THE PATIENT IDENTIFICATION PROCESS AS IT RELATES TO ELECTRONIC HEALTH RECORD SAFETY: A LITERATURE REVIEW

By

Eric K. Gebhardt

A CAPSTONE

Presented to the Department of Biomedical Informatics & Clinical Epidemiology
and the Oregon Health & Science University
School of Medicine
in partial fulfillment of
the requirements for the degree of

Master of Biomedical Informatics

March 2013

School of Medicine

Oregon Health & Science University

CERTIFICATE OF APPROVAL

This is to certify that the Master's Capstone of

Eric K. Gebhardt

has been approved

_____

Mentor/Advisor

_____

Member

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

To Joan Ash, Ph.D., M.L.S., M.S., M.B.A., Professor and Vice Chair, Department of Medical Informatics & Clinical Epidemiology (DMICE), OHSU for being an advisor, teacher, and mentor. She taught me self-reliance, perseverance, and to not be satisfied with the status quo. Although I did not meet her until the final year of my academic journey, the quality of her instruction and guidance, including teaching me to teach myself, will live in me long after I leave the Biomedical Informatics program.

To Kathryn Pyle, A.M.L.S., M.A., Assistant Professor, DMICE, OHSU, who offered me great critical insight concerning my scientific writing skills while attending her course and during the writing of my capstone. She has instilled in me the desire for continual improvement.

To Vishnu Mohan, M.D., M.B.I., M.B.C.S., F.A.C.P., Assistant Professor, DMICE, OHSU, for teaching me the complex and rewarding nature of project design and always being there as an impromptu advisor and confidant. I enjoy our talks regarding Biomedical Informatics and all other random subjects.

Joanne Valerius, M.P.H., R.H.I.A., Assistant Professor, DMICE, OHSU, for guiding me through the inaugural courses of the HIM certificate and being my initial advisor in the Biomedical Informatics program at OHSU. Whether the subject was about coursework, careers, or general matters of life, Joanne always listened with open ears and a cheerful smile.

Diane Doctor, Web Manager and Educational Program Coordinator, DMICE, OHSU, for being my advisor and guiding light these last 5 years, and still guiding me through to the end of the program. I wouldn't have made it without you.

William Hersh, M.D., F.A.C.P., F.A.C.M.I. Professor and Chair, DMICE, OHSU, for the electric atmosphere created by my introduction to Biomedical Informatics course so many years ago. Bill is a pioneer in the field of Informatics, and the leader of our great BMI program, yet still manages to take the time to address the concerns of students

individually. His leadership throughout the years has not only created world-class Informaticians, but also a sense of family that is seldom seen today.

To my loving parents, Captain Hellmut C. Gebhardt, M.D. and his beloved wife Carolyn D. Gebhardt, RN, MA Ed., they gave me the inspiration to follow my dreams and enter the field of health care for the sake of helping others. They also instilled in me the notion that I can do anything if I make up my mind and go after it.

To my son, Harper, you will not be able to read this today, but thank you for the joy you bring to my life on a daily basis.

Finally, to my loving wife, Danielle R. Gebhardt, RNC, who has continually supported me in all my endeavors, and has had the patience to put up with the entirety of this academic journey. I am so blessed to have her and Harper in my life.

ABSTRACT

Objective The goal of this project is to provide a comprehensive review of published evidence regarding best practices for the patient identification (PID) process as related to electronic health record (EHR) safety, which entails accurate documentation about who an individual is at all times in a healthcare facility. The PID process is critical in assuring patient safety and data integrity during a visit to a healthcare facility, during subsequent visits within a patients' current health system, and during visits to disparate systems during his or her lifetime.

Methodology & Framework To benefit the reader, the PID process is defined to include patient identification at all points of care that could risk patient safety, or jeopardize the integrity of patient data within the EHR. Medical literature databases such as MEDLINE and Scopus were searched to find relevant articles associated with patient identification and EHR safety, using a combination of keywords and subject headings, and medical subject heading (MeSH) terms. Due to the relative infancy of EHR safety research, and, in particular, the type of research related to patient identification, there are not many published papers, so we also searched for web-based articles, and for white papers and unpublished papers, from well-known health information management (HIM) associations such as AHIMA (American Health Information Management Association) and HIMSS (Health Information Management Systems Society). We then applied a forward and reverse search methodology to relevant documents. In addition, we searched the Gartner Research web site for papers, to view PID from a purely IT/business point-of-view. To illustrate the wide-spread nature of the PID process in the current environment

of EHR's and health information exchanges (HIE), the results are displayed using the newly developed, eight-dimension, socio-technical model of safe and effective EHR use, as an organizing framework.

Results Out of thousands of documents found in our initial search, a total of 31 documents, (papers, articles, and white papers) are summarized in this paper. Of those 31 documents, 28 were found using rigorous academic standards. In those documents the authors discussed the various different aspects of PID and its system wide effects on patient safety and also proposed some solutions to the problems associated with PID. The organizing framework was useful to show widespread effects of PID on different dimensions of the system, even without having a definitive dimension for one article about the business of health information technology (HIT) and another about the dire consequences of wrong patient identity.

Discussion and conclusion Patient identification in the context of EHR patient safety is a fairly new concept, but there have been some pioneers in this area of research. The adoption rate of EHRs has been increasing at a steady pace due to meaningful use, and there needs to be more research in this area to mitigate patient risks associated with wrong patient identification. Patient identification is now a ubiquitous concept and to ensure the integrity of patient data, and subsequently improve patient safety, we must continually look at all aspects of the healthcare delivery process.

BACKGROUND

Two groundbreaking reports were released by the Institute of Medicine (IOM) over 10 years ago. *To Err is Human: Building a Safer Health System,*[1](IOM, 1999) concluded that tens of thousands of people die each year as the result of mistakes that otherwise could have been avoided, one example is deaths due to medication errors. In response, *Crossing the Quality Chasm,*[2] (IOM, 2001) outlined six aims for improvement and 10 rules for redesign, with the first aim being "*Safe:* avoiding injuries to patients from the care that is intended to help them"[2] and the sixth rule for redesign being, "Safety is a system property. Patients should be safe from injury caused by the care system. Reducing risk and ensuring safety require greater attention to systems that help prevent and mitigate errors."[2] Since then, there has been a push for health information technology (HIT) to transform health care in a way that increases patient safety. An important component of using HIT to improve patient safety is the electronic health record (EHR). As asserted by the Office of the National Coordinator of Health Information Technology (ONC), part of the Office of the Secretary of the U.S. Department of Health and Human Services (HHS), "The Health Information Technology for Economic and Clinical Health (HITECH) Act provides HHS with the authority to establish programs to improve health care quality, safety, and efficiency through the promotion of health information technology (HIT), including electronic health records and private and secure electronic health information exchange".[3] One caveat to the implementation of EHRs to increase patient safety is that an EHR is not a panacea for all patient safety issues and there is evidence, through several studies, that there are "inherent risks in commercial EHRs."[4] One risk associated with the use of an EHR is incorrectly identifying a patient during a

healthcare encounter or assigning the wrong information (e.g., another person's medical information) to a patient.

The goal of this project is to provide a comprehensive review of published evidence regarding best practices for the patient identification process as related to EHR safety. What is the patient identification process? To that end, what is patient identification? We will shortly explore these before moving to the methods portion of the paper. **Patient identification (PID)**, according to The Joint Commission's (TJC) National Patient Safety Goal (NPSG) 01.01.01, (Improve the accuracy of patient identification), (paraphrasing), it is using two identifiers, such as name, date of birth, medical record number, etc., when providing care, treatment or services.[5] This is to ensure that you have the right person before administering healthcare services, especially at critical times when patient safety is at risk. **Patient identification process –** TJC, through NPSG 01.01.01, implies that this is how you identify a patient when performing a specific task associated with patient care. The contention of this author is that the PID process encompasses correctly identifying the patient at all critical points where patient safety is at risk. This spans the time from the moment the patient enters the healthcare facility, to the moment the patient leaves. This includes not only ordering and administering medication, blood and blood products, lab specimens, and other treatments or procedures, (and all critical points within those processes), but also registering the patient when entering the facility, when care of the patient is being transferred to another provider (patient handoff), and when the patient is discharged or transferred to another facility outside of the current healthcare

system. The PID process includes patient identification at all points of care that puts patient safety at risk or jeopardizes the integrity of patient data within the EHR.

This capstone presents a comprehensive definition of patient identification and the patient identification process and then defines additional terminology surrounding PID, before describing the organizing framework and the methods used to perform the literature search. The paper then presents patient identification best practices, identified through a literature review, and organized around the newly developed eight-dimension, socio-technical model of safe and effective EHR use[6], 1.) Hardware & Software computing infrastructure, 2.) Clinical content, 3.) Human Computer Interface, 4.) People, 5.) Workflow & Communication, 6.) Internal Organizational Features, 7.) External Rules & Regulations, and 8.) Measurement & Monitoring. Using this framework will illustrate that patient identification is prevalent in all aspects of the healthcare process and that you cannot separate patient identification into electronic and non-electronic realms because one affects the other. We will then discuss the complex nature of the policies, personnel, training, infrastructure, technology, and future solutions needed to mitigate patient safety risks associated with patient identification.

THE PATIENT IDENTIFICATION PROCESS

We briefly introduced definitions of patient identification and the patient identification process in the background section of this paper. Here we will compare and contrast the two terms, to define the patient identification process in the context of an episode of care.

To improve patient safety and "improve the accuracy of patient identification"[5], TJC NPSG 01.01.01 states, "Use at least two patient identifiers when providing care, treatment, and services".[5] The Joint Commission provides a rationale:

> Wrong-patient errors occur in virtually all stages of diagnosis and treatment. The intent for this goal is two-fold: first, to reliably identify the individual as the person for whom the service or treatment is intended; second, to match the service or treatment to that individual. Acceptable identifiers may be the individual's name, an assigned identification number, telephone number, or other person-specific identifier. [5]

TJC has provided us with identifiers to use for patient identification and certain instances within an episode of care to use those identifiers, but are there other moments when PID is important? What are the effects of the implementation of EHRs and other HIT on patient identification? EHRs are being used to provide safer delivery of modern healthcare and increased communication among not only providers within one facility, but among multiple providers at multiple facilities, both in the present and in the future. This phenomenon has made patient identification ubiquitous in nature. How does the use of an EHR affect patient ID at registration, while ordering a procedure/medication, and during handoff? These critical areas where patient ID is paramount to patient safety, can not only have a cascading effect in a healthcare facility during a current episode of care, but can also affect future healthcare being delivered across town, across the nation, and around the globe. TJC provides two elements of performance for NPSG.01.01.01:

1. Medication administration, lab specimen collection (including blood-work), and providing treatments or procedures
2. Labeling in the presence of the patient.

There are many other healthcare delivery areas where patient identification can create patient safety risks in a healthcare system:

- Patient admission & registration occurs when patients visit a clinic or hospital. They are required to go through a process to be admitted to the hospital or be registered as a patient at a clinic. Usually, this involves matching patients to their medical record at the facility, or creating a new record if they have never been to the facility before this encounter. There are several errors that can happen at this stage and several ways to mitigate the risks that are explored in this paper. Getting the correct patient associated with the correct medical record is the first critical step in ensuring patient safety.
- Patient handoff occurs when a patient's care is transferred from one provider to another, whether that happens during shift change, from one inter-facility department, (e.g., intensive care unit or operating room), or to another facility within the same healthcare system. Patient handoffs are well documented as a patient safety risk,[7 8 9] and another paper even discusses the inherent handoff problem associated with shift-to-patient load differentials (figure 1)[10]. What is not evident by the handoff research was if there was any attention given to patient identification as a patient safety risk.

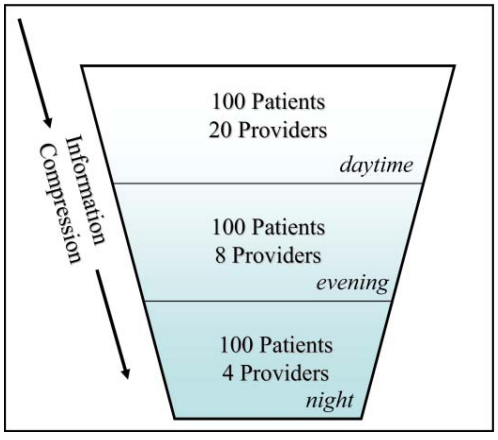


Figure 1 Difference in patient load by shift[10]

- Patient discharge can include a discharge to home, indicating that care is now transferred to the primary care provider (PCP), or a discharge/transfer to another facility that is either within or not within the same healthcare system.

- Transcription of orders – although mitigated with the use of computerized provider order entry (CPOE), orders that are not directly documented into a medical record, (either phone orders or written on blank order forms when the patient's medical record is not present), are a patient safety risk due to the possibility of placing an order in the wrong chart, or a wrong label being affixed to the order form.[11] An order is the written or verbal instructions of authorized personnel (e.g., physician) to administer medication, perform a procedure, or otherwise treat a patient in a healthcare setting. CPOE facilitates authorized personnel entering the order directly into the electronic record via a computer interface.

In the article, *Oops, sorry, wrong patient! A patient verification process is needed everywhere*, the anonymous author stated, "one fundamental cause of these errors is a flawed or absent patient identification process."[11] The PID process needs to be considered on a system wide basis, with training on policies and procedures that not only ensure that the right treatment is delivered to the right patient, at the right time, but also make all members of the healthcare team know their responsibilities and the far-reaching consequences that could happen by not following best-practices. In response to a process improvement article in H&HN (Hospitals & Health Networks) daily, Jeff stated:

> These four categories all have one thing in common: process. As the evidence shows and author after author write, we in health care continue to struggle with providing the expected level of safety patients deserve. Until we can consistently follow a best-practice process and hold the entire team accountable, regardless of role, events will happen. Minimizing variation through process has demonstrated positive results. With leadership commitment, we can implement a process, drive behavior and belief changes, and then begin to change the culture.[12]

There needs to be more research on the best practices associated with all aspects of PID in an episode of care, from entry to exit, so that a robust, widely adopted standard of the PID process can be established.

TERMINOLOGY

To aid the reader, a list of terminology associated with electronic health records, health information technology, and patient safety is provided, which includes other terminology that represents specialized concepts in informatics:

1. **AHIMA** – The American Health Information Management Association (AHIMA) is the premier association of health information management (HIM) professionals. Serving 52 affiliated component state associations and more than 67,000 members, it is recognized as the leading source of "HIM knowledge," a respected authority for rigorous professional certification, and one of the industry's most active and influential advocates in Congress.[13] AHIMA is a key contributor to the creation and development of the core data elements of a standard Master Patient Index (MPI – see full definition below) and the development of HIM policy and regulation.

2. **Duplicate** – more than one entry or file for the same person in a single facility-level MPI (Master Patient Index – see full definition below). This causes one patient to have two different medical records within the same facility.[14]
3. **EHR –** electronic health record – An electronic record of health-related information on an individual that conforms to nationally recognized interoperability standards and that can be created, gathered, managed, and consulted by authorized clinicians and staff across more than one healthcare organization.[15]
4. **EMR** – electronic medical record – "an electronic record of health-related information on an individual that can be created, gathered, managed, and consulted by authorized clinicians and staff within a single healthcare organization." [15]
5. **EMPI –** Enterprise-wide Master Patient Index – An index that is able to access several MPIs (Master Patient Index – see full definition below) across multiple facilities in an organization.
6. **HCIS –** Health care information system, aka Health Information System or Hospital Information System (HIS) for the purpose of this paper – "An information system used within a health care organization to facilitate communication, to integrate information, to document health care interventions, to perform record keeping, or otherwise to support the functions of the organization."[16]

7. **HIE –** Health Information Exchange. According to the HealthIT.gov website: The term "health information exchange" (HIE) actually encompasses two related concepts:
    a. Verb: The electronic sharing of health-related information among organizations.
    b. Noun: An organization that provides services to enable the electronic sharing of health-related information.[17]
8. **HIMSS –** Health Information Management Systems Society is a cause-based, not-for-profit organization exclusively focused on providing global leadership for the optimal use of information technology (IT) and management systems for the betterment of healthcare.[18] HIMSS has been a healthcare industry leader in health information management, pushing for standards in data elements, interfaces, and algorithmic patient matching to ensure patient data integrity. HIMSS is also a staunch proponent for a universal patient identifier to get the most potential out of Health Information Technology.
9. **HIT –** Health Information Technology is the technology associated with exchanging health information via electronic methods.
10. **MPI –** Master Patient Index – a list or database created and maintained by a healthcare facility to record the name and identification number of every patient who has ever been admitted or treated in the facility.[19] The identification number is typically a medical record number and is the single identifier that associates all of the visits of a patient to a facility. A visit is usually indicated by a specific account number associated with that specific visit.

11. **Overlap** – more than one MPI entry or file for the same person in two or more facilities within an enterprise. For example, patient John Smith has medical record number 12345 at facility A and a medical record number 447788 at facility B within the same enterprise-wide system. When both MPI databases are loaded into an enterprise MPI, the database does not link the two records. Thus, Smith ends up with two different enterprise identifiers and providers cannot view all clinical information across the enterprise for that patient. [14]
12. **Overlay** – one MPI entry or file for more than one person (i.e., two people erroneously sharing the same identifier). Overlaid records are frequently caused when patient access staff selects another patient's record during a scheduling or registration event. Sometimes interfaces cause the error if the receiving system lacks a robust patient record-matching program and "overlays" another patient's record from that inbound interface transaction. On occasion, overlays are caused by an incorrect merge of two records that belong to two different people. [14]
13. **Patient Identification Integrity** – PI Integrity (PII) is the accuracy and completeness of data attached to or associated with an individual patient. Data must be reliable, reproducible, and sufficiently extensive for matching purposes. Completeness refers not only to having adequate data elements present but also the correct pairing or linking of all existing records for that individual within and across information systems. PI Integrity is of central importance to achieving quality of care, patient safety, and cost control. [20]
14. **Patient Identity within Integrity Management (PIIM) –** The totality of business processes required to assure PI Integrity within and across organizations. [20]

15. **Unique Patient Identifier (UPI)** – aka unique identifier (UI), or Universal Patient Identifier. Unique Patient Identifier is the value permanently assigned to an individual for identification purposes and is unique across the entire national healthcare system. Unique Patient Identifier is not shared with any other individual.[21]

FRAMEWORK & METHODOLOGY

Socio-technical framework

This literature review is organized around the framework of the socio-technical model illustrated in the work, "Roadmap for the Provision of Safer Healthcare Information Systems: Preventing e-Iatrogenesis"[4]. That model was adapted, by the provider order entry team (POET) team, from the work by Sittig and Singh on the eight dimensions of health information technology (HIT) framework[6], which was in turn, adapted from other socio-technical models. The eight dimensions of the HIT framework are:

1. Hardware & Software computing infrastructure
2. Clinical Content
3. Human Computer Interface
4. People
5. Workflow & Communication
6. Internal Organizational Features
7. External Rules & Regulations
8. Measurement & Monitoring

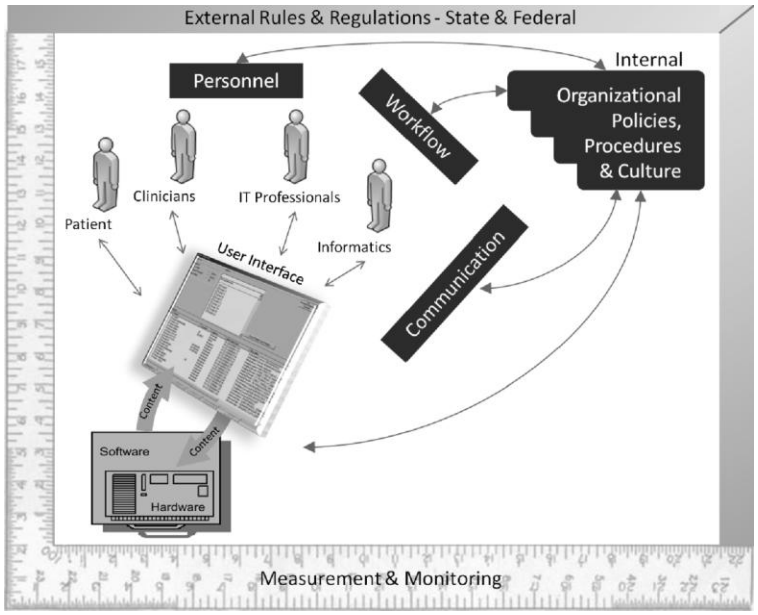


Figure 2 Illustration of the complex inter-relationships between the eight dimensions of the new socio-technical model[6]

The diagram, (see figure 2), from Sittig and Singh's socio-technical model article is an "Illustration of the complex inter-relationships between the eight dimensions of the new socio-technical model".[6] I show that the prevalence of the patient identification process has an equally complex relationship among the eight dimensions of the socio-technical model. The evidence of best practices relating to patient identification safety, as it relates to the EHR, is associated with a given dimension from socio-technical model to illustrate the complex, system-wide nature of patient identification and the PID process.

LITERATURE REVIEW

The basic search strategy sought papers on best practices for the patient identification process as related to electronic health record safety. My first criterion for inclusion was patient identification. My second criterion was that it should either be directly related to or affect electronic health record safety. To benefit the reader, I defined the patient identification process as being in all areas of patients' visits to a healthcare facility, especially in the areas of patient registration and admission, patient handoffs and discharge, and transcription of orders.

METHODS

The issue of patient safety, as it relates to EHR systems, has not been widely studied as of 2013, and even less research has been conducted regarding EHR System safety in relation to patient identification. However, the literature search revealed a few pioneers in this area who have already researched EHR system safety. Looking at previous studies referenced by those documents (reverse bibliographic searching), and then looking at what studies cite those documents (forward bibliographic searching), helped me assemble a well-rounded set of literary references. These references provide a comprehensive review of the best practices associated with patient identification as it relates to EHR safety.

Brief descriptions of the databases used in my literature review are as follows:

1. Ovid and PubMed are both search engines for MEDLINE. MEDLINE is published by the U.S. National Library of Medicine is a comprehensive biomedical database that is updated daily. It offers bibliographic citations and author abstracts from more than 5,500 biomedicine and life sciences journals. The difference between the two is the interface for searching, how it displays results, and then how you can use those results to fine tune your search. I used both search engines to search MEDLINE. Ovid was my main database for my literature review, with PubMed and Scopus being used for secondary searches.

2. Scopus is the world's largest abstract and citation database of peer-reviewed literature. I was introduced to Scopus by the library staff at the Oregon Health & Science University after inquiring about forward searching of bibliographic database entries. I only used Scopus for searching for works that had cited the work that I had already found relevant to my criteria.

3. Gartner Research is research and technical reports focused on information technology and business advisory research. I mainly used this to see if there were any links to business reasoning associated with patient identification as related to electronic health records.

The Ovid search engine was used as my main source of searching, with PubMed and Scopus being used to reverse search the references of inclusive papers. Scopus was used for forward searching. MEDLINE (both Ovid and PubMed) has over 22,000,000 citation entries of peer reviewed literature. Scopus, at the beginning of my capstone project, was introduced to me as the only database that revealed current citations from database entries, also known as forward searching.

Considering the lack of publications regarding the subject, in addition to using Ovid, PubMed, and Scopus, I also searched the publications and web-based articles of two organizations which are at the forefront of PID and EHRs, AHIMA and HIMSS. These papers may not have necessarily met the stringency of peer review, but in my estimation, met my main inclusion criteria of patient identification and EHR safety.

Finally, I chose Gartner Research because their knowledge base includes business literature related to HIT. Economic realities often demand looking at decisions from a business perspective. Gartner describes itself as the world's leading information technology research and advisory company that assists its clients in making every day decisions.

I started the literature review using a combination of keywords and subject headings. I carefully looked at the terms to determine if they met the inclusion criteria of patient identification and EHR safety. For example, when I searched for the keyword term "patient identification", it resulted in the following medical subject headings (MeSH terms):

Patient identification systems	Medical Errors
Hospitals	Patients
Medical Records	Blood Transfusion
Schizophrenia	United States
Medical Records Systems, Computerized	Emergency Medical Service

The terms that met the criteria of my literature search included Patient identification systems, Hospitals, Medical Records, Medical records systems, computerized, Medical errors, and Patients. I would then explode, (expand the search tree of the given MeSH term to see if there are any sub-headings), each of those terms to see if there was relevant information further down the search tree. For example, Medical Errors expanded or exploded to include Diagnostic Errors, Medication Errors, Observer Variation, and Radiotherarpy Setup Errors.

RESULTS

This section will look at the results of the literature review regarding the numbers associated with my inclusion criteria, and then look at specific documents, that met that the inclusion criteria, in the context of the socio-technical framework. Additionally, we will look at any additional findings that may not have a definitive dimension in the current framework.

My main inclusion criteria are focused on patient identification and EHR safety, while also keeping in mind the patient identification process and key areas such as admission

and registration, handoff and discharge, and order transcription and errors. Table 1 shows the initial results of the literature search on patient identification.

Table 1 – Ovid search results for Patient identification

Inclusion Criteria	Resulting MeSH terms	Articles found
Patient identification	Patient Identification Systems	1897
	Hospitals	50692
	Medical Records	32880
	Schizophrenia	77238
	Medical Record Systems, Computerized	17683
	Medical Errors	11469
	Patients	15145
	Blood Transfusion	51234
	United States	700113
	Emergency Medical Services	29759
	Total	988110

To reduce the number of articles found in the initial search, I exploded the search tree on the remaining terms, to see if there were any more specific terms relevant to my literature search and also excluded some of the initial MeSH terms. I removed Schizophrenia, United States, Hospitals, and Patients because a specific type of a disorder or patient, and a specific geographic location or type of hospital, was not relevant to my literature search. This reduced the overall number by 828,043, bringing the total down to 160,067.

Table 2 shows the results of the remaining MeSH terms and the subheading resulting from exploding the search tree. This still resulted in too many articles to review, but it revealed additional terms that I could either explode or link with other terms to further reduce the number of articles.

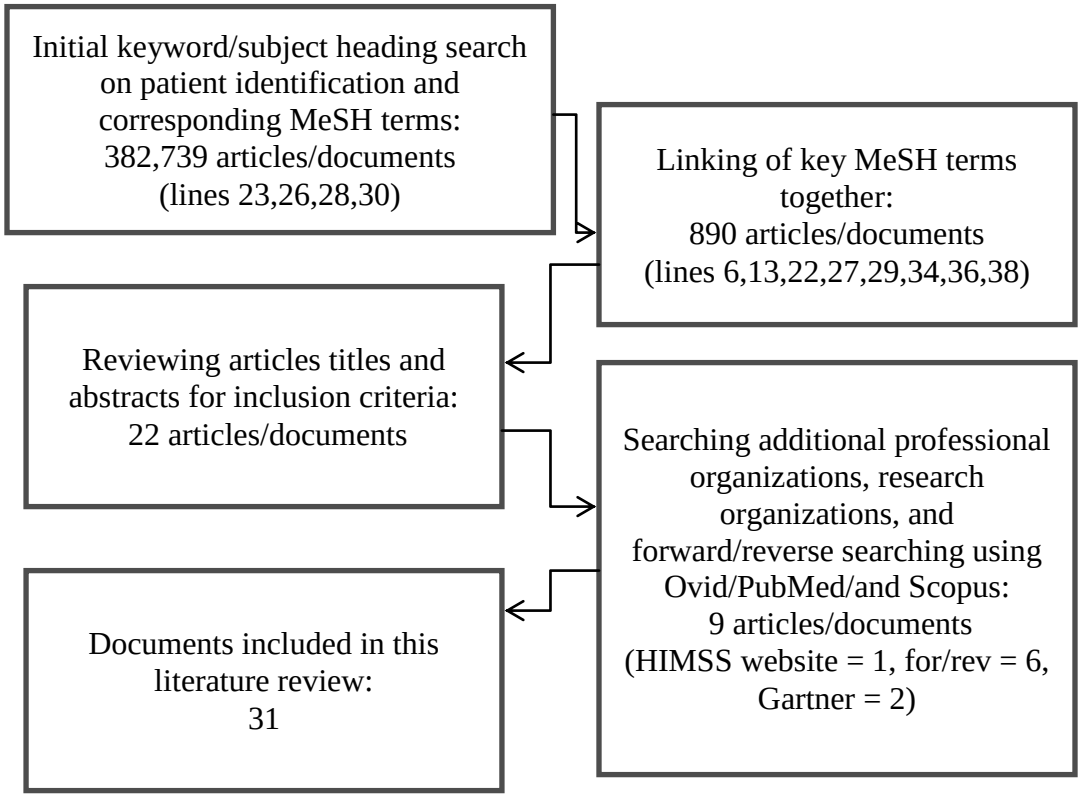
Table 2 – explosion of MeSH terms related to Patient identification

Initial MeSH term	Subheading	Articles found
Patient identification Systems		1897
	Patient Identification Systems	1712
	Radio Frequency Identification Device	185
Medical Records		32880
	Health Records, Personal	482
	Medical Record Linkage	3275
	Medical Records, Problem-Oriented	1403
	Medical Record Systems, Computerized	17683
	Trauma Severity Indices	5296
Medical Record Systems, Computerized		17683
	Electronic Health Records	4089
Medical Errors		11469
	Diagnostic Errors	29283
	Medication Errors	9618
	Observer Variation	29078
	Radiotherapy Setup Errors	87
Blood Transfusion		51234
	Blood Component Transfusion	2657
	Blood Transfusion, Autologous	6445
	Blood Transfusion, Intrauterine	1345
	Exchange Transfusion, Whole Blood	4069
	Plasma Exchange	4660
Emergency Medical Services		29759
	Advanced Trauma Life Suport	

	Care	6
	Emergency Medical Service Communication Systems	1440
	Emergency Service, Hospital	39279
	Emergency Services, Psychiatric	2034
	Poison Control Centers	2147
	Transportation of Patients	7722
	Triage	7375

Additional tables showing the same process for EHR Safety (second inclusion criterion) can be found in Appendix B.

Once the MeSH terms were exploded to the fullest extent, I used those results to link terms in Ovid to get an initial pool of documents to review. Using my search history, (see Appendix A) the progression of my search was:



Appendix A displays the Ovid search of the main keywords and subject headings used in the initial search, including linking terms together with the Boolean operators 'AND' and

'OR'. I chose to start linking terms together to see if I could get the results down to a manageable level of under at least 500 hundred documents. I was able to reach that 10 times in my search. I would then review the titles of the documents to see if they were relevant to my search, read the abstract of titles that met the inclusion criteria, and if the abstract showed a definite relevance to the patient identification process relating to EHR safety, I would review the article and document it in my findings.

As an unexpected benefit to my search efforts, while searching the MeSH term patient identification systems, exploded to reveal the MeSH term Radio Frequency Identification Device(RFID). Those two MeSH terms resulted in 1712 "hits" for patient identification systems and 185 hits for RFID, (a total of 1897 documents that are retrieved using patient identification systems as a MeSH term). These documents provided additional information on possible solutions to the patient identification process that I included in my findings, (such as the use of RFID).

Another interesting result of my literature review was the inclusion of a HIMSS white paper that was not found using traditional search methods, but was found because a colleague of mine that is a HIM professional, after hearing of my project, suggested that I search AHIMA and HIMSS for white papers regarding patient identification. Upon searching the HIMSS website for, "patient identification white paper", it brought up the white paper on patient identity integrity discussed in the following paragraph. It revealed great deal of information regarding patient identification. Organizations that are looking address the issue of patient identification in relation to EHR safety would definitely benefit from including this document in their research. It is easily the most

comprehensive document that I found on the subject and it nicely illustrates the point that PID is a system-wide process.

In 2008, HIMSS created a patient identity integrity workgroup, which created a white paper about the necessity of maintaining PII across the healthcare spectrum:

> To solve the problem of assuring a state of high quality PI Integrity, one must look at the entire process of patient identity management (PIM). The PI Integrity Work Group identified nine variables that influence, in varying degrees, our ability to build and sustain a database in a high state of identity integrity. These key influencers are: industry standards, interfaces, algorithms, unique identifiers, business processes, data accuracy, data quality, training, and medical devices.[20]

My paper does not go into all of the variables mentioned above, but the concept of "the entire process of patient identity management" reinforces the concept in my paper regarding the patient identification process. One needs to look at varying factors, both internal and external, both electronic and non-electronic, to maintain the integrity of patient identification.

Hardware & Software computing infrastructure

In the eight-dimension socio-technical model,[6] the "Hardware and software computing infrastructure refers to equipment and software used to power, support, and operate clinical applications and devices."[6] Essentially, the infrastructure includes the computer terminals, cables, modems, servers, and other equipment that are used throughout a healthcare system and the associated software needed for health information technology to support clinical practice. Here I focus on three areas that I think pertain to the

hardware/software dimension of the socio-technical model; algorithms, standards, and medical devices.

Algorithms. With varying levels of sophistication, algorithms have been proposed to provide a software-based solution to accurate patient identification. In France, Quantin, et al, have proposed a unidirectional hash function, "such as the secure hash algorithm (SHA-2) function that can guarantee the security, quality, and reliability of information if these techniques are applied to the Social Security Number. Hashing produces a strictly anonymous code that is always the same for a given individual, and thus enables patient data to be linked."[22] A hash function is a highly technical mathematical computation performed by a computer, in association with an algorithm, which ensures the high probability of secure and accurate data. It transforms the data, (e.g., a social security number) in a cryptic fashion, and then links it to a medical identifying number, or universal patient identifier. The advantage of a "unidirectional" hash function is that it cannot be used in the opposite direction, (e.g., taking a patient identification number and trying to find the social security number). For more information, the National Institute of Standards and Technology has an in-depth, technical paper titled, Secure Hash Standard.[23]

A paper in the Journal of AHIMA discusses the use of basic, intermediate, and advanced algorithms to compare and match records from various entities.[24] This same article also discusses MPI definitions and organizational training issues that contribute to the creation of an EMPI, which is critical if you want to have and maintain patient identity integrity

and mitigate patient safety issues associated with the patient identification process. However, one should be cautious and exercise due diligence, "Record-linking algorithm effectiveness should be validated prior to linking records within an organization or releasing records to an HIE."[24] The development and/or implementation of strong and robust matching algorithms are essential to creating an MPI at a single facility and an EMPI at multiple facilities within and organization. However, more research is needed to determine the best algorithmic solutions for matching, as indicated by the HIMMS white paper:

> The matching criteria are built within the MPI solutions or can be positioned above several MPIs in an Enterprise. These solutions include criteria based settings capabilities along with weighting mechanisms to assign a level of match probability. Unfortunately, the settings are configured differently and inconsistently within and across organizations; not implemented correctly to the point of total ineffectiveness; or implemented too stringently or too loosely for adequate matching purposes. There is a lack of industry knowledge and scientific study on the reliability of these proprietary applications. Consequently, no standards have been set for performance expectations or successful outcome ratio. In an ideal scenario, the matching outcome ratio would be 100% successful matches. Without any data on the effectiveness of the matching solutions, there is no way of knowing if they are functioning at a 99 percent or 75 percent level of successful match. Canned data reports provide incomplete information based on their formulaic view of the data.[20]

The HIMSS patient identity integrity white paper suggests short, intermediate, and long-term actions to "address the accuracy and effectiveness of record linking methodologies."[20] Those HIMSS suggestions are as follows:

1) Short Term (within the next five years):

- Create data definitions (data dictionary) for all key demographic data fields utilized in record matching algorithms to facilitate consistency across providers in the collection of these data fields. Recommend minimum data elements to be utilized in record matching algorithms.
- Perform a research study to validate algorithm effectiveness for electronically linking patient records.

- Adopt an industry standard method of computing duplicate record rates in MPI databases and a standard formula for computing the "creation" rate of newly created duplicate records.
- Provide industry guidance on the process that providers and health information exchange organizations should follow to resolve potential duplicate records within their database. Guidance on staff education and experience requirements of individuals who are capable of monitoring potential duplicate records and resolving them is needed.

2) Intermediate (five to ten years):

- Using study results, recommend algorithm standards including search threshold minimums and record auto-linking minimums.
- Using study results; provide industry standards for maximum duplicate record rates.
- Using study results, improve tools and industry standards for IT systems.

3) Long Term (ten years and beyond):

- Adoption of a patient identifier solution.
- Reduce dependence on algorithms.[20]

Standards are needed in multiple facets of a healthcare organization to make patient identification processes work. They are needed to facilitate the effective use of algorithmic matching in the near term, in the development of a universal patient identifier in the future, across medical devices being used in healthcare facilities, and in the user interface, so that users can get accustomed to layouts and the content associated with pages displayed in an EHR. A paper discussing the contextual nature of patient identification, by Lichtner, Galliers, and Willson, endorses the use of a patient banner in an EHR, "The NHS ((National Health Service),United Kingdom) undertook an initiative, in collaboration with Microsoft, for a standard common user interface design that should provide a well-designed, always-visible, 'patient banner' in electronic patient records[25]…We argue that this information is not only useful but indeed necessary to support the identification of the correct record and to detect and correct any record mix-ups."[26]

Medical Devices are created by a myriad of vendors, with multiple hardware, interface and internal software configurations that are proprietary and often times designed to work insulated from the health information system. This situation will not lend itself to a fully integrated EHR and, more importantly, could lead to patient safety issues surrounding patient identity integrity. "Every vendor implements data communication differently…'Plug-and-play' should be the ultimate goal."[20] What is needed is standardization of the common data elements, the interface, and the connecting hardware, which would lead to improved identification of patients and their data.

A final topic about the hardware and software dimension is the possible future direction of patient identification systems. The technology is already here, but widespread use is not happening due to a variety of factors. Biometric palm scanning and RFID (Radio Frequency Identification) are in place in some healthcare facilities. An article refers to the use of a biometric technology that is 100 times more accurate than fingerprints, "A New York City hospital is taking patient identification into the 21st century by using palm scans to avoid identity confusion and improve patient safety."[27] Implementing this type of technology can reduce duplicate patient records. "Utilizing near infrared light to map an image of the blood-flow pattern through the veins in a person's palm, the digital palm image is converted into a unique patient identifier that interfaces with the medical center's electronic health record system."[27] RFID is already in use in healthcare in a myriad of ways, such as use of employee badges to unlock doors and ankle bracelets attached to newborns to prevent them from being taken from the facility. There are several studies[28,29,30,31,32,33] discussing the use of RFID to track patients in a facility and

prevent medical errors. A study by Dondelinger gives a detailed account of how RFID works and also discusses the future implications. "These RFIDs will eventually migrate to the healthcare community. Someday RFIDs capable of being implanted under a patient's skin can be used to store medical information such as identification, personal physician, history, medications, etc. for use by emergency personnel."[34] These two technologies, when robust and secure for wide-spread adoption, will allow for great strides in patient identification and patient safety.

Clinical Content

Sittig and Singh state, "Clinical content refers to textual or numeric data and images that constitute the 'language' of clinical applications."[6] They also discuss the nature of clinical content and certain elements that depend on correct patient identification. "Examples include…and the logic required to generate an alert for certain types of medication interactions. These elements may also describe certain clinical aspects of the patients' condition (e.g., laboratory test results, discharge summaries or radiographic images). Other clinical content, such as demographic data and patient location, can be used to manage administrative aspects of a patient's care." [6] If a provider is depending on an EHR to bring in the correct patient history, including demographics, test results, and discharge summaries, and there is a breakdown in the patient identification process, then the logic for alerts and follow-up care will not be fully realized. One way to mitigate that risk is to follow the suggestion of Adelman, et al.,[35] so that the CPOE system requires, "providers to reaffirm patient identification when placing orders using a second and tertiary identifier."[35] In an effort to reduce wrong-patient electronic orders, they introduced an "ID-verify alert" and an "ID-verify function" and "demonstrated that an

ID-verify alert (single-click confirmation of patient identity) reduced wrong-patient electronic orders by 16%, while an active ID-reentry function (requiring active reentry of identifiers) achieved a 41% reduction." [35]

Human Computer Interface (HCI)

As defined by Sittig and Singh, "The human--computer interface includes all aspects of the computer that users can see, touch or hear as they interact with it." [6]

When one considers the relative infancy of EHR use, and the even newer study of improving patient safety associated with EHR use, there has been little research regarding HCI and EHR safety. One study, "The Use of Patient Pictures and Verification Screens to Reduce Computerized Provider Order Entry Errors",[36] conducted by Daniel Hyman, et al., showed an improved error rate after the introduction of pictures into the electronic patient chart when ordering medications and procedures through the CPOE. Their methodology was to have a verification screen pop up, with the patient's photograph, so that the provider could verify he or she had the correct patient. Hyman et al[36] provided correlating t-charts, denoting the increase in days between adverse events after the photographs were introduced, and also stated, "It is significant that following the introduction of patient pictures, no patient whose picture was in the EMR was reported to have received unintended care based on erroneous order placement in his or her chart for more than 450 days."[36]

People

In the context of EHR safety, "People refers to everyone who interacts in some way with the system, from developer to end-user, including potential patient-users."[6] The people dimension of the model is an interesting dimension for the sheer breadth that it can cover across the socio-technical model as well as across the spectrum of healthcare. The activities that people do in all dimensions of patient care can affect patient identification processes and patient safety. One paper from the Journal of Emergency Nursing, "Accurate Patient Identification in the Emergency Department: Meeting the Safety Challenges,"[37] provides a training reference in a nice table format, (See Table 3),

TABLE 3[37]

Strategies for improving the safety of patient identification during medication use

Patient Registration
Ask for a full legal name, birth date, address, and telephone number
Verify information by cross checking on photo identification if possible
Ask the patient to reconfirm the identification wristband before application
Identify patients with similar names and take steps to segregate these patients in assignment planning; make this risk known to others with patient contact
Prescribing
Require prescribers to confirm that that they have the correct patient each time they enter/write orders
Limit the number of computerized prescriber order entry records that an ED prescriber can have open on the desktop at the same time
Enhance the size and readability of patient names on the electronic health record screens
Transcribe Orders
Verify the information on patient labels with the original medical record before applying the identification to chart forms or requisition slips
Label all pages of the patient's chart immediately when identification is established; do not document any information on a chart form that does not have full patient identification applied
Confirm the chart identification before transcription of any information to the record
Fax/scan only one patient's orders at a time to the pharmacy
Document all verbal orders (except in an emergency or when under sterile conditions) directly onto the medical record and validate the identification of the patient along with the components of the order during verification procedures with the prescriber
Dispensing Medications
Gather/prepare only one patient's medication at a time using the original order
Ensure that the order makes sense given the patient's chief complaint and clinical condition
Apply patient identification to any medication prepared away from the bedside; for example, label syringes prepared in the medication room with the patient's name as well as the drug name and dose
Administering Medications
Provide education to the patient regarding the need for frequent identification checks
Tell the patient the name of the medication being administered and its purpose
Confirm the patient's identification by checking two unique identifiers and comparing these to the

medical record or to the order requisition that contains the ordered treatment or study Avoid confirming patient identification through the use of passive communication techniques (eg, "Is your birthday March 9th?") Apply bar code medication administration technology to confirm patient identification wherever available **Monitoring** Verify at least 2 patient identifiers before reporting or receiving laboratory or diagnostic results and treating the patient Record/post laboratory and diagnostic results directly to the medical record **Work Flow** Avoid referring to patients by the use of a bed location Limit the number of rooms or bed location for a patient during the course of a single ED stay **Human Factors** Limit distractions during critical tasks such as medication selection and administration Create a mindfulness in the department about the possibility of wrong patient error; create shared accountability for accurate de-identification procedures Never assume working memory is better than comparing information to the original record at the bedside
Modified with permission from The Institute for Safe Medication Practices. Oops, Sorry, wrong patient! A patient verification process is needed everywhere, not just at the bedside. ISMP Medication Safe Alert. 2011;16(5).[11]

that could be used by emergency departments (ED) to reduce errors associated with patient identification practices. The author also notes the need to inform the patient of the reasoning behind multiple identification checks throughout their stay. "This is the perfect time to explain to the patient the importance of the ID wristband for safety and to remind him or her that although the personal queries of name and date of birth may feel excessive, the purpose of these checks is safety, and thus multiple repeated checks of this information by various health care providers during the course of the patient's hospital stay should be expected."[37] This demonstrates the need for training to help care givers understand the importance of patient identification.

Workflow & Communication

"Workflow and communication are the processes or steps involved in ensuring that patient care tasks are carried out effectively."[6] One issue with workflow and communication is that you have to have alternate workflows and alternate forms of

communication available, "in case of emergency", when the computer system becomes unavailable. One solution is to go back to the paper-based system that you had before EHR implementation, but you must re-enter the information into the system. Sittig and Ash, et al., proposed, "This might require using old-fashioned paper orders in emergency situations with subsequent entry into the CPOE system after the patient is stable. Under no circumstances can the care of a patient be subordinated to the idiosyncrasies of a computer system."[38] This is by no means the only area to review policies and procedures related to workflow and communication; there are handoffs, inter-departmental and intra-facility transfers, and new technologies being introduced to the workplace environment and there must be constant workflow analysis to maintain a high level of patient safety.

Internal Organizational Features

Within organizations, policies need to be developed and implemented that enhance patient identification processes to increase patient safety, as indicated by Sittig and Singh, "internal organisational features (e.g., policies, procedures and culture)."[6] These policies also need to be reviewed on a regular basis, to improve or add to, as new technologies and methods come along. Radecki and Sittig eluded to two different policies that could enhance correct patient identification. "The EHR should highlight patients with sound-alike or look-alike names and require reentry of the patient's initials or date of birth before order completion. In addition, BCMA (bar code medication administration) systems should be used in the pharmacy and at the point of care to ensure that the correct patient receives the correct medication or blood product."[39] While the former policy

would require collaboration with one's IT department and/or your EHR vendor, both are policies that are effective and could be easily implemented.

Another article from The Joint Commission Journal on Quality and Patient Safety provided many insights into correct patient identification. "He thought the "Lady in the Door" was the "Lady in the Window": A Qualitative Study of Patient Identification practices"[40] has been cited by 6504 articles according to MEDLINE. The paper has a wealth of information on current practices, improvement, training and future research on PID practices. Concerning the internal organizational dimension of the socio-technical framework, the paper discusses the perceptions of the caregivers regarding PID policy and the follow-up after the findings were presented to patient safety committees. While this is a single study and may not be readily accepted as a solution for all practice environments, there are lessons to be learned, which could be customized to fit different locations. "Repeatedly asking the patient his or her name can be viewed as disruptive to the caregiver's relationship with the patient or to the caregiver's professionalism"[40]was one of the major findings of the study, even though caregivers understood the patient identification policy and the risks associated with not following the protocol set forth by The Joint Commission NPSG. The follow-up resulted in; (paraphrasing) annual RN training in patient safety about the importance of integrating PT ID practices while maintaining a caring relationship and how to achieve that goal within the context of PID policy.[40]

External Rules & Regulations

External rules and regulations can be from local, state and federal governments and also accrediting bodies such as The Joint Commission. Paraphrasing Sittig and Singh, both internal organizational features and external rules and regulations can facilitate and constrain the dimensions in their model.[6] There are several entities that have rules and regulations that affect healthcare and can either help or hinder the effectiveness and use of EHR technology in a safe manner. The U.S. Government passed the American Recovery and Reinvestment Act into law in 2009, which contained Title XIII, subtitled the Health Information Technology for Economic and Clinical Health (HITECH) Act. This Act alone had effects on the Health Insurance Portability and Accountability Act (HIPAA), the major legislation associated with privacy and security of healthcare information. HITECH also brought Meaningful Use into existence. Meaningful use is an government incentive program stating that in order to receive Medicare and Medicaid payments, eligible providers and hospitals, must not only use HIT, but must use it in a meaningful way (meeting certain criteria), through the use of a certified EHR. The breadth of HITECH, HIPAA, and Meaningful Use is far too large for this paper, but, in looking into HIPAA and HITECH in association with patient identification and patient safety, I identified the Nationwide Privacy and Security Framework For Electronic Exchange of Individually Identifiable Health Information, which stipulates in section II:

> The completeness and accuracy of an individual's health information may affect, among other things, the quality of care that the individual receives, medical decisions, and health outcomes. Persons and entities, that participate in a network for the purpose of electronic exchange of individually identifiable health information, have a responsibility to maintain individually identifiable health information that is useful for its intended purposes, which involves taking reasonable steps to ensure that information is accurate, complete, and up-to-date, and has not been altered or destroyed in an unauthorized manner. Persons and

> entities have a responsibility to update or correct individually identifiable health information and to provide timely notice of these changes to others with whom the underlying information has been shared. Moreover, persons and entities should develop processes to detect, prevent, and mitigate any unauthorized changes to, or deletions of, individually identifiable health information.[41]

This paper not only shows the influence of external forces on how we deliver care, but emphasizes the need to be vigilant regarding PID at all critical points of care from registration to discharge.

I identified 4 different documents that mentioned the influence of The Joint Commission's NPSGs regarding "the use of two identifiers when providing care, treatment, or services".[5] This is possibly the most widely known non-governmental external rule that influences healthcare delivery. The government can also hamper efforts in the industry. The HIMSS patient identity integrity workgroup discussed voluntary universal healthcare identification (VUHID) project in an Appendix to their white paper.[20] This is in response to HIPAA legislation not allowing federally funded research regarding a UPI. It seems that the effort to initiate a voluntary UPI is gaining momentum, even without government funded research.[42]

Measurement & Monitoring

In their paper regarding their socio-technical framework, Sittig and Singh describe this last dimension, "Measurement and monitoring, which refers to the process of measuring and evaluating both intended and unintended consequences of HIT implementation and use."[6]

In the Journal of AHIMA, the 2009 HIE Practice Council discusses the many aspects associated with managing the integrity of patient identity. A portion of that article is concerned with measuring duplicate rates within patient records and the Council conceded that there is a multitude of ways to approach this issue. "Different methods can be found within the healthcare industry to measure the duplicate rate at a given point in time or measure the ongoing duplicate-creation rate. Algorithms used to identify potential duplicate records are also widely different."[24] The authors shared several equations that measure duplicate rates over a period of time and also show ways to calculate a per day measurement of duplicate records created in a given facility and when there is overlap. Interestingly, the Council mentions, "It is critical that all HIEs routinely monitor linked or merged records within their systems and regularly work the lists of potential overlap (enterprise duplicate) records identified by their record-matching algorithms. Without such data maintenance, large databases will become riddled with data integrity problems. Providers using the system will start seeing duplicate and overlap records, lose confidence in the system, and stop using it."[24]

There are many approaches that can be taken to measure and monitor patient identification practices. The Phipps et al.[40] article discussed qualitative studies to discover perceptions related to the patient identification process. In the article on understanding and preventing wrong-patient electronic orders, Adelman et al.,[35] created a "retract-and-reorder measurement tool…effectively identified 170 of 2223 events as wrong-patient electronic orders…estimated that 5246 electronic orders were placed on wrong patients in 2009."[35] While all of these orders did not cause harm, (i.e., the error was caught and

corrected in time), coming up with solutions to solve this issue, as Adelman and his colleagues demonstrated, is surely warranted.

Additional Findings

There were some findings that I found hard to assign to a dimension in the socio-technical model, but they still deserve attention. Gartner Research is well known for its research in the information technology world and the reason for including them in this paper is to relay some findings that I discovered while investigating their "Hype Cycles", one of their main products for their clients to determine the value of a technology.

> The basic message of the Hype Cycle is that organizations should not invest in a technology just because it is being hyped, nor should they ignore a technology just because it did not live up to early expectations. Rather, they should be selectively aggressive and move early with technologies that are potentially beneficial to their businesses. The Hype Cycle is also useful in identifying technologies for which the hype has abated and demonstrable value has accrued."[43]

After viewing a few of the cycles on healthcare technology pertaining to data management and identity and then reviewing another document by Gartner analysts on positively identifying the patient, I realized that some of the technologies that I have mentioned, such as biometrics and RFID, were shown as viable technologies and possibly on the rise in healthcare, in widespread current use.

One anecdote regarding PID is described by Lichtner, et al.,[26] in their article about the contextual nature of PID. It was a short reference to a newspaper article in London where the handoff of patient care was bungled by a hospital and a man suffering from food poisoning died. "… I was leaving the ICU, and I was approached by the surgical

senior house officer who said, "We've seen the patient and we'll be taking over his care,' and as he was the only referral I had made, I assumed she was talking about him."[44] While Lichtner et al. were making a point about context, this scenario illustrates the ubiquitous nature of PID, where even the most inconsequential of events, in places where it does not seem that anything can go wrong, the most dire of consequences can happen. If there had been an electronic intervention, (e.g., RFID tag to confirm identity, or a picture of the patient shown on their record), or at least a PID policy, in place for handoff, this tragedy could have been avoided.

DISCUSSION

Using Medline (Ovid) as my primary database, and using PubMed and Scopus as secondary databases to search in a reverse and forward chronological fashion, I accessed 31 documents that addressed the issue of patient identification in healthcare. Having searched for documents for nearly a year on this subject, one lesson of note was that having two or three databases to verify information (e.g., cited by or find citing articles) was not only helpful but necessary to do a thorough search. For instance, even though Scopus did not list the Adelman article as having been cited, Ovid listed it as having one citation. While the cause is unclear, Scopus may not have updated its Database. I found that by searching in more than one database my search yielded greater results.

The initial objective of my capstone project was PID related to EHR safety, but as I discovered in my research, PID is so prevalent in the healthcare process, that one needs to look at all aspects of an episode of care to see how the integrity of patient identification

can be affected. This meant the patient ID process needed to be defined in a way that incorporated all the critical points of care where patient ID presented a safety risk. There was no clear definition available outside of the HIMSS PIIM definition,[20] so using that definition and incorporating my own ideas, I attempted to create a more complete definition. While this may not be the definitive version, it opens the door to more research.

After defining the PID process and noting an article calling for the PID process to be everywhere, [11]I wanted to show that it is prevalent across the healthcare system. To do this, I chose to organize the results of the literature search in terms of the eight-dimension socio-technical model[6]. There will continue to be more literature made available as research progresses and the documents I identified in my search seem to back up the view that PID is prevalent throughout the healthcare system. One of the difficulties in organizing this paper around the eight dimensions was that some of the relevant information fell across several dimensions. For example, I feel that Adelman's alerts could have been categorized in clinical content as well as HCI, and other documents, such as Lichtner's discussion of context, had parts that fit into Hardware & Software and HCI, but also they alluded to the newspaper article that illustrated the importance of context in a hand-off situation. Also, any discussion about UPI seems to fit into several dimensions. Other documents were also difficult to categorize, such as the Gartner Hype Cycle[43] because it was about business decisions regarding HIT. One could argue hardware & software since the Hype Cycle discussed RFID and palm scanning that would be considered a medical device. On the other hand, maybe assign it to the internal

policy & procedure dimension, since the article discussed the value of waiting for the right moment to invest in a technology, and those decisions are made by leadership. Even the tragic death in the ICU was hard to categorize as the responsibility of one dimension. The people dimension concerns training and avoiding a repeat of this type of event could be used as a training model, which would also involve internal policy. Workflow and communication was also at fault here, and there could have been hardware and software solutions to mitigate the risks. It seems that there really isn't any papers that were found that can't be linked to at least one dimension, it is just that some papers and subject matter spread across multiple dimensions and therefore shouldn't be restricted to one dimension.

In the literature identified in this paper, I have found solutions to the PID process in many areas, including Algorithmic matching in the records systems, biometric systems to positively ID the patient, RFID to track the patient and confirm medication orders, and the possibility of VUHID to give each patient their own identifier. To make algorithms, biometrics, VUHID, and RFID work, it will take some cooperation among private entities, or a government mandate, to create standards so that HIEs can exchange information with limited errors. The solution may come in the form of a public/private partnership that maximizes the positive traits of both. If the HIT industry and the government comes together to embrace these actions, the issue of wrong patient identity will be reduced. The linkages to patient records would be secure and accurate so that the identity of patients is assured throughout their stay and patient safety is improved.

All of these practices help to maintain the integrity of the patient data, and I conclude can also be used to optimize patient safety.

I also identified possible ways to improve the user interface in these systems, such as the passive and active ID alerts purposed by Adelman et al., [35] and patient banners suggested by Lichtner et al. [26] Along with standardizing the information that is available on the EHR interface, so that providers can positively identify a patient, having a picture of the patient displayed on the interface, especially during registration, ordering, handoffs, and transfers, would greatly improve patient safety. This, in conjunction with measuring and monitoring these interventions for continual improvement, will greatly mitigate patient safety risks. The Hyman study, and the Adelman study, both illustrated ways to measure results from identification alerts; it is my opinion is that more research needs to be done in the area. In addition the 2009 HIE practice Council proposed several ways to measure duplicate records. It is my contention that all data managers at all facilities should be using at least one method to determine and reduce the rate of duplicates, overlaps, and overlays, so that data integrity, and most importantly, patient safety, is maintained at its highest possible level. Another example of measuring and monitoring is instigating qualitative studies like that in the Phipps article.[40] Taking results from studying the patient identification process at one's institution and then incorporating internal policies to address problematic areas is an excellent way to improve patient safety.

Additionally, there were calls to put organizational training policies in place to improve care giver perceptions of the importance of PID and to use the moments of confirming

PID to teach patients the value of multiple PID checks during their episode of care. The many people involved in a single episode of care, need to be fully aware of PID policies and the consequences associated with wrong-patient identity. The people dimension is complex in healthcare. Strategic leadership decisions, EHR vendor decisions, and information technology decisions can affect how patient identification affects EHR safety. To understand the roles and responsibilities of all people involved in a patient encounter, and all the critical areas where PID needs to be considered, more research needs to be done. One example is completing a modeling diagram that tracks normal patient encounters, but also looks at the different scenarios that can happen (abnormal encounters) and different people that enter into a single episode of care. As indicated by the ICU patient in the London newspaper article, tragic consequences can occur even in what seems to be a normal interaction.

Hopefully more research in the area of EHR safety, patient identification, and in defining the PID process as whole will be in our future. It seems the authors highlighted in this literature review concur. For example, in the HIMSS whitepaper, there is a call for more research into the effectiveness of algorithmic matching to improve on finding and eliminating duplicate records. "Ensuring the integrity of the data and accuracy of patient identification is the most essential infrastructure component of interoperability and communication process, particularly when data from a patient care device are exported to the enterprise HIS system." [20]

We also need to come together as an industry to create standards and regulations in the name of patient safety. First introduced in 2003, Goal 01.01.01 of the NPSGs gives rise to the

exigent nature of creating standards, rules, and regulations surrounding patient identification practices in an electronic health record. These will be needed in the future as the complex relationship of the electronic health record and patient identification, becomes even more intertwined with facility, enterprise, regional, and national health information systems. I also suggest that the development of a universal patient identifier on a national scale would greatly reduce the chance of wrong patient identification and therefore greatly improve patient safety, but unfortunately there has been restrictions placed on federally funded research in this area.

SUMMARY

The literature reviewed in this paper provided examples of the system wide nature of PID relating to EHR safety and a variety of solutions to help mitigate the associated risks. While this illustrates some pioneering work in the file of Informatics, more research is needed on the PID process as it relates to EHR safety. First and foremost is the need to have everyone involved in healthcare understand the importance of correct PID, that it is ubiquitous in nature, and that wrong patient identity can have dire consequences not only during a current visit to a healthcare facility, but in all subsequent visits that a patient may make to the same facility and to all facilities globally. The healthcare industry is working on solutions to mitigate the risks and new technologies are coming that will help to make it easier on caregivers and safer for patients, but we need to continue to make advancements in mapping the patient identification process. This will allow us to improve our methods and hopefully find unknown risk areas before they occur, thus

continually improving the patient identification process and patient safety, in the context of an EHR.

REFERENCES

[1] Committee on Quality of Health Care in America, Institute of Medicine. To Err is Human: Building a Safer Health System. The National Academies Press. Washington D.C. Institute of Medicine. 2000.

[2]Committee on Quality of Health Care in America, Institute of Medicine. Crossing the Quality Chasm. The National Academies Press. Washington D.C. Institute of Medicine. 2001.

[3] Office of the National Coordinator for Health Information Technology [homepage on the Internet]. U.S. Government. [updated 2011 Feb 9; cited 2011 Aug 29]. Electronic Health Records and Meaningful Use; [about 2 screens]. Available from: http://healthit.hhs.gov/portal/server.pt?open=512&objID=2996&mode=2

[4] Ash J, et al. Roadmap for the Provision of Safer Healthcare Information Systems: Preventing e-Iatrogenesis. Institute of Medicine. 2011. Available at: http://www.iom.edu/~/media/Files/Report%20Files/2011/Health-IT/Commissioned-paper-Roadmap-for-Provision-of-Safer-HIS.pdf

[5] The Joint Commission. National Patient Safety Goals. Goal 1. Available at: http://www.jointcommission.org/assets/1/18/NPSG_Chapter_Jan2013_HAP.pdf Accessed March 15, 2013.

[6] Sittig DF, Singh H. A new socio-technical model for studying health information technology in complex adaptive healthcare systems. Qual Saf Health Care. 2010 Oct;19 Suppl 3:i68-74.

[7] Petersen LA, Orav EJ, Teich JM, O'Neil AC, Brennan TA. Using a computerized sign-out program to improve continuity of inpatient care and prevent adverse events. Jt Comm J Qual Improv 1998 Feb;24(2):77-87.

[8] Foster PN, Sidhu R, Gadhia DA, DeMusis M. Leveraging computerized sign-out to increase error reporting and addressing patient safety in graduate medical education. J Gen Intern Med 2008 Apr;23(4):481-484

[9] Alpert JS, Frishman WH. A bridge too far: a critique of the new ACGME duty hour requirements. Am J Med 2012 Jan;125(1):1-2.

[10] Frishman WH, Nabors C, Peterson SJ. Faculty supervision of the house staff handoff process: the time has come. Am J Med 2013 Jan;126(1):e1-2.

[11]Anonymous. Oops, sorry, wrong patient! A patient verification process is needed everywhere, not just at the bedside. Alta RN 2012;67(6):18-22.

[12] Jeff. "All about the process." H&HN Hospitals & Health Networks Feb. 2013: 14. Academic OneFile. Web. 16 Mar. 2013. Available at: http://go.galegroup.com/ps/i.do?id=GALE%7CA321057129&v=2.1&u=ohsu&it=r&p=AONE&sw=w

[13]AHIMA. AHIMA [homepage on the Internet]. AHIMA [updated 2013; cited 2013 Feb 21] AHIMA Facts; [about 2 screens]. Available at: http://www.ahima.org/about/facts.aspx

[14] AHIMA. MPI Task Force. "Building an Enterprise Master Person Index." Journal of AHIMA 75, no. 1 (Jan. 2004): 56A–D.

[15] Amatayakul M., *Electronic Health Records: A Practical Guide for Professionals and Organizations. Fifth edition.* Chicago, IL. AHIMA. 2012. P.5

[16] Vogel L., Perreault L. Management of Information in Healthcare Organizations. Shortliffe E. (ed.), Cimino J. (assoc. ed.), *Biomedical Informatics, Computer Applications in Health Care and Biomedicine. Health Informatics Series. Third edition*. New York, NY. Springer. 2006. p. 476, 945.

[17] Office of the National Coordinator for Health Information Technology. Health Information Exchange. HealthIT.gov website. Accessed March 15th, 2013. Available at: http://www.healthit.gov/providers-professionals/health-information-exchange

[18] HIMSS. HIMSS [homepage on the Internet]. HIMSS [updated 2012 – 2013; cited Feb 21] About HIMSS; [about 3 screens]. Available at: http://www.himss.org/about

[19] LaTour K., Eichenwald-Maki S. *Health Information Management: Concepts, Principles, and Practice. Second Edition.* Chicago, IL. AHIMA. 2006. p. 933

[20] Demster B, et al . Patient Identity Integrity - A White Paper by the HIMSS Patient Identity Integrity Work Group. 2010; Available at: http://www.himss.org/files/HIMSSorg/content/files/PrivacySecurity/PIIWhitePaper.pdf. Accessed May/12, 2012.

[21] National Committee on Vital and Health Statistics. U.S. Department of Health & Human Services. Unique Patient Identifier. Available at: http://www.ncvhs.hhs.gov/app3.htm
Accessed May/12, 2012.

[22] Quantin C., Allaert F., Avillach P., et al., "Building Application-Related Patient Identifiers: What Solution for a European Country?," International Journal of Telemedicine and Applications, vol. 2008, Article ID 678302, 5 pages, 2008. doi:10.1155/2008/678302. Available at: http://www.hindawi.com/journals/ijta/2008/678302/cta/

[23] National Institutes of Standards and Technology, "Secure Hash Standard". FIPS Publication 180 – 2. Available at: http://csrc.nist.gov/publications/fips/fips180-2/fips180-2.pdf

[24] AHIMA. "Managing the Integrity of Patient Identity in Health Information Exchange " Journal of AHIMA 80, no.7 (July 2009): 62-69. Available at: http://library.ahima.org/xpedio/groups/public/documents/ahima/bok1_044000.hcsp?dDocName=bok1_044000

[25] Microsoft. Design guidance: patient banner—first release, version 1.0.0.0–5 July 2007. Microsoft Health Common User Interface, 2007. http://www.mscui.org/ (accessed 28 Aug 2008).

[26] Lichtner V, Galliers JR, Wilson S. A pragmatics' view of patient identification. Qual Saf Health Care 2010 Oct;19(Suppl 3):13-19.

[27] Anonymous. Palm scan technology improves patient safety. Healthcare Benchmarks Qual Improv 2011 Dec;18(12):143-144.

[28] Catarinucci L, Colella R, Esposito A, Tarricone L, Zappatore M. RFID sensor-tags feeding a context-aware rule-based healthcare monitoring system. J Med Syst 2012 Dec;36(6):3435-3449.

[29] Chen JC, Collins TJ. Creation of a RFID based real time tracking (R-RTT) system for small healthcare clinics. J Med Syst 2012 Dec;36(6):3851-3860

[30] Fosso Wamba S. Guest editorial for the special issue on RFID-enabled healthcare: applications, issues and benefits. J Med Syst 2012 Dec;36(6):3389-3392.

[31] Pletersek A, Sok M, Trontelj J. Monitoring, control and diagnostics using RFID infrastructure. J Med Syst 2012 Dec;36(6):3733-3739.

[32] Ullah S, Alsalih W, Alsehaim A, Alsadhan N. A review of tags anti-collision and localization protocols in RFID networks. J Med Syst 2012 Dec;36(6):4037-4050.

[33] Weis J. [Will RFID technology improve economic efficiency and patient safety?]. Dtsch Med Wochenschr 2012 Nov;137(46):2359.

[34] Dondelinger RM. Radio frequency identification. Biomed Instrum Technol 2010 Jan-Feb;44(1):44-47.

[35] Adelman JS, Kalkut GE, Schechter CB, Weiss JM, Berger MA, Reissman SH, et al. Understanding and preventing wrong-patient electronic orders: a randomized controlled trial. Journal of the American Medical Informatics Association 2013 March 01;20(2):305-310.

[36] Hyman D, Laire M, Redmond D, Kaplan DW. The use of patient pictures and verification screens to reduce computerized provider order entry errors. Pediatrics 2012 Jul;130(1):e211-9.

[37] Paparella SF. Accurate patient identification in the emergency department: meeting the safety challenges. J Emerg Nurs 2012 Jul;38(4):364-367.

[38] Sittig DF, Ash JS, Zhang J, Osheroff JA, Shabot MM. Lessons from "unexpected increased mortality after implementation of a commercially sold computerized physician order entry system". Pediatrics 2006 08;118(2):797-801.

[39] Radecki RP, Sittig DF. Application of electronic health records to the Joint Commission's 2011 National Patient Safety Goals. JAMA 2011 Jul 6;306(1):92-93.

[40] Phipps E, Turkel M, Mackenzie ER, Urrea C. He thought the "lady in the door" was the "lady in the window": a qualitative study of patient identification practices. Jt Comm J Qual Patient Saf 2012 Mar;38(3):127-134.

[41]Office of the National Coordinator of Health Information Technology (ONC). Nationwide Privacy and Security Framework For Electronic Exchange of Individually Identifiable Health Information. 2008; Available at: http://www.healthit.gov/sites/default/files/nationwide-ps-framework-5.pdf Accessed August 25, 2012

[42] McCann E. Rekindling the patient ID debate. Healthcare IT News. Through HIMSS Media. 2013. Available at: http://www.healthcareitnews.com/news/rekindling-patient-id-debate Accessed March 26, 2013

[43] Gartner, Inc. The Gartner Hype Cycle on Health Information Technology. Gartner Research. 2013. Available at: http://www.gartner.com/technology/core/home.jsp Accessed March 12, 2013

[44] Pinch E. Death of a patient lost in the hospital system. icBirmingham, Birmingham Post, UK, 2006. Available at: http://icbirmingham.icnetwork.co.uk/0100news/0100localnews/tm_objectid=17062582&method=full&siteid=50002&headline=death-of-a-patient-lost-in-the-hospital-system-name_page.html (accessed 3 Aug 2009 by Lichtner et al., confirmed 18 Mar 2013).

APPENDICES

Appendix A

Ovid Search History

1. exp Patient Identification Systems/

2. Patient ID.mp.

3. Patient Identification.mp.

4. exp Risk Management/

5. 1 or 2 or 3

6. 4 and 5

7. exp Patient Identification Systems/mt, st, ut [Methods, Standards, Utilization]

8. exp Public Health/

9. 5 and 8

10. Safety Management/ or Medical Errors/ or Medical Records Systems, Computerized/ or Medical Order Entry Systems/

11. exp Safety Management/

12. exp Safety Management/es, hi, lj, mt, og, st, td [Ethics, History, Legislation & Jurisprudence, Methods, Organization & Administration, Standards, Trends]

13. 9 and 12

14. exp "Quality of Health Care"/

15. 9 and 14

16. (Electronic health records and national patient-safety goals).m_titl.

17. Computers/ and exp Efficiency, Organizational/ and Patient Transfer/ and Patient flow management systems.mp.

18. Computers/ or exp Efficiency, Organizational/ or Patient Transfer/ or Patient flow management systems.mp.

19. Patient flow management systems.mp.

20. Roadmap for the Provision of Safer Healthcare Information Systems: Preventing e-Iatrogenesis.m_titl.

21. palm scan.mp.

22. Radio Frequency Identification Device/mt, og, st, ut [Methods, Organization & Administration, Standards, Utilization]

23. Patients/ or Hospitals/ or Medical Records Systems, Computerized/ or Patient Identification Systems/ or patient identification.mp. or Medical Records/ or Medical Errors/

24. exp Patient Identification Systems/

25. Patients/ and Hospitals/ and Medical Records Systems, Computerized/ and exp Patient Identification Systems/ and Medical Records/ and Medical Errors/

26. hospitals, group practice/ or hospitals, private/ or hospitals, public/ or hospitals, rural/ or hospitals, teaching/

27. 24 and 26

28. diagnostic errors/ or medication errors/ or observer variation/ or radiotherapy setup errors/

29. 27 and 28

30. Algorithms/

31. Total Quality Management/ or Medication Errors/ or Medication Systems, Hospital/ or Medical Order Entry Systems/ or User-Computer Interface/ or Health Maintenance Organizations/

32. patient registration.mp.

33. Safety Management/ or Electronic Health Records/ or Patient Safety/

34. 1 and 31

35. 23 and 30

36. 28 and 35

37. exp workflow/

38. 33 and 37

Ovid search showing articles found

1	exp Patient Identification Systems/	1883
2	Patient ID.mp.	41
3	Patient Identification.mp.	2192
4	exp Risk Management/	186366
5	1 or 2 or 3	2380
6	4 and 5	331

7	exp Patient Identification Systems/mt, st, ut [Methods, Standards, Utilization]	463
8	exp Public Health/	5174575
9	5 and 8	1455
10	Safety Management/ or Medical Errors/ or Medical Records Systems, Computerized/ or Medical Order Entry Systems/	41974
11	exp Safety Management/	15519
12	exp Safety Management/es, hi, lj, mt, og, st, td [Ethics, History,	8726
13	9 and 12	160
14	exp "Quality of Health Care"/	4560071
15	9 and 14	1218
16	(Electronic health records and national patient-safety goals).m_titl.	2
17	Computers/ and exp Efficiency, Organizational/ and Patient Transfer/ and Patient flow management systems.mp.	0
18	Computers/ or exp Efficiency, Organizational/ or Patient Transfer/ or Patient flow management systems.mp.	69795
19	Patient flow management systems.mp.	0
20	Roadmap for the Provision of Safer Healthcare Information Systems: Preventing e-Iatrogenesis.m_titl.	0
21	palm scan.mp.	1
22	Radio Frequency Identification Device/mt, og, st, ut [Methods, Organization & Administration, Standards, Utilization]	89
23	Patients/ or Hospitals/ or Medical Records Systems, Computerized/ or Patient Identification Systems/ or patient identification.mp. or Medical Records/ or Medical Errors/	126011

24	exp Patient Identification Systems/	1883
25	Patients/ and Hospitals/ and Medical Records Systems, Computerized/ and exp Patient Identification Systems/ and Medical Records/ and Medical Errors/	0
26	hospitals, group practice/ or hospitals, private/ or hospitals, public/ or hospitals, rural/ or hospitals, teaching/	34443
27	24 and 26	34
28	diagnostic errors/ or medication errors/ or observer variation/ or radiotherapy setup errors/	67456
29	27 and 28	5
30	Algorithms/	154829
31	Total Quality Management/ or Medication Errors/ or Medication Systems, Hospital/ or Medical Order Entry Systems/ or User-Computer Interface/ or Health Maintenance Organizations/	63259
32	patient registration.mp.	272
33	Safety Management/ or Electronic Health Records/ or Patient Safety/	21608

34	1 and 31	178
35	23 and 30	1042
36	28 and 35	22
37	exp workflow/	603
38	**33 and 37**	**71**

Appendix B

Table 4 – Ovid search results for EHR Safety

Inclusion Criteria	Resulting MeSH terms	Articles found
EHR Safety		
	Electronic Health Records	4,089
	Safety	31,436

Table 5 – Explosion of MeSH terms related to EHR Safety

Initial MeSH term	Subheading	Articles found
Electronic Health Records	N/A	4,089
Safety		31,436
	Chemical Safety	8
	Safety Management	15,519
	Patient Safety	2,291