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Information Governance: An Investigation of Interface Errors Between Source and Receiving Systems

MIchelle R. Mitcheff
University of Tennessee Health Science Center

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Michelle R. Mitcheff, RHIA, CDIP, CCS

University of Tennessee Health Science Center

Abstract

The monitoring of interoperability of information in healthcare organizations is of increasing interest due to patient safety, operational and financial considerations. This monitoring is referred to as information governance (IG) and is a complex topic based on several underlying concepts. Interfacing information at the foundational, structural and semantic level is necessary for meaningful use of health information. Issues that arise range from incongruent transfer of information from source systems to receiving systems, discrepancies in the source system and receiving system and failures in interfacing information. This research project examines information governance from the perspective of failures in interfacing information from the perspective of people, process and technology in monitoring interface errors between health information systems. The research design is evaluation and the methodology is case study in order to evaluate the effectiveness of interfaces between source and receiving systems. Particularly 17 Health Level Seven (HL7) interfaces were reviewed within a Critical Access Hospital (CAH) to investigate information governance from a people, process and technology perspective. This case study helped to identify needed information governance within the organization and plan for implementation of an information governance committee in order to address foundational and structural issues and to monitor unintended consequences caused by interface errors in the areas of patient safety, operational and financial impact due to interface errors.

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Chapter 1 – Introduction

Information governance (IG) is not a standalone concept but one that requires the understanding of other complex definitions upon which IG is based. These concepts include external demands such as interoperability, Triple Aim and meaningful use. One of the concepts that IG is based upon is interoperability. The definition of interoperability is crucial in understanding IG. The Healthcare Information and Management Systems Society (HIMSS) published a definition of interoperability as the following:

> In healthcare, interoperability is the ability of different information technology systems and software applications to communicate, exchange data, and use the information that has been exchanged. Data exchange schema and standards should permit data to be shared across clinicians, lab, hospital, pharmacy, and patient regardless of the application or application vendor. Interoperability means the ability of health information systems to work together within and across organizational boundaries in order to advance the effective delivery of healthcare for individuals and communities (HIMSS, 2013).

This interoperability is described by HIMSS in levels with advancing capabilities from exchange of information to interpretation of information with the highest level being the ability for exchange, interpretation and the triggering of clinical decision support based on the most current patient information in order to "improve quality, safety, efficiency, and efficacy of healthcare delivery" (HIMSS, 2010).

There are three types of interoperability identified in the literature reviewed by the author. The first type of interoperability identified by the authors is "foundational interoperability" which is the transfer of information from one system to another without the recipient system being able to interpret the information. The second type of interoperability is "structural interoperability" which is the interface of data at a "granular" level. This is usually through an interface such as Health Level Seven which allows the information to be transmitted, received, "translated" and integrated into the receiving system. The third and highest level of interoperability is "semantic interoperability." Semantic interoperability is the ability of multiple healthcare encounters with different systems being able to pull the most current patient information through standards and coding which "triggers clinical decision support" based on the information pulled (Studeny and Coustassi, 2014). This research project is in relation to the first two types of interoperability as defined by HIMSS; foundational and structural. The third level of interoperability is not possible without the foundational and structural components of interoperability being achieved first. The definitions also support the need for IG from a patient safety perspective as if the information is not current, available nor interfaced appropriately the various levels of interoperability cannot be achieved.

Based upon the definition of interoperability there is the need for monitoring flow of information which is information governance (IG). IG is of increasing interest in the world of meaningful use of the electronic health record. "Meaningful Use" of information technology is defined as information technology to improve outcomes, increase efficiency and improve quality healthcare (Healthit.gov, n.d.). The benefits of interoperability or interface of information within and outside an organization are a

network of health information that support quality, safety and efficiency of healthcare, which are also two of the three elements of the "Triple Aim" initiative at improving healthcare in the United States (Berwick, 2011). The Triple Aim is an initiative for improving quality, access and cost and the incentive money provided by the government through the Health Information Technology for Economic and Clinical Health Act of 2009 (HITECH) supports this initiative.

Information governance is a part of achieving this high level goal. This study supports this goal and investigates challenges at an organizational level that impact patient safety, operational and financial considerations of one organization. Based on the previous foundational definitions, IG is defined in the *Journal of AHIMA* article as:

> An organization-wide framework for managing information throughout its lifecycle and supporting the organization's strategy, operations, and regulatory, legal and environmental requirements (AHIMA, 2015).

Interfacing information from source systems to receiving systems in a congruent manner, discrepancies in the source system and receiving system and failures in interfacing information are areas that must be monitored by healthcare organizations in order for the larger national goal to be achieved. This research project examines source information, foundational and structural interoperability at the interface level between systems and errors in interface between source and receiving systems. The research design is evaluation and the methodology is case study in order to evaluate the effectiveness of interfaces between source and receiving systems.

Particularly all interfaces within a CAH healthcare organization were reviewed for errors during a designated timeframe. Although all interfaces had errors there were three interfaces with errors chosen for further study due to the high number of interface errors and potential for various impacts defined later in the research. Once identified, the people, process and technology was considered for ways to address IG issues identified. A consideration of a formal Information Governance Committee to monitor people, process and technology in order to improve the flow of information within the organization was recommended to the Quality department.

The structural interoperability that was studied were the HL7 interfaces and include the following:

1. Admission, Discharge Transfer (ADT) in from the Financial System
2. Ambulatory Surgery Documents from the Operating Room to the Hospital System
3. Lab Billing Import from the Lab System to the Hospital system and the Financial System.

These three were chosen due to having the highest number of errors with the interfaces during a designated time period of review.

This study came about from a chart review conducted by the Quality department. It was discovered the intraoperative report was missing from the medical record during the chart review and a meeting was called to see if anyone from the Operating Room was monitoring the interfaces error log within the electronic health record. During this time the Quality department discovered the intraoperative reports that normally interface from the Operating Room to the Hospital system had not interfaced correctly for a period of three

months from October 15, 2015 to January 15th, 2016. Due to this, there was the need to consider what are the interfaces in the various systems in the organization, who is monitoring the interfaces between systems and how are errors being corrected in a timely way for patient safety, operational and financial reasons.

The significance of this study is to have an understanding of the people, processes and technology for monitoring each interface and how errors are being corrected in a timely way in order to reduce the impact of the errors on patient safety, operations and financial reimbursement. At a granular level it is also to investigate if the foundation and structural capability is present to support the interfaces between systems.

Due to operational needs and patient care needs there is the need to have a variety of systems within healthcare organizations. These systems often do not interface information from system to system in a manner that meets the needs of the organizations and the cost to build the systems so they interface is expensive. There is the need to not only have various information systems but also to understand how each system "talks" to another system, the importance of monitoring these interfaces and the implications of errors if interfaces are not monitored. Additionally, how errors are corrected are a significant area of study and contribution to literature. For Critical Access Hospitals (CAH) the resources may be limited in making sure this is happening so it is imperative for organizations to plan for the need for interoperability by budgeting for foundational and structural build and design, staffing for monitoring these interfaces and having a process for correcting errors in a timely manner (Strasber, et. al., 2013). The purpose of the study is to evaluate who is monitoring the interface(s), how errors are being addressed and if systems interface design needs to occur at the foundational and structural level.

Initially the study was to investigate the interface of orders from the Ambulatory system to the Hospital system but it was discovered there is currently not an interface between the Ambulatory system and Hospital outpatient lab system. The 17 interfaces to and from the hospital system are outlined below:

Table 1

Source System	Receiving System	Interface Type
Financial System	ADT to hospital system	HL7
Admission, Discharge, Transfer (ADT) – Hospital System	Cardiology System	HL7
Cardiology Results	Hospital System	HL7
Lab System	Hospital System/Financial System	HL7
Admission, Discharge, Transfer and Orders	Laboratory System	HL7 – not set up
Ambulatory System Orders	Laboratory System	HL7
Lab System	Lab Results to Ambulatory System	HL7
Radiology System	Radiology Results to Ambulatory System	HL7
Ambulatory Surgery Documents	Hospital System	HL7
Results	Public Health System(s)	HL7
Laboratory System	Orders and Results to Hospital System	HL7
Admission, Discharge, Transfer Orders from Hospital System	PACS and Radiology Information Systems	HL7
PACS	Results to Hospital System	HL7
Radiology Information System	Results to Hospital System	HL7
Syndromic Surveillance	Hospital System	HL7
Admission, Discharge, Transfer Hospital System	Nuance Transcription	HL7

The three interfaces that were determined most necessary to study were ADT in from the Financial System, Ambulatory Surgery Documents to the Hospital System and the Lab Billing Import to the Financial System via the Hospital System.

This study is based on the work of the Office of the National Coordinator for Health Information Technology's Self-Assessment Guide, "SAFER: Safety Assurance Factors for EHR Resilience" (January 2014). It is also based on the secondary source which is the article prepared for the Agency for Healthcare Research and Quality (AHRQ) by JASON: the Mitre Corporation entitled "A Robust Health Data Infrastructure" (2014) which covers the high level goal of a nationwide health information exchange network built on a robust health data infrastructure with health information that is interoperable not only within an organization, nor regional level, but at a nationwide and even international level.

The questions to be answered through this evaluation study are whether interfaces are being monitored and by whom, processes to resolve errors and whether systems are set up adequately for the interface.

The limitations of the study include the type of hospital where the evaluation took place, the geographic location of the hospital, lack of response from the vendor related to interface error messages and interface design, bias issues related to the evaluator and the vendor of the EHR, and lack of information about particular errors identified.

Chapter 2 – Review of Literature

The purpose of this literature review is to identify literature to support the need for research on IG pertaining to interface errors. The author identified the literature through a search on key terms using the search engines at the University of Tennessee

Health Science Center library databases. Key words used for the search include: Electronic Medical Records, Electronic Health Records, Critical Access Hospitals EHR, Information Governance, Interface Design, Systems Integration, Health Level 7, Vendor Relations and Patient Safety, Safety EHR interface, and Unintended Consequences of EHR. Additionally, a previous research paper references list conducted by the author was used which pertained to interoperability at a national level.

The sections of the review of literature include the history and background related to IG, current research pertaining to the research topic and support for further research related to IG. This support includes source and receiving system IG, interfaces between systems and errors between source and receiving systems as well as the responsibility of organizations to monitor the interfaces between systems.

Primary literature was identified as the self-assessment guide developed based on the Office of the National Coordinator and Institute of Medicine recommendations for IG. Only one article references the need for interface error monitoring as a part of IG internal monitoring, validating the need for further research. The secondary literature to base the research on was identified as Agency for Healthcare Research and Quality (AHRQ): Prepared by JASON: The Mitre Corporation. (2014). A Robust Health Data Infrastructure. McLean, VA.

History/Background

According to an article in *Health Affairs* (2015) many healthcare organizations have implemented Electronic Health Records (EHR) since the institution of the Health Information Technology for Economic and Clinical Health (HITECH, 2009). Although there has been progress with implementation of EHRs in healthcare, literature shows that

in Critical Access Hospitals (CAH) implementation has been slower and with greater challenges. By 2013, 89 percent of CAHs had implemented an EHR in part or in full but challenges in implementation have varied and advanced capabilities have been limited due to limited resources and use of the EHR. The article notes the importance of making available "necessary resources and support…to critical-access hospitals, especially those that operate independently, to assist them in adopting health IT and becoming able to electronically link to the broader health care system" (2015). The CAH in this research study is an independent CAH. It is critical for CAH to address organizational interface issues as they often transfer patients to a higher level of care. If the interfaces are not addressed within the CAH it is possible the information interfaced will contain errors or missing health information.

In addition the HITECH the requirements of Meaningful Use evolving rapidly have placed additional burden on healthcare organizations to implement, get interoperable and bear a financial burden that is often beyond the budget of a CAH. The challenge of interoperability is one of the greatest frustrations noted in meaningful use of the electronic health record. Interfacing, exchanging and interpreting health information between disparate systems continues to be a challenge as meaningful use standards rapidly evolve without the health care system being prepared for the advancement. The HITECH Act as well as other quality initiatives are pushing the healthcare industry to be accountable for quality, safety and efficiency by integrating health information through "Meaningful Use" of information technology to improve outcomes, increase efficiency and improve quality healthcare (Healthit.gov, n.d.).

According to an article by David Raths (2014) Health Information Exchange (HIE) is impeded by interfaces not working correctly. Raths noted three main considerations to the impediment as the "financial cost of building interfaces, lack of consistent and timely response from EHR vendor interface developers, and technical difficulty of building the interfaces." The article was the compilation of survey data from a panel of HIE executives. Although this article is not specific to a healthcare organization but to the broader scope of HIE on a regional and national level, the frustrations are similar to those experienced by standalone CAH with interface issues. The article's scale is larger but it is important to consider that if hospitals are unable to have interface resolution within their organizations then it is difficult to reach the level of interoperability across the entire healthcare system.

The consideration for this study is based on the history of the challenges related to interfaces and the impact on HIE. The author reviewed the topic of IG and owning that process within the organization. An article by Erin Head (AHIMA, 2015) describes owning IG in the Health Information Management department through implementing an IG Committee. With the definition of IG and the need for the ownership of IG in each organization there was the need to study an area of IG within a particular organization to have a broader understanding of the people, processes and technology in place in order to move forward with a recommendation that can be implemented within organizations. Although the scope of IG is broader than what is defined in this article, this study is limited to IG as it pertains to the three interfaces identified in the introduction. The AHIMA (2015) article identifies steps for implementing IG within an organization. These steps include involvement of a multidisciplinary team that is aligned with organizational

goals and identifies people, process and technology in order to achieve these goals. This study is to identify if there are people in place to implement IG, are there processes in place to take care of IG issues and is the technology adequate to support the IG goals of the organization.

The development of the need for IG is also based on the Safety Assurance Factors for Electronic Health Record Resilience (SAFER) guide which identifies a process of how to assess IG issues within an organization. One of the seven recommendations of the SAFER guide by the Department of Health and Human Services identifies system interfaces as one of the areas organizations need to self-assess in order to optimize the "safety and safe use of electronic health records." (Department of Health and Human Services, 2015).

Interfaces were identified as a complex process due to several factors outlined in SAFER (2015) which include "the involvement of many stakeholders in various departments, often with differing agendas." Additionally identified were the challenges of software and hardware "that are developed independently" with the need to integrate for patient safety and operational purposes of the organization. The other area identified was the data in different systems "matching" in order to interface data without error. The mapping of data prior to implementing an interface is necessary in order to avoid these type of interface errors. (I.e. managing changes in the meaning of a data item). Finally, mapping and updates must be coordinated between systems and managing free text versus discrete data (SAFER, 2015). CAH organizations often have limited resources to meet this challenge and financial constraints on paying the vendor to do this mapping and build. Additionally, the information technology personnel are often frequently overturned

during a project and lack the understanding as to why it is critical for the information to flow appropriately (Raths, 2014). Another weakness related to vendors identified by Raths is that support for vendors often work out of a queue of issues and some from the survey identified they are six months behind in addressing issues within their queues (Raths, 2014).

In the AHRQ article (2014), multiple challenges are addressed to achieving interoperability. These include the inability of information exchange due to lack of "mutually comprehensible formats" and various parties deeming different information as important (JASON, 2014). Without a common language it is difficult to move to higher levels of interoperability if not impossible. Additionally, there is the need for interfaces between systems. Although there is interface using Health Level 7 (HL7) this is not true interoperability particularly between disparate systems. Part of the challenge is that although there are interfaces there are not true interoperability where vendors have developed "cross-platform standards" that would make it easier for the disparate systems to not only exchange but also interpret exchanged information (Rogoski, 2012). This would help to achieve semantic interoperability. Additionally, Rogoski's article mentions the cost to bridge health information. If one system needs a bridge to a disparate system there is a price tag attached by vendors which can be in the millions. Most healthcare organizations cannot absorb the cost associated with true interoperability and the incentive money received is used for implementation, upkeep and upgrades of systems currently in place to include the cost of new staff to oversee their new systems. For CAH this is an even greater concern as the census is limited to 25 beds and limited

communities so often cash on hand and budget constraints limit the available budget for information technology.

One example cited by JASON (2014) was the mandate by Congress for the Veterans Administration (VA) electronic health record system and the Department of Defense (DOD) to be interfaced and achieve semantic interoperability. The VA had been cited as a system that once implemented had increased access, reduced staff, reduced length of stay and also hospital admissions. However, achieving interoperability was an elusive endeavor that was abandoned. The cost of the failed attempt rose from $4 billion to $12 billion before being abandoned citing cost and management problems (JASON, 2014). The same attempts are being endeavored in the public sector with cost also being a prohibitive frustration.

Providers are also speaking out about their frustration with interoperability. Commins (2015) comments that there is still much "handholding" and "manual processes." Commins cited his own experience of a patient needing to be admitted to the hospital up the hill from his office, yet his system does not interface with the hospital system so there is the need to print out the record, hand deliver it to the hospital who has to scan it into their system where it is not searchable by the care team. This was also an issue identified through investigating interface errors when it was discovered the interface of orders has not yet been built between the clinic and hospital lab system.

In the *Health Affairs* article the authors identify the progress and challenges in implementing and effectively using health information technology of Critical Access Hospitals (CAH). Particularly identified are the rural nature of CAH facilities, lack of resources to support the implementation and the adoption of the information technology.

The majority of CAHs identified that the support was from the system owners (vendors) or a consultant company rather than internal IT professionals. This study primarily identified the progress of making more funds available to Critical Access Hospitals and identified ongoing challenges but did not specifically investigate interfaces particularly but the challenges faced by CAH in implementation and workflow of EHRs in a CAH. The one area addressed that impacted interface was related to infrastructure due to lack of broadband access which could potentially impact the interface of information (Hufstader, M, Jones, E., Samy, L., and King, J, 2014).

The SAFER guide was used for a research study by Singh, Ash and Sittig (2013). In their research the authors used all eight dimensions of SAFER for their research using a multidisciplinary team and developing a guide for addressing the eight dimensions and testing the assessment tool at different healthcare organizations. The authors identified some of the "unintended consequences" of EHR implementation experienced by healthcare organizations to include decreased efficiency by providers, and potential errors. The authors define errors as, "EHR-related errors should be defined from the sociotechnical viewpoint of end users, rather than from the purely technical viewpoint of manufacturers, developers, vendors, and personnel responsible for implementation. In this context, EHR-related errors could occur anytime the EHR is unavailable for use, malfunctions, is used incorrectly, or when EHR components interact incorrectly, resulting in data being lost or incorrectly entered, displayed, or transmitted." Examples are given by the authors of errors due to "technology errors, such as lack of transmission of test results due to software configuration problems." This research article identifies lack of transmission of test results with the potential for patient safety errors.

The Institute of Medicine Report, *Health IT and Patient Safety: Building Safer Systems for Better Care* (2011) was sponsored by the Office of the National Coordinator for Health Information Technology (ONC) and also implemented an "ongoing project" on "Anticipating the Unintended Consequences of Health IT" to include a safety self-assessment guide to address safety concerns (Singh, et. al., 2013). In the article *Defining Health Information Technology-Related Errors: New Developments Since to Err is Human,* Singh, et al, 2011 define an error related to interfaces as "sociotechnical" in nature meaning the errors are not purely technical nor human but a combination of sociotechnical methods. Singh, et. al identified eight areas that could potentially impact HIT-Related Errors. The two that were specific to interfaces were outlined as "Clinical content; data, information and knowledge entered, displayed or transmitted" and "People; the humans involved in the design, development, implementation and use of HIT." Remedies to these identified Sociotechnical Model Dimensions were related to prerelease testing for system to system data exchange and improvement of interfaces (Singh, et.al, 2011). The area not addressed by this study in detail was disparate system interfaces and interface design from system to system.

One of the original promises of IT in healthcare was to make healthcare safer and quality of care better. In order to achieve this goal it is necessary for hospitals, healthcare organizations and all clinical settings that utilize EHRs to implement "proactive monitoring strategies to detect new, unexpected EHR-related errors." The purpose of this research is to determine if people, processes and technology in a CAH hospital are in place to avoid potential patient safety, operational and financial negative impacts. It also is to seek out vendor interaction related to the issues identified. According to Singh, et.

al. (2013) this type of monitoring will "enable them to transform into safe and effective "EHR-enabled clinical work systems" by building resilience into their systems and processes".

Shermann, et. al. (2009) defined resilience in relation to information governance as the "degree to which a system continuously prevents, detects, mitigates or ameliorates hazards or incidents so that an organization can bounce back to its original ability to provide care. Through proactive, systematic assessment of risks and vulnerabilities, health care organizations can address potential EHR-related safety hazards before harmful incidents occur" (2009). Although the assessment tool developed by Singh et.al (2013) was not used in this research it was an indicator of the type of action that could be taken by the healthcare organization in addressing the issues that were detected through the research project in order to mitigate potential patient safety, operational and financial impacts to the organization due to interface errors.

Pinejab, Bahl and Berg (2008) identified that the issues of "inter-organizational communication" was not mainly a technical issue but a challenge that occurs when "technical linkage is implemented without the work processes being aligned and integrated" (2008).

A further development of socio-technical issues were identified by Siemieniuch and Sinclair (2014) in their concept of "System of Systems" information governance. This concept involves the fact that many systems are non-interoperable, created by different vendors or not interfaced properly for flow of information. A key concept of their work is the need to address proprietary information for different systems and the

need for interface building and working out how to interface between a "system of systems."

In the article *Effect of EHR user interface changes on internal prescription discrepancies* (Turchin, et. al., 2014), the authors identified discrepancies in prescriptions within an organization. The study was a retrospective analysis of 960,000 prescriptions within one EHR over a seven year period. Findings included 18.4% of prescriptions with discrepancies. A discrepancy is defined as what is input in one system does not match the receiving system. The reason identified for discrepancies related to using structured and narrative input techniques by providers. The study implemented changes in the EHR to reduce discrepancies which included clinician alerts and dropdown options to eliminate discrepancies. The study also identified the need for further research related to discrepancies in source and receiving systems.

In an interview, Paul Varghese (2013), a clinician and vendor, Varghese notes four things that healthcare IT must have to provide safe patient care. These include "content that is accurate and complete, organization of data so that it is meaningful to the clinician, workflow that conforms to convenient, efficient, and familiar clinical workflows; and output—on the part of the clinician to interact with a healthcare IT device should produce a meaningful output, either in coherent, unambiguous, pleasing sentences, or useful data." He notes that a frustration to achieving this is the implementation of the Affordable Care Act when clinicians were given a "push to adopt an EHR." This created an environment of vendors that were "eager to oblige" without having the necessary understanding of clinician workflow and workflow being considered "cosmetic" by the vendor(s). Now that there are multiple clinicians using the EHR it is Vargheses'

expectation that clinicians are in a position to require better EHRs and better response from vendors about potential and real issues.

In the article *Report Anaylzes EHR patient Safety Concerns,* Chapman (2014) identifies that vendors often build IT applications outside of the complex clinical workflow with the expectation that when implemented it will work within that complex workflow. Recommendations addressed in the article include required training at implementation, utilizing scribes for documentation, questioning vendor about risk mitigation and reporting on errors. In her article, Chapman speaks with Dick Taylor, MD the managing director and chief medical officer at MedSys Group who believes that HIT errors are not reported in a consistent manner in order to be addressed. Key reasons identified are the need for error reporting systems internally and externally that are specific to health IT errors. These need to be "simple, automated and blame-free" in order for issues to be addressed.

A research article that addressed User Centered Design was reviewed. This research visited eleven vendors to investigate if they had User Centered Design processes in place during EHR design as designated by the Office of the National Coordinator certification requirements. These requirements allow vendors "to develop their own UCD process or follow published processes such as the International Organization for Standardization guidelines or guidance from the National Institute of Standards and Technology." Although this research was not specifically related to interface errors, there was indication that clinicians are dissatisfied with EHRs due to information needs and display of data difficult to read due to interfaces of information that are not congruent (Ratwani, et. al., 2015).

Lou Ann Wiedemann (2012) addresses the unintended consequence of EHRs on patient safety. She particularly cites unavailable lab results to clinicians due to interface errors from disparate lab systems into the EHR. This article was particularly interesting for this research due to the interfaces studied. Eight of the nineteen interfaces reviewed were related to results from a diagnostic system. One of the three chosen for refined study does involve the lab interface via the EHR to the hospital system. Although this is not a patient safety issue it is potentially due to the interface having to do with ADT. Another result issue is related to the cardiology results interfacing with the EHR which potentially impacts availability of key information to the clinical team and potential patient safety issues.

A study by Strasberg, Del Fiol, and Cimino (2013) addresses the challenges of Health Level 7 interfaces in identifying relevant patient information. This study is not specifically related to the research but does address unique challenges with HL7 interfacing as it relates to indexing with standardized data. This is important in this research as the errors identified in data gathering included non-congruent data between systems as a potential cause for interface errors.

The article, *Management of laboratory data and information exchange in the electronic health record* (2015) identifies areas of concern as patient identification (ADT interface), Computerized Physician Order Entry, and results interfacing to the EHR. One of these identified areas of concern was identified in this research which is the ADT interface and special considerations for blood administration which have specific requirements that according to this article are not well developed modules within EHRs but have accreditation requirements that are stringent. Also identified is the concept of

results being available within the EHR in a manner that allows clinical decision support by the care team. This supports the need for further study of interface of information and the monitoring of interfaces within healthcare organizations through a multi-disciplinary IG Committee.

The literature review was limited by the number of research articles that specifically dealt with interface errors from one system to another system and the monitoring of interface errors by people, process and technology. Although there were multiple articles related to interfaces this was primarily human/system interface and not monitoring of interface errors between disparate systems. This case study will significantly contribute to the literature on the subject of IG with people, process and technology review particular to interface errors and how they are handled within an organization.

Chapter 3 – Methodology

In this section the research design, population and sample design, data collection procedures, data collection instrument and data analysis will be discussed.

The research design is evaluation and the methodology is case study in order to evaluate the effectiveness of interfaces between source and receiving systems. The reason for this type of design is access to an interface error log that will benefit the organization with findings and recommendations.

The population reviewed were all seventeen interfaces as outlined in the introduction. Based on the initial population of interface, three were selected for further review and this was determined by the number of errors that were identified. The timeframe of interface error review was from February 15, 2015 to February 15, 2016.

The reason for this timeframe was to gather data for one year starting from the date of data collection and going back one year.

Data collection procedures involved review of the HL7 Interface Error Log within the Hospital EHR system. The interface error log is a query that is run for the interface which returns number of errors within a specified timeframe as well as the specific error message. The data collection instrument is within the EHR.

The following table shows the Clinical Database Repository (CDR) Interface Audit conducted for the timeframe from 2/15/2015 to 2/15/2016 and the total number of errors. The interface error message will be discussed in the results section.

Table 2

Source System	**Receiving System**	**Total Errors**	**Interface Error Message**
Financial System	ADT to Hospital System	1230	i. – vii. ix. – xi.
Lab Billing Import	Financial System	287	viii. xii. xiii. xiv.
Intraoperative Report	Hospital System	353	xv.

It was not necessary to develop a data collection instrument since this is part of the design of the EHR. One issue was that the Cardiology results interface to the hospital system did not return a specific error message although there were error data returned. Further investigation will be necessary in the future as to why no specific error message was returned.

It was necessary to quantify total errors and the type of errors for each interface. One interface error message did not exist for an identified interface error and the vendor was unable to answer questions related to this interface issue.

Chapter 4 – Results

This chapter will cover the results of the data captured in the data collection in the previous chapter. This chapter will cover the type of errors returned from the HL7 audit tool within the EHR system.

As mentioned in the introduction to this research the background for this research is due to a realization that the intraoperative report was not interfaced into the EHR for the timeframe of October 15, 2015 to January 15, 2016. The total number of intraoperative reports not interfaced were 353. This created a significant operational challenge for the management of the legal health record. It was discovered that there were seven releases of information that required follow up in order to have released the complete medical record. Each record had to be re-reviewed and a list of patients gone through (353 records) to make sure if the record was released that it was a complete legal record release. Additionally a quality project was delayed due to this missing information. The total amount of time spent on re-working the release of information was two days for one staff member and three meetings by two department directors to address the process that would need to take place to correct the errors.

Based on this background it was determined it was necessary to conduct an interface error review of all systems available in the HL7 audit. The HL7 Audit tool within the EHR was used and it was discovered there are 17 interfaces into and out of the EHR. Not every system within the organization was reviewed because not all systems

have an interface to the hospital EHR. The listing of these interfaces is in table 1 in the introduction. The reasons for this study related to potential patient safety concerns of not having available information for the care team, operational impacts of this interface error which caused re-work for release of information. An unexpected finding was that there are also financial ramifications to failed interfaces when the financial system is involved.

In total there were 1870 errors in three interfaces between six systems over a one year timeframe. The vendor was contacted to define the meaning of the interface error messages. Of the 14 error messages there were definitions given for five but no solution was offered as to how to resolve the error except that a specialist could be involved and it would require a support ticket which would be prioritized. The error messages that were defined were vi., xi., xii., xiii., and xiv. Additionally it was suggested that the system design may need to be addressed. This was outside the scope of the author and was not pursued but the findings were reported within the organization.

Table 3

Interface Error Messages	
i.	Could not delete visit record
ii.	ADT cannot be processed
iii.	Visit deleted
iv.	Could not save MPI Record
v.	Patient type M not found
vi.	Visit number does not exist
vii.	Could not merge visit record because record number does not exist
viii.	ICD9 diagnosis code not found
ix.	Registration status P not found
x.	Received A08 on inactive patient
xi.	Visit did not pass inactive checking
xii.	Failed to load ICD diagnosis list (ICD10 error message)
xiii.	Could not store charge
xiv.	Charge code not found
xv.	No error message

Error Message	Vendor Response
vi. Visit does not exist	This could occur if Clinicals receives a message for a patient visit that does not exist in the system
xi. Visit did not pass inactive checking	This typically shows when Financials sent a "delete" visit message but clinicals could not delete visit due to clinical data that was added in the system
xii. Failed to load ICD diagnosis list	Could be occurring when clinicals is receiving an invalid ICD10 code from financials system. The code in the HL7 is the ICD9 code and the ICD10 code.
xiii. Could not store charge	A generic error that would require more research by a technical specialist (reason could be missing information in message, issue at application layer, etc.
xiv. Charge code not found	Error occurs when clinicals receives a charge code (in a billing transaction) that it cannot match on.

The purpose of this study was to determine if people, process and technology were involved in IG related to interface errors.

The conclusion of this case study shows that interface errors are not being monitored, processes are not in place in order to resolve interface errors and technology is inadequate in assisting in resolution.

Chapter 5 – Conclusions and Recommendations

This chapter will cover why this case study was conducted and how the case study was conducted to include a summary of findings, conclusions and also implications of the study.

This case study was conducted due to a finding by the Quality department that Ambulatory Surgery Documents had not interfaced to the Hospital EHR for a period of

three months. This was the impetus for conducting a study to determine if an IG Committee would be beneficial for the organization. Particularly reviewed were the questions of if there are people monitoring interface errors, what are the processes in place to resolve interface errors and does technology support information governance related to interface errors to include definition of interface errors in the HL7 audit tool. Also from and information technology perspective, are interface designs appropriate for the systems interfacing such as foundational system design and structural system design for appropriate interface of information (AHRQ, 2014)?

A synopsis of the study results is that there were 1870 interface errors between six systems over a one year period of time. The consequences of not monitoring these interface errors included potential patient safety concerns due to patient information not being available to the care team, operational hardship due to needing to rework data in downstream systems and processes (release of information and coding and billing), and financial consequences of missed charges and inadequate diagnosis codes. Additionally unavailable patient information to the care team could result in unintended consequences of the health information technology on patient safety.

This case study builds on the literature review to show the importance of system design, interface design, system of systems information governance, understanding the flow of information, and unintended consequences of Health Information Technology. The implications of this study include the need for a more detailed review of these unintended consequences, a greater need for information governance to include people to monitor interface errors, processes to correct interface errors in a timely manner and vendor technology input and expertise. The cost of the input by the vendor is something that needs

to be addressed at a national level as well as at the vendor/hospital contractual level. All systems reviewed were from the same vendor but as identified in the JASON report there is the need to also address the issue of proprietary information when building interfaces between systems developed by different vendors.

Critical Access Hospitals are allowed to keep patients for three days prior to transferring them to a higher level of care. Due to their rural nature it is imperative that when patients are transferred all patient information goes with the patient to the higher level of care so that patient safety is not compromised by the receiving care team. Although there are patient safety, operational and financial consequences within the organization itself when information does not interface appropriately there are also consequences when transferring patients from one healthcare organization to another without all information being available. This creates a risk situation that is outside the walls of only one organization.

Recommendations based on study results, findings and conclusions include the need for standard definitions for interface error messages, staffing to monitor interface errors, a multi-disciplinary team to review error logs and discuss processes to improve interface errors and financial analysis of missed reimbursement due to failed interfaces with the financial system. On an interorganizaitonal level there needs to be development of an anonymous way to report unintended consequences of Health Information Technology. This would allow organizations to report errors based on IG Committee findings. There does need to be oversight of vendors in response time to client concerns as well as accountability at the vendor level. There needs to be monitoring of cost associated with foundational and structural interface design, consideration by organizations of their IT

budget in absorbing this cost, grants available for assistance to organizations that show financial need, and timely response by vendors as well as transparency at time of contractual negotiations. Many organizations assume that interfaces are already available when purchasing an EHR when the modules are the same system, but this case study shows this is not the case and there is a cost to set the systems up appropriately for interfaces to work even when it is the same vendor. Also, there needs to be better testing on the side of the vendor. It is not adequate to test systems outside of a complex healthcare system that has multiple moving parts; people, patients, technology as well as operates on a twenty four hour, seven days a week and 365 days a year.

The solutions suggested in the JASON article (2014) are reducing the strict requirements of meaningful use, assuring interoperability prior to more meaningful use requirements, allowing time for providers to become used to new systems and allowing more innovation among vendors to achieve true interoperability. Rogoski (2012) also cites the need for vendors to come together outside of their proprietary systems in order to develop interfaces and true interoperability but at this point there is no incentive to do so.

An innovative approach is also to find out where the healthcare system is in relationship to exchanging, interfacing and interpreting health information between systems. A conceptual model was developed to test this on a regional level by McMurray, et. al. (2015). The model tested types of data exchanged across various healthcare organizations. It tests what is exchanged and what is received and disparity in information in order to test interoperability. There is the need for more conceptual models to test the interoperability that is currently taking place and at what level.

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