan	This table provides information on the types of facilities that are included in the system's disaster recovery plan.	This table links to the other tables by the HAEntityID	
DistributionPlan	This table provides information on how the hospital distributes and physicians access softcopy images in the radiology and	This table links to the other tables by the HAEntityID	
ExpeditureApproval	This table provides information regarding the expenditure approval process at the integrated delivery system.	This table links to the other tables by the HAEntityID	
HAEntity	This table contains the demographic information for all the facilities and systems tracked in the database. (This is a self referencing table).	This table links to the other tables by the HAEntityID. This table also links to itself by HAEntityID to ParentID. The table linked by HAEntityID will pull the IDS	

Table Name	Description	Links	New in 2008
HAEntityApplication	This table contains the automation information for all the facilities in the database.	This table links to the other tables by the HAEntityID. This table also links to the HAEntityApplicationPla	
HAEntityApplicationPlan	This table contains the plan details for the applications tracked in the HAEntityApplicaiton table.	This table links to the other tables by the HAEntityID. This table also links to the HAEntityApplication	
HAEntityContact	This is an index table that links contact information to facility and IDS demographic information in other tables. This table includes the status of the contact type.	This table links to the Contact table by ContactID (to include names), to the Contact Source table by HAEntityContactSourceID to ContactSourceID (to determine functions) and to the Contact Type table by TypeID (to included contact type information) as	
HAEntityHistory	This table provides information on the construction, divestiture, merger and acquisitions that have occurred at the	This table links by NewIDSID to the HAEntity table by	
HAEntityRegion	This table provides information regarding the regions or areas a health system provides services to.	This table links to the other tables by the HAEntityID	
HandheldInfo	This table provides information on how and where handheld devices are used at a	This table links to the other tables by the	
IHDSChanges	This table is designed to provide insight into changes made to the IHDSs in the database. Included in this table are any IHDSs that have been deleted or added to	This table links by NewIDSID to the HAEntity table by EntityNo	
ISPlan	This table provides information on what areas the IS Strategic plan addresses at the	This table links to the other tables by the	
ISPlanDecision	This table provides information on the facilities that drive the IS Strategic plan.	This table links to the other tables by the	
LongTermStorage	This table provides information on the types and status of general long term storage used and the vendors who provide this technology to the hospitals.	This table links to the other tables by the HAEntityID	
MedAdministration	This table provides information on the elements that are bar coded or have an RFID tag for the medication administration	This table links to the other tables by the HAEntityID	Yes
PACSComponent	The tables contains information on PACS components in use and PACS component purchase plans.	This table links to the other tables by the HAEntityID	
PACSInfo	The table provides an overview of PACS, including number and types of images, image distribution, and purchase plans and	This table links to the other tables by the HAEntityID	
PacsInterface	This table contains information on PACS and RIS/CIS interface issues and systems.	This table links to the other tables by the	

Table Name	Description	Links	New in 2008
PACSVendor	This table contains the PACS vendor, products, and number of licensed work	This table links to the other tables by the	
ParentInfo	This table contains parent level demographic information including, number and types of visits, parent financial data, date of data, sources of patient revenue, number of physicians, disaster recovery	This table links to the other tables by the SuveryID of by ParentID	
Pharmacy	This tables provides an overview of the pharmacy department, including FDA bar code regulations, use and planned ADMS, Robots, and EMARs, and the status and products in use in the outpatient pharmacy.	This table links to the other tables by the HAEntityID	
PharmacyProduct	This table contains the vendor and product detail for the pharmacy department.	This table links to the other tables by the	
PreferredSupplier	This table contains detail on preferred hardware suppliers and preferred channels for acquiring hardware from those vendors	This table links to the other tables by the HAEntityID	
ProductHistory	This table provides by ProductID the history of a product appearing in the database. These changes include name changes, company mergers and product acquisitions.	This table links to the VendorHistory table by VendorID	
PurchasingOrganization	This table lists the GPOs that parent or hospital (2008) organizations are members	This table links to the other tables by the	
SecuritySoftware	This tables lists the security systems in place at the organizations	This table links to the other tables by the	
Server	This table contains information on the use of servers such as mainframes, application servers, and network servers, including types, vendors and products, numbers in	This table links to the other tables by the HAEntityID	
Service	This table contains detail on consultants and outsourcers in use or planned, including the service, the supplier, and the contract date and length.	This table links to the other tables by the HAEntityID	
Survey	This table identifies the year the system's interview was completed.	This table links to the other tables by the	
SurveySegment	This table identifies the segment that the survey in.	This table links to the other tables by the	
Telecommunication	This table contains the vendors used for long distance and network voice and data telecommunications services.	This table links to the other tables by the HAEntityID	
UseOfITComponent	This table contains detail on the types of IT components used by physicians, what percentage of physicians use those components, and whether the components are accessible via a physician dashboard	This table links to the other tables by the HAEntityID	

Table Name	Description	Links	New in 2008
VendorHistory	This table provides by VendorID the history of a product appearing in the database. These changes include name changes, company mergers and product acquisitions.	This table links to the AppVendorPlan, CardiologyBarCode, Computer, Connectivity, DocMgmtApp, HAEntityApplication, LaboratoryBarCode, LongTermStorage, MaterialMgmtApp, NurseBarCode, PACSLongTermStorage, PACSVendor, PharmacyBarCode, PharmacyProduct, PreferredSupplier, ProductHistory, RadiologyBarCode, Server, Service	
Wireless	This table contains an overview of the wireless environment, including WLAN use and plans, 802.11 standards planned and in use, WLAN types, number of access points planned and in use, number and types of devices on WLAN, percent using WLAN, percent using handhelds, where wireless access is in use and planned, and how	This table links to the other tables by the HAEntityID	
WirelessAccess	This table list the departments where wireless devices are in use.	This table links to the other tables by the	
WirelessSecurity	This table lists the type of wireless security in place.	This table links to the other tables by the	
WirelessVendor	This table lists the vendors and products in use for the various types of wireless	This table links to the other tables by the	

Appendix E

2008 HIMSS Analytics Database

Element List

Table Name	Field Name	SQL Data Type	Access Data Type	Description	New in 2008
AcuteInfo	AcuteId	int	Number/Long Integer	Record identification number	
AcuteInfo	CIOBiometricalOper	bit	Yes/No	Yes = the hospital CIO has responsibility for Biomedical Operations	
AcuteInfo	CIOTelecommunications	bit	Yes/No	Yes = the hospital CIO has responsibility for Telecommunications	
AcuteInfo	ConsumerDashboard	bit	Yes/No	Yes = the hospital utilizes a consumer dashboard	Yes
AcuteInfo	CPOEConsultationPerc	varchar	Text	The percentage range of consultation orders being entered into the CPOE system (see tab AS-Perc Ranges)	Yes
AcuteInfo	CPOELaboratoryPerc	varchar	Text	The percentage range of laboratory orders being entered into the CPOE system (see tab AS-Perc Ranges)	Yes
AcuteInfo	CPOEMedicalOrderPerc	varchar	Text	The percentage range of medication orders that are electronic (see tab AS-Perc Ranges)	Yes
AcuteInfo	CPOEMedicationPerc	varchar	Text	The percentage range of medication orders being entered into the CPOE system (see tab AS-Perc Ranges)	Yes
AcuteInfo	CPOEOtherOrderDesc	varchar	Text	Additional information about types of orders being entered into the CPOE system	Yes
AcuteInfo	CPOEOtherOrderPerc	varchar	Text	The percentage range of other types of orders being entered into the CPOE system (see tab AS-Perc Ranges)	Yes
AcuteInfo	CPOEPhysicianPerc			The percentage range of all medical orders entered by physicians using CPOE (see tab AS-Perc Ranges)	Yes
AcuteInfo	CPOERadiologyPerc	varchar	Text	The percentage range of radiology orders being entered into the CPOE system (see tab AS-Perc Ranges)	Yes
AcuteInfo	CPOEWhenOwnOrders	varchar	Text	The time frame for all physicians to be entering all orders into the CPOE system (see tab F-CPOEOwnOrdersTimeFrames)	
AcuteInfo	ElectronicMedRecPerc	varchar	Text	The percent range of the hospital's current medical record that is electronic (includes digital and/or scanned data) (see tab AS-Perc Ranges)	Yes
AcuteInfo	HAEntityId	int	Number/Long Integer	Identification number associated with surveyed entity. Unique within survey year.	
AcuteInfo	IEInitiative	bit	Yes/No	Yes = the hospital participates in an Information Exchange Initative(s)	
AcuteInfo	IEInitiativeAgency	bit	Yes/No	Yes = the hospital participates in an "Agency for Health Research and Quality HIT project" Information Exchange Initiative	
AcuteInfo	IEInitiativeAgencyName	varchar	Text	Name of the "Agency for Health Research and Quality HIT project" Information Exchange Initiative	
AcuteInfo	IEInitiativeAgencyPlan	bit	Yes/No	Yes = the hospital plans to participate in an "Agency for Health Research and Quality HIT project" Information Exchange Initiative	
AcuteInfo	IEInitiativeAgencyPlanType	varchar	Text	Timeframe in months for when the hospital plans to begin participation in the "Agency for Health Research and Quality HIT project" Information Exchange Initiative (See tab A-Plan Timeframe)	
AcuteInfo	IEInitiativeBridge	bit	Yes/No	Yes = the hospital participates in a "Bridges to Excellence "Link" programs" Information Exchange Initiative	
AcuteInfo	IEInitiativeBridgeName	varchar	Text	Name of the "Bridges to Excellence "Link" programs" Information Exchange Initiative	
AcuteInfo	IEInitiativeBridgePlan	bit	Yes/No	Yes = the hospital plans to participate in an "Bridges to Excellence "Link" programs" Information Exchange Initiative	
AcuteInfo	IEInitiativeBridgePlanType	varchar	Text	Timeframe in months for when the hospital plans to begin participation in the "Bridges to Excellence "Link" programs" Information Exchange Initiative (See tab A-Plan Timeframe)	
AcuteInfo	IEInitiativeCMSChronic	int	Yes/No	Yes = the hospital participates in a "CMS's Chronic Care Improvement Programs" Information Exchange Initiative	
AcuteInfo	IEInitiativeCMSChronicName	varchar	Text	Name of the "CMS's Chronic Care Improvement Programs" Information Exchange Initiative	
AcuteInfo	IEInitiativeCMSChronicPlan	bit	Yes/No	Yes = the hospital plans to participate in an "CMS's Chronic Care Improvement Programs" Information Exchange Initiative	
AcuteInfo	IEInitiativeCMSChronicPlanType	varchar	Text	Timeframe in months for when the hospital plans to begin participation in the "CMS's Chronic Care Improvement Programs" Information Exchange Initiative (See tab A-Plan Timeframe)	
AcuteInfo	IEInitiativeCMSQIO	bit	Yes/No	Yes = the hospital participates in a "CMS's QIO Doctors' Office Quality Improvement Technology program" Information Exchange Initiative	
AcuteInfo	IEInitiativeCMSQIOName	varchar	Text	Name of the "CMS's QIO Doctors' Office Quality Improvement Technology program" Information Exchange Initiative	

Table Name	Field Name	SQL Data Type	Access Data Type	Description	New in 2008
AcuteInfo	IEInitiativeCMSQIOPlan	bit	Yes/No	Yes = the hospital plans to participate in an "CMS's QIO Doctors' Office Quality Improvement Technology program" Information Exchange Initiative	
AcuteInfo	IEInitiativeCMSQIOPlanType	varchar	Text	Timeframe in months for when the hospital plans to begin participation in the "CMS's QIO Doctors' Office Quality Improvement Technology program" Information Exchange Initiative (See tab A-Plan Timeframe)	
AcuteInfo	IEInitiativeHealth	bit	Yes/No	Yes = the hospital participates in a "Health Information Exchange/RHIO initiative" Information Exchange Initiative	
AcuteInfo	IEInitiativeHealthName	varchar	Text	Name of the "Health Information Exchange/RHIO initiative" Information Exchange Initiative	
AcuteInfo	IEInitiativeHealthPlan	bit	Yes/No	Yes = the hospital plans to participate in an "Health Information Exchange/RHIO initiative" Information Exchange Initiative	
AcuteInfo	IEInitiativeHealthPlanType	varchar	Text	Timeframe in months for when the hospital plans to begin participation in the "Health Information Exchange/RHIO initiative" Information Exchange Initiative (See tab A-Plan Timeframe)	
AcuteInfo	IEInitiativePlan	bit	Yes/No	Yes = the hospital plans to participate in an Information Exchange Initative(s)	
AcuteInfo	IsAttachmentRules	bit	Yes/No	Yes = that claims attachment rules are available to identify claims the require additional clinical information before being transmitted to the payer	
AcuteInfo	IsBiometric	bit	Yes/No	Yes = the hospital uses biometric technology for security	
AcuteInfo	IsBiometricPlan	bit	Yes/No	Yes = the hospital plans to purchase/use biometric technology for security	
AcuteInfo	ISBudget	decimal	Number/Decimal	The total amount budgeted by the IS department at the Acute-Care Hospital for the current fiscal year end. This amount includes all operating expenses.	
AcuteInfo	IsClaimsRemittance	bit	Yes/No	Yes = claims remittance transactions are received directly from the payer and the AR system is automatically updated with no clearinghouse involved	
AcuteInfo	IsDashBoard	bit	Yes/No	Yes = the biller has a dashboard for the business office on which rejected claims can be edited and resubmitted and updates to the files used to create the bills are triggered by the editing process	
AcuteInfo	IsEFTTransaction	bit	Yes/No	Yes = electronic funds transactions are submitted directly to the hospital's bank by the payer with no clearinghouse involved	
AcuteInfo	IsEligibilityTransaction	bit	Yes/No	Yes = eligibility and authorization transactions are executed directly with the payer with no clearinghouse involved	
AcuteInfo	IsEMRDocumentation	bit	Yes/No	Yes = bill can be created from the encoded clinical documentation of the EMR and no intervention from the HIM department is required	
AcuteInfo	IsIdentifyRules	bit	Yes/No	Yes = that pended or rejected claims are identified and rules can be created to ensure future claims are not pended or rejected for the same reason	
AcuteInfo	IsNecessityAlert	bit	Yes/No	Yes = the scheduling system has medical necessity checking rule alerts for services not covered by the payer	
AcuteInfo	IsPayerSubmitted	bit	Yes/No	Yes = claims are submitted directly to the payer with no clearinghouse involved	
AcuteInfo	IsPreRegister	bit	Yes/No	Yes = patient/consumers can pre-register for services via the hospital's website	
AcuteInfo	IsRegistrationNecessity	bit	Yes/No	Yes = the registration system has medical necessity checking rule alerts for services not covered by the payer	
AcuteInfo	IsSchedule	bit	Yes/No	Yes = patient/consumers can request schedules for services via the hospital's website	
AcuteInfo	IsSelfPay	bit	Yes/No	Yes = patients/consumers can pay bills or self-pay portions of their services via the hospital's website	
AcuteInfo	LastMonthFiscalYear	int	Number/Long Integer	The month of the year that the Acute-Care Hospital fiscal year closes	
AcuteInfo	NetOperRevenue	float	Number/Double	Net operating revenue includes revenues associated with the main operations of the hospital (net inpatient+ net out patient revenue). It does not include dividends, interest income or non-operating income.	
AcuteInfo	NofAdjDischarge	int	Number/Long Integer	For 2007 this field is defined as an aggregate figure that reflects outpatient utilization. This is accomplished by dividing gross revenue by gross inpatient revenue which usually results in a factor greater than 1.0, unless there was no outpatient revenue. For 2008, this field is defined as total number of discharges at each acute care hospital in the most recent fiscal year.	

Table Name	Field Name	SQL Data Type	Access Data Type	Description	New in 2008
AcuteInfo	NofAdjPatientDays	int	Number/Long Integer	For 2007 this field is defined as an aggregate figure reflecting the number of days of inpatient care, plus an estimate of the volume of outpatient services, expressed in units equivalent to an inpatient day in terms of level of effort. For 2008, this field refers to each calendar day of care provided to a hospital inpatient under the terms of the patient's health plans, excluding the day of discharge.	
AcuteInfo	NofBirths	int	Number/Long Integer	Number of births at each Acute-Care Hospital in the most recent fiscal year	Yes
AcuteInfo	NofEmergRoomVisits	int	Number/Long Integer	Number of emergency room visits at each Acute-Care Hospital in the most recent fiscal year	
AcuteInfo	NofOperatingRooms	int	Number/Long Integer	Number of operating rooms at each Acute-Care Hospital	
AcuteInfo	NofOutpatientVisits	int	Number/Long Integer	Number of outpatient visits at each Acute-Care Hospital in the most recent fiscal year.	Yes
AcuteInfo	NofTotDischarge	int	Number/Long Integer	The number of calendar days of care provided for hospital inpatient treatment under the terms of the patient's health plan, excluding the day of discharge.	Yes
AcuteInfo	NofTotPatientDays	int	Number/Long Integer	The total number of patients discharged from the hospital in a calendar year	Yes
AcuteInfo	PhysicianDashboard	bit	Yes/No	Yes = the hospital utilizes a physician dashboard	
AcuteInfo	RevManagedCare	int	Number/Long Integer	Percent of Managed Care that makes up the patient revenue at the hospital	Yes
AcuteInfo	RevMedicaid	int	Number/Long Integer	Percent of Medicaid that makes up the patient revenue at the hospital	Yes
AcuteInfo	RevMedicare	int	Number/Long Integer	Percent of Medicare that makes up the patient revenue at the hospital	Yes
AcuteInfo	RevOther	int	Number/Long Integer	Additional information on the patient revenue breakdown at the hospital	Yes
AcuteInfo	RevTradComm	int	Number/Long Integer	Percent of traditional commercial insurance that makes up the patient revenue at the hospital	Yes
AcuteInfo	StructuredPhysDocPerc	varchar	Text	The percent range of physician documentation that is captured from structured template documentation solutions (see tab AS-Perc Ranges)	Yes
AcuteInfo	SurveyId	int	Number/Long Integer	Identification number assigned to survey	
AcuteInfo	TotalOperExpense	float	Number/Double	The total amount of money the Acute-Care Hospital spends on operations such as staffing, property expenses, etc. for the most recent fiscal year.	
AppVendorPlan	AppId	int	Number/Long Integer	Identification number for applications with software purchase plan. Use this field to link to the HAEntityApplicationPlan table.	
AppVendorPlan	Id	int	Number/Long Integer	Record identification number	
AppVendorPlan	ProductId	int	Number/Long Integer	Unique identification number for product	
AppVendorPlan	ProductName	varchar	Text	The software product being considered for purchase	
AppVendorPlan	VendorId	int	Number/Long Integer	Unique identification number for vendor	
AppVendorPlan	VendorName	varchar	Text	The software vendor being considered for purchase	
AutoIdentification	DepartmentId	int	Number/Long Integer	Identification number of the department type	Yes
AutoIdentification	HAEntityId	int	Number/Long Integer	Identification number associated with surveyed entity. Unique within survey year.	Yes
AutoIdentification	InUseFlag	bit	Yes/No	Yes = the hospital utilizes bar coding, RFID or bar coding/RFID	Yes
AutoIdentification	PlanFlag	bit	Yes/No	Yes = the hospital plans to use bar coding, RFID or bar coding/RFID	Yes
AutoIdentification	SurveyId	int	Number/Long Integer	Identification number assigned to survey	Yes
AutoIdentification	Timeframe	varchar	Text	The timeframe for purchasing bar coding, RFID or bar coding/RFID	Yes
AutoIdentification	Type	varchar	Text	Type of autoidentification (see tab AT-AutoID Type)	Yes
AutoIdentificationProduct	Category	varchar	Text	The type of bar coding equipment (See tab B-Category)	Yes
AutoIdentificationProduct	Department	varchar	Text	The department where bar coding, RFID, or bar coding/RFID is being used.	Yes
AutoIdentificationProduct	DepartmentId	int	Number/Long Integer	Identification number of the department type	Yes
AutoIdentificationProduct	HAEntityId	int	Number/Long Integer	Identification number associated with surveyed entity. Unique within survey year.	Yes
AutoIdentificationProduct	ProductId	int	Number/Long Integer	Identification number for product	Yes
AutoIdentificationProduct	ProductName	varchar	Text	The product name for bar coding, RFID, bar coding/RFID equipment	Yes
AutoIdentificationProduct	PurchaseMonth	int	Number/Long Integer	Month the bar coding, RFID or bar coding/RFID equipment was purchased	Yes
AutoIdentificationProduct	PurchaseYear	int	Number/Long Integer	Year the bar coding, RFID, bar coding/RFID equipment was purchased	Yes
AutoIdentificationProduct	Status	varchar	Text	Status of the bar coding, RFID, bar coding/RFID equipment	Yes

Table Name	Field Name	SQL Data Type	Access Data Type	Description	New in 2008
AutoIdentificationProduct	SurveyId	int	Number/Long Integer	Identification number assigned to survey	Yes
AutoIdentificationProduct	Type	varchar	Text	Type of autoidentification (see tab AR- AutoId Time Frame)	Yes
AutoIdentificationProduct	VendorId	int	Number/Long Integer	Identification number for vendor	Yes
AutoIdentificationProduct	VendorName	varchar	Text	The vendor name for bar coding, RFID, bar coding/RFID equipment	Yes
BiometricTechnology	HAEntityId	int	Number/Long Integer	Identification number associated with surveyed entity. Unique within survey year.	
BiometricTechnology	Id	int	Number/Long Integer	Record identification number	
BiometricTechnology	SurveyId	int	Number/Long Integer	Identification number assigned to survey	
BiometricTechnology	TechnologyId	int	Number/Long Integer	Identification number for biometric technology type used	
BiometricTechnology	TechnologyName	varchar	Text	The type of biometric technology used (See tab C-Biometric Tech)	
BiometricTechnology	Type	varchar	Text	The status of the use of the biometric technology (i.e. current or plan)	
Computer	ComputerType	varchar	Text	Type of Computer (see tab D-CompuerTypes)	
Computer	HAEntityId	int	Number/Long Integer	Identification number associated with surveyed entity. Unique within survey year.	
Computer	HowManyPlanned	int	Number/Long Integer	Number of Units Planned	
Computer	Id	int	Number/Long Integer	Record identification number	
Computer	InUse	bit	Yes/No	Yes = the hospitals is using the specified vendor currently	
Computer	NofComputers	int	Number/Long Integer	Number of Units in Use	
Computer	OperatingSystem	varchar	Text	Name of the operating system the computers run on	
Computer	Planned	bit	Yes/No	Yes/No Field indicating Computer purchase plans	
Computer	SurveyId	int	Number/Long Integer	Identification number assigned to survey	
Computer	VendorId	int	Number/Long Integer	Record identification number	
Computer	VendorName	varchar	Text	Name of Computer Vendor	
Connectivity	Category	varchar	Text	Further Detail on Connectivity Type (See tab E-Connectivity Types)	
Connectivity	HAEntityId	int	Number/Long Integer	Identification number associated with surveyed entity. Unique within survey year.	
Connectivity	Id	int	Number/Long Integer	Record identification number	
Connectivity	PlanTerm	varchar	Text	Planned timeframe to purchase Broadband services (See tab A-Plan Timeframes)	
Connectivity	SurveyId	int	Number/Long Integer	Identification number assigned to survey	
Connectivity	Type	varchar	Text	Type of Connectivity (See tab D-Connectivity Types)	
Connectivity	UsePlan	varchar	Text	Indicated current or planned use	
Connectivity	VendorId	int	Number/Long Integer	Unique identification number for vendor	
Connectivity	VendorName	varchar	Text	Name of Connectivity Vendor	
Contact	ContactId	int	Number/Long Integer	Unique identification number for contact	
Contact	Credentials	varchar	Text	Contact's Credentials (See tab H-Credentials)	
Contact	Email	varchar	Text	Contact's Email Address	
Contact	Ext	varchar	Text	Contact's Phone Extension	
Contact	FirstName	varchar	Text	Contact's First Name	
Contact	LastName	varchar	Text	Contact's Last Name	
Contact	MiddleInitial	varchar	Text	Contact's Middle Initial	
Contact	ParentId	int	Number/Long Integer	Parent Entity identification number for the contact	
Contact	Phone	varchar	Text	Contact's Phone	
Contact	Salutation	varchar	Text	Contact's Salutation	
Contact	SurveyId	int	Number/Long Integer	Identification number assigned to survey	
Contact	Title	varchar	Text	Contact's Title	
ContactSource	ContactSourceId	int	Number/Long Integer	Identification number of the position	
ContactSource	Name	varchar	Text	The name of the position function (See tab I-Contact Sources)	
ContactType	Name	varchar	Text	The name of the type of contact (See tab J-Contact Types)	
ContactType	TypeId	int	Number/Long Integer	identification number of the contact type	
DataCenterFacility	HAEntityId	int	Number/Long Integer	Identification number associated with surveyed entity. Unique within survey year.	
DataCenterFacility	Id	int	Number/Long Integer	Record identification number	
DataCenterFacility	ParentId	int	Number/Long Integer	Unique Identification number of data center	

Table Name	Field Name	SQL Data Type	Access Data Type	Description	New in 2008
DecisionType	DecisionType	varchar	Text	The types of decisions the facilities can make with out the involvement of the parent organization (See tab K-Decision Types)	
DecisionType	DecisionTypeId	int	Number/Long Integer	Identification number of the decision type	
DecisionType	DecisionTypeOther	varchar	Text	Description of the Other (specify) decision the hospital can make without the involvement of the parent organization	
DecisionType	HAEntityId	int	Number/Long Integer	Identification number associated with surveyed entity. Unique within survey year.	
DecisionType	Id	int	Number/Long Integer	Record identification number	
DecisionType	SurveyId	int	Number/Long Integer	Identification number assigned to survey	
DisasterRecoveryPlan	HAEntityId	int	Number/Long Integer	Identification number associated with surveyed entity. Unique within survey year.	
DisasterRecoveryPlan	Id	int	Number/Long Integer	Record identification number	
DisasterRecoveryPlan	Plan	varchar	Text	Facilities Included in Disaster Recovery Plan (See tab L-Plan Facilities)	
DisasterRecoveryPlan	PlanId	int	Number/Long Integer	Identification number for type of facilities included in Disaster Recovery Plan	
DisasterRecoveryPlan	PlanOther	varchar	Text	Description of Other Planned Facilities	
DisasterRecoveryPlan	SurveyId	int	Number/Long Integer	Identification number assigned to survey	
DistributionPlan	HAEntityId	int	Number/Long Integer	Identification number associated with surveyed entity. Unique within survey year.	
DistributionPlan	Id	int	Number/Long Integer	Record identification number	
DistributionPlan	Option	varchar	Text	Options for expanding the distribution of PACS images	
DistributionPlan	Other	varchar	Text	Description of Other Distribution Plans	
DistributionPlan	SurveyId	int	Number/Long Integer	Identification number assigned to survey	
DistributionPlan	Type	varchar	Text	Type of PACS Images, Radiology or Cardiology	
ExpeditureApproval	ApprovedBy	varchar	Text	The individual or group with the authority to approve the expenditure	
ExpeditureApproval	ApprovedFrom	float	Number/Double	The least amount of money the approving individual or group has the authority to approve	
ExpeditureApproval	ApprovedTo	float	Number/Double	The largest amount of money the approving individual or group has the authority to approve	
ExpeditureApproval	HAEntityId	int	Number/Long Integer	Identification number associated with surveyed entity. Unique within survey year.	
ExpeditureApproval	Id	int	Number/Long Integer	Record identification number	
ExpeditureApproval	SurveyId	int	Number/Long Integer	Identification number assigned to survey	
HAEntity	AcuteId	int	Number/Long Integer	For sub-acute care facilities the HAEntityID of the acute care facility that the sub-acute care facility uses the same software platform as.	
HAEntity	Address1	varchar	Text	Entity's Street Address	
HAEntity	Address2	varchar	Text	Additional Address Info if Necessary	
HAEntity	CBSA	varchar	Text	Core Business Statistical Area where the Entity is located	
HAEntity	City	varchar	Text	City where the Entity is located	
HAEntity	DataCenterAcuteId	int	Number/Long Integer	Unique identifier of Data Center serving the Entity	
HAEntity	EmailConvention	varchar	Text	Email Convention for Entity	
HAEntity	EntityNo	int	Number/Long Integer	FacilityID or IDS or Independent Health SystemID from 2004	
HAEntity	Fax	varchar	Text	Fax Number	
HAEntity	FreeStanding	bit	Yes/No	Yes = the sub-acute care facility is not housed in another facility	
HAEntity	FTEEMRSupport	int	Number/Long Integer	Number of IS FTEs that support EMR applications	Yes
HAEntity	FTEHelpDesk	decimal	Number/Decimal	Number of IS FTEs at the Help Desk	
HAEntity	FTEMgmt	decimal	Number/Decimal	Number of IS FTEs in management	
HAEntity	FTENetworkAdmins	decimal	Number/Decimal	Number of IS FTEs that are network administrators	
HAEntity	FTEOperations	decimal	Number/Decimal	Number of IS FTEs working in operations	
HAEntity	FTEOther	decimal	Number/Decimal	Number of other IS FTEs	
HAEntity	FTEPCSupport	decimal	Number/Decimal	Number of IS FTEs providing PC support	
HAEntity	FTEProgrammers	decimal	Number/Decimal	Number of IS FTEs that are Programmers	
HAEntity	FTEProjectMgmt	decimal	Number/Decimal	Number of IS FTEs that are Project Managers.	

Table Name	Field Name	SQL Data Type	Access Data Type	Description	New in 2008
HAEntity	FTERCMSupport	int	Number/Long Integer	Number of IS FTEs that support RCM applications	Yes
HAEntity	FTESecurity	decimal	Number/Decimal	Number of IS FTEs in IS Security	
HAEntity	FTETotal	decimal	Number/Decimal	Total number of IS FTEs	
HAEntity	HAEntityId	int	Number/Long Integer	Identification number associated with surveyed entity. Unique within survey year.	
HAEntity	HAEntityType	varchar	Text	Description of surveyed entity type (See tab M-Facility Types)	
HAEntity	HAEntityTypeId	int	Number/Long Integer	Unique identification number associated with surveyed entity type (See tab M-Facility Types)	
HAEntity	IsImaging	bit	Yes/No	Yes = the ambulatory facilities provides imaging services (sometimes in addition to the primary service offered)	
HAEntity	MedicareNumber	varchar	Text	Medicare identification number	
HAEntity	Name	varchar	Text	Entity's Name	
HAEntity	NofBeds	int	Number/Long Integer	Number of Licensed Beds	
HAEntity	NofFTE	decimal	Number/Decimal	Total number of FTEs	
HAEntity	NofHCareVisits	int	Number/Long Integer	Number of Home Health Visits annually	
HAEntity	NofPhysicians	int	Number/Long Integer	Number of Physicians employed at the ambulatory	
HAEntity	NofStaffedBeds	int	Number/Long Integer	Number of Beds that can be operated at present staffing levels	
HAEntity	OwnershipStatus	varchar	Text	Ownership Status; Owned, Managed, Leased, or Affiliated	
HAEntity	ParentId	int	Number/Long Integer	identification number of the IDS and Independent Health System that the facilities and data centers are associated	
HAEntity	Phone	varchar	Text	Phone Number	
HAEntity	PhysAffiliated	int	Number/Long Integer	Total number of physicians affiliated with the hospital through an affiliated physician organization	
HAEntity	PhysFT	int	Number/Long Integer	Total number of full-time salaried physicians employed by the hospital, receiving a regular paycheck from the organization	
HAEntity	PhysHospitalists	int	Number/Long Integer	Total number of hospitalists employed by the hospital who are responsible for the patient's care during the hospital stay.	Yes
HAEntity	PhysOther	int	Number/Long Integer	Additional information on the physicians at the hospital	Yes
HAEntity	PhysResidents	int	Number/Long Integer	Total number of residents at the hospital.	Yes
HAEntity	PhysTotal	int	Number/Long Integer	Total number of physicians in the hospital	
HAEntity	ProfitStatus	varchar	Text	Not for Profit or Profit	
HAEntity	SameISSystem	bit	Yes/No	Yes = the sub-acute care facility uses the same software platform as a hospital in the health care system	
HAEntity	ServicePopulation	int	Number/Long Integer	Size of Population served by entity	
HAEntity	State	varchar	Text	State where entity is located	
HAEntity	SurveyId	int	Number/Long Integer	Identification number assigned to survey	
HAEntity	Type	varchar	Text	Description of the entities primary service provided (see tab N-Facility Descriptions)	
HAEntity	UniqueId	int	Number/Long Integer	Fixed unique identifier for the entity. This number will not change from year to year.	
HAEntity	VendorSelStrategy	varchar	Text	Description of the facility's vendor selection strategy (See tab O-Selection Strategies)	
HAEntity	Website	varchar	Text	Entity's website	
HAEntity	YearFormed	int	Number/Long Integer	Year Entity Formed	
HAEntity	YearOpened	int	Number/Long Integer	Year Entity was acquired	
HAEntity	Zip	varchar	Text	Entity's Postal Zip Code	
HAEntityApplication	AEMR_CDR	bit	Yes/No	Yes = the clinical data repository component of the Ambulatory EMR system is in use.	
HAEntityApplication	AEMR_CPOE	bit	Yes/No	Yes = the CPOE component of the Ambulatory EMR system is in use.	
HAEntityApplication	AEMR_DocChart	bit	Yes/No	Yes = the Document Charting component of the Ambulatory EMR system is in use.	
HAEntityApplication	AppId	int	Number/Long Integer	Record identification number	
HAEntityApplication	Application	varchar	Text	Software application name (See tab P-Application List)	
HAEntityApplication	ApplicationId	int	Number/Long Integer	Unique identification number for application	
HAEntityApplication	Category	varchar	Text	The category the software application is associated with (See table P-Application List)	

Table Name	Field Name	SQL Data Type	Access Data Type	Description	New in 2008
HAEntityApplication	CategoryId	int	Number/Long Integer	Unique identification number for application category	
HAEntityApplication	ContractMonth	int	Number/Long Integer	The month the software was contracted	
HAEntityApplication	ContractYear	int	Number/Long Integer	The year the software was contracted	
HAEntityApplication	HAEntityId	int	Number/Long Integer	Identification number associated with surveyed entity. Unique within survey year.	
HAEntityApplication	HardwareProductId	int	Number/Long Integer	Unique identification number for product	
HAEntityApplication	HardwareProductName	varchar	Text	Hardware model running the software system	
HAEntityApplication	HardwareVendorId	int	Number/Long Integer	Unique identification number for vendor	
HAEntityApplication	HardwareVendorName	varchar	Text	Hardware vendor running the software system	
HAEntityApplication	HospitalSystem	bit	Yes/No	Yes = an Ambulatory, Home Health, or Payer facility is using same software as hospital	
HAEntityApplication	ImplementedMonth	int	Number/Long Integer	The month the contracted software will be implemented	
HAEntityApplication	ImplementedYear	int	Number/Long Integer	The year the contracted software will be implemented	
HAEntityApplication	ReplacementPlan	bit	Yes/No	Yes = there are plans to replace the software system for facilities	
HAEntityApplication	SoftwareProductId	int	Number/Long Integer	Unique identification number for product	
HAEntityApplication	SoftwareProductName	varchar	Text	Software vendor's product utilized	
HAEntityApplication	SoftwareVendorId	int	Number/Long Integer	Unique identification number for vendor	
HAEntityApplication	SoftwareVendorName	varchar	Text	Name of the software vendor utilized	
HAEntityApplication	Status	varchar	Text	Indicates the status of an application (See Q-Automation Status)	
HAEntityApplication	SurveyId	int	Number/Long Integer	Identification number assigned to survey	
HAEntityApplicationPlan	AppId	int	Number/Long Integer	identification number for applications with software purchase plan	
HAEntityApplicationPlan	Application	varchar	Text	Software application name (See tab A-Application List)	
HAEntityApplicationPlan	ApplicationId	int	Number/Long Integer	Unique identification number for application	
HAEntityApplicationPlan	Budgeted	bit	Yes/No	Yes = the software purchase has been budgeted	
HAEntityApplicationPlan	Contract	varchar	Text	The estimated timeframe the facility plans to sign a contract (See tab A-Plan Timeframe)	
HAEntityApplicationPlan	HAEntityId	int	Number/Long Integer	Identification number associated with surveyed entity. Unique within survey year.	
HAEntityApplicationPlan	Installation	varchar	Text	The estimated timeframe the facility plans to have completed installation of the system (See tab A-Plan Timeframe)	
HAEntityApplicationPlan	RFP	bit	Yes/No	Yes = the facility uses RFP's when purchasing	
HAEntityApplicationPlan	RFPDateMonth	int	Number/Long Integer	The month the RFP has or will be sent out	
HAEntityApplicationPlan	RFPDateYear	int	Number/Long Integer	The year the RFP has or will be sent out	
HAEntityApplicationPlan	SurveyId	int	Number/Long Integer	Identification number assigned to survey	
HAEntityApplicationPlan	VendorDecision	varchar	Text	The estimated timeframe the facility plans to make a vendor decision (See tab A-Plan Timeframe)	
HAEntityContact	ContactId	int	Number/Long Integer	Unique identification number for contact	
HAEntityContact	HAContactSourceId	int	Number/Long Integer	Identification number of the position	
HAEntityContact	HAEntityId	int	Number/Long Integer	Identification number associated with surveyed entity. Unique within survey year.	
HAEntityContact	Id	int	Number/Long Integer	Record identification number	
HAEntityContact	Status	varchar	Text	The status of the position and the system or facility (See tab G-Contact Status)	
HAEntityContact	SurveyId	int	Number/Long Integer	Identification number assigned to survey	
HAEntityContact	TypeId	int	Number/Long Integer	identification number of the contact type	
HAEntityHistory	Action	varchar	Text	Type of current or planned activity (See tab R-Actions)	
HAEntityHistory	BedSize	int	Number/Long Integer	Planned Number of Licensed Beds for a hospital being constructed or expanded	
HAEntityHistory	BeginConstruction	varchar	Text	Timeframe to begin the construction or expansion project (see Tab A - Plan Timeframe)	
HAEntityHistory	EndConstruction	varchar	Text	Timeframe to complete the construction or expansion project (see Tab A - Plan Timeframe)	
HAEntityHistory	FundingAmount	varchar	Text	Amount of funding for the construction or expansion project	
HAEntityHistory	HAEntityId	int	Number/Long Integer	Identification number associated with surveyed entity. Unique within survey year.	
HAEntityHistory	HAEntityTypeId	int	Number/Long Integer	Unique identification number associated with surveyed entity type	

Table Name	Field Name	SQL Data Type	Access Data Type	Description	New in 2008
HAEntityHistory	HistoryId	int	Number/Long Integer	Record identification number	
HAEntityHistory	IsPlan	bit	Yes/No	Yes = the project is planned (See tab R-Actions)	
HAEntityHistory	ProjectDescription	text	Memo	Details for the plan the facility is a part of which may include time frames and facility details such as bed size	
HAEntityHistory	ProjectType	varchar	Text	Type of planned construction or expansion project (see Tab ## ProjectType)	
HAEntityHistory	SubjectHAEntityId	int	Number/Long Integer	HAEntityID of the facility that the project is associated with	
HAEntityHistory	SubjectName	varchar	Text	Name of the entity that the project is associated with.	
HAEntityHistory	SurveyId	int	Number/Long Integer	Identification number assigned to survey	
HAEntityRegion	Description	varchar	Text	The specific names of the counties, states, etc. the IDS/ Independent Health System services	
HAEntityRegion	HAEntityId	int	Number/Long Integer	Identification number associated with surveyed entity. Unique within survey year.	
HAEntityRegion	RegionId	int	Number/Long Integer	Record identification number	
HAEntityRegion	RegionName	varchar	Text	The type of region that the IDS/Independent Health System services (Counties; State; Regional; National; or Other)	
HAEntityRegion	SurveyId	int	Number/Long Integer	Identification number assigned to survey	
HandheldInfo	HAEntityId	int	Number/Long Integer	Identification number associated with surveyed entity. Unique within survey year.	
HandheldInfo	Id	int	Number/Long Integer	Record identification number	
HandheldInfo	SurveyId	int	Number/Long Integer	Identification number assigned to survey	
HandheldInfo	Type	varchar	Text	Handheld Use or Areas	
HandheldInfo	Value	varchar	Text	Description of Handheld use and areas of use (see tab S-HandHeld Uses)	
HandheldInfo	ValueOther	varchar	Text	Further Description of Other uses or areas of uses	
IHDSChanges	ChangeDate	varchar	Date/Time	The date the change was made to the HIMSS Analytics Database	
IHDSChanges	ChangeId	int	Number/Long Integer	Record identification number	
IHDSChanges	ChangeType	varchar	Text	Description of the reason for the change to the HIMSS Analytics Database, such as a merger, a new system or a deletion	
IHDSChanges	Comment	text	Memo	Explanation of changes made to the HIMSS Analytics Database	
IHDSChanges	Edition	varchar	Text	Indicates which edition of the HIMSS Analytics Database the data is from	
IHDSChanges	Id	int	Number/Long Integer	Unique identification for each changed record	
IHDSChanges	IsPlan	bit	Yes/No	Yes = the change is planned	
IHDSChanges	NewIDSId	int	Number/Long Integer	The new healthcare system's EntityNo	
IHDSChanges	OldIDSId	int	Number/Long Integer	The old healthcare system's EntityNo	
IHDSChanges	Surveyid	int	Number/Long Integer		
ISPlan	HAEntityId	int	Number/Long Integer	Identification number associated with surveyed entity. Unique within survey year.	
ISPlan	Id	int	Number/Long Integer	Record identification number	
ISPlan	Plan	varchar	Text	Description of the areas the IS strategic plan addresses (See tab T-Strategic Plans)	
ISPlan	SurveyId	int	Number/Long Integer	Identification number assigned to survey	
ISPlanDecision	HAEntityId	int	Number/Long Integer	Identification number associated with surveyed entity. Unique within survey year.	
ISPlanDecision	Id	int	Number/Long Integer	Record identification number	
ISPlanDecision	Plan	varchar	Text	Description of the facilities that drive the IS strategic plan (See tab L-Plan Facilities)	
ISPlanDecision	PlanId	int	Number/Long Integer	Identification number for the type of facilities that drive the IS strategic plan	
ISPlanDecision	PlanOther	varchar	Text	Description of the other facilities that drive the IS strategic plan	
ISPlanDecision	SurveyId	int	Number/Long Integer	Identification number assigned to survey	
LongTermStorage	Area	varchar	Text	Indicates the area where the long term storage technology is used (See tab AN-Storage Areas)	
LongTermStorage	HAEntityId	int	Number/Long Integer	Identification number associated with surveyed entity. Unique within survey year.	
LongTermStorage	Id	int	Number/Long Integer	Record identification number	
LongTermStorage	StorageOther	varchar	Text	Description of Other storage types	

Table Name	Field Name	SQL Data Type	Access Data Type	Description	New in 2008
LongTermStorage	StorageType	varchar	Text	Type of storage used for all long term storage at the hospital (See tab U-Storage Types)	
LongTermStorage	SurveyId	int	Number/Long Integer	Identification number assigned to survey	
LongTermStorage	Type	varchar	Text	Current or Planned Use	
LongTermStorage	VendorId	int	Number/Long Integer	Unique identification number for vendor	
LongTermStorage	VendorName	varchar	Text	Name of the vendor used for long term storage.	
MedAdministration	HAEntityId	int	Number/Long Integer	Identification number associated with surveyed entity. Unique within survey year.	Yes
MedAdministration	ProcessDesc	varchar	Text	A decsription of the elements that are bar coded or have an RFID tag in the medication administration process (see tab AV-ProcessDec)	Yes
MedAdministration	ProcessID	int	Number/Long Integer	Identification number associated with the elements that are bar coded or have an RFID tag in the medication administration process	Yes
MedAdministration	SurveyId	int	Number/Long Integer	Identification number assigned to survey	Yes
PACSComponent	Category	varchar	Text	Already Purchased or Planned	
PACSComponent	Component	varchar	Text	Type of PACS Component (See tab V-PACS Components)	
PACSComponent	HAEntityId	int	Number/Long Integer	Identification number associated with surveyed entity. Unique within survey year.	
PACSComponent	Id	int	Number/Long Integer	Record identification number	
PACSComponent	Other	varchar	Text	Further Description of Other components	
PACSComponent	SurveyId	int	Number/Long Integer	Identification number assigned to survey	
PACSComponent	Type	varchar	Text	Department that is referred to regarding PACS (see tab W-PACS Types)	
PACSInfo	HAEntityId	int	Number/Long Integer	Identification number associated with surveyed entity. Unique within survey year.	
PACSInfo	Id	int	Number/Long Integer	Record identification number	
PACSInfo	ImgDistrCCU	bit	Yes/No	Yes/No Images distributed to Critical Care Unit	
PACSInfo	ImgDistrDC	bit	Yes/No	Yes/No Images distributed to diagnostic centers	
PACSInfo	ImgDistrER	bit	Yes/No	Yes/No Images distributed to Emergency Room	
PACSInfo	ImgDistrHome	bit	Yes/No	Yes/No Images distributed to physician's homes	
PACSInfo	ImgDistrHospital	bit	Yes/No	Yes/No Images distributed throughout hospital	
PACSInfo	ImgDistrICU	bit	Yes/No	Yes/No Images distributed to Intensive Care Unit	
PACSInfo	ImgDistrOffice	bit	Yes/No	Yes/No Images distributed to physician's offices	
PACSInfo	ImgDistrOR	bit	Yes/No	Yes/No Images distributed to Operating Rooms	
PACSInfo	ImgDistrOther	bit	Yes/No	Yes/No Images distributed to other departments	
PACSInfo	ImgDistrOtherComment	varchar	Text	Description of other distribution departments	
PACSInfo	ImgDistrOutsideOther	varchar	Text	A description of where the images are distributed outside of the hospital	
PACSInfo	ImgDistrThisDeptOnly	bit	Yes/No	Yes/No Images only distributed with in Radiology or Cardiology	
PACSInfo	ImgDistrWeb	bit	Yes/No	Yes/No Images distributed over the Web	
PACSInfo	NofDigitalStudies	int	Number/Long Integer	Number of digitized studies or procedures done annually	
PACSInfo	NofStudies	int	Number/Long Integer	Total number of studies or procedures done annually	
PACSInfo	PlanPurchase	bit	Yes/No	Yes/No Planning to Purchase PACS	
PACSInfo	SurveyId	int	Number/Long Integer	Identification number assigned to survey	
PACSInfo	Type	varchar	Text	Department that is referred to regarding PACS (see tab W-PACS Types)	
PacsInterface	Category	varchar	Text	Type of PACS CIS/RIS Interface data; Systems, Problems, or Steps	
PacsInterface	HAEntityId	int	Number/Long Integer	Identification number associated with surveyed entity. Unique within survey year.	
PacsInterface	Id	int	Number/Long Integer	Record identification number	
PacsInterface	Other	varchar	Text	Further description of Other value	
PacsInterface	SurveyId	int	Number/Long Integer	Identification number assigned to survey	
PacsInterface	Type	varchar	Text	Radiology or Cardiology	
PacsInterface	Value	varchar	Text	Detail on PACS CIS/RIS interface (see tab X-PACS Interface)	
PACSVendor	HAEntityId	int	Number/Long Integer	Identification number associated with surveyed entity. Unique within survey year.	
PACSVendor	NofWorkstations	int	Number/Long Integer	Number of Workstations Licensed from PACS vendor	
PACSVendor	PACSVendorId	int	Number/Long Integer	Unique identification number for vendor	
PACSVendor	SurveyId	int	Number/Long Integer	Identification number assigned to survey	
PACSVendor	Type	varchar	Text	Radiology or Cardiology	
PACSVendor	VendorId	int	Number/Long Integer	Unique identification number for vendor	
PACSVendor	VendorName	varchar	Text	Name of PACS vendor	

Table Name	Field Name	SQL Data Type	Access Data Type	Description	New in 2008
ParentInfo	AnnualOpCost	float	Number/Double	The annual operating cost for the entire healthcare organization spent on operations such as staffing, property expenses, etc. In numeric form for the most recent fiscal year end	
ParentInfo	AnnualRevenue	float	Number/Double	The amount of net income that a system generated from patient care, investments and other sources for the most recent fiscal year end; revenues in excess of expenses	
ParentInfo	BackUpFacilityType	varchar	Text	Description of the type of backup facility (see tab Z-Backup Facility Types)	
ParentInfo	DataCenter	bit	Yes/No	Yes = the system has a data center	
ParentInfo	DateOfData	datetime	Date/Time	Date the data collection was completed	
ParentInfo	ExtAuditFirmId	int	Number/Long Integer	Unique identification number for vendor	
ParentInfo	ExtAuditFirmName	varchar	Text	Name of the external auditing firm	
ParentInfo	ExtAutidFirm			The integrated healthcare delivery system's external auditing firm	
ParentInfo	FiscalEndDateMonth	int	Number/Long Integer	The month the fiscal year ends	
ParentInfo	ISBudget	decimal	Number/Decimal	The total amount budgeted by the IS department at the healthcare systems for the current fiscal year end. This amount includes all operating expenses.	
ParentInfo	ISPlan	bit	Yes/No	Yes = the system has an IS strategic plan	
ParentInfo	ISPlanInEffect	varchar	Text	The length of time the strategic plans is in effect for from the year it was written (See tab Y-ISPlan Timeframes)	
ParentInfo	ISPlanYear	int	Number/Long Integer	The year the IS strategic plan was written	
ParentInfo	NofDataCenters	int	Number/Long Integer	The number of data centers the system has	
ParentInfo	NofOutpatientVisits	int	Number/Long Integer	Total number of individuals seen on an outpatient basis at the integrated healthcare delivery system for the most recent fiscal year	
ParentInfo	NofRadiologyProc	int	Number/Long Integer	Number of radiology studies/procedures at the health system for the most recent fiscal year	
ParentInfo	OutsourceRecovery	bit	Yes/No	Yes = the IDS/Independent Hospital System outsourcers their disaster recovery	
ParentInfo	OutsourceRecoveryVendor	varchar	Text	The name of the vendor the IDS/Independent Hospital System providing the outsourced disaster recovery services	
ParentInfo	OutsourceRecoveryVendorId	int	Number/Long Integer	Unique identification number for vendor	
ParentInfo	ParentId	int	Number/Long Integer	Identification number for IDS and Independent Health Systems. Unique with survey year	
ParentInfo	PhysAffiliated	int	Number/Long Integer	Total number of physicians affiliated with the system through an affiliated physician organization	
ParentInfo	PhysFT	int	Number/Long Integer	Total number of full-time salaried physicians employed by the ihealth care system, receiving a regular paycheck from the organization	
ParentInfo	PhysHospitalists	int	Number/Long Integer	Total number of hospitalists employed by the health care system	Yes
ParentInfo	PhysOnStaff	int	Number/Long Integer	Total number of on-staff physicians with practicing privileges	
ParentInfo	PhysOther	int	Number/Long Integer	Additional information on the physicians at the health care system	Yes
ParentInfo	PhysResidents	int	Number/Long Integer	Total number of residents at the health care system	Yes
ParentInfo	PhysTotal	int	Number/Long Integer	Total number of other (not on-staff, full-time salaried or affiliated) physicians at the health care system	
ParentInfo	RecoveryPlan	bit	Yes/No	Yes = the IDS/Independent Hospital System has a disaster recover plan	
ParentInfo	RecoveryPlanIsBackup	bit	Yes/No	Yes = the IDS/Independent Hospital System has a backup facility for disaster recovery	
ParentInfo	RecoveryPlanYear	int	Number/Long Integer	The year the disaster recover plan was written	
ParentInfo	RevManagedCare	float	Number/Double	Percentage of patient revenue from managed care organizations	
ParentInfo	RevManagedCareOther	float	Number/Double	Percentage of patient revenue from other types of managed care organizations	
ParentInfo	RevMedicaid	float	Number/Double	Percentage of patient revenue from Medicaid (Public) insurance	
ParentInfo	RevMedicare	float	Number/Double	Percentage of patient revenue from Medicare	
ParentInfo	RevOther	float	Number/Double	Percentage of patient revenue from other sources, such as CHAMPUS, worker's comp., self pay, etc.	
ParentInfo	RevTradComm	float	Number/Double	Percentage of patient revenue from traditional commercial insurance	
ParentInfo	SCMeetingFreqId	int	Number/Long Integer	Description of how often the steering committee meets	
ParentInfo	SCMeetingFreqOther	varchar	Text	Additional information about when a steering committee meets	

Table Name	Field Name	SQL Data Type	Access Data Type	Description	New in 2008
ParentInfo	StarkNofClinics	int	Number/Long Integer	Number of clinicls the system currently provides Ambulatory EMR services to community physicians under the current Stark relaxation laws (non-owned clinics)	Yes
ParentInfo	StarkNofSolutions	int	Number/Long Integer	Number of Ambulatory EMR solutions the system currently provides to community physicians under the current Stark relaxation laws (non-owned clinics)	Yes
ParentInfo	StarkPlan	bit	Yes/No	Yes = the system plans to offer Ambulatory EMR services to community physicians (non-owned clinics) (See tab A-Plan Timeframe)	Yes
ParentInfo	StarkPlanTimeFrame	varchar	Text	The timeframe in which the system plans to offer Ambulatory EMR services to community physicians (non-owned clinics)	Yes
ParentInfo	StarkRelaxation	bit	Yes/No	Yes = the system currently provides Ambulatory EMR services to community physicians under the current Stark relaxation laws (non-owned clinics)	Yes
ParentInfo	SteeringCommittee	bit	Yes/No	Yes = the system has a formal IS steering committee	
ParentInfo	SurveyId	int	Number/Long Integer	Identification number assigned to survey	
Pharmacy	ADM	bit	Yes/No	Yes = the facility uses ADMs to dispense medication	
Pharmacy	ADMPerc	decimal	Number/Decimal	The percentage of the total dispensed medication that is done via the Automated Dispensing Machines (ADMs)	
Pharmacy	ADMPlanned	bit	Yes/No	Yes = the facility plans to purchase ADMs to dispense medication (See tab A-Plan Timeframes)	
Pharmacy	ADMTimeFrame	varchar	Text	The time frame for purchasing ADMs to dispense medication (See tab AA-Pharmacy Plan Timeframes)	
Pharmacy	DeptED	bit	Yes/No	Yes = the facility uses ADMs to dispense medication in the emergency department	
Pharmacy	DeptMedical	bit	Yes/No	Yes = the facility uses ADMs to dispense medication in the Medical/Surgical department	
Pharmacy	DeptOR	bit	Yes/No	Yes = the facility uses ADMs to dispense medication in the operating room	
Pharmacy	DeptOther	bit	Yes/No	Yes = the facility uses ADMs to dispense medication in the another department	
Pharmacy	DeptOtherName	varchar	Text	Description of the other department where ADMs are used to dispense medication	
Pharmacy	DifferentThanInpatient	bit	Yes/No	Yes = the software system in the outpatient facility is different than the inpatient Pharmacy Management System	
Pharmacy	HAEntityId	int	Number/Long Integer	Identification number associated with surveyed entity. Unique within survey year.	
Pharmacy	Id	int	Number/Long Integer	Record identification number	
Pharmacy	IVPumpPlanned	bit	Yes/No	Yes = the facility plans to purchase IV Pumps	
Pharmacy	IVPumpsPlanTimeFrame	varchar	Text	The timeframe the hospitals plans to purchase IV Pumps in months (See tab AA-Pharmacy Plan Timeframes)	
Pharmacy	IVPumpsPlanTimeQty	varchar	Text	Number of IV Pumps the hospital plans to purchase	
Pharmacy	IvPumpsSafetySoftware	bit	Yes/No	Yes = safety software is utilized on the IV Pumps	
Pharmacy	OutpatientDispensing	bit	Yes/No	Yes = the facility's outpatient pharmacy uses an automated system for bottle filling and pill counting	
Pharmacy	OutpatientPharmacy	bit	Yes/No	Yes = the facility has an outpatient pharmacy	
Pharmacy	OutpatientPlanned	bit	Yes/No	Yes = the facility has plans to use an automated outpatient dispensing software for pill counting and bottle filling	
Pharmacy	OutpatientTimeFrame	varchar	Text	The timeframe to implement the planned automated outpatient dispensing software for pill counting and bottle filling (See tab A-Plan Timeframes 1)	
Pharmacy	Robot	bit	Yes/No	Yes = the facility uses robot technology to fill medication orders	
Pharmacy	RobotPlanned	bit	Yes/No	Yes = the facility has plans to use or change robot technology to fill medication orders	
Pharmacy	RobotTimeFrame	varchar	Text	The time frame for purchasing robot technology to fill medication orders (See tab AA-Pharmacy Plan Timeframes)	
Pharmacy	SurveyId	int	Number/Long Integer	Identification number assigned to survey	
PharmacyProduct	ContractMonth	int	Number/Long Integer	The month the facility plans to purchase the technology for the pharmacy	
PharmacyProduct	ContractYear	int	Number/Long Integer	The year the facility plans to purchase the technology for the pharmacy	
PharmacyProduct	HAEntityId	int	Number/Long Integer	Identification number associated with surveyed entity. Unique within survey year.	
PharmacyProduct	Id	int	Number/Long Integer	Record identification number	
PharmacyProduct	NofDevices	int	Number/Long Integer	Number of ADM devices used at the facility	
PharmacyProduct	ProductId	int	Number/Long Integer	Unique identification number for product	
PharmacyProduct	ProductName	varchar	Text	The name of the vendor's product used	
PharmacyProduct	Qty	varchar	Text	The number of devices the hospital has	

Table Name	Field Name	SQL Data Type	Access Data Type	Description	New in 2008
PharmacyProduct	SurveyId	int	Number/Long Integer	Identification number assigned to survey	
PharmacyProduct	Type	varchar	Text	The type of technology used (See tab AB-Pharmacy Technology)	
PharmacyProduct	VendorId	int	Number/Long Integer	Unique identification number for vendor	
PharmacyProduct	VendorName	varchar	Text	The name of the vendor used	
PreferredSupplier	Channel	varchar	Text	Preferred Channel for acquiring hardware; Direct from Manufacturer, Reseller, Third Party Vendor, or No Preference	
PreferredSupplier	HAEntityId	int	Number/Long Integer	Identification number associated with surveyed entity. Unique within survey year.	
PreferredSupplier	Id	int	Number/Long Integer	Record identification number	
PreferredSupplier	Supplier	varchar	Text	Preferred Vendor for specified Type of Hardware (see tab AC-Preferred Supplier Types)	
PreferredSupplier	SupplierId	int	Number/Long Integer	Unique identification number for vendor	
PreferredSupplier	SurveyId	int	Number/Long Integer	Identification number assigned to survey	
PreferredSupplier	Type	varchar	Text	Types of Hardware	
ProductHistory	AcquisitionDate	datetime	Date/Time	Date and time the acquisition occurred in the HIMSS Analytics DatabaseTM derived from the Dorenfest IHDS+ DatabaseTM	
ProductHistory	Comment	varchar	Text	Description of the action putting the product in the history table	
ProductHistory	CurrentOwnerName	varchar	Text	Name of the vendor who currently owns the product	
ProductHistory	DateNameChanged	datetime	Date/Time	Date and time the acquisition occurred in the HIMSS Analytics DatabaseTM derived from the Dorenfest IHDS+ DatabaseTM	
ProductHistory	Id	int	Number/Long Integer	Record identification number	
ProductHistory	IndustryChangeDate_Day	varchar	Text	Day the product was acquired in the industry by the new vendor	
ProductHistory	IndustryChangeDate_Month	varchar	Text	Month the product was acquired in the industry by the new vendor	
ProductHistory	IndustryChangeDate_Year	varchar	Text	Year the product was acquired in the industry by the new vendor	
ProductHistory	PreviousName	varchar	Text	The previous name of the product	
ProductHistory	PreviousOwner	varchar	Text	The vendor who owned the product before an acquisition	
ProductHistory	Product	varchar	Text	Product Name	
ProductHistory	ProductID	int	Number/Long Integer	Identification number for the product	
PurchasingOrganization	HAEntityId	int	Number/Long Integer	Identification number associated with surveyed entity. Unique within survey year.	
PurchasingOrganization	Id	int	Number/Long Integer	Record identification number	
PurchasingOrganization	Organization	varchar	Text	Name of purchasing alliance or group	
PurchasingOrganization	OrganizationId	int	Number/Long Integer	Identification number of purchasing alliance or group	
PurchasingOrganization	SurveyId	int	Number/Long Integer	Identification number assigned to survey	
SecuritySoftware	HAEntityId	int	Number/Long Integer	Identification number associated with surveyed entity. Unique within survey year.	
SecuritySoftware	Id	int	Number/Long Integer	Record identification number	
SecuritySoftware	Software	varchar	Text	Type of Security software (See tab AD-Security Technology)	
SecuritySoftware	SoftwareId	int	Number/Long Integer	Identification number for type of security used	
SecuritySoftware	SurveyId	int	Number/Long Integer	Identification number assigned to survey	
SecuritySoftware	Type	varchar	Text	Indicates if the security technology is current or planned	
Server	HAEntityId	int	Number/Long Integer	Identification number associated with surveyed entity. Unique within survey year.	
Server	HostSWVendorID	int	Number/Long Integer	Identification number for the vendor for the host software on Virtual Servers	Yes
Server	HostSWVendorName	varchar	Text	Name of Host Software Vendor in Use on Virtual Servers	Yes
Server	Id	int	Number/Long Integer	Record identification number	
Server	InUseFlag	bit	Yes/No	Yes = the server is currently used	
Server	NofUnits	int	Number/Long Integer	Number of Servers	
Server	OperatingSystem	varchar	Text	Unique ID for Server Operating System	
Server	OperatingSystemName	varchar	Text	Name of Server Operating System	
Server	PlannedFlag	bit	Yes/No	Yes/No Planning New Servers	
Server	ProductId	int	Number/Long Integer	Unique identification number for product	
Server	ProductName	varchar	Text	Name of Server Product in Use	

Table Name	Field Name	SQL Data Type	Access Data Type	Description	New in 2008
Server	ServerType	varchar	Text	The type of server used at the hospital (See tab AE-Server Types)	
Server	SurveyId	int	Number/Long Integer	Identification number assigned to survey	
Server	Timeframe	varchar	Text	The timeframe in which there are plans to implement virtual servers	Yes
Server	VendorId	int	Number/Long Integer	Unique identification number for vendor	
Server	VendorName	varchar	Text	Name of Server Vendor in Use	
Service	Category	varchar	Text	The status of the use of the consulting services or outsourcing (i.e. current or plan)	
Service	CompanyId	int	Number/Long Integer	Identification of the organization providing the consulting or outsourcing service	
Service	CompanyName	varchar	Text	Name of the organization providing the consulting or outsourcing service	
Service	ContractLength	varchar	Text	The length of the contract from the date it was contracted	
Service	ContractMonth	int	Number/Long Integer	The month the service was or will be contracted	
Service	ContractYear	int	Number/Long Integer	The year the service was or will be contracted	
Service	Function	varchar	Text	Type of service being supplied (See tab AF-Service Types)	
Service	FunctionOther	varchar	Text	Description of services out side of the listed options	
Service	HAEntityId	int	Number/Long Integer	Identification number associated with surveyed entity. Unique within survey year.	
Service	Id	int	Number/Long Integer	Record identification number	
Service	SignContractTimeframe	varchar	Text	The time frame the hospital will sign a contract for outsourcing and consulting services	
Service	SurveyId	int	Number/Long Integer	Identification number assigned to survey	
Service	Type	varchar	Text	Indicates if the service (see tab AF-Service Types)	
Survey	IncompleteData	bit	Yes/No	Yes = new hospitals added in 2006 updates were not completed	
Survey	IsUncooperative	bit	Yes/No	Yes = the entire health system was uncooperative and no IT data was updated	
Survey	SurveyId	int	Number/Long Integer	Identification number assigned to survey	
Survey	Year	int	Number/Long Integer	Year the system and facilities have been updated in	
SurveySegment	SegmentID	varchar	Number/Long Integer	Unique identification number for segment	
SurveySegment	SegmentName		Text	Name of the segment (See tab ??-Segments)	
SurveySegment	SurveyId	int	Number/Long Integer	Identification number assigned to survey	
Telecommunication	Category	varchar	Text	Differentiates between type of telecommunication types (see tab AG-Telecommunication Types)	
Telecommunication	HAEntityId	int	Number/Long Integer	Identification number associated with surveyed entity. Unique within survey year.	
Telecommunication	Id	int	Number/Long Integer	Record identification number	
Telecommunication	Status	varchar	Text	The status of the use of the telecommunication technology (i.e. current or planned)	
Telecommunication	SurveyId	int	Number/Long Integer	Identification number assigned to survey	
Telecommunication	Type	varchar	Text	Differentiates between the types of services (see tab AG-Telecommunication Types)	
Telecommunication	VendorId	int	Number/Long Integer	Unique identification number for vendor	
Telecommunication	VendorName	varchar	Text	The vendor providing the telecommunication technology	
UseOfITComponent	Component	varchar	Text	The component or application that the physicians can access via a dashboard (See tab AH-Physician Access Components)	
UseOfITComponent	ComponentId	int	Number/Long Integer	Identification number for the type of component or application that the physicians can access via a dashboard	
UseOfITComponent	ComponentOther	varchar	Text	Description for the other components the physicians can access via a dashboard that are not included in the options	
UseOfITComponent	HAEntityId	int	Number/Long Integer	Identification number associated with surveyed entity. Unique within survey year.	
UseOfITComponent	Id	int	Number/Long Integer	Record identification number	
UseOfITComponent	Perc	varchar	Text	The percentage or percentage range of the physicians accessing the component via the dashboard	Yes
UseOfITComponent	SurveyId	int	Number/Long Integer	Identification number assigned to survey	
UseOfITComponent	Type	varchar	Text	Indicated if the component are accessed via the dashboard and which are not	

Table Name	Field Name	SQL Data Type	Access Data Type	Description	New in 2008
VendorHistory	DateOfChange	datetime	Date/Time	Date the action was taken on the vendor	
VendorHistory	HistoryID	int	Number/Long Integer	Record identification number	
VendorHistory	IndustryChangeDate_Day	varchar	Text	Day the vendor change occurred in the industry	
VendorHistory	IndustryChangeDate_Month	varchar	Text	Month the vendor change occurred in the industry	
VendorHistory	IndustryChangeDate_Year	varchar	Text	Year the vendor change occurred in the industry	
VendorHistory	Note	text	Text	Description of the action putting the vendor in the history table	
VendorHistory	PrevName	varchar	Text	Previous name of the original vendor that the action was taken on	
VendorHistory	Vendor	varchar	Text	Name of the original vendor that the action was taken on	
VendorHistory	VendorID	int	Number/Long Integer	Identification number for the vendor	
VendorHistory	vendorName	varchar	Text	Name of the vendor that acquired the original vendor	
Wireless	HAEntityId	int	Number/Long Integer	Identification number associated with surveyed entity. Unique within survey year.	
Wireless	HandHeldPerc	decimal	Number/Decimal	The percentage of physicians using handheld devices	
Wireless	Id	int	Number/Long Integer	Record identification number	
Wireless	IsWLAN	bit	Yes/No	Yes = the hospital has a wireless local area network (WLAN)	
Wireless	IsWLANPlan	bit	Yes/No	Yes = the hospital has plans to implement or expand their wireless local area network (WLAN)	
Wireless	NofAccessPoints	int	Number/Long Integer	The number of current access points to the WLAN	
Wireless	NofAccessPointsEndOfYear	int	Number/Long Integer	The number of access points to the WLAN planned in the next year.	
Wireless	NofPDAonWLAN	int	Number/Long Integer	The number of PDAs on the WLAN	
Wireless	NofTabletPConWLAN	int	Number/Long Integer	The number of table PCs on the WLAN	
Wireless	SurveyId	int	Number/Long Integer	Identification number assigned to survey	
Wireless	Version	varchar	Text	The 802.11 standard used (i.e. a, b, g, n)	
Wireless	VersionEndOfYear	varchar	Text	The 802.11 standard planned (i.e. b, g, n)	
WirelessAccess	HAEntityId	int	Number/Long Integer	Identification number associated with surveyed entity. Unique within survey year.	
WirelessAccess	Id	int	Number/Long Integer	Record identification number	
WirelessAccess	Location	varchar	Text	The location of the WLANs in the facility (see tab AK-WLAN Locations)	
WirelessAccess	SurveyId	int	Number/Long Integer	Identification number assigned to survey	
WirelessSecurity	HAEntityId	int	Number/Long Integer	Identification number associated with surveyed entity. Unique within survey year.	
WirelessSecurity	Id	int	Number/Long Integer	Record identification number	
WirelessSecurity	Security	varchar	Text	The type of security protocols on the WLAN (See tab AL-WLAN Security Protocols)	
WirelessSecurity	SurveyId	int	Number/Long Integer	Identification number assigned to survey	
WirelessVendor	HAEntityId	int	Number/Long Integer	Identification number associated with surveyed entity. Unique within survey year.	
WirelessVendor	Id	int	Number/Long Integer	Record identification number	
WirelessVendor	NofUnits	int	Number/Long Integer	The number of units provided by the vendor for the type of wireless technology	
WirelessVendor	OperatingSystem	varchar	Text	Unique identification number for product	
WirelessVendor	OperatingSystemName	varchar	Text	The name of the operating system running the wireless device	
WirelessVendor	SurveyId	int	Number/Long Integer	Identification number assigned to survey	
WirelessVendor	Type	varchar	Text	The type of wireless technology (See tab AM-Wireless Devices)	
WirelessVendor	VendorId	int	Number/Long Integer	Unique identification number for vendor	
WirelessVendor	VendorName	varchar	Text	The name of the vendor used for the type of wireless technology	

Appendix F

2011 HCUP Data Elements

Appendix III: Data Elements

Table 1. Data Elements in the NIS Inpatient Core Files

Data elements that are *italicized* are not included in the 2011 NIS Inpatient Core files, but are only available in previous years' files.

Type of Data Element	HCUP Name	Years Available	Coding Notes	Unavailable in 2011 for:
Admission information				
Admission day	AWEEKEND	1998-2011	Admission on weekend: (0) admission on Monday-Friday, (1) admission on Saturday-Sunday	
	ADAYWK	*1988-1997*	*Admission day of week: (1) Sunday, (2) Monday, (3) Tuesday, (4) Wednesday, etc.*	
Admission month	AMONTH	1988-2011	Admission month coded from (1) January to (12) December	FL, WV
Admission source	ASOURCE	1988-2011	Admission source, uniform coding: (1) ER, (2) another hospital, (3) another facility including long-term care, (4) court/law enforcement, (5) routine/birth/other	AK, AZ, CO, CT, FL, GA, HI, IA, KS, KY, ME, MI, MN, MO, MT, NC, ND, NE, NM, OK, OR, PA, RI, SC, SD, TN, TX, UT, VT, WA, WI, WY
	ASOURCE_X	1998-2011	Admission source, as received from data source using State-specific coding	AK, AZ, CO, CT, FL, GA, HI, IA, KS, KY, ME, MI, MN, MO, MT, NC, ND, NE, NM, OK, OR, PA, RI, SC, SD, TN, TX, UT, VT, WA, WI, WY

Type of Data Element	HCUP Name	Years Available	Coding Notes	Unavailable in 2011 for:
	ASOURCEUB92	2003-2011	Admission source (UB-92 standard coding). For newborn admissions (ATYPE = 4): (1) normal newborn, (2) premature delivery, (3) sick baby, (4) extramural birth; For non-newborn admissions (ATYPE NE 4): (1) physician referral, (2) clinic referral, (3) HMO referral, (4) transfer from a hospital, (5) transfer from a skilled nursing facility, (6) transfer from a another health care facility, (7) emergency room, (8) court/law enforcement, (A) transfer from a critical access hospital, (B) transfer from another home health agency, (C) readmission to same home health agency, (D) transfer from one distinct unit of the hospital to another distinct unit of the same hospital resulting in a separate claim to the payer, (E) transfer from ambulatory surgery center, (F) transfer from hospice and under hospice plan	AK, AZ, CA, CO, CT, FL, GA, HI, IA, KS, KY, MD, ME, MI, MN, MO, MT, NC, ND, NE, NM, OK, OR, PA, RI, SC, SD, TN, TX, UT, VT, WA, WI, WY
	POINTOFORIGIN_X	2009-2011	Point of origin for admission or visit, as received from source	CA, MA, MD, ME
	POINTOFORIGIN_UB04	2007-2011	Point of origin for admission or visit, UB-04 standard coding. For newborn admission (ATYPE = 4): (5) Born inside this hospital, (6) Born outside of this hospital; For non-newborn admissions (ATYPE NE 4): (1) Non-health care facility point of origin, (2) Clinic, (4) Transfer from a hospital (different facility), (5) Transfer from a skilled Nursing Facility (SNF) or Intermediate Care Facility (ICF), (6) Transfer from another health care facility, (7) Emergency room, (8) Court/law enforcement, (B) Transfer from another Home Health Agency, (C) Readmission to Same Home Health Agency, (D) Transfer from one distinct unit of the hospital to another distinct unit of the same hospital resulting in a separate claim to the payer, (E) Transfer from ambulatory surgery center, (F) Transfer from hospice and is under a hospice plan of care or enrolled in a hospice program	CA, MA, MD, ME

Type of Data Element	HCUP Name	Years Available	Coding Notes	Unavailable in 2011 for:
Transferred into hospital	TRAN_IN	2008-2011	Transfer In Indicator: (0) not a transfer, (1) transferred in from a different acute care hospital [ATYPE NE 4 & (ASOURCE=2 or POO=4)], (2) transferred in from another type of health facility [ATYPE NE 4 & (ASOURCE=3 or POO=5,6)]	
Indicator of emergency department service	HCUP_ED	2007-2011	Indicator that discharge record includes evidence of emergency department (ED) services: (0) Record does not meet any HCUP Emergency Department criteria, (1) Emergency Department revenue code on record, (2) Positive Emergency Department charge (when revenue center codes are not available), (3) Emergency Department CPT procedure code on record, (4) Admission source of ED, (5) State-defined ED record; no ED charges available	
Admission type	ATYPE	1988-2011	Admission type, uniform coding: (1) emergency, (2) urgent, (3) elective, (4) newborn, (5) Delivery (coded in 1988-1997 data only), (5) trauma center beginning in 2003 data, (6) other	CA
	ELECTIVE	2002-2011	Indicates elective admission: (1) elective, (0) non-elective admission	

Patient demographic and location information

Type of Data Element	HCUP Name	Years Available	Coding Notes	Unavailable in 2011 for:
Age at admission	AGE	1988-2011	Age in years coded 0-124 years	
	AGEDAY	1988-2011	Age in days coded 0-365 only when the age in years is less than 1	FL, HI, MA, ME, SC, TX
Sex of patient	FEMALE	1998-2011	Indicates gender for NIS beginning in 1998: (0) male, (1) female	
	SEX	*1988-1997*	*Indicates gender for NIS prior to 1998: (1) male, (2) female*	
Race of patient	RACE	1988-2011	Race, uniform coding: (1) white, (2) black, (3) Hispanic, (4) Asian or Pacific Islander, (5) Native American, (6) other	MN, ND, OH, WV

Type of Data Element	HCUP Name	Years Available	Coding Notes	Unavailable in 2011 for:
Location of patient's residence	PL_NCHS2006	2007-2011	Patient Location: NCHS Urban-Rural Code (V2006). This is a six-category urban-rural classification scheme for U.S. counties: (1) "Central" counties of metro areas of >=1 million population,(2) "Fringe" counties of metro areas of >=1 million population,(3) Counties in metro areas of 250,000-999,999 population,(4) Counties in metro areas of 50,000-249,999 population,(5) Micropolitan counties,(6) Not metropolitan or micropolitan counties	MA
	PL_UR_CAT4	*2003-2006*	*Urban–rural designation for patient's county of residence: (1) large metropolitan, (2) small metropolitan, (3) micropolitan, (4) non-metropolitan or micropolitan*	
Median household income for patient's ZIP Code	ZIPINC_QRTL	2003-2011	Median household income quartiles for patient's ZIP Code. For 2008, the median income quartiles are defined as: (1) $1 - $38,999; (2) $39,000 - $47,999; (3) $48,000 - 62,999; and (4) $63,000 or more.	
	ZIPINC	*1998-2002*	*Median household income category in files beginning in 1998: (1) $1-$24,999, (2) $25,000-$34,999, (3) $35,000-$44,999, (4) $45,000 and above*	
	ZIPINC4	*1988-1997*	*Median household income category in files prior to 1998: (1) $1-$25,000, (2) $25,001-$30,000, (3) $30,001-$35,000, (4) $35,001 and above*	
	ZIPINC8	*1988-1997*	*Median household income category in files prior to 1998: (1) $1-$15,000, (2) $15,001-$20,000, (3) $20,001-$25,000, (4) $25,001-$30,000, (5) $30,001-$35,000, (6) $35,001-$40,000, (7) $40,001-$45,000, (8) $45,001 or more*	

Payer information

Primary expected payer	PAY1	1988-2011	Expected primary payer, uniform: (1) Medicare, (2) Medicaid, (3) private including HMO, (4) self-pay, (5) no charge, (6) other	

Type of Data Element	HCUP Name	Years Available	Coding Notes	Unavailable in 2011 for:
	PAY1_N	*1988-1997*	*Expected primary payer, nonuniform: (1) Medicare, (2) Medicaid, (3) Blue Cross, Blue Cross PPO, (4) commercial, PPO, (5) HMO, PHP, etc., (6) self-pay, (7) no charge, (8) Title V, (9) Worker's Compensation, (10) CHAMPUS, CHAMPVA, (11) other government, (12) other*	
	PAY1_X	1998-2011	Expected primary payer, as received from the data source	ME
Secondary expected payer	PAY2	1988-2011	Expected secondary payer, uniform: (1) Medicare, (2) Medicaid, (3) private including HMO, (4) self-pay, (5) no charge, (6) other	AZ, CA, FL, HI, IA, OH, OK, RI, SD, VA
	PAY2_N	*1988-1997*	*Expected secondary payer, nonuniform: (1) Medicare, (2) Medicaid, (3) Blue Cross, Blue Cross PPO, (4) commercial, PPO, (5) HMO, PHP, etc., (6) self-pay, (7) no charge, (8) Title V, (9) Worker's Compensation, (10) CHAMPUS, CHAMPVA, (11) other government, (12) other*	
	PAY2_X	1998-2011	Expected secondary payer, as received from the data source	AZ, CA, FL, HI, IA, ME, OH, OK, RI, SD, VA

Diagnosis and procedure information

ICD-9-CM diagnoses	DX1 – DX25	1988-2011	Diagnoses, principal and secondary (ICD-9-CM). Beginning in 2003, the diagnosis array does not include any external cause of injury codes. These codes have been stored in a separate array ECODEn. Beginning in 2009, the diagnosis array was increased from 15 to 25.	
	NDX	1988-2011	Number of diagnoses coded on the original record	
	DSNDX	*1988-1997*	*Number of diagnosis fields provided by the data source*	
	DXSYS	*1988-1997*	*Diagnosis coding system (ICD-9-CM)*	
	DXV1 - DXV15	*1988-1997*	*Diagnosis validity flags*	

Type of Data Element	HCUP Name	Years Available	Coding Notes	Unavailable in 2011 for:
External causes of injury and poisoning	ECODE1 - ECODE4	2003-2011	External cause of injury and poisoning code, primary and secondary (ICD-9-CM). Beginning in 2003, external cause of injury codes are stored in a separate array ECODEn from the diagnosis codes in the array DXn. Prior to 2003, these codes are contained in the diagnosis array (DXn).	
	NECODE	2003-2011	Number of external cause of injury codes on the original record. A maximum of 4 codes are retained on the NIS.	
ICD-9-CM procedures	PR1 - PR15	1988-2011	Procedures, principal and secondary (ICD-9-CM)	
	NPR	1988-2011	Number of procedures coded on the original record	
	DSNPR	*1988-1997*	*Number of procedure fields in this data source*	
	PRSYS	*1988-1997*	*Procedure system (1) ICD-9-CM, (2) CPT-4, (3) HCPCS/CPT-4*	
	PRV1 -PRV15	*1988-1997*	*Procedure validity flag: (0) Indicates a valid and consistent procedure code, (1) Indicates an invalid code for the discharge date*	
	PRDAY1	1988-2011	Number of days from admission to principal procedure.	OH, OK, UT, WV
	PRDAY2 - PRDAY15	1998-2011	Number of days from admission to secondary procedures	HI, OH, OK, UT, WI, WV

DRG information

Diagnosis Related Group (DRG)	DRG	1988-2011	DRG in use on discharge date	
	DRG_NoPOA	2008-2011	DRG in use on discharge date, calculated without Present On Admission (POA) indicators	
	DRGVER	1988-2011	Grouper version in use on discharge date	
	DRG10	*1988-1999*	*DRG Version 10 (effective October 1992 - September 1993)*	
	DRG18	*1998-2005*	*DRG Version 18 (effective October 2000 - September 2001)*	
	DRG24	2006-2011	DRG Version 24 (effective October 2006 - September 2007)	
Major Diagnosis Category (MDC)	MDC	1988-2011	MDC in use on discharge date	
	MDC_noPOA	2009-2011	MDC in use on discharge date, calculated without Present on Admission (POA) indicators	

Type of Data Element	HCUP Name	Years Available	Coding Notes	Unavailable in 2011 for:
	MDC10	*1988-1999*	*MDC Version 10 (effective October 1992 - September 1993)*	
	MDC18	*1998-2005*	*MDC Version 18 (effective October 2000 - September 2001)*	
	MDC24	2006-2011	MDC Version 24 (effective October 2006 - September 2007)	

Other data elements derived from ICD-9-CM codes
see also:
Table 3, Data Elements in the NIS Disease Severity Measures File and
Table 4, Data Elements in the NIS Diagnosis and Procedures Groups File

Clinical Classifications Software (CCS) category	DXCCS1 – DXCCS25	1998-2011	Clinical Classifications Software (CCS) category for all diagnoses for NIS beginning in 1998. Beginning in 2009, the diagnosis array was increased from 15 to 25.	
	DCCHPR1	*1988-1997*	*CCS category for principal diagnosis for NIS prior to 1998. CCS was formerly called the Clinical Classifications for Health Policy Research (CCHPR).*	
	E_CCS1 - E_CCS4	2003-2011	CCS category for the external cause of injury and poisoning codes	
	PRCCS1 - PRCCS15	1998-2011	CCS category for all procedures for NIS beginning in 1998	
	PCCHPR1	*1988-1997*	*CCS category for principal procedure for NIS prior to 1998. CCS was formerly called the Clinical Classifications for Health Policy Research (CCHPR).*	
Number of chronic conditions	NCHRONIC	2008-2011	Count of chronic conditions in the diagnosis vector	
Operating room procedure indicator	ORPROC	2009-2011	Major operating room procedure indicator for the record: (0) no major operating room procedure, (1) major operating room procedure	
Neonatal/ maternal flag	NEOMAT	1988-2011	Assigned from diagnoses and procedure codes: (0) not maternal or neonatal, (1) maternal diagnosis or procedure, (2) neonatal diagnosis, (3) maternal and neonatal on same record	
Indicates in-hospital birth	HOSPBRTH	2006-2011	Indicator that discharge record includes diagnosis of birth that occurred in the hospital: (0) Not an in-hospital birth, (1) In-hospital birth	

Resource use information

Total charges	TOTCHG	1988-2011	Total charges, edited	
	TOTCHG_X	1988-2011	Total charges, as received from data source	ME
Length of stay	LOS	1988-2011	Length of stay, edited	
	LOS_X	1988-2011	Length of stay, as received from data source	ME

Discharge information

Discharge quarter	DQTR	1988-2011	Coded: (1) First quarter, Jan - Mar, (2) Second quarter, Apr - Jun, (3) Third quarter, Jul - Sep, (4) Fourth quarter, Oct - Dec	
	DQTR_X	2006-2011	Discharge quarter, as received from data source	
Discharge year	YEAR	1988-2011		
Disposition of patient (discharge status)	*DISP*	*1988-1997*	*Disposition of patient, uniform coding used prior to 1998: (1) routine, (2) short-term hospital, (3) skilled nursing facility, (4) intermediate care facility, (5) another type of facility, (6) home health care, (7) against medical advice, (20) died*	
	DIED	1988-2011	Indicates in-hospital death: (0) did not die during hospitalization, (1) died during hospitalization	
	DISPUB92	*1998-2006*	*Disposition of patient, UB-92 coding: (1) routine, (2) short-term hospital, (3) skilled nursing facility, (4) intermediate care, (5) another type of facility, (6) home health care, (7) against medical advice, (8) home IV provider,(20) died in hospital, (40) died at home, (41) died in a medical facility, (42) died, place unknown, (43) alive, Federal health facility, (50) Hospice, home, (51) Hospice, medical facility, (61) hospital-based Medicare approved swing bed , (62) another rehabilitation facility, (63) long-term care hospital, (64) certified nursing facility, (65) psychiatric hospital, (66) critical access hospital (71) another institution for outpatient services, (72) this institution for outpatient services, (99) discharged alive, destination unknown*	

DISPUB04	2006-2011	Disposition of patient, UB04 standard coding: (1)Discharged to Home or Self Care (Routine Discharge), (2) Discharged/transferred to a Short-Term Hospital for Inpatient Care, (3) Discharged/transferred to a Skilled Nursing Facility (SNF), (4) Discharged/transferred to an Intermediate Care Facility (ICF), (5) Discharged/transferred to a Designated Cancer Center or Children's Hospital (Effective 10/1/07), (5) Discharged/transferred to another type of institution not defined elsewhere (Effective prior to 10/1/07), (6) Discharged/transferred to Home under care of Organized Home Health Service Organization, (7) Left Against Medical Advice or Discontinued Care, (8) home IV provider, (9) Admitted as an inpatient to this hospital - valid only on outpatient data, (20) Expired, (40) Expired at home, (41) Expired in a Medical Facility, (42) Expired - place unknown, (43) Discharged/transferred to a Federal Health Care Facility, (50) Hospice – Home, (51) Hospice - Medical Facility , (61) Discharged/transferred to a Hospital-Based Medicare approved Swing Bed, (62) Discharged/transferred to an Inpatient Rehabilitation Facility (IRF) including Rehabilitation Distinct part unit of a hospital, (63) Discharged/transferred to a Medicare certified Long Term Care Hospital (LTCH), (64) Discharged/transferred to a Nursing Facility certified by Medicaid, but not certified by Medicare, (65) Discharged/transferred to a Psychiatric Hospital or Psychiatric distinct part unit of a hospital, (66) Discharged/transferred to a Critical Access Hospital (CAH), (70) Discharged/transferred to another type of institution not defined elsewhere (Effective 10/1/07), (71) Another institution for outpatient services, (72) This institution for outpatient services, (99) Discharged alive, destination unknown	CA, MD, ME

	DISPUNIFORM	1998-2011	Disposition of patient, uniform coding used beginning in 1998: (1) routine, (2) transfer to short-term hospital, (5) other transfers, including skilled nursing facility, intermediate care, and another type of facility, (6) home health care, (7) against medical advice, (20) died in hospital, (99) discharged alive, destination unknown
	TRAN_OUT	2010-2011	Transfer Out Indicator: (0) not a transfer, (1) transferred out to a different acute care hospital, (2) transferred out to another type of health facility

Weights (to calculate national estimates)

Discharge weights (weights for 1988-1993 are on Hospital Weights file)	DISCWT	1998-2011	Discharge weight on Core file and Hospital Weights file for NIS beginning in 1998. In all data years except 2000, this weight is used to create national estimates for all analyses. In 2000 only, this weight is used to create national estimates for all analyses, excluding those that involve total charges.
	DISCWT_U	*1993-1997*	*Discharge weight on Core file and Hospital Weights file for NIS prior to 1998*
	DISCWTcharge	*2000*	*Discharge weight for national estimates of total charges. In 2000 only, this weight is used to create national estimates for analyses that involve total charges.*
	DISCWT10	*1998-2004*	*Discharge weight on 10% subsample Core file for NIS from 1998 to 2004. In all data years except 2000, this weight is used to create national estimates for all analyses. In 2000 only, this weight is used to create national estimates for all analyses, excluding those that involve total charges.*
	D10CWT_U	*1993-1997*	*Discharge weight on 10% subsample Core file for NIS prior to 1998*
	DISCWTcharge10	*2000*	*Discharge weight for national estimates of total charges on 10% subsample file. In 2000 only, this weight is used to create national estimates for analyses that involve total charges.*

Hospital information				
Hospital identifiers (encrypted)	DSHOSPID	1988-2011	Hospital number as received from the data source	AK, GA, HI, IN, KS, LA, ME, MI, MO, NE, NM, OH, OK, SC, SD, TN, TX, WY
	HOSPID	1988-2011	HCUP hospital number (links to Hospital Weights file)	
Hospital location	HOSPST	1988-2011	State postal code for the hospital (e.g., AZ for Arizona)	
	HOSPSTCO	*1988-2002*	*Modified Federal Information Processing Standards (FIPS) State/county code for the hospital links to Area Resource File (available from the Bureau of Health Professions, Health Resources and Services Administration). Beginning in 2003, this data element is available only on the Hospital Weights file.*	
Hospital stratifier	NIS_STRATUM	1998-2011	Stratum used to sample hospitals, based on geographic region, control, location/teaching status, and bed size. Stratum information is also contained in the Hospital Weights file.	
Other identifiers				
Physician identifiers, synthetic	*MDID_S*	*1988-2000*	*Synthetic attending physician number in files prior to 2001*	
	MDNUM1_R	*2003-2009*	*Re-identified attending physician number in files starting in 2003*	
	MDNUM1_S	*2001-2002*	*Synthetic attending physician number in files beginning in 2001 and discontinued in 2003*	
	SURGID_S	*1988-2000*	*Synthetic primary surgeon number in files prior to 2001*	
	MDNUM2_R	*2003-2009*	*Re-identified secondary physician number in files starting in 2003*	
	MDNUM2_S	*2001-2002*	*Synthetic secondary physician number in files beginning in 2001 and discontinued in 2003*	

Data source information	*DSNUM*	*1988-1997*	*Data source number*
	DSTYPE	*1988-1997*	*Data source type: (1) State data organization, (2) Hospital association, (3) Consortia*
Record identifier, synthetic	KEY	1998-2011	Unique record number for file beginning in 1998
	SEQ	*1988-1997*	*Unique record number for NIS prior to 1998*
	SEQ_SID	*1994-1997*	*Unique record number for NIS and SID prior to 1998*
	PROCESS	*1988-1997*	*Processing number for NIS prior to 1998*

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Table 2. Data Elements in the NIS Hospital Weights Files

Data elements that are *italicized* are not included in the 2011 NIS Hospital Weights File, but are only available in previous years' files.

Type of Data Element	HCUP Name	Years Available	Coding Notes	Unavailable in 2011 for:
Discharge counts	N_DISC_U	1988-2011	Number of AHA universe discharges in the stratum	
	S_DISC_U	1988-2011	Number of sampled discharges in the sampling stratum (NIS_STRATUM or STRATUM)	
	S_DISC_S	*1988-1997*	*Number of sampled discharges in the stratum STRAT_ST*	
	N_DISC_F	*1988-1997*	*Number of frame discharges in the stratum*	
	N_DISC_S	*1988-1997*	*Number of State's discharges in the stratum*	
	TOTAL_DISC	1998-2011	Total number of discharges from this hospital in the NIS	
	TOTDSCHG	*1988-1997*	*Total number of discharges from this hospital in the NIS*	
Discharge weights	DISCWT	1998-2011	Discharge weight used in the NIS beginning in 1998. In all data years except 2000, this weight is used to create national estimates for all analyses. In 2000 only, this weight is used to create national estimates for all analyses, excluding those that involve total charges.	
	DISCWT_U	*1988-1997*	*Discharge weights used in the NIS prior to 1998.*	
	DISCWT_F	*1988-1997*	*Discharge weights to the sample frame are available only in 1988-1997*	
	DISCWT_S	*1988-1997*	*Discharge weights to the State are available only in 1988-1997*	
	DISCWTcharge	*2000*	*Discharge weight for national estimates of total charges for 2000 only.*	
Discharge Year	YEAR	1988-2011	Discharge year	
Hospital counts	*N_HOSP_F*	*1988-1997*	*Number of frame hospitals in the stratum*	
	N_HOSP_S	*1988-1997*	*Number of State's hospitals in the stratum*	
	N_HOSP_U	1988-2011	Number of AHA universe hospitals in the stratum	
	S_HOSP_S	*1988-1997*	*Number of sampled hospitals in STRAT_ST*	
	S_HOSP_U	1988-2011	Number of sampled hospitals in the stratum (NIS_STRATUM or STRATUM)	

Type of Data Element	HCUP Name	Years Available	Coding Notes	Unavailable in 2011 for:
Hospital identifiers	HOSPID	1988-2011	HCUP hospital number (links to Inpatient Core files)	
	AHAID	1988-2011	AHA hospital identifier that matches AHA Annual Survey Database (not available for all States)	AK, GA, HI, IN, KS, LA, ME, MI, MO, NE, NM, OH, OK, SC, SD, TN, TX, WY
	IDNUMBER	1988-2011	AHA hospital identifier without the leading 6 (not available for all States)	AK, GA, HI, IN, KS, LA, ME, MI, MO, NE, NM, OH, OK, SC, SD, TN, TX, WY
	HOSPNAME	1993-2011	Hospital name from AHA Annual Survey Database (not available for all States)	AK, AR, GA, HI, IN, KS, LA, ME, MI, MO, NE, NM, OH, OK, SC, SD, TN, TX, WY
Hospital location	HOSPADDR	1993-2011	Hospital address from AHA Annual Survey Database (not available for all States)	AK, AR, GA, HI, IN, KS, LA, ME, MI, MO, NE, NM, OH, OK, SC, SD, TN, TX, WY
	HOSPCITY	1993-2011	Hospital city from AHA Annual Survey Database (not available for all States)	AK, AR, GA, HI, IN, KS, LA, ME, MI, MO, NE, NM, OH, OK, SC, SD, TN, TX, WY
	HOSPST	1988-2011	Hospital State postal code for hospital (e.g., AZ for Arizona)	
	HOSPSTCO	2002-2011	Modified Federal Information Processing Standards (FIPS) State/county code	AK, GA, HI, IN, KS, LA, ME, MI, MO, NE, NM, OH, OK, SC, SD, TN, TX, WY

Type of Data Element	HCUP Name	Years Available	Coding Notes	Unavailable in 2011 for:
	HFIPSSTCO	2005-2011	Unmodified Federal Information Processing Standards (FIPS) State/county code for the hospital. Links to the Area Resource File (available from the Bureau of Health Professions, Health Resources and Services Administration)	AK, GA, HI, IN, KS, LA, ME, MI, MO, NE, NM, OH, OK, SC, SD, TN, TX, WY
	HOSPZIP	1993-2011	Hospital ZIP Code from AHA Annual Survey Database (not available for all States)	AK, AR, GA, HI, IN, KS, LA, ME, MI, MO, NE, NM, OH, OK, SC, SD, TN, TX, WY
Hospital characteristics	HOSP_BEDSIZE	1998-2011	Bed size of hospital (STRATA): (1) small, (2) medium, (3) large	
	H_BEDSZ	*1993-1997*	*Bed size of hospital: (1) small, (2) medium, (3) large*	
	ST_BEDSZ	*1988-1992*	*Bed size of hospital: (1) small, (2) medium, (3) large*	
	HOSP_CONTROL	1998-2011	Control/ownership of hospital, collapsed (STRATA): (0) government or private, collapsed category, (1) government, nonfederal, public, (2) private, non-profit, voluntary, (3) private, invest-own, (4) private, collapsed category	
	H_CONTRL	1993-1997, 2008-2011	Control/ownership of hospital: (1) government, nonfederal (2) private, non-profit (3) private, investor-own	
	ST_OWNER	*1988-1992*	*Control/ownership of hospital: (1) public (2) private, non-profit (3) private for profit*	
	HOSP_ LOCATION	1998-2011	Location: (0) rural, (1) urban	
	H_LOC	*1993-1997*	*Location: (0) rural, (1) urban*	
	HOSP_ LOCTEACH	1998-2011	Location/teaching status of hospital (STRATA): (1) rural, (2) urban non-teaching, (3) urban teaching	
	HOSP_ MHSMEMBER	2007-2011	Multi-hospital system membership: (0) non-member, (1) member	CO, CT, SC
	HOSP_ MHSCLUSTER	2007-2011	Multi-hospital system cluster code: (1) centralized health system, (2) centralized physician/insurance health system, (3) moderately centralized health system, (4) decentralized health system, (5) independent hospital system, (6) unassigned	AK, CO, CT, SC, VT
	HOSP_RNPCT	2007-2011	Percentage of RNs among all nurses (RNs and LPNs)	CO, CT, GA, SC
	HOSP_ RNFTEAPD	2007-2011	RN FTEs per 1000 adjusted inpatient days	CO, CT, GA, SC

Type of Data Element	HCUP Name	Years Available	Coding Notes	Unavailable in 2011 for:
	HOSP_ LPNFTEAPD	2007-2011	LPN FTEs per 1000 adjusted inpatient days	CO, CT, GA, SC
	HOSP_ NAFTEAPD	2007-2011	Nurse aides per 1000 adjusted inpatient days	CO, CT, GA, SC
	HOSP_ OPSURGPCT	2007-2011	Percentage of all surgeries performed in outpatient setting	CO, CT
	H_LOCTCH	*1993-1997*	*Location/teaching status of hospital: (1) rural, (2) urban non-teaching, (3) urban teaching*	
	LOCTEACH	*1988-1992*	*Location/teaching status of hospital: (1) rural, (2) urban non-teaching, (3) urban teaching*	
	HOSP_REGION	1998-2011	Region of hospital (STRATA): (1) Northeast, (2) Midwest, (3) South, (4) West	
	H_REGION	*1993-1997*	*Region of hospital: (1) Northeast, (2) Midwest, (3) South, (4) West*	
	ST_REG	*1988-1992*	*Region of hospital: (1) Northeast, (2) Midwest, (3) South, (4) West*	
	HOSP_TEACH	1998-2011	Teaching status of hospital: (0) non-teaching, (1) teaching	
	H_TCH	*1993-1997*	*Teaching status of hospital: (0) non-teaching, (1) teaching*	
	NIS_STRATUM	1998-2011	Stratum used to sample hospitals beginning in 1998; includes geographic region, control, location/teaching status, and bed size	
	STRATUM	*1988-1997*	*Stratum used to sample hospitals prior to 1998; includes geographic region, control, location/teaching status, and bed size*	
	STRAT_ST	*1988-1997*	*Stratum for State-specific weights*	
Hospital weights	HOSPWT	1998-2011	Weight to hospitals in AHA universe (i.e., total U.S.) beginning in 1998	
	HOSPWT_U	*1988-1997*	*Weight to hospitals in AHA universe (i.e., total U.S.) prior to 1998*	
	HOSPWT_F	*1988-1997*	*Weight to hospitals in the sample frame*	
	HOSPWT_S	*1988-1997*	*Weight to hospitals in the State*	

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