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A Mixed Methods Assessment of the Implementation of Electronic Health Records in Local Health Departments

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A MIXED METHODS ASSESSMENT OF THE IMPLEMENTATION OF ELECTRONIC HEALTH RECORDS IN LOCAL HEALTH DEPARTMENTS

by

KARMEN SENYAUN WILLIAMS

(Under the Direction of Gulzar H. Shah)

ABSTRACT

Background: Electronic Health Record (EHR) implementation has seen great advances in health care, but the movement is leaving public health agencies behind. EHRs have shown improvement in operational and societal outcomes when implemented. Scarce allocation of resources, lack of trained staff, and security are limiters to implementation, despite the varied benefits of EHRs. The objective of this research is to establish a comprehensive view of EHR implementation in local health departments (LHDs) through assessing the status of implementation, benefits, barriers, and strategies to overcome challenges. *Methods:* This research uses a mixed methods approach to assess 49 key-informant interviews and 324 web-based surveys from leaders and primary users of informatics within LHDs. These data assist in the evaluation of current practices, capabilities, and needs of LHDs. The qualitative interviews are coded by themes and sub-themes using NVivo software. Using SPSS and SAS analytical software, survey logistic regression and descriptive statistics the quantitative data were analyzed. *Results:* The majority of the LHDs do not have EHR implementation activity and are using non-EHR systems for data storage. Approximately 42 percent of LHDs implemented a type of EHR system. The most frequently mentioned benefits of EHR implementation are care coordination, retrieval or managing information, track outcomes of care, increased efficiencies, and accurate records. However, the barriers are costs or financial resources, resistance to change, no clinical services, lack of training, and low priority. LHD characteristics individually, significantly associated with the implementation of EHRs at least at

the 0.05 significance level are: hardware allocation and acquisition within a central department in the LHD, hardware allocation and acquisition at county or city IT department, type of internet, and organizational activities related to informatics within the LHDs. For LHDs who have not implemented EHR systems, almost half have selected a system and are in the process of implementation. *Conclusion:* Despite the barriers of costs and resistance to change of EHR implementation in LHDs, the leaders are optimistic about the future of EHRs in LHDs even making plans for future implementation. Successful implementation is influenced by the level of control of informatics and organizational activities related to informatics.

INDEX WORDS: Local Health Department, Electronic Health Records, Implementation

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DEDICATION

This research is first dedicated to Olive Marie Thompson-Williams, Cleo McConnell, and L. Dante Hanks and to all those who were connected in one way or another. I only hope that the impact they had on my life, was as great as in yours. Each time during this journey I thought I might not make it, the memory of these people, their support and faith in me, I was encouraged.

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Finally, the journey to complete this work is dedicated to all the little black girls who want to achieve greatness in life. Unfortunately, you will face difficulties, stressors, fears, long days and nights, and many challenges, but you can make it. Go after your dreams, have faith, and you will be exactly where you are supposed to be. You can do it. Stay positive and know that someone is rooting for you.

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CHAPTER I: BACKGROUND AND SIGNIFICANCE

Introduction

Technological advances in health care are evolving at a rapid pace and in some cases leaving public health behind. The use of health informatics, such as electronic health records (EHRs), can increase efficiency in public health agencies, especially local health departments (LHDs), and in the provision of the services provided to their communities (Baker & Ross, 2013; Menachemi & Collum, 2011). EHR users assert benefits of linking organizational efficiencies to societal outcomes which improve population health (Marsolo, 2012; Menachemi & Collum, 2011). According to the 2013 National Profile of Local Health Departments, only 22 percent of LHDs in the United States had implemented EHRs (NACCHO, 2014). LHDs are challenged in improving and implementing technologies due to various reasons, including funding, staffing, and low priority (Chaudry et al., 2006; Menachemi & Collum, 2011; Pilkington & Macchione, 2013; Richardson et al., 2011). In recent years, health care has seen an increase in health informatics priority, but public health is slow to follow (NACCHO, 2014).

The focus on the implementation of health informatics, especially EHRs, has amplified in priority through legislation and incentive programs. The enactment of The Patient Protection and Affordable Care Act of 2010 supports the innovation of public health systems and informatics (Ostrovosky & Katz, 2011). The Health Insurance Portability and Accountability Act (HIPAA) of 1996 through the Health and Human Services (HHS) Office for Civil Rights manages privacy and security regulations to protect the type and methods through which information can be used and shared. In addition, HIPAA contains privacy protections and safeguards to ensure electronic health information is appropriately protected. The Health Information Technology for Economic and Clinical Health (HITECH) Act of the American Recovery and Reinvestment Act of 2009,

purposes to improve the adoption and use of Health information technology in the United States. The HITECH Act also established the Office of the National Coordinator for Health Information Technology (ONC) which envisions a nationwide fully interoperable health system to continuously improve care, public health, and science through access to real-time data by the year 2024. The ONC and Centers for Medicare and Medicaid Services (CMS) provide incentive payments for the adoption of certified EHRs. Although public health is included in the vision of ONC, the EHR Incentive Programs are for qualifying eligible professionals, eligible hospitals, and critical access hospitals (CMS, 2015). Despite the exclusion of LHDs from the EHR incentive program, these legislations are integral parts to the use and implementation of EHRs in LHDs.

Statement of Problem

Local health departments, regardless of size and governance, have the responsibility to provide services to the communities they serve (Handler & Turnock, 1996). Research indicates a lack of health informatics in LHDs not only affects the internal organizational operations, but also the external provision of those services. Several studies discuss the impacts and limitations in the implementation of EHRs such as financial and staff resources, but an updated and deeper view of informatics implementation is needed to further examine these and other reasons LHDs are still falling short of this health IT initiative (Adler, 2010; Adler-Milstein, Everson, Shoou-Yih, & Lee, 2015; Gagnon et al., 2016; McCullough, 2013; Qiao, Asan, & Montague, 2015). Being that LHDs are a part of the front-line public health defense to approaching population health issues, LHDs have a responsibility to adopt, maintain, and use the best practices,

evidence-based methods and technology pertinent to achieving real outcomes in population health.

Existing literature provides a cursory assessment of LHDs' EHR implementation, but an updated and deeper examination of the use, failures, and barriers by LHD staff does not exist. In addition, very few studies mention the impact of organizational activities, such as strategic planning, and control of IT as factors for implementation. Although the literature provides examples of status and systems of patient health information storage, a current assessment and future plans for implementation are left untapped. Using a mixed methods study design, this research fills some of the gaps in the existing body of literature as it explores the benefits, barriers, and strategies experienced by LHD staff who use the EHR systems on a regular basis. In addition, this research surveys LHD staff regarding the current status of patient health information storage and future plans for implementation of EHRs.

Purpose Statement

The aim of this mixed methods research, guided by the Organizational Innovation framework, Resource Dependence theory, and triangulation, is to determine a fuller view of the level of implementation of electronic health records in local health departments. By examining the LHD characteristics associated with the implementation of EHRs, the benefits, barriers, and strategies, and future plans of implementation can provide a comprehensive idea of EHR implementation in LHDs. Qualitative, in-depth interviews provide themes and supportive quotes of the benefits, barriers, and strategies from respondents within LHDs. A quantitative survey supplies the status of patient health information storage and future plans of implementation of EHRs in LHDs. The mixing of these methods assists in the transformation of the data to clarify

issues and gain an integrated view of the implementation of EHRs in LHDs (Creswell & Plano Clark, 2007).

Research Questions

This research pursued the following research questions:

Main Questions:

1. What is the current level of implementation of electronic health records in local health departments?

Sub-questions

- a. What are the benefits of implementation?
 - b. What are the barriers of implementation?
 - c. What strategies have worked for implementation?
2. What LHD characteristics are associated with electronic health record implementation in local health departments?
 3. What are the future plans of implementation of electronic health records in local health departments?

Delimiters

The qualitative data for this research are from a sample which was purposively drawn from the respondents of the 2013 Profile of Local Health Departments by population and state. It was determined that an overall sample of 50 respondents from LHDs would provide a saturation of the topic and questions. The quantitative data for this research are from the 2015 Informatics Capacity and Needs Assessment Survey from a stratified random sample of 650 LHDs, based on

seven population strata: less than 25,000; 25,000—49,999; 50,000—99,999; 100,000—249,999; 250,000—499,999; 500,000—999,999; and 1,000,000 and more. LHDs with larger population were systematically over-sampled to ensure inclusion of sufficient number of large LHDs in the completed surveys.

Significance of Study

This research adds to scholarly research by exploring the electronic health record implementation needs of local health departments nationwide, especially smaller LHDs who tend to be excluded from studies and services. It helps improve policies by examining current status and future plans of nationally representative samples of LHDs to prove the need for multiple levels of support in the implementation and priority of health informatics. The timing of this research is significant in that the data used are collected before the full implementation of the Patient Protection and Affordable Care Act (ACA) of 2010, Meaningful Use (MU) and ICD-10 implementation. Being that EHR implementation is a beginning step of the ACA and MU goal for health information exchange among health providers, this research provides vital information to the delay in reaching this goal. Since LHDs are at the ground level of influencing health in the populations they serve, this research can assist in the development of a plan to improve population health. This research adds to public health practice by compiling evidence-based and practice-based strategies of successful EHR implementation in LHDs of multiple sizes and governance. The implications of this research to implement EHRs can assist in the systematic identification of health disparities and gaps in care for LHDs to better address and reduce such issues in the populations they are serving. Additionally, documentation of specific geographic

areas could inform programs and policy to address environmental and social factors affecting health in those populations.

This research uses data which did not exclude any LHDs, but are limited to the information provided by the respondents of the study. The assumptions are that responses received from LHDs representatives reflect professional opinions, honest and informed answers, and that respondents are knowledgeable of health informatics within the LHDs.

Definition of Terms

The following terms are used throughout this research.

Electronic health records (EHRs). A digital version of a paper chart in real-time making information available instantly and securely to authorized users. EHRs are designed to go beyond the organization, which collects and compiles the information, built to share information with other providers, organizations, and all involved in patient's care. The information moves with the patient (Garrett & Seidman, 2011; HealthIT.gov, 2013).

Governance. The organizational relationship or model of authority, characterized by decentralized, centralized, or mixed, shared or hybrid (Salinsky, 2010).

Health Informatics. A scientific discipline that is concerned with the cognitive, information-processing, and communication tasks of healthcare practice, education, and research, including the information science and technology to support these tasks (AHIMA, 2014); The interdisciplinary study of the design, development, adoption, and application of IT-based innovations in healthcare services delivery, management, and planning (Ong, 2014).

Informatics. A field of study that focuses on the use of technology to improve access to, and utilization of, information (AHIMA, 2014).

Interoperability. The capability of different information systems and software applications to communicate and exchange data (AHIMA, 2014).

Meaningful use. Demonstration of engagement in improving quality, safety, efficiency and reducing health disparities, engaging patient and families in their health, improving care coordination, improving population and public health, and ensuring adequate privacy and security protection for personal health information (CMS, 2015).

Office of the National Coordinator for Health Information Technology (ONC). The principle federal entity charged with coordination of nationwide efforts to implement and use the most advanced health information technology and the electronic exchange of health information. The position of the National Coordinator was created in 2004, through an Executive Order, and legislatively mandated in the HITECH Act of 2009 (AHIMA, 2014).

Public health informatics. Public health informatics is systematic application of information, computer science, and technology for public health practice, research, and learning. It implies the electronic exchange of data for support to public health operations (Yasnoff, O'Carroll, Koo, Linkins, & Kilbourne, 2000).

Organization of Remaining Chapters

This research is segmented into five chapters, references, and an appendix. Chapter 1 includes the background and significance, which explains the need for this research regarding the implementation of EHRs in LHDs, states the problem, provides a purpose and significance statement, delimitations, research questions, and definitions of the terminology in use throughout the document. Chapter 2 provides a thorough appraisal of related literature including historical trends and future predictions. Chapter 3 explains the research design, relationships between

parts of research, instruments, study sample information, and methods to answer the research questions. The results and findings are included in Chapter 4 with figures and tables. Chapter 5 contains a discussion of the findings, conclusions, and public health implications from the study.

CHAPTER II: LITERATURE REVIEW

In this review of the literature, the implementation of electronic health records, as a public health informatics tool is defined in context of local health departments, policies which regulate the implementation and use, and explanation of research using the theoretical frameworks, Organizational Innovation framework and Resource Dependence Theory, and the research design of mixed methods triangulation. This review includes evidence of status, benefits, and barriers of implementation of EHRs in LHDs and illuminates the gaps in the current field of study. It also provides a platform to which this overall research is based.

Current society is governed by ever-evolving technology and simplifying the processes of human life through its use. Health care and public health are no different. The constant need for information to improve processes and work flows are pertinent for the outcomes for delivery of care. “Information is central to driving health improvement (Baker & Ross, p. 383, 2013).” Health information has motivated and made public health practice dependent on it (Gebbie & Turnock, 2006). Information Technology (IT) began as the center stage for health discussions to facilitate knowledge, enable consultations across distances, and keep people updated on job duties (Magruder, Burke, Hann & Ludovic, 2005). Informatics focuses on using technology to enhance the use of and access to information (AHIMA, 2014). Informatics is used in various industries, but is the interdisciplinary use of components from different fields of science to advance the solutions through using information technology (Abramson, McGinnis, Moore, & Kaushal, 2014; AMIA, 2015; Laird-Maddox, Mitchell, & Hoffman, 2014; Merrick, Hinrichs, & Meigs, 2014; Meslin & Schwartz, 2015; Potts & Earwicker, 2011). The term informatics is believed to be derived from terms ‘information’ and ‘automatic’ to insinuate an automatic information processing. Health informatics is the scientific discipline focused on the cognitive,

information-processing, and communication tasks of healthcare practice, education, and research, including the information science and technology to support these tasks (AHIMA, 2014). In addition, it is the design, development, adoption, and application of IT-based innovations in healthcare services delivery, management, and planning (Ong, 2014). Health informatics is generally related to health care, but there are many other areas of health that have adopted specialized technologies (Cesnik & Kidd, 2010). Examples include radiology, laboratory systems, and public health informatics.

Public Health Informatics

Public health informatics is the systematic application of information, computer science, and technology for public health practice, research, and learning (Yasnoff, O'Carroll, Koo, Linkins, & Kilbourne, 2000). It also implies the electronic exchange of data for support to public health operations (Cheatham, 2013). Public health informatics emphasizes use of information technology applications to implement programs that promote health of populations, prevent disease and injury through surveillance of conditions or environments that put populations at risk, discover prevention at all vulnerable points in causation of disease, injury, or disability, and reflect a governmental context of public health (Yasnoff et al., 2000). Informatics in public health describes complex systems, identifies opportunities for improving efficiency and effectiveness of public health system through data collection or use of information, and implements and maintains processes and systems for achieving improvement (Savel & Foldy, 2012). Functional capabilities of public health informatics are clinical documentation, results management, order entry management, decision support, electronic communication and connectivity, patient support, administrative processes, and reporting population health

(Chaudry, Wang, Wu, Maglione, Mojica, Roth, Morton & Shekelle, 2006). Public health informatics focuses on the technology for groups of individuals to include the environment, work and living areas (AMIA, 2015). Examples of these systems are biosurveillance and outbreak and emergency management (AMIA, 2015).

National organizations and agendas give insight for the future of health informatics and recommended implementation of health informatics in public health agencies. In 2001, the national agenda for public health informatics highlighted, 1) funding and governance, 2) architecture and infrastructure, 3) standards and vocabulary, 4) research, evaluation, and best practices, 5) privacy, confidentiality, and security, and 6) training and workforce. These focus areas lead to the 74 recommendations under 2 main themes: 1) all stakeholders need to be engaged in coordinated activities related to PH information architecture, standards, confidentiality, best practices, and research and 2) informatics training is needed throughout the PH workforce. In 2011, the American Medical Informatics Association provided recommendations for the implementation of public health informatics based on a focus of technical framework, research and evaluation, ethics, education, professional training and workforce development, and sustainability (Massoudi, Goodman, Gotham, Holmes, Lang, Miner, Potenziani, Richards, Turner & Fu, 2012). These recommendations included: 1) enhance communication and information sharing within the public health informatics community (p694); 2) improve the consistency of public health informatics through common public health terminologies, rigorous evaluation methodologies, and competency-based training (p694-695); and 3) promote effective coordination and leadership that will champion and drive the field forward (p695) (Massoudi et al., 2012). The implementation of public health informatics in

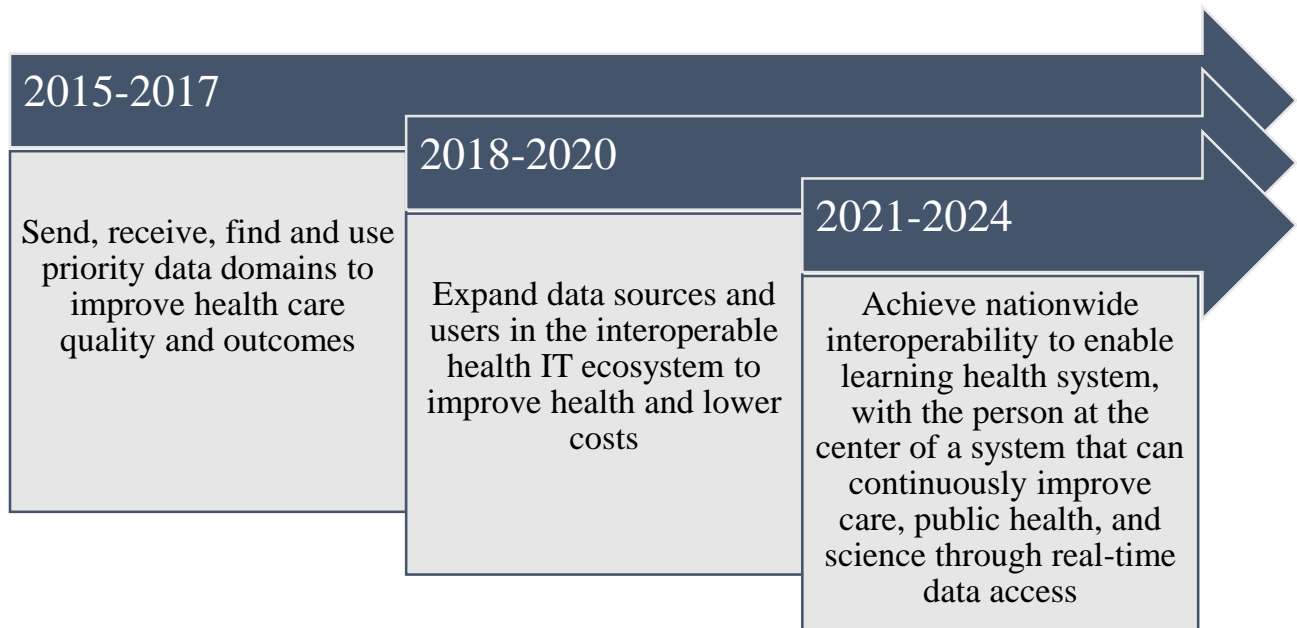
public health agencies has and is expected to improve operations, community health outcomes, and increase effectiveness and efficiency despite funding, staffing, and sustainability concerns.

Legislation Related to Informatics

Healthcare legislation serves as a catalyst for the implementation of public health informatics. The enactment of The Patient Protection and Affordable Care Act of 2010 supported the innovation of public health systems and informatics (Ostrovosky & Katz, 2011). The Health Insurance Portability and Accountability Act (HIPAA) of 1996 through the Health and Human Services (HHS) Office for Civil Rights manages privacy and security regulations to protect the type and methods through which information can be used and shared. In addition, HIPAA contains privacy protections and safeguards to ensure electronic health information is appropriately protected. The Health Information Technology for Economic and Clinical Health (HITECH) Act of the American Recovery and Reinvestment Act of 2009, purposed to improve the adoption and use of Health information technology in the United States. The HITECH Act also established the Office of the National Coordinator for Health Information Technology (ONC) which envisions a nationwide fully interoperable health system to continuously improve care, public health, and science through access to real-time data by the year 2024. The ONC and Centers for Medicare and Medicaid Services (CMS) provide incentive payments for the adoption of certified EHRs. Although public health is included in the vision of ONC, the EHR Incentive Programs are for qualifying eligible professionals, eligible hospitals, and critical access hospitals (CMS, 2015). Despite the exclusion of LHDs from the EHR incentive program, these legislations are integral parts to the use and implementation of EHRs in LHDs.

Through the HITECH Act, the Office of the National Coordinator for Health Information Technology (ONC) was established and given authority to recommend, promote and improve programs, standards, privacy and security, and incentive programs for health information technology (HealthIT.gov, 2015). The ONC (2015) expressed a 10-year vision for connecting health and care through interoperable health information technology (IT). The Federal Health IT Strategic Plan vision is for “high-quality care, lower costs, healthy population, and engaged people (p.9)” with a mission to “improve the health and well-being of individuals and communities through the use of technology and health information that is accessible when and where it matters most (p.9).” This vision includes a roadmap of plans to use health IT to improve standards and implementation guidance, shift and align policies to value-based models which demands interoperability, clarify privacy and security requirements to allow for interoperability, and promote coordination among stakeholders to support and remove barriers to interoperability (ONC, 2015). The ONC aims to reach 4 goals: (1) advance person-centered and self-managed health, (2) transform health care delivery and community health, (3) foster research, scientific knowledge, and innovation, and (4) enhance the nation’s health IT infrastructure. The fourth goal is presented in Figure 2.1 in steps by the proposed years.

Figure 2.1: Goals for Enhancing the Nation’s Health IT Infrastructure with Proposed Years
(ONC, 2015a)



Certification of EHRs is based on standards and criteria by Centers for Medicare and Medicaid Services (CMS) and ONC for structure data for EHR use (CMS, 2015). Health IT product and system vendors develop EHR products which meet the standards and certification criteria of CMS and ONC, test EHR products based on that criteria, certify test EHR products, submit information to ONC for posting on the Certified Health IT Product List (CHPL), the certified EHR is used in accordance with meaningful use objectives and measures, and eligible entities can receive incentive payments from CMS (CMS, 2015). This certification assures purchasers and users of EHR systems that the capability, functionality, and security standards of CMS and ONC are met based on the meaningful use requirements. It protects patients and providers in the use of electronic health IT products and systems through secure and confidential means. Health entities are able to search a comprehensive list of certified health IT vendors and products on ONC’s website (ONC, 2015a).

Under the HITECH Act, meaningful use of certified EHRs are standards created by the Center for Medicare and Medicaid Services (CMS) which provides monetary incentives to health care providers and hospitals that purchase, implement, and use EHRs. For meaningful use of interoperable health IT and certified EHRs. HITECH's provisions and grants have potential to impact the way local health departments (LHDs) receive and use information (NAACHO, 2014a). Meaningful use specifies objectives for eligible participants to qualify for the incentive program. These objectives include focuses on Stage 1 in 2011 – 2012 on data capture and sharing; in 2014 on Stage 2 advance clinical processes; and in 2016 on Stage 3 for improved outcomes (Silverman, 2013). Certain criteria determine the ability to achieve meaningful use at each stage. For Stage 1, electronic health information must be captured in a standardized format, key clinical conditions must be tracked, that information must be communicated for care coordination processes, reporting of clinical quality measures and public health information, and information must be used to engage patients and their families in care. Stage 2 has an increased rigor of health information exchange (HIE), e-prescribing and lab results, electronic transmission of patient care summaries across various settings, and increase in patient control of data. Stage 3 purports improved outcomes by improving quality safety, and efficiency, decision support of national high-priority conditions, greater patient access through tools for self-management, access to comprehensive patient data through HIEs that are patient centered, and improved population health (HealthIT.gov, 2015). Although public health is included in the vision of ONC, the EHRs Incentive Programs are for qualifying eligible professionals, eligible hospitals, and critical access hospitals. However, the eligible Medicare and Medicaid hospitals (HealthIT.gov, 2015). Meaningful Use objectives for public health agencies focuses on immunization registries

and information systems, syndromic surveillance data, specialized registries, electronic lab reporting, and certified electronic health records (HHS, 2010).

On August 21, 1996 the Health Insurance Portability and Accountability Act (HIPAA) was passed to improve the efficiency and effectiveness of the health care system through the adoption of “national standards for electronic health transactions and codes sets, unique identifiers, and security” (HHS, 2015). For public health, HIPAA governs the privacy and security of protected health information through the HIPAA Privacy Rule. This Rule ensures safe access and permits certain entities, called covered entities, to disclose protected health information (PHI) without authorization for specific public health reasons (CDC, 2003; HHS, 2015). PHI is an individual’s identifiable health information which is transmitted or maintained in any form, but excludes certain educational records and employment records (CDC, 2003). Public health was and is impacted by the HIPAA Privacy Rule through the sharing of PHI to accomplish essential public health services and reporting to identify threats to individuals and public. PHI may be used for public health purposes without a written patient authorization. This rule supports the interoperability of health informatics in local health departments.

Types of Informatics

Various types of health information technology systems assist with transforming the public health and the health care industry. Some include: Electronic Health Records (EHRs), computerized provider order entry, decision support, electronic results reporting, electronic prescribing, consumer health informatics or patient decision support, mobile computing, telemedicine, electronic health communication, administration, data exchange networks, knowledge retrieval systems, and Health Information Technology (HIT) in general (Chaudry et

al., 2006). LHDs use information technology at different activities levels, including EHRs, Health Information Exchange (HIE), immunization registries, electronic disease reporting systems, electronic lab reporting, and electronic syndromic surveillance systems (Love & Shah, 2006; Shah, Leider, Castrucci, Williams, & Luo, 2016; Soper et al., 2013; Yaraghi et al., 2015).

Electronic Health Records (EHRs)

EHRs are important and change the way LHD operates, making it more efficient and opening up new options for providing and sustaining services (Cheatham, 2013). Advantages associated with EHRs are the ease of access to computerized records, elimination of poor penmanship, access to clinical decision support (CDS) tools, availability of computerized physician order entry (CPOE) systems, and health information exchange (HIE) abilities. EHRs can assist with improvement in quality of care through patient safety, effectiveness, and efficiency, medical error reduction, and advances in describing appropriateness of care through patient-level measures (Menachemi & Collum, 2011). Organizational outcomes of EHRs can include: better financial and operational performance, patient and clinician satisfaction, increased revenue through the capturing of charges, decreased errors in billing, and better mechanisms for cash flow which enhances revenue (Menachemi & Collum, 2011). In addition, costs are averted by appropriate utilization of tests, staff resources suitable for patient management, decrease in maintenance of paper files, reduction of costs for transcription, chart pulls, use of tests, and reduction in mailing hard copies to different providers (Menachemi & Collum, 2011). Legality and compliance to regulations are improved through the ability to conduct research, physician satisfaction in job and career which can lead to higher operational performance (Menachemi &

Collum, 2011). Societal implications of EHRs allow for research and availability of clinical data to assist in the improvement of population health (Menachemi & Collum, 2011).

Electronic Health Record systems symbolize fundamental change in how clinical operations and clinical practices are approached by providers. However, this transformation at provider and practice level offers expense and challenges. There are potential negative impacts of day-to-day operations, affects provider satisfaction, workflow, and efficiency, concerns of management, vendor selection process, and implementation support, long term training, obtaining qualified workforce, and budget allocations (Richardson et al., 2011). Other disadvantages associated with EHRs are financial issues in the adoption, implementation, and constant maintenance costs, workflow changes, productivity loss even though temporary, concerns for risk of privacy violations and security, hardware and software purchase and installation, tasks of converting paper to electronic records, training, medical errors, resistance and negative emotions, the structure of power changes, and overdependence and reliance on technology (Menachemi & Collum, 2011).

The Institute of Medicine describes EHR system implementation as “a critical element of the establishment of an IT infrastructure for health care (IOM, 2003, p. 2).” This document indicated five areas that an EHR system must address as: patient safety improvement, effective patient care delivery support, facilitation of the management of chronic disease, efficiency improvement, and implementation feasibility (IOM, 2003). This report also provided core functionalities of an EHR system to be: health information and data able to evolve as new knowledge becomes available and for the needs of differing users; reporting and population health to assist with standardization of practices and terminology and reduce errors; administrative processes with multiple layers of information for billing, scheduling, and insurance; patient support through encouraging

involvement in patient treatment; electronic communication and connectivity through correct interfaces for exchange of data; decision support management for enhancing clinical care; order entry and management for efficient workflow processes and reduction of errors; and results management for critical links and improved coordination of care (IOM, 2003). EHR systems include Electronic Medical Records (EMRs) which are often used synonymously. However, EMRs are localized or stay within a single health organization, where EHRs are designed to reach beyond a health organization which collects and stores the information for a holistic coordination of care for the patient (Silverman, 2013).

The US Department of Health and Human Services, Health Resources and Services Administration (HRSA) developed a toolkit to assist in the implementation of EHR systems (HHS, 2015). This toolkit provides information on planning the project, workflow adaptations, budgeting and funding, workforce building, collaboration, selection of certified EHRs, implementation of the system, privacy and security, and evaluation and optimization of that system (HRSA, n.d.). The first step mentioned is to develop an EHR implementation plan which includes a roadmap with delineation of responsibilities, leaders for each step in process, timelines, and quality control procedures (HRSA, n.d.). This step is especially useful in order to reduce the challenges and potential workflow reductions. Other steps mentioned are customizing type of patient data collection needed and ensure it meets interoperability standards, customizing Clinical Decision Support (CDS) functions for quality improvement, reassessing workflow processes, training users, testing the system and having feedback to correct any issues, entering patient data into EHR and prepare timeline for entering existing data, pilot testing as if full run, and “Go-live” by using the a checklist, rehearsing, and having a disaster recovery procedure (HRSA, n.d.). Mooney and Boyle (2011) suggest in the implementation of EHR systems, health

organizations should establish objectives, assess the current situation, determine leadership and project procedures, define system requirements, compare products and software, budget and estimate costs and benefits, negotiate, purchase, and adapt, train, evaluate, and document for meaningful use. These steps align with the recommendations and toolkit by HRSA.

Challenges to Implementation

Challenges with the implementation of public health informatics in local health departments are inevitable. These challenges tend to center around the allocation of resources, prioritization of programming and resources, and measures for disease control are based on outdated data (Pilkington & Macchione, 2013). The public health workforce raises challenges in the insufficient numbers of skilled workers especially due to competition from other sectors, experienced workers almost at retirement age with no adequately trained pipeline, education and training insufficient for the jobs workers perform, experience and on-the-job trial and error, and no incentives which acknowledge or reward performance and skills (Gebbie & Turnock, 2006). These issues are enhanced by the increase in work without the proper public health workforce, expansion of information technology without proper training or workers not being trained specifically in information technology, and lack of proper technical support for administrators, professionals, and technical staff (Blackburn, 2013; Gebbie & Turnock, 2006). At an administration level, funds are limited to invest in technology, state-based IT programs and systems are designed without being catered to LHDs, and HIE connections may not be top priority (Blackburn, 2013).

Several authors agreed that roadblocks include: limited funding and time resources, no infrastructure for clinical or operation IT in research, disputes with intellectual property when

interfacing external applications of EHRs, need to develop governance policies which allow integration of third-parties without threats to stability or loss of control, the lack of standards and compatibility, issues with bureaucracy and legality, lack of availability of technology and capacity, perceptions of privacy and security, skepticism and trust, readiness of organization for meaningful use, current staff lacking technical expertise, administrative barriers in the integration and coordination, variability among data collection usually due to multidisciplinary data collection parties, little control over the data content and quality, questions of validity, troubleshooting difficulty, multiple confusing protocols, and issues of jurisdictions (Hessler, Soper, Bondy, Hanes & Davidson, 2009; Kirkwood & Jarris, 2012; Marsolo, 2012; Smith et al., 2013; Wild & Fehrenbach, 2004).

Ethical issues with the implementation of electronic health records align with the challenges and disadvantages of implementation. Patient's right to autonomy and decision-making in the management of their personal health information requires decisions, access, content, and ownership of records has not been the standard in health agencies. The idea of fairness and equity in access to care and information increases a gap between the access and usage of computers and technology. The technology gap and digital divide is among status of socioeconomics (Mercuri, 2010). There is an issue of protection of information and security of records. Ethics encourage beneficence and non-maleficence which is 'do good, avoid evil' when documenting, viewing, and managing patient records. The inconsistencies of an integrated data storage system during temporary outages and total system failures there could be a loss of patient data and the lack of a foolproof security system for electronic data. Privacy and confidentiality has been an issue before from breaches and leaking of patient information. In addition, coordinated care can be inadvertently prevented if a patient is concerned about privacy and

decides not to allow access to records (Mercuri, 2010). Recommendations for combating ethical challenges are suggested by Mercuri (2010) that when initially creating an EHR system, include representation from all stakeholders which includes physicians, technology professionals, ethics professionals, administrative personnel, and patients, implement strategies which reduce risks and overcome barriers, increase capacity of systems, and train and use quality control. Various issues surround the implementation of health informatics in public health and health care despite the advantages. Prioritizing the use of informatics, realizing the need for public health informatics, and development of standards for reporting is important to critically transform health through health information technology (Chaudry et al., 2006).

Qualitative studies about the implementation of EHRs in multiple health related organizations express frustrations, challenges, and recommendations. Ser, Robertson, and Sheikh (2014) explored the perceptions and reported practices of mental health hospital staff in London, UK to inform future implementation of EHRs. Thirty-three interviews characterized barriers to implementation and use of EHRs by workarounds or improper uses of EHRs, such as entering patient information hours or days later or entering data under another worker's login. Perceived operational factors, such as the equipment taking too much time to use, lack of options and functionality directly related to mental health services, lack of integration into Information Technology (IT) systems with other health organizations, and IT skills are limited.

Recommendations for Successful Implementation

The new and evolving discipline of public health informatics is the key to systematically and scientifically exploiting this opportunity to the benefit of the public's health (Yasnoff et al., 2000). Two-way electronic information exchange between pre-hospital providers and local

emergency departments, rapid electronic data exchange reduces time needed to treat and manage patients; data shared are part of a better system to protect public from communicable and chronic diseases and enhance resilience in emergencies (Pilkington & Macchoine, 2013).

Recommendations from Cheatham (2013) are that LHDs need to figure out how to use data to prove their value and make the case for expanded offerings, public health informatics develop new business models to ensure public health remains relevant and capable in a new era, success for LHDs involves informatics, strategic prioritization among leadership at local and state levels, allocation of sufficient resources, determine measures for outcomes, hire right workforce, and use care when selecting systems. Managers and leaders in public health need to acquire relevant information about health problems and needs of the health systems, to manage health data with proper storage and protection, translate data into meaningful information, and apply information in wise ways that effect health outcomes (Baker & Ross, 2013). Scheck McAlearney, Hefner, Sieck, & Huerta (2015) utilized the five stages of grief to describe the successful implementation of EHRs in six United States health care organizations. Collecting data from 47 physician and 35 key informant interviews it was determined that due to the need for personal and organizational change, consideration of the loss of power and content knowledge. Expectations should be managed (denial stage), express vision for quality (denial stage), find champions (anger stage), communicate (anger stage), acknowledge the transition even if painful (anger stage), train well (bargaining stage), consistently improve functionality (bargaining stage), be aware of competing priorities (bargaining stage), allow adaption time (depression stage), and promotion of better future (acceptance stage) (Scheck McAlearney, Hefner, Sieck, & Huerta, 2015).

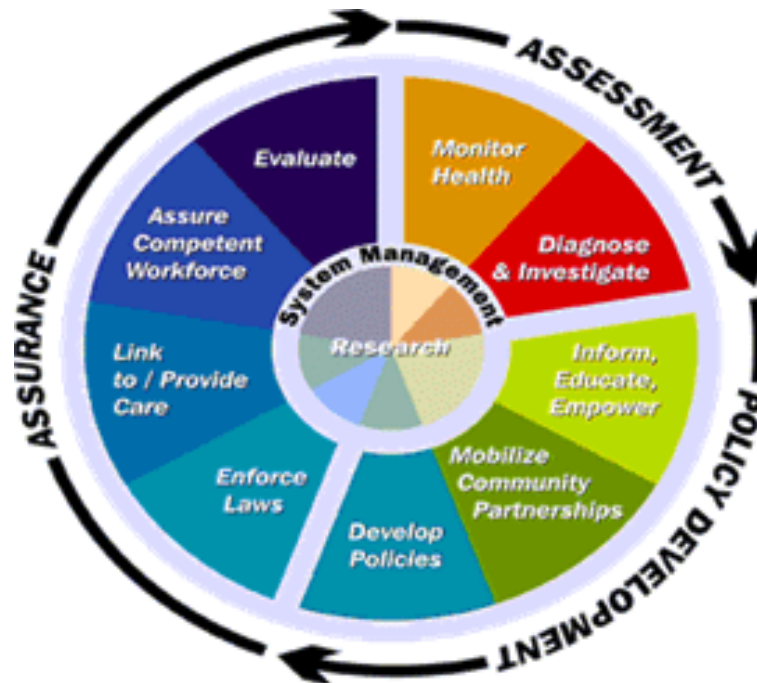
Maenpaa and colleagues determined that factors of successful implementation of health informatics are: community support building, developing key stakeholders' interest in clinical data exchange, and demonstrating the benefits (Edmunds, Thorpe, Sepulveda, & Bezold, 2014; Maenpaa et al., 2012). Empowering patients by offering options to share personal information through HIEs provides some personal control over one's privacy (Smith et al., 2013). However, this option does allow for loss of value or incomplete information for surveillance (Smith et al., 2013). Other solutions could be to establish a code of service in order to compete in private markets, system development that has a service component strictly endorsed by the constituents, balancing investment in information technologies and limited resources, clarify value, and collectively provide solutions for public health problems (Ross, 2002). "PH [public health] officials need timely access to valid and reliable data necessary to monitor health status and health-related factors (Ross, p7, 2002)."

Local Health Departments

Local health departments' (LHDs) health informatics capacity tends to be low, however, they have been found to be relevant (NACCHO, 2014). Local health departments vary in jurisdiction size, ranging from less than 1,000 to approximately 10 million, and geographic location. There are approximately 2,800 local health departments in the United States (NACCHO, 2014). Local Health Departments are charged to meet 10 model standards of the National Public Health Performance Standards Program (NPHPSP) (CDC, 2014). These standards are known as the 'The 10 Essential Public Health Services'. An overview is shown in Figure 2.2 below. The main components are assessment, assurance, and policy development as sections of public health system management. These 10 Essential Public Health Services include:

(1) monitoring health status to identify and address community health problems, (2) diagnose and investigate health problems and health hazards in the community, (3) inform, educate, and empower people about health issues, (4) mobilize community partnerships and action to identify and solve health problems, (5) develop policies and plans that support individual and community health efforts, (6) enforce laws and regulations that protect health and ensure safety, (7) link people to needed personal health services and assure the provision of health care when otherwise unavailable, (8) assure competent public and personal health care workforce, (9) evaluate effectiveness, accessibility, and quality of personal and population-based health services, and (10) research for new insights and innovative solutions to health problems (CDC, 2014).

Figure 2.2: The 10 Essential Public Health Services (CDC, 2014)



LHD Organizational Factors

Population size of LHD can influence the workforce, resources, and control in relation to informatics capacity (Beck & Boulton, 2015; Shah & Madamala, 2015; Shah, Leider, Castrucci, Williams, & Luo, 2016). Larger LHDs are more likely to have public health informatics specialists on staff and trained staff in informatics (Beck & Boulton, 2015; Shah et al., 2016). LHDs with health information specialists and training for employees are in a position to implement EHR systems (Shah et al., 2016). Population size also affects the scope and class of services provided by an LHD which can limit the use of informatics (Bekemeier, Pantazis, Dunbar, & Herting, 2014). Smaller LHDs are at greater risk for informatics gaps, data sharing, lack of data sharing capabilities with state health departments, and even with control of their informatics activities and capacities are unable to change them (Vest and Issel, 2014).

Governance is the “organizational relationship or model of authority” (Salinsky, 2010). Governance structure describes the relationship between state health agencies (SHAs) and local public health agencies and is classified as centralized, mixed, shared, or decentralized. These categories are used to explain the “availability and perceived effectiveness of public health activities; performance of public health systems; internal organizational structures of SHAs and LHDs; participation of managed care plans in local public health activities; and spending and resource allocation by public health agencies (Meit et al., p.522, 2012).” LHDs have varied relationships with state health agencies and other public health agencies (Vest, Menachemi, & Ford, 2012). LHDs with state health agency governance are centralized, while LHDs governed locally are decentralized (NACCHO, 2014). To further operationalize governance in public health agencies, Meit et al. (2012) employed a decision tree for categorization. If a state has no local health agency the state is centralized; if the LHD is led by a state employee, it is

centralized; if led by a local employee it is decentralized; and if all LHD in a state have the same type of organizational structure and there is no predominant model the state is mixed governance. Meit et al. (2012) studied the typology of governance and determined certain criteria based on the findings. LHDs with shared authority with state government are characterized by those in which state entities have the authority to make budget decisions, local government does not establish taxes nor fees for service for public health or the revenue goes to the state government, more than half of LHD budget is provided by the state, LHDs cannot issue public health orders, and local chief executives are appointed and approved by state officials (Meit et al., 2012). Even the three or four categories (centralized, mixed and/or shared, decentralized) of governance have limitations in defining. There are also sub-categories which include largely centralized and largely decentralized. Other limitations acknowledged by Meit et al. (2012) are categorization as an analytic challenge, merging categories can force multiple reports per SHAs, there is room for further refinement, it is a new system without sufficient time for validity, and only considers governance between SHAs and LHDs, not taking into account other components of the public health system.

High-speed Internet availability could be a factor in the implementation of EHRs in LHDs. For LHDs with no or little access to high-speed internet, it is virtually impossible to have a high enough infrastructural capacity for informatics adoption. Harris, Mueller, and Snider (2013) in the assessment of social media use and LHDs, found that LHDs with larger population sizes and urban geographic regions are associated with early adoption of social media use (Harris, Mueller, Snider, Haire-Joshu, 2013; Mason & Bezold, 2013). Rural areas tend to have more difficult time receiving internet services and experience weather difficulties with connectivity, therefore may be less likely to have high-speed internet availability.

LHDs with no clinical services may not see the benefit of EHR implementation, but Foldy and colleagues (2014, p. 1592) state, “Regardless of whether health department provide direct clinical services they will manage unprecedented quantities of sensitive information for the public health core functions of assurance and assessment, including population-level health surveillance and metrics.” A focus on health information management and training is pertinent for local health departments in this quickly changing technological environment (Foldy et al., 2014; Sellers et al., 2015; Turner, Stavri, Revere, & Altamore, 2008). In addition, Turner and colleagues (2014) suggests that LHDs plan to act as partners and facilitators of data sharing, advocates for communication, and use evidence-based public health through public health informatics. Although control of informatics decisions may not be through the LHD, the LHD leadership can be knowledgeable and decisive while advocating for implementation (LaVenture, Brand, Ross, & Baker, 2014). In addition, having supportive policies and governance, partnerships, and a skilled workforce can assist in having “informatics-savvy health departments” (LaVenture, Brand, Ross, & Baker, 2014).

Informatics in health care is advancing at a steady pace, while public health is trying to catch up. Although legislation has increased the priority of health informatics in public health agencies and the benefits are numerous, the literature suggests there are still barriers challenging the implementation of EHRs.

Theoretical Frameworks

Organizational innovation provides a framework about the influences of individuals, organizations, and environment have on the adoption of new innovations (Damanpour, 1991). The relationships between organizational factors and innovation are delineated as (1) type of

organization, including centralization of authority, attitudes towards change, resource availability, and communication, (2) type of innovation, such as technical innovations like software, processes, services and products related to technology, (3) stage of adoption, defined as initiation stage with activities which lead to adoption and implementation stage which are activities which modify innovation and organization, and (4) scope of innovation, includes the magnitude of innovation and the quantity of innovations in a time period (Damanpour, 1991). Organizational innovation framework allows for a guiding ideation of how various barriers can effect EHR implementation in local health departments.

This research will also use the Resource Dependence Theory of Pfeffer and Salancik (1978). Resource Dependence theory examines the areas of power, interdependence and dependency, autonomy, social control of organizational choice, interorganizational influence, resource importance, and constraint on an organization's allocation of resources (Pfeffer & Salancik, 1978). Hillman, Withers, and Collins (2009) explain Pfeffer and Salancik's perspective that Resource Dependence Theory acknowledges the influence external factors have on organizational behavior and context (Hillman, Withers, & Collins, 2009). This theory relies on the assumptions that organizations are comprised of coalitions within and outside of organization which come from exchanges socially that influence and possibly control behavior, the environment contains minimal and valued resources essential to survival of the organization, which causes organizations to be uncertain about in the acquisition of resources, and organizations tend to aim for gaining control over resources that minimize dependence on other organizations or control over resources to maximize other organizations' dependence (Pfeffer & Salancik, 1978). This theory was created to describe relationships between organizations, however, it is applicable to departments or units within one organization. In addition, due to

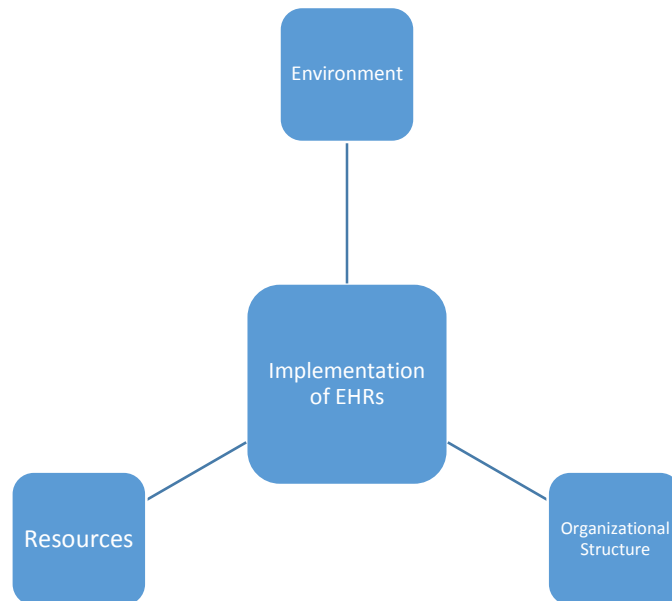
ever-changing environments inside and outside of organizations this theory has many interpretations and interacts with different environments and fits with many fields.

The environment component in the resource dependence theory is a system of interdependencies which are activities outside of organization's control and subject to boundaries (Malatesta & Smith, 2014). The environment is characterized by concentration or the degree of authority or power dispersed within the environment, munificence or scarcity of needed resources, and interconnectedness or extent to which organizations are linked within the system (Malatesta & Smith, 2014). The Resource Dependence Theory will help explain how resources, such as staff shortage, lack of training, and limited funding, affect LHDs ability to implement EHRs. The environment of the local health department in this study is characterized by the population size of the LHD, governance structure, and control of informatics within the LHD.

To examine the importance of EHR implementation, resource importance or munificence describes the critical resources of funding to implement EHRs in LHDs. The organization's resource allocation will be determined by the governance of the local health department and health informatics budget and hardware allocation. The relationship between the governance structures of LHDs and health informatics will be characterized by dependence. If the LHD has control over both LHD and health informatics, the LHD would be independent and if the LHD has no control over either LHD or health informatics it is dependent on the controlling government. If the health informatics governance is controlled by a department within the LHD, then there is interdependence within the organization. In explanation of social control of organizational choice is determined by whether the governance of the LHD and health informatics belongs to the LHD. In the case of mixed or shared governance, the LHD is able to combine resources, expand, and provide better collaboration of getting needed resources

(Malatesta & Smith, 2014). In addition, shared or mixed governance tends to manage interdependence, reduce uncertainty, reduce competition, lessen dependence on one organization or the other, can reduce costs, increase learning, lessen risk, and increase comrade among alliances and partnerships (Malatesta & Smith, 2014). Organization activities and training also factor into the environment and organizational structure of an LHD. Figure 2.3 depicts how the environment, resources, and organizational structure of the LHD can influence the implementation of EHRs.

Figure 2.3: Resource Dependency Model of EHR Implementation (Adapted from Pfeffer & Salancik, 1978)



Summary

The implementation of public health informatics in public health agencies is expected to improve operations, community health outcomes, and increase effectiveness and efficiency despite funding, staffing, and sustainability concerns. The HITECH Act, ACA, and HIPAA impact the support of EHRs, how data is stored and shared through health organizations, and the funding streams to back such efforts. Multiple types of health informatics, including EHRs and Health Information Exchanges offer support to health care and public health organizations for a further reach of services provided. Societal implications of EHRs allow for research and availability of clinical data to assist in the improvement of population health (Menachemi & Collum, 2011). HRSA, HealthIT.gov and other agencies provide EHR implementation toolkits for things to consider when implementing EHRs and how-to-guides for a likelihood of successful implementation. Employee training, lack of resources, low priority by leadership, lack of buy-in by employees, resistance to change, no control over informatics, and privacy and security concerns are commonly mentioned barriers to implementation. However, recommendations for success despite these challenges, include patient empowerment through access to information, demonstration of benefits, stakeholder buy-in, and team building and involvement. Using Organizational innovation and Resource Dependence Theory as a guide, this research explores how different factors influence the implementation of EHRs in LHD organizations. LHDs being at the frontline of public health can implement EHRs to affect the quality of care in population health.

Although the literature is forthcoming on costs, employee buy-in, and leadership priorities effect on informatics implementation, there are few studies which examine organizational activities and control of IT. This research inspects factors such as population,

governance, internet availability, organizational activities, and control of IT effect on EHR implementation. In addition, very few studies analyzed LHDs which are in the process of implementation, but this research acknowledges LHDs which are in the process and the LHDs with future plans to implement. This research provides an updated assessment of level of implementation, benefits, barriers, and strategies for success, addresses the gaps by assessing the odds of EHR implementation, and evaluates the future plans of EHR implementation in LHDs.

CHAPTER III: METHODOLOGY

This chapter describes the population and sample, instrumentation, data collection, and data analysis of this research. Using secondary data, a mixed methods approach was used for this research with an emphasis on triangulation of the qualitative and quantitative data. Combining the two methods through triangulation can act as a continuum rather than separate methods for an integrated and comprehensive view of the research issue (Jick, 1979). This approach can also reduce many limitations and biases of using just one method (Creswell, 2003). The pragmatic paradigm used for mixed methods in this research, in that it focuses on the problem and is oriented for real-world practice (Creswell, 2003). This method allows for contextual and multiple perspectives to address the research questions.

Using both qualitative and quantitative data illuminates the current status of implementation of EHRs, issues regarding implementation, and plans for the future of implementation to provide basis for the development of multiple strategies to address the latency or lack of EHR implementation. This methodology includes two sections: qualitative methodology and quantitative methodology. The final portion describes the convergence of the two methods to report the findings for this research.

Research Design

A mixed methods approach using secondary data from qualitative, key-informant interviews and quantitative, cross-sectional study design assesses the issues surrounding implementation and characteristics of LHDs. Acknowledging that each method contains limitations, triangulation of the data sources through a mixed methods approach reduces potential research biases in using one method and more clearly identify the issues regarding EHR

implementation. Triangulation of both qualitative and quantitative data converges the data to arrive at a method which can reduce various limitations of using just one method (Creswell, 2003). Triangulation purposes to use the strengths and neutralize the weaknesses of each method used (Jick, 1979). The combination of two methods can act as a continuum rather than two separate methods to derive at a more integrated and comprehensive view of an issue (Jick, 1979). Triangulation is appropriate for this research due to the inability to compare qualitative and quantitative data in terms of significance and measures, but in compliment of each other can produce consistent and integrated results. Although, convergence of the findings from the two methods is expected, divergence in the findings provided areas for further research and need for further explanation. Triangulation of the data sources allows for confident interpretations, hypothesis testing and development, and wide variety of findings as they relate to the research topic (Jick, 1979). In addition, triangulation provides illumination of a study's issues in regards to the appropriate context (Jick, 1979). Ultimately, triangulation of mixed methods can provide a strengths for productive research on EHR implementation in LHDs.

This research focuses on a mixed methods approach, using the quantitative method to explore the issues around EHR implementation and the quantitative methods to gain a larger view of the population. The qualitative research data are first and the quantitative data act as a confirmation, corroboration, and validation of the qualitative data findings. Together, these methods further define the problem with implementation to inform the masses and form concrete plans to reduce the barriers among LHDs. In true qualitative nature, this portion of the research includes the whys and hows of implementation of EHRs in LHDs. The qualitative portion delves into the benefits, barriers, and strategies to overcome the barriers from individuals working with health informatics in the public health field daily. Qualitative data can be limited in

generalization to the larger population, but a mild generalization within the LHD context is possible. Also, with triangulating with quantitative data will help confirm the findings from the qualitative data. The quantitative, cross-sectional portion of the study describes and characterizes an updated view of implementation of EHRs by LHDs using population size and governance types from a recent study. Although, cross-sectional study designs are limited in that they do not infer causality, there is no need for a sequence of events to answer the study's objectives. A mixed methods, triangulation approach is appropriate for this study for a description of the status of EHR implementation in LHDs, characteristics associated with that LHD regarding implementation, and further identification of issues surrounding the implementation of EHRs in LHDs.

The qualitative interviews explore the level of EHR implementation, the benefits, the barriers, and the strategies for successful implementation (Research Question 1, 1a-1c). The quantitative survey examines research questions one, two, and three by addressing the level of implementation of EHR system (Research Question 1), LHD characteristics associated with EHR implementation (Research Question 2), and the future plans of EHR implementation (Research Question 3).

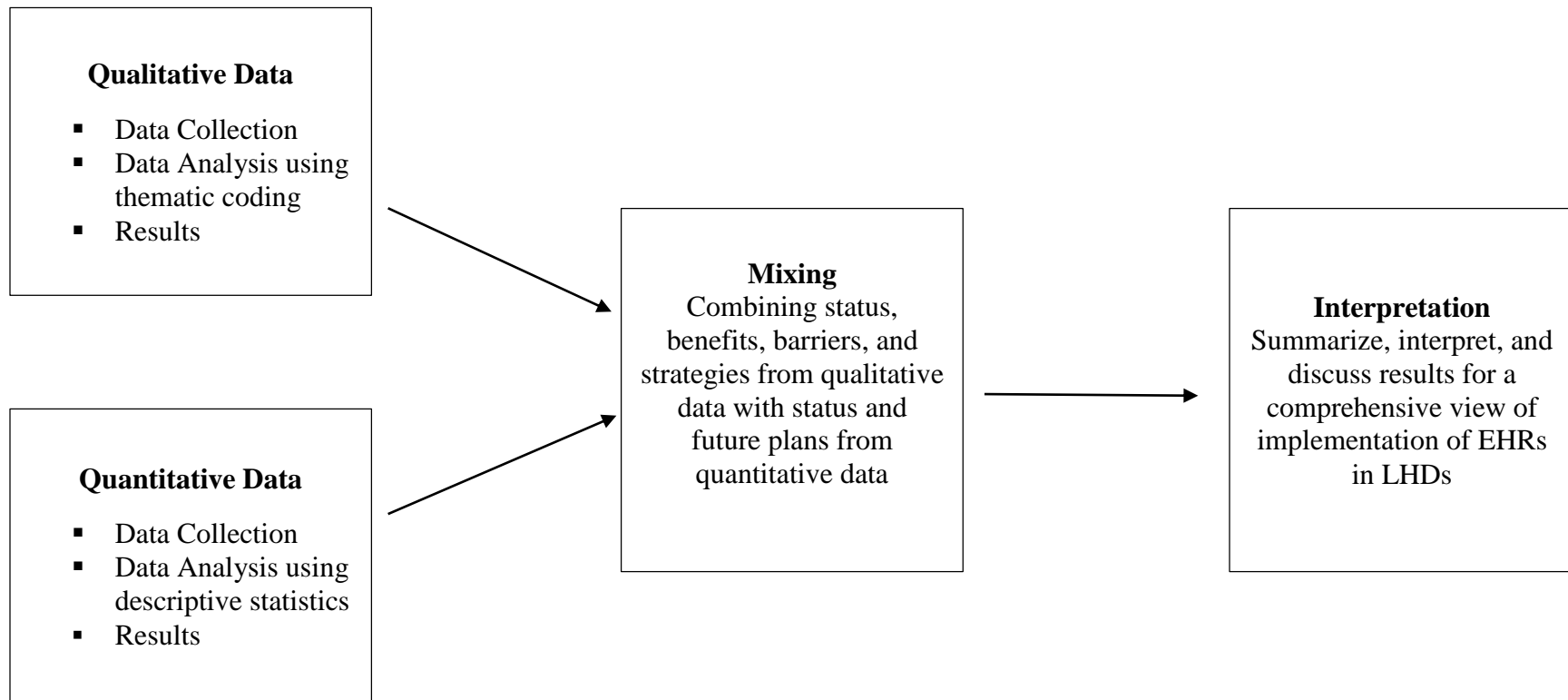


Figure 3.1: Triangulation Design for Mixed Methods Research (adapted from Creswell & Plano, 2007)

Qualitative Methodology

Qualitative Population and Sample

This research uses qualitative data funded by the de Beaumont Foundation and conducted by a team at the Jiann-Ping Hsu College of Public Health at Georgia Southern University. In 2014, this team conducted 2 focus groups and 49 key-informant interviews among LHD staff members. These studies received approval by the Institutional Review Board at Georgia Southern University and use of this data in this research project was sanctioned.

The focus groups were based on perspectives from 17 different of public health professions from small, medium, and large LHDs. These focus groups were held in-person at the 2014 Centers for Disease Control and Prevention (CDC) and National Association of County and City Health Officials (NACCHO) Public Health Informatics Conference from April 29 to May 1, 2014. The invitations were sent to 55 LHD staff who were expected to attend the conference. Seventeen agreed to participate and attended one of the two sessions. The first focus group was comprised of 9 participants, all from LHDs serving 50,000 or fewer people (classified as small LHDs) and the second comprised of 8, all from LHDs serving more than 50,000 people (classified as medium and large LHDs). The focus groups were conducted by the study's principal investigators (Shah, Leider) using a structured instrument consisting of open-ended questions organized in three sections. These sections included: (1) LHDs' information needs and barriers, (2) Electronic Health Records and their Meaningful Use, and (3) participant perspectives on the future of informatics. Each focus group was 90-minutes and were recorded, transcribed verbatim, and coded thematically. A codebook of the broader themes was developed and subthemes were systematically created by the project researchers. The data were managed, coded, and analyzed using NVivo 10 (QSR International, Doncaster, Victoria, Australia). The

results of this focus group also informed the direction and production of the survey instrument for the key-informant interviews.

The 49 key-informant interviews were conducted with leaders of LHDs across the United States. NACCHO's 2013 Profile of Local Health Departments (Profile) study was used to identify the leaders within LHDs as potential participants in the study through purposive selection (Creswell, 2007a; NACCHO, 2013). The 2013 Profile study used a census methodology to survey 2,532 LHDs in the United States. Using a web-based questionnaire with available paper copies, the survey was piloted October through November 2012 and fielded January through March 2013. The study received an 80% response rate. This study excluded Hawaii and Rhode Island because the state health departments operate as local public health without sub-state units. NACCHO staff and Profile study advocates followed-up with non-respondents offering technical support through e-mail and by phone.

A stratified random sample of 625 LHDs were surveyed using a module containing informatics questions, where 490 LHDs responded. From this list of 490 LHDs, approximately 117 potential interviewees were selected based on geographic (HHS) region and informatics adoption as reported in the Profile study. LHDs with both high and low informatics capacity were selected. Emails and phone calls were made to reach a desired sample size of 50 participants. Technical errors occurred for one interview, therefore 49 interviews were used for the analysis. Due to the variation in the levels of informatics capacity and geographic variation, an estimated 50 interviews was the target to achieve saturation in the major themes of interest (Creswell, 2007b). The characteristics of the sample of LHDs included in the study are shown in Table 3.1.

Table 3.1: Characteristics of LHDs in qualitative study sample

Characteristics	Number of LHDs (n = 49)
<i>Governance Category</i>	
State	12
Local	34
Shared	3
<i>Population Size served</i>	
>1,000,000	3
500,000 – 999,999	5
250,000 – 499,999	4
100,000 – 249,999	8
50,000 – 99,999	11
25,000 – 49,999	12
<25,000	6
<i>Census Region</i>	
South	10
West	10
Northeast	13
Midwest	16

Qualitative Instrument and Analysis

The interview instrument was developed based on a literature review and focus groups and was pretested with 7 local health officials. The instrument was segmented into three main themes: current data systems and capacities, informatics capacity and set-up, and the future of informatics, to assess everyday uses of informatics and future directions in LHDs. The status of EHR implementation and use are included in the informatics capacity and setup section. In order to determine the status, benefits, barriers, and strategies to overcome these barriers, this research used the following questions drawn from the de Beaumont project. These questions included: ‘With respect to EHR implementation clinically, would you say there has been “no activity”, “have investigated”, “planning to implement”, or “have implemented”’. In order to clarify meaning of EHR implementation, this section of the instrument also supplied an operating definition of EHRs as “An electronic health record (EHR) is a digital version of a patient’s

medical record that can be securely shared digitally to authorized users.” Two routes of follow-up questions were developed based on the level of implementation.

For LHDs with no activity, have investigated, or planning to implement:

- (1) ‘Why have you not implemented EHRs’
- (2) ‘What would be the benefit of implementing EHRs’

For LHDs which have implemented EHRs:

- (1) ‘What does implementation of EHRs look like in your LHD’
 - a. ‘Have all components been implemented or just some’
- (2) ‘What have been benefits of implementing EHRs’
- (3) ‘What are barriers encountered’
 - a. ‘How did you overcome those barriers to implementing EHRs’

The key-informant interviews were an average of 60 minutes and conducted by the two principal investigators (Shah, Leider). Each interview was recorded, transcribed, verified, and coded thematically and independently by two researchers (Creswell, 2007a). A codebook was developed using the three major themes and sub-thematic codes were developed by four researchers following the review of the interview transcripts. Using multiple rounds, two sets of two researchers independently applied codes, compared inter-coder reliability, and performed recodes with synchronized definitions (Creswell, 2007a). The rounds of coding examined commonly discussed themes, response types, non-confirming cases, sidebar mentions, and insistent answers during analysis (Creswell, 2007b). These data were also managed and analyzed using NVivo 10 (QSR International, Doncaster, Victoria, Australia). NVivo software supports qualitative and mixed methods research as a way to organize, manage, and analyze unstructured

data, such as open-ended surveys, interviews, social media and web content, and manuscripts (NVivo, 2015). The benefits of NVivo are more efficient work, time savings, swift retrieval of data, organization, storage, illuminate connections not seen by researchers, and the ability to back-up findings with evidence (NVivo, 2015). In addition, NVivo provided security for projects and the capability to collaborate with others on a single project, which was pertinent in this study.

Quantitative Methodology

Quantitative Population and Sample

The National Association of City and County Health Officials' (NACCHO) 2015 Informatics Needs Assessment was used for up-to-date status of implementation of EHRs in LHDs. The 2015 Informatics Needs Assessment is the third study in a series of NACCHO studies which examined the needs and capacities of informatics in LHDs. NACCHO also funded assessments in 2009-2010 and 2010-2011 (NACCHO, 2015). The 2009-2010 study was based on quantitative surveys of a random sample of 750 LHDs, yielding a response rate of 43%. This study also included in-person focus groups for qualitative data collection (NACCHO, 2015). The 2010-2011 study was based on 562 LHDs to assess the readiness of LHDs to exchange data with eligible healthcare providers and hospitals and to determine technical assistance needs to meet public health informatics objectives (NACCHO, 2015). This study, however, sampled 262 LHDs serving populations of 250,000 or greater and a random sample of 300 LHDs from LHDs with small population sizes. The overall response rate was 32%. These studies were used to inform the 2015 study design, survey development, and plan for the study.

Data were drawn from the 2015 Informatics Capacity and Needs Assessment Survey, conducted by a team at the Jiann-Ping Hsu College of Public Health at Georgia Southern University in collaboration with National Association of County and City Health Officials' (NACCHO). This web-based survey had a target population of all LHDs in the United States. A representative sample of 650 LHDs was drawn using a stratified random sampling design, based on seven population strata: less than 25,000; 25,000—49,999; 50,000—99,999; 100,000—249,999; 250,000—499,999; 500,000—999,999; and 1,000,000 and more. LHDs with larger population were systematically over-sampled to ensure inclusion of sufficient number of large LHDs in the completed surveys. The targeted respondents were informatics staff designated by the LHDs through a mini-survey conducted prior to the main survey. A structured questionnaire was constructed and pre-tested with 20 informatics staff. The questionnaire included various measures to examine the current informatics capacity and needs of LHDs. The survey questionnaire was sent via the Qualtrics survey software to the sample of 650 LHDs. The survey remained open for 8 weeks in 2015. A total of 324 completed responses were received with a 50 percent response rate. Given that only a sample of all LHDs participated in the study and the larger LHDs were oversampled and over-represented, statistical weights were developed to account for three factors: (a) disproportionate response rate by population size (7 population strata, typically used in NACCHO surveys), (b) oversampling of LHDs with larger population sizes, and (c) sampling rather than the census approach. The sample delineation is indicated below in Table 3.2.

Quantitative Instrument

The instrument for the 2015 Informatics Study purposed to survey local health departments' informatics capacity and needs to raise the profile of LHD informatics needs nationally to ensure LHDs are included when funding and resource decisions are made. The instrument was constructed using instruments from previous studies, expert input, and brainstorming sessions of the Local Public Health Informatics Needs Assessment Advisory Group. After several feedback sessions and expert reviews, the instrument was pretested with 20 informatics specialists. Adjustments to the instrument were made after recommendations and suggestions by the Advisory group and informatics specialists. The structured interview was uploaded into the web-based Qualtrics survey software with logical skips and displays, multiple choice, and open-ended and close-ended questions. Qualtrics is used for development and distribution of online surveys and related research services. Qualtrics is an Application Service Provider (ASP) with a Software-as-a-Service (SaaS) platform which assists with the recording of response data, analysis and reports on the data. Qualtrics uses Transport Layer Security (TLS) encryption for transmitted data. The records were password-protected with unique access through Georgia Southern University system. This software also allows for users to own and control all data entered or collected through Qualtrics. Privacy policies are available elsewhere (Qualtrics, 2015).

The survey included various measures to examine the current state of informatics in local health departments. These included: use of formal and proven processes for acquiring, implementing and maintaining information tools, staff skills available for conducting purposes, integration or interoperability of health information systems, data exchange capabilities, type and process of data sent and received, informatics and information needs, satisfaction with

information systems, costs of the systems, and strategic plans for evolution of information system, standards, and use. In addition, the use of information staff, technology, or tools to support, enhance, and improve the ability of health departments to meet performance and organizational goals, essential services, statutory requirements, and community expectations. The survey questions were organized into five topic areas: Physical Infrastructure, Skills and Capacity Available, Public Health Workforce Development Needs, Electronic Health Records, and Health Information Exchange.

The survey collected demographics, such as, name of LHD, name of person completing survey, title of person completing survey, and a multi-answer question regarding role related to health informatics. The next section was regarding infrastructure of health informatics and LHD including multi-component questions: access to high-speed internet, internet service, control of informatics, IT infrastructure, and organizational activities relating to informatics in the past two years. The skills and capacity available to organization questioned LHDs about activities performed and activities possibly performed by outside agencies. The section regarding public health informatics workforce development needs included questions regarding information system needs for LHD, areas for informatics staff development, training in past 12 months, and ways informatics are used in LHD. Questions regarding electronic health records requested indication of types of clinical health care services at LHD, types of organization and storage of clinical and non-clinical information, interoperability at LHD, electronic surveillance system use, meaningful stage 1 status, and receiving and sending environmental information. The final section included questions about Health Information Exchange, LHD connection with HIE, send or receiving health information electronically, and most challenging issues related to HIE.

To further understand the current use and future plans for implementation of EHRs in LHDs, questions from the 2015 Informatics study from section 4, Electronic Health Records, were used. The operational definition for EHRs from this study was, “An electronic health record (EHR, also known as an electronic medical record or EMR) is a longitudinal, digital record of a patient’s care. This record may include identifiable information about individual patients, such as demographics, medical conditions, procedural history, allergies, and medications. An EHR system houses individual EHRs.” The questions to address the objectives of this study included:

- (1) What is your local health department’s primary system to contain/organize patient health information (clinical service data) in house?
- (2) What are your local health department’s plans for implementing an electronic health record (EHR) system?

For question 1, the response categories were: (a) paper records, (b) basic software (ex. Microsoft Word, Access, Excel), (c) a federally provided system (ex. Epi info), (d) a custom built electronic health record (EHR) system (ex. the system was designed in-house), (e) a vendor built electronic health record (EHR) system (ex. An “out the box” system, potentially with some local customization), (f) an open source electronic health record (EHR) system (ex. Software whose source code is freely available and modifiable), and (g) electronic records systems other than those listed above. For operationalization in this research, these responses are categorized as follows: response categories (d), (e), and (f) are grouped into a variable EHR system; while response categories (a), (b), (c), and (g) are grouped into a variable non-EHR system. For question 2, regarding future plans for implementation, the response categories were: (a) we have no plans to implement a system, (b) we are in the process of researching and/or selecting a system, (c) we have selected a system but have not yet begun implementation, and (d) we have

selected a system and are in the process of implementing it now. These survey questions were only made available through logical skips built into the survey for respondents who indicated any other answer besides, 'no clinical service provided'. LHDs who indicated 'no clinical service provided' were excluded from answering any further questions in the electronic health records section.

Quantitative Data Collection

Using the Qualtrics web-based survey, the link was emailed to the desired sample size of 650 informatics staff and leaders within LHDs. The 2015 Informatics study was emailed to LHD directors, health information/informatics specialist and directors, and health information officers based on a list provided by NACCHO's directory. The study piloted in March 2015 and fielded April to May 2015, approximately 8 weeks. After the first two weeks, a second email was sent to motivate completion by non-respondents and those with incomplete surveys. This strategy encouraged several new respondents to start the survey and a few to complete. After two more weeks, another request was sent stating that the survey was closing in two days and this strategy garnered more completions. After one additional week, most of the incomplete survey respondents were phoned and provided assistance or answers if needed to complete the survey. This strategy provided approximately 20 more survey completions. After reaching a 50 percent response rate, the survey closed. The survey resulted in 324 (out of 650) responses for a 50% response rate. NACCHO's agency viewed this as an acceptable rate for this type of study. The distribution and response rates are indicated in Table 3.2.

Table 3.2: LHDs in Sample, Number of Respondents, and Response Rates

Population Category	Number of LHDs in Sample	Number of Respondents	Response Rate
<25,000	209	87	42%
25,000 - 49,999	117	65	56%
50,000-99,999	100	43	43%
100,000-249,999	82	45	55%
250,000-499,999	56	34	61%
500,000-999,999	47	25	53%
>=1000,000	39	25	64%
All LHDs	650	324	50%

The dependent variables for Research Questions 1 and 2 are: (1) in-house primary system used to contain patient health information for clinical service data with dichotomized as (a) EHR system and (b) non-EHR system. For Research Question 3 the dependent variable is (1) future plans for implementing EHR systems with four responses (a) we have no plans to implement a system, (b) we are in the process of researching and/or selecting a system, (c) we have selected a system but have not yet begun implementation, and (d) we have selected a system and are in the process of implementing it now.

The independent variables in this research are LHD characteristics and survey questions theoretically associated with informatics capacity. Variables representing infrastructural, skills, and workforce capacity include: LHD governance (local, shared, state); access to high-speed internet (yes, no/do not know); type of internet service available (Broadband ISDN, Asymmetric Digital Subscriber Line (ADSL), ADSL+2, Wireless Internet, Fiber Optic or Ethernet, Other, do not know); informatics governance and control (hardware allocation or acquisition and IT budget allocation within each department or program in LHD, within central department of LHD, city/county IT department, state health agency, or someone else); organizational activities related

to informatics in the past two years (reviewed some or all of the current systems to determine if they need to be improved or replaced, created a strategic plan for information systems throughout LHD, used a formal project management process to implement a new information system, formally conducted security risk analysis in regards to public health information systems, formally conducted a readiness assessment for health information exchange, other, none); and informatics training in the past 12 months (Yes, No/Do not know/Unsure).

Quantitative Data Analysis

The data were downloaded from the Qualtrics software and cleaned using SPSS and STATA systems. The data received from the 2015 Informatics study was collected, cleaned, and reported and is available on the NACCHO website (NACCHO, 2015). Partially completed surveys were received possibly due to many LHD respondents finding the sections were not relevant, for example LHDs with no clinical services. Programmed skip logics were included in the instructions, but some respondents may have determined relevance based on the section headings. For cleaning purposes, surveys with at least the first section of the questionnaire fully completed were included in the final data due to the applicability to all LHDs. While surveys with mostly incomplete responses on the first section were excluded. Being that only a sample of all LHDs participated in the study and the larger LHDs were oversampled and over-represented, statistical weights were developed to account for three factors: (a) disproportionate response rate by population size (7 population strata, typically used in NACCHO Surveys), (b) oversampling of LHDs with larger population sizes, and (c) sampling rather than the census approach. The 2015 Informatics study were reported through descriptive statistics.

Statistical Analysis

This research uses descriptive statistics to analyze the dependent and independent variables in SPSS and survey logistic regression in SAS. The descriptive statistics explain the frequencies and percentages of each variable within the study. SPSS provides use in displaying the graphs and tables of population size, governance category, and future plans for implementation of EHRs. Using the 7-level population as strata to account for the sampling design in SAS, the survey logistic regression procedure is used to build models which express the significance levels for the variables in the research. The dependent variable is first dichotomized as *EHR system* (custom built EHR system, vendor built EHR system, open source EHR system) and *non-EHR system* (paper records, basic software, federally provided system, other). The variables are all added in the full, original model (26 variables), then systematically removed through reduced models to reach significant model fit statistics using the -2 Log Likelihood. The final model contains in 19 variables. Using the raw p-values from this model, p-value adjustment methods, Stepdown Bonferroni, Hochberg, and False Discovery Rate are added to determine true significance. These p-value adjustment methods account for the errors of false null rejections when using multiple testing, due to the simultaneous testing of individual null hypotheses (Sarkar, 2008). The benefits of the Stepdown Bonferroni method is tests are more powerful with smaller adjusted p-values while maintaining the error rate (SAS, n.d.). In the Hochberg method, p-values are independently and evenly dispersed adding power, but there is an assumption of independence (SAS, n.d.). The false discovery rate (FDR) procedure controls for an expected proportion of rejected null hypotheses that are incorrectly rejected or falsely discovered (SAS, n.d.). These methods assist in determining the significant LHD characteristics associated with the implementation of EHRs in LHDs. Based on this model and methods, the

model would only need to have 1 significant variable to reject the null hypothesis of reduced model equaling the full model. At 7 degrees of freedom and a chi-square p-value of 0.11, this research fails to reject the null hypothesis and the two are equal.

Triangulation

Using an unequal balance of the data, the qualitative data is emphasized in this research and the quantitative data supports and corroborates the qualitative data. The qualitative data provides supportive quotes and themes of the status, benefits, barriers, and strategies from respondents in LHDs, while the quantitative data provides the status and future plans of implementation of EHRs in LHDs. This mixing seeks to transform the data and clarify meanings for an integrated view of EHR implementation in LHDs (Creswell & Plano Clark, 2007). The pragmatic view of mixed methods allows this research to derive answers in context to the LHD and informatics setting.

Ethical Considerations

The Georgia Southern University Institutional Review Board approved research for exemption Category B4 for both data sets and this dissertation research (Appendix A). This research involves the study of existing data of de-identified and publically available data. Data received from the de Beaumont Foundation and the National Association of County and City Health Officials were approved for use by the organization and principal investigator. The collected data examined the behaviors and characteristics of an organization regarding use of technology systems and norms. No personal information or behaviors are used in this research.

CHAPTER IV: RESULTS

This chapter presents the findings of the key-informant interviews and the survey. Through coding and analysis of the qualitative data, the main themes are, status (level of implementation), benefits from LHDs which have implemented EHR systems and perceived benefits from those who have not implemented EHR systems, barriers to implementation, and strategies and suggestions from overcoming the barriers to implementation by those LHDs which implemented EHR systems. The surveys indicate the responses of 324 LHDs.

Level of EHR Implementation

In order to answer research question 1 regarding the level of EHR implementation in LHDs, both qualitative and quantitative data are analyzed. The status of EHR system implementation results 6 sub-themes as seen in Table 4.1. These sub-themes helped to characterize the true levels of implementation among LHDs beyond just implemented or not implemented.

Table 4.1: Sub-themes of Level of EHR Implementation

Main Themes	Sub-themes
Level of EHR Implementation (Status)	Have implemented
	Almost implemented
	Planning to implement
	Investigating
	No activity
	Implemented at state level

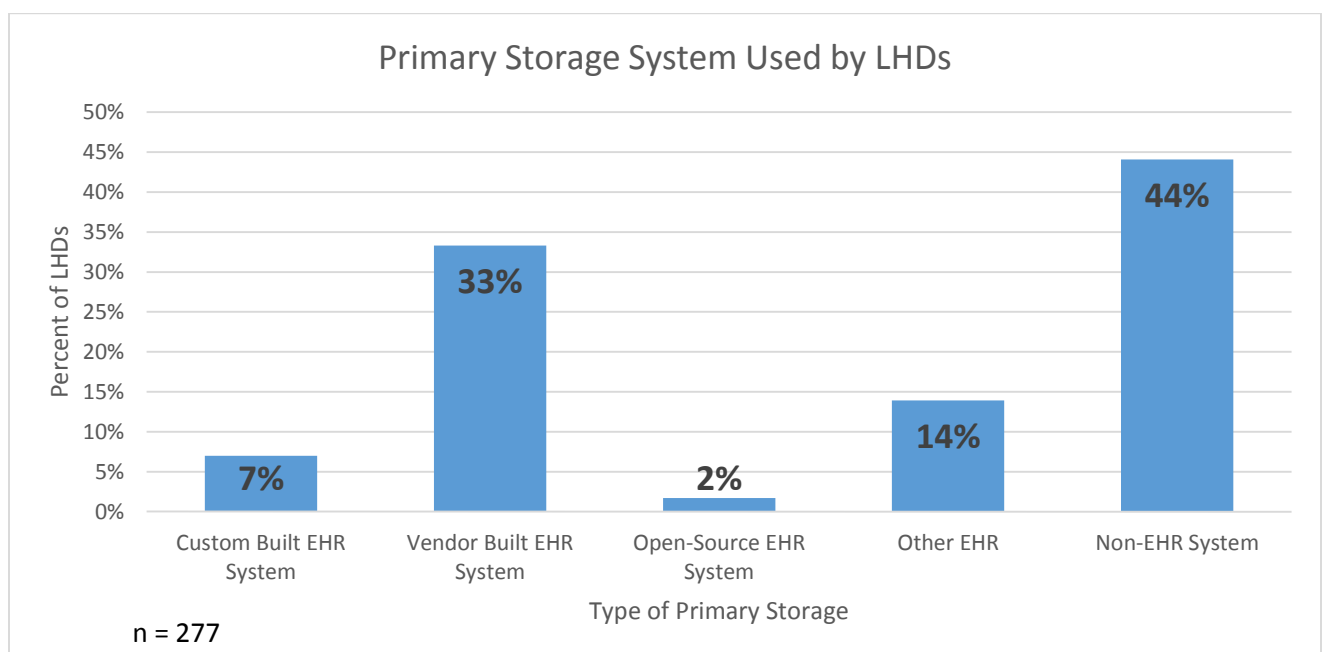
Level of EHR Implementation in LHDs

In determining the primary system used by the local health department to contain or organize patient health information or clinical service data in-house, the data are coded into EHR system versus non-EHR System or other. The frequencies and percentages of the delineated categories of primary storage system are indicated in Table 4.2. An aggregated total of the categories represented in the logistic regression are 42% for EHR systems and 58% for non-EHR systems.

Table 4.2: Frequencies of primary storage system for patient health information at LHDs

Primary Storage System	N	Percent
Custom Built EHR System	24	7.0%
Vendor Built EHR System	107	33.3%
Open-Source EHR System	4	1.7%
Other EHR	38	13.9%
Non-EHR System	104	44.1%
Not Applicable	47	-
Total	324	100%

Figure 4.1: Percent of primary storage system use by local health departments



Have implemented EHRs

The majority of the LHDs in the sample have no activity in implementation of EHRs, which is supported by the quantitative data in that 58% of LHDs have a non-EHR system for data storage of patient information. However, the qualitative data indicated the next largest category have fully implemented EHRs, which was supported by the quantitative data of 42% of LHDs have implemented EHR systems. In addition, the qualitative data includes some LHDs who are in the process of implementing, planning to implement, and those investigating implementation. For LHDs which have implemented EHRs, there are uses for billing, scheduling, clinical work, and recording patient information. Respondents provided characterization of their systems and their experiences in implementation.

“We went live on September 2011. We had the clinical and the practice management component. At that time had access to everything, so you have the potential, the patient portal, you had a more robust reporting and then what's just inside the system so you could go in and do accounting reports, you could do more specific disease-related items and we did not, this is just a big bang thing. We spent a lot of time doing preliminary work. We spent, 8 months investigating an electronic health record, we looked all the ONC and requirements and meaningful use and made sure they were certified EHR. We were small, so we looked at class scores for the small providers, 1 to 2 or less than 5 provider site, and the clinical kind of went out on—when we just did an overall assessment, we also knew that we had to have a host system because the state or the county has one IT person for all departments. We knew that we can manage the security and all the items associated with having servers. So, we have a host system.”

“We have fully implemented clinically all electronic health records. They are the primary care clinical areas such as; pediatrics, adult health, family planning, STD, immunizations, so we do have a fully electronic health record as of May 2013.”

“We implemented and we use a current commercial software. We use less for scheduling. We use for billing, we use for clinical work and recording patient’s information there, and therefore I say we have quite strong IT capacity complying with HIPAA requirements.”

“We do everything from demographics to billing, to noting, to doing the worse payment, the whole nine out of the electronic record system.”

“All of our ordering is done through the EHR, billing is done through the EHR, all prescribing that we can do is done through the EHR, yeah, everything.”

Although there was implementation, some mentioned there were still issues to be resolved. Resistance to change in staff and getting used to a new system are still some issues faced after implementation.

“We have already implemented, it's still a work in progress, we do have an electronic health records system in our clinics now. We started about two years ago.”

“And part of the concern now is my staff are just really nervous about just letting go of the papers, it’s the change, the whole thing about oh my God if we let this go and then something happens to the computer that’s all we have. We have these e-records but the e-records can’t, at this point they are just for use here, it’s for use for staff to get– to make it easier to work. It doesn’t link with any other systems, no other offices, it doesn’t link with the state or anything. It’s comprehensive (meaning billing, scheduling, and medical). It’s just isn’t used anywhere else in the health department for anything and it’s not used for– we don’t share those records yet with any other offices or anything.”

Although some LHDs use EHRs for all or the majority of their departments, some have isolated use. An example, “It’s only used in nursing. We’ve implemented it about two years ago now. It takes a long time to get and we are still not there yet. We still have paper records and e-records.” Meaningful Use being the next level, a respondent mentioned “We are getting certified for meaningful use.”

In process of Implementation

Local health departments almost or in the process of implementation, shared insight to their process. One quantified their implementation rate to be 90 percent, while the other described issues with the compatibility of other systems.

“We are in the process of implementing Electronic Health Record. The state has a system for a lot of our expectant moms and newly delivered moms that is secure, but they don’t approve of the Electronic Health Record that we purchased for other items. So my understanding is those two systems won’t talk. My understanding is we’ll be completing

some of the paperwork manually and then scanning it and uploading it into this Electronic Health Record, which to me is kind of a settling of our time for recording information.”

Planning to or investigating

For some LHDs who have investigated and are planning to implement EHRs, there are clear strategic plans and goals for the systems. Vendor selection, service selection, and areas of implementation are integral to the phases of planning and investigating. LHD respondents mentioned their experiences in this process. This data are also used to answer research question 3 mentioned in the “Future plans for EHR implementation” section.

“We are developing electronic health records, we are in the process of talking to vendors, we don’t have an electronic health record, but the rest of the counties do not have electronic health record at this time.”

“We have investigated and planning to implement. We have actually just in the process of contracting with a provider of electronic health record. We will continue to do the electronic data for billing purposes but it will go beyond data for billing purposes and allow us to actually put patient health information on there for the visit they have with us.”

“We are planning to implement. And I guess I should also – it might be helpful that we don’t do public health clinics in (state). We don’t do a lot of direct service. Our primary direct service role is (syndromic surveillance system). We do a little bit of direct service for immunization and infectious disease outbreak but other than that we really work on

certain more policy systems in health environment efforts, compare to the rest of the country we did very little direct service.”

One respondent summed up the level of investigation as, “I would say that we are investigating it”. Although no EHRs have been implemented, investigation is a worthy experience to fully decide the proper way to implement. Weighing the costs, software, streamlining processes, and functionality are themes presented by LHDs in the investigation process.

“We are investigating a newer or different software to streamline some things but we are currently using, for instance the immunization records to—and we input all of that into the state system so that it’s accessible to all health providers across the state but I am certainly always open to other electronic health records for other functions and public health.”

“We have done all of the components and prior to that was we actually retained a grant, because again public health has no money to implement that. As far as functioning we have not implemented. It is still working on billing and limitation of that and it is going to take some time to get that up and running.”

“We have no health electronic record or health medical record, we have none of that. We are in the process of looking into that, so we do have clinic sites that we would have that. Right now, we would have to mail a record from one clinic to the other in case of news, so there is no record that is electronically saved throughout our clinical services.”

“There has been definite activity here investigating it. Now, they have been saying, and I say they, because it’s our state office, that we are going to go on a full electronic medical record. They’ve been saying that for 10 years. I see within the next three years we’ll have one.”

No Activity

Unfortunately, for many LHDs there is no clear benefit perceived for EHRs to be implemented. There are many which do not perform clinical services, therefore there is no need for a clinical EHR. No activity implies, no investigation, no plan to implement, no process of implementation and no implementation at the state level. LHD respondents provide some explanations of why EHRs are not on their radar for implementation. Themes include no clinical services, little clinical services, no primary care, and benefits not apparent.

“It hasn’t been implemented at the state level but there are certain counties I have chosen to do it, and those are the counties, the health departments that have, they are larger and they generally have family planning associated with them.”

“I can’t justify the cause when we don’t provide that much primary care. We don’t have primary healthcare services, we do immunizations and the state has a web-based vaccine registry that we plug in all the immunizations that we give into it. At the state level they are trying to work to do an interface with the EHRs.”

“I believe our service areas are more or less siloed so that I don’t think they have an EHR that they all contribute to so there is one patient record, particular one client record.”

“Our health department wouldn't because we do very little clinical services at all. We may do four hours a week of clinical services and that's all.”

“Yeah, no activity. I think it’s just not applicable...we do not provide any clinical services at this time.”

Benefits to EHR Implementation

Regardless of the level of EHR implementation, the LHD respondents offered perceived or actual benefits of EHR systems. This data are used to answer research sub-question 1a regarding benefits of EHR implementation in LHDs. The most commonly mentioned perceived benefits are care coordination, retrieval or management of information, and tracking outcomes of care. LHDs with shared governance most frequently mentioned coordination of care, followed by state governed and local governed LHDs. The benefits are closely related to data accuracy, security, interoperability, and outcomes, while some resources, decision-making and planning, and other operational factors. The expected benefits mentioned by LHD staff which have not implemented EHR systems, are closely related to the benefits mentioned by staff in those LHDs which have implemented. Major themes can be seen in Table 4.3.

Table 4.3: Qualitative Themes of EHR benefits, EHR barriers, and overcoming challenges of implementation

<i>Major Themes</i>	<i>Themes</i>
<i>EHR Benefits</i>	Elimination of paper
	Flexibility
	Infrastructure
	Interface with the community
	Reportable quality improvement
	Systems communicate with state systems
	Accurate records
	Anonymity and security easy to maintain
	Care coordination
	Readmissions
	Completeness of data
	Consistency with medical school training
	Data entry ease
	Decision-making
	Policy Development
	Detect outbreaks
	Efficiencies due to EHRs
	Financial benefits
	Grant writing support
	Immunization completion information
	Information for leadership readily available
	Interoperability
	Inventories
	Medical errors prevented
	Paper copy reduction
	Patient can access their information
	Planning
	Quality improvement
	Quantify service provision
	Retrieve or manage information
	Billing tracking
	Patient information
	Secure or protect against loss
	Share information with partners
Staff morale	
Timely information	
Track outcomes of care	
Transportability	

EHR Barriers

Benefits are unknown
Federal regulations
Financial resources needed
Low IT capacity
No clinical services
No control over decision
No staff or no trained staff
Priority is low
Resistance to or fear of change
Training, lack of
Bad relationship with IT and turf battles
Data are bad or unavailable
Dependent on state
HIPAA
Infrastructure
Lack of collaboration between state and local agencies
Lack of collaboration between hospitals and public health agencies
Lack of vendors
Lack of Vision
Leadership and vision
Limited trained Staff
Money
More requirements
Small size makes estimates hard
Staff capacity
Time
Cost
Problems from lack of EHRs
Staff taking quality improvement personally
Problems from lack of EHRs

Overcoming Challenges

Begging money
Communication
Control over system purchase
Cost Benefit Analysis
Quality Improvement
Relationships
Specialized software
Staff Involvement in process
Staff Training
Staff with expertise
Technical Assistance

Although many LHDs find the benefits of EHRs irrelevant, there is an acknowledgement of the benefits in general. There is a "...need for electronic health records and that those electronic health records should be able to interface with other partners in the community, for example, visiting nurse and hospitals." Many are anticipative that EHRs will assist with processes, easing the workflow, and have a positive impact on the patients in which they serve.

"I think if we were doing that, we could track our client services better, we could be able to quantify the type of services and maybe outcomes that we are seeing with people versus people just coming in for a shot or they came in for a TB test and they were positive or negative, but actually see what we're doing as a whole."

"I guess it would be helpful, it would be easy to find records. Less search time, as long as it is secured database."

"I think the ability to share, easily retrieve, less paper, all of that... Cost-savings, I would say with some of the programs absolutely if you are able to access data such as immunization records, it's wonderful. For example, we have an eighth grader come in August and said needed the Tdap or they wouldn't let her come to school. So we pulled up her immunization records on the state system and lo and behold she had a Tdap you know last year but she didn't know that."

"Having a better understanding of what's happening with the population that's been served in overall fashion and in that way being able to better manage and understand even some

of the potential risk factors or the potential clinical outcomes in that population. I think what hasn't been happened is in terms of even understanding that clinical side tapping into...partnership with public health who is trying to impact externally then environment that the patients return to in order to improve health outcomes.”

“Well I think it would be a good thing to do, because most of our clients do not stay in one place. So having a transient population often, if you had electronic records, any health department can follow the client across the state wherever they are, and still have a continuity of care, a continuum of care if you had that.”

“...the space and transportability. With paper it's a lot of manual labor, with EHR you can just set that up and preprogram dates or whatever. So the paper burden that we have is manual.”

“That would be to share I guess big picture information which you have, total information with regards to patients and activities and or other things that may be going on in their health history and or currently, sharing that information so that you can have a better complete picture of the patient.”

“I think it would be as far as I think the future of public health and with health care and hospitals and large medical groups is for us to have seamless integration of data for patients to help plan population health interventions to improve outcomes on our patients. If the predictions that the health economic literature were true, that ensures our going to start

demanding that patients start having improving health outcomes for you to get paid versus fee for service, then I think we are going to have motivation for hospitals and medical groups to try to work with public health and municipalities to try to do more integrated programs to help decrease obesity or prevent obesity and improve physical activity, safety and things like that because there has been no incentive for the large marketers that have the money and health care to look at the drivers of poor health. Their incentive is to do procedures and get paid for it. And, I think if they truly change the fee structure to where they have to show health outcomes to get paid, then I think the more we have an integrated system and that we share data and track data and can show the outcomes the better we get to survive as an industry.”

Although hopeful, LHDs which have implemented are waiting on the actual benefits to manifest. There are indicators of potential positive changes.

“I haven’t personally seen what the benefits are and the clinics would I think better be able to tell you about the benefits that they see. But what I anticipate being as soon as we figure out how to like access the information is that we would be able to use the information for the development of policy. It used to be the case and this is a little bit less so now as a result of the Affordable Care Act, but it used to be the case. And I think we are not I think we’re still the largest Medicaid provider in our jurisdiction. I think the hospital systems may have taken a little bit of a chunk of that but something tells me that we are still the largest health provider of Medicaid services. And because of that and because of the work that we do for you know our maternal and child health programs and other programs that

are geared towards persons who are low income and low socio-economic status. We anticipate using the information that we get about the health and well-being of our Medicaid clients. From the EHR to help fashion program and policy and you know for decisions such as where we need additional sides or what percentage of our diabetic clients have uncontrolled diabetes. And so we would be able to use that both for practice and for the policy. And again it's a little bit less so now than it was before. But before you know we would basically have the population of Medicaid recipients presented it in our system.”

“We are still working on people understanding it, will be the true quality that leadership will be able to establish by being able to look at the information that's in the systems, they will be able to have a true understanding of the services that they provide, how many people see services, what type of resources they are getting and by that I mean how many are copays, how many are self-pays and just will have a standard way of defining the data, so that the leadership can take a cross cutting look across and actually get meaningful use of the data that's in there. Right now, before people used it, it was just paper and was hear-say so they will have electronic means of understanding of what we are really doing out there in the clinics and how we can improve them. That will be the benefit.”

The benefits of EHR implementation is seemingly limitless. Staff of LHDs explained in various ways the perceived and actual benefits experienced. A few are: medical error reduction, efficiency among staff, patient retention, quality improvement, capturing of patient demographic data, information exchange with local hospitals and community healthcare providers, mobility of records, patients ability to access records in the comfort of their home without having to keep up

with paper documents, reduction of physical storage, efficiency among staff and workflow of facilities, streamlining of processes, tracking and ability to monitor locations and diseases, quicker response times to outbreaks and emergencies, monitoring, decrease in spelling and writing errors and difficulties, program coordination, and ease of access. In addition, a unique perspective in this research indicates the new generation of employees being fresh graduates and the benefit of them being well versed in technology. The new generation have not had to work with paper records, therefore they are able to assist older employees and learn new technologies many times at a quicker pace.

“Medication errors, that's the biggest thing in having a pharmacy trying to read whether it's BID or PRN. or whatever, so that has made a world of difference, I am sure pharmacies would agree, now it's very clear what's on the prescription and again it's legal issues, you take a written record into court, nobody can read it and you can't read the doctor's writing or you can't read his signature, I mean that's right there, that can cause some legal issues if you have to go to court.”

“It has freed up staff time because in the past we had, you know, paper records, staff spend a lot of time pulling records and filing records out of a record room. Now they don't have to do that, so it saved a lot of clerical staff time. You can actually read it, it's very let's say, in other words you can go in and look at a summary, it's very concise, you can read it, we don't have to read somebody's writing. So, I think it's very efficient. I think the e-prescribing has been a huge benefit for patients. I just think as far as, once you get over

the transition and you have used it a while, it just becomes easier and easier and I think it is far more efficient in many ways, I guess, so that would be what I would say.”

“Well, again it saves staff time, therefore we don’t need as many clerical staff to handle records. It freed up space because of not having to create paper records. The patient can get back to the providers quicker and I think if we do it from beginning to end, where the patient checks in and they see all of the health care providers and at the end there is everything that has happened to them and the process is in there, it's right there on the computer and so the billing staff can look quickly and see what has happened and can print out a summary for the patient to take. So, I think it's probably the process is much faster. I would say too when you think about it, you don’t have a record, a paper record hanging around from person to person to person, that could be overseen by somebody else or not really lost, the records get handled by so many people before the provider, or by the time they leave, in this way, you know, it's all computer.”

“I mean one of the benefits we’re seeing is that we have all of the patient information on hand immediately. We don’t have to go back in archives and find all the information. As far as we know, since we’ve started using our electronic health record, we’ve not had to store any of that patient information in an off-site server because we ran out of space, it’s all there and it seems to be growing along with the capacity of our clinic. So that’s one of the benefits.

The other benefit is making sure that everything is timely, so that providers are using the EHR, that information is there for them if they check it again later that night or the next day where paper chart may or may not be there, whether it was dictated or transcribed or...so the immediate accessibility is the benefit, and then I think this is having everything, I guess the paper chart, you have everything in the same spot, but it seems to be more organized and predictable in the EHR. You know where your labs are going to be, they won't get misfiled or anything like that."

"I think to better capture clinical information and patient demographic information, it will enable us to better standardize some of our care and our service delivery and a lot of it is just the data that we can capture not only from an administrative standpoint. We've processed patient flow, things like that and we can also look at you know certain performance measures with regard to best practices for inpatient care, you know, who is doing this, you know. I think we have an opportunity to capture some information then we have not otherwise been able to and hopefully at some point we will become much more efficient because we will be dealing primarily with one system, well actually it will be two because we don't even know for sure if they will be separate so again with two systems as opposed to four."

"...better information exchange with our hospitals and our community healthcare providers."

“Again, I’m because kind of sort of focused on (system) because that’s where we are doing it I think, I am trying to think of – there are so many – I guess there’s sort of a basic customer service aspect of it that we’re really not able to serve our (system) participants and in the way that they are served in many other areas of their life because we are just so far behind in the technology, we sort of do just about everything with pen and pencil or paper and pencil and then I think there are high, very high staffing burden for administrative tasks like filing and data entry sort of chart maintenance all of that. The program weighs a large number of staffing resources on our pen paper and pencil kind of that is the doing thing, so I think those are, if I were to choose just kind of two those would in terms of customer service and efficiency, those are the biggest.

I think another benefit is the staff morale. I think it is really, really hard for our staff to function in what we consider to be a dinosaur system when again you know I mentioned the sort of customer service piece for our (system) participants, but for our staff also that in so many other areas of their life that their use of technology is sort of engrained in their day-to-day and then they come to work in our office and we are using these almost laughable systems that, especially when new staff come on and they see what we do, it is almost outrageous to think that we are functioning so behind the time. So I think there is a staff morale piece. And then I think our ability to be I think the other big and a part of this is sort of and we don’t have the system yet so I maybe anticipating this advantage but we will be able to be, I think, much better with our referrals out to communities because a lot of that will be kind of delved into the record, you know if something comes up how someone answers an intake question might automatically trigger a referral to a service

where before a staff person might have had to really think about that and make it happen and it will offer some more prompts so I think our ability to provide sort of a quality care for lack of a better term will be improved, because we won't be so reliant on the person in the room kind of to making decisions in the moment.”

“Right now as far as benefits as what it would be, the real benefit I would say right now is visiting with staff, after all the stress of doing it they are seeing the benefit and not having to handle and manage all written hard copy records. As far as long term benefit, one is simply just the ability to be able to get on to the health information exchange to put the information services we provide in public health out there so that primary care physicians would be able to access it. In addition to that, just the reduction in the amount of hard copy paper work or papers or files that we actually have to maintain and sustain here, within an organization and agency and then the other part that is nice is the just in the working within staff and clinic flow is it with the electronic health records it's not the passing of the file but it's the ability of accessing that on an electronic format so that as it goes from one stage of services to another, that's transition is much easier.”

The overwhelming amount and variation in the benefits of EHRs provides anticipation to LHDs which have implemented and have not implemented EHRs. The benefits are closely related to data accuracy, security, interoperability, and outcomes, while some resources, decision-making and planning, and other operational factors. The theme most frequently mentioned was the benefit of care coordination.

Barriers to EHR Implementation

Research sub-question 1b regarding the uses of this section on barriers. Costs, staff (lack of, training, resistance), and issues related to the technology (interoperability, privacy, issues during implementation) are among the most frequently mentioned barriers. IT issues such as internet not reliable and implementation not being available for all information systems can exasperate an already challenging situation. Thirty-one of the 49 LHD respondents provided reasons for not implementing EHRs. Employee and provider buy-in leading to hesitancy and resistance, funding, resources, priority, and lack of technical guidance are challenges experienced and keeping many LHDs from the benefits of EHRs mentioned above.

“No, we don’t have a buy-in. The clinic staff wants to continue doing paper and they won't change and they don’t want anybody to be able to see what they are doing because what we are finding out is they say they are really, really busy. We are finding that actually 50% of their patient load every day are no-shows. So, we are uncovering some work issues that people didn't want us to uncover and I feel lot of the public health nurses are older and they don’t want to use the technology. So, that’s our biggest challenge there, it's getting easier, it's getting better but they are doing everything possible to try not to use it.”

“Funding is probably the priority reason, but the second reason is as long as the state provides the database for us to enter the information into we are satisfied with that.”

“I think for most of the vendors if we had an infinite amount of money that we devote to them, they could design something that would be flexible enough for our needs. But

without having infinite amount of money vendors, most of the vendors are really geared towards the clinical setting. There are a few vendors that deal with the public health setting but they are very underdeveloped in the clinical side of it. And so it wouldn't necessarily be a good fit for us...it is an issue of there is not a vendor that is have a solution that's flexible enough for all of our needs and again you know we're kind of in a unique situation. Most local health departments don't run federally qualified health centers and have the clinical operations that we do and vice versa. Most vendors do a very good job and are geared towards more clinical operations and those few vendors that you have solutions or public health services would not necessarily, I mean it doesn't, it's not to our advantage to have two different systems.”

“Well we, one of the biggest barriers to doing this is funds and resources primarily for changing and for actually getting the system and we did get some money from the state and federal government in order to get to purchase and implement a particular system. One unintentional consequence you know that we experienced sort of going through the EHR process is that not all of our providers were amiable or even sometimes has the expertise to utilize to its fullest extent the EHR. I know that we had a couple of providers who were sort of opposed to learning and I think we even had some early retirements, I believe so.”

“Provider resistance to a change. The older the physician the more difficult for the change. What kind of IT equipment to use for the provider, whether they are going to have a portable laptop or they are going to have stationary work station in each room. It's so much as where they are going to sit in the room with the patient and type as they are talking or

they are going to talk directly to the patient and go back into their office and type in what was said or what was done. There were a lot of IT issues, huge, either things, servers down, or connections not working right or the whole system being very, very slow because it comes out of our state office, kind of complicated. So we had a lot of IT issues, provider resistance and some of our electronic health records they are very slow to get designed because they are designed by our state office to integrate with our billing system. So, I can't say that we—because of public health we provide a variety of programs, so it's not like a doctor's office where you are just doing primary care, for us we do a lot of things like family planning, STD, child health, adult health, so we didn't have all of those templates setup to begin with. So that was a little frustrating, we were kind of paper and electronic to begin with. But I think we have overcome all of those things and it's been 2 or 3, it's almost three years now, anyway those were our biggest barriers.”

“Budgets have to be able to withstand the cost of the electronic systems, the computes, the screens and everything else, especially when they get upgraded. The system requires a certain level of computer capability the local municipality as to pay the bills for them, for the computer hardware, that's sometimes a problem. That's the biggest issue. There is a way of being able to, but the local level budgets try to do the best they can and right now there is no grant funding like we used to get in the state, to support some of that.”

“Training is generally free, but that could be a barrier also, making sure people are able to get to training.”

“One was basically staff hesitancy to do it and the work load involved with getting it setup and building some of the levels. Next, was just internally we did have a little bit of technical assistance but staff had to spend, and especially those division managers they did spend a lot of time getting up to speed on what it was and then just working through the some of the technical glitches internally just to make sure that our IT system and infrastructure was deployed and right now we have gotten down to the identification of down to the simple fact right now is we are going to upgrade our wireless process throughout the building so we have a more consistent and trustworthy networking system.”

“Time and money, because obviously we are very small office and only four are in and so while we are doing a training patient still needed to be seen, so it is difficult sometimes to get that accomplished and if it is anything else, anything the new system is just...changing. But money probably is the biggest barrier because even though we got a grant to implement it and buy the initial software of \$55,000 maintenance for a year, so we would like to put the budget to the county supervisors for that money. That is probably the biggest. We all have worked at different locations and had different Electronic Medical Records. There is none that is perfect, but this one seems to be meeting their needs and the software vendors are very good at, if we need reports or something done they will help work with us and to meet our needs.”

Money, time, staff resistance are among the commonly mentioned themes for barriers to EHR implementation. Even the LHDs which have implemented EHRs are continuing to face challenges with interfaces, system communications, updates, and data sharing. The challenges for LHDs which have not implemented EHR systems have been too great to move beyond, although some are working towards this goal.

Strategies for Successful EHR Implementation

LHDs which have implemented EHR systems offer strategies and tools to assist with a smoother implementation process. This section is used to answer research sub-question 1c regarding the strategies for EHR implementation. These strategies have emphasis on the people within and outside the organization. Involvement of internal and external stakeholders and the reduction of barriers for resistance to implementation are common themes. Teamwork and relationship building through staff involvement and communication in the implementation process was the most frequently mentioned strategy. In addition, having a relationship with board of health and external organizations can assist with securing funding, advocacy, support, and buy-in from stakeholders. Training, providing computers with Wi-Fi access, and constructing planning or steering committees reduce barriers and assist with the resistance during the transition of technology. Grant funding, external assistance, and buy-in are indicators of improvement in improve efficiency and productivity during the process.

“It’s not very scientific. I think the biggest thing we had that what I called the RC factor, resistance to change and I guess the way that we overcame that is —first thing we did was we created a steering committee to look at the electronic health record and design we’re how we’re going to roll out to staff.”

A large proportion of LHDs have fully implemented electronic health records, but no activity is still represents well over half of the LHDs in the sample. The top five mentioned benefits of EHR implementation are: care coordination, retrieval or managing information, track outcomes of care, increased efficiencies, and accurate records. The top five barriers to EHR

implementation if LHD have implemented, included costs or financial resources, resistance to change, interoperability, IT related issues during implementation, and lack of training for usefulness and use of EHRs. For those LHDs who did not implement EHRs, the barriers included: Money or funding, no clinical services, no control over decisions, lack of training, resistance or fear of change, low IT capacity, federal regulations, and low priority.

LHD Characteristics Associated with Implementation of EHRs

The majority of the respondents in this portion of research are representing the LHDs with less than populations of 25,000 (41%), followed by 25,000 – 49,999 (20%), as displayed in Table 4.8. The majority are LHDs with local governance (82%) and almost equal amount of shared (10%) and state (9%) governed LHDs. High-speed internet is evident in 85 percent of the LHDs, while 15 percent either do not have or are uncertain of its existence. The majority of LHDs use wireless internet (48%), followed by fiber optic or Ethernet (41%). Forty-three percent of LHDs have hardware allocation or acquisition through county or city IT department, while only 6 percent was through someone else. Approximately 35 percent of respondents are in LHDs with IT budget allocation in each programs and departments within the LHD, followed by through central department in LHD (28%). Seventy-one percent of the LHDs have reviewed current information systems to determine if there should be changes and 24 percent have created a strategic plan for informatics within LHD in the past two years. Only 27 percent of LHDs have provided informatics training in the past 12 months.

Table 4.4: Descriptive statistics for variables in the analysis

LHD Characteristics	Number	Percent
7-level population category		
<25,000	87	41.1

25,000-49,999	65	19.9
50,000--99,999	43	15.8
100,000--249,999	45	11.8
250,000--499,999	34	5.9
500,000--999,999	25	3.8
1,000,000+	25	1.6
Governance		
Local	256	81.5
Shared	38	9.6
State	30	8.9
High-speed internet		
Yes	275	84.9
Do Not Know	30	10.0
No	13	5.0
Type of Internet Connection		
Broadband ISDN	99	31.3
ADSL	11	3.5
ADSL+2	4	0.9
Wireless Internet	162	47.8
Fiber Optic or Ethernet	149	41.3
Other	20	5.6
Do not know	68	21.5
IT Control		
Hardware allocation or acquisition		
Within each department or program	78	25.4
Within LHD (through central department)	115	32.7
City or county IT department	141	43.3
State agency	64	20.1
Someone else	15	5.6
IT budget allocation		
Within each department or program	127	35.4
Within LHD (through central department)	97	27.6
City or county IT department	78	25.6
State agency	75	23.8
Someone else	17	7.6
Organizational Activities related to informatics		
Reviewed current system	230	71.1
Created a strategic plan for information systems	95	23.7
Used formal project management process	73	16.9
Formally conducted security risk analysis	83	21.9
Formally conducted a readiness assessment	27	6.0
Other	17	5.6
None	54	21.0
Training		
Yes	92	27.3

Do not know/not sure	33	10.9
No	168	61.9

Table 4.5: Adjusted odds ratios, raw p-values, and adjusted p-values for LHDs with EHR systems versus non-EHR systems

LHD Characteristics	AOR	Raw p-values	Stepdown Bonferroni	Hochberg	False Discovery Rate
Type of Internet Connection					
Broadband ISDN	0.671	0.3181	1.0000	0.4012	0.3555
ADSL	4.672	0.3063	1.0000	0.4012	0.3555
ADSL+2	0.081	0.1964	1.0000	0.4012	0.2870
Fiber Optic or Ethernet	0.579	0.1668	1.0000	0.4012	0.2870
Other	0.571	0.3919	1.0000	0.4012	0.4012
Do not know	0.369	0.0536	0.8370	0.4012	0.1542
IT Control					
Hardware allocation or acquisition					
Within LHD (through central department)	0.374	0.0060	0.1140	0.1140	0.1140
City or county IT department	0.517	0.0512	0.8370	0.4012	0.1542
IT budget allocation					
State agency	0.683	0.2819	1.0000	0.4012	0.3555
Someone else	2.002	0.3118	1.0000	0.4012	0.3555
Organizational Activities related to informatics					
Reviewed current system	3.163	0.0568	0.8370	0.4012	0.1542
Created a strategic plan for information systems	1.645	0.1947	1.0000	0.4012	0.2870
Used formal project management process	0.496	0.0773	0.9276	0.4012	0.1836
Formally conducted security risk analysis in regards to public health information systems	0.462	0.0507	0.8370	0.4012	0.1542
Formally conducted a readiness assessment	2.282	0.1498	1.0000	0.4012	0.2846
Other	4.589	0.0465	0.8370	0.4012	0.1542
None	3.766	0.0472	0.8370	0.4012	0.1542
Training (v. no)	0.546	0.1013	1.0000	0.4012	0.2139
High-speed internet (v.no)	1.478	0.4012	1.0000	0.4012	0.4012

Individually there are 6 variables statistically significant at the 0.05 alpha level, awareness of the type of internet service available, not having hardware allocation and acquisition through central department of LHD or city/county IT department, not having formally conducted a security risk analysis in regard to public health information systems within the past two years, and conducting other organizational activities related to informatics or conducting no organizational activity related to informatics. However, when adding the p-value adjustments there is no statistical significance of either variable. The Stepdown Bonferroni p-values results 0.114, 0.8370, and 1.000, Hochberg p-value 0.4012, and FDR p-value ranging (0.1140 – 0.4012). The individual significance proves there is some interaction with the variables, but it is very small.

Future Implementation of EHRs

As indicated in the qualitative data, there are several LHDs which are in the process of planning, investigating, and most with no activity. The quantitative survey requested information on the plans to implement an EHR system. These data help answer research question 3 regarding the future implementation of EHRs in LHDs. The responses include, we have no plans to implement; we are in the process of researching and/or selecting a system; we have selected a system but have not yet begun implementation; we have selected a system and are in the process of implementing it now. These correlate with the qualitative data as shown in Table 4.6. The descriptive statistics of the future plans are displayed in Table 4.7.

Table 4.6: Correlation of qualitative and quantitative data codes for future plans for EHR implementation

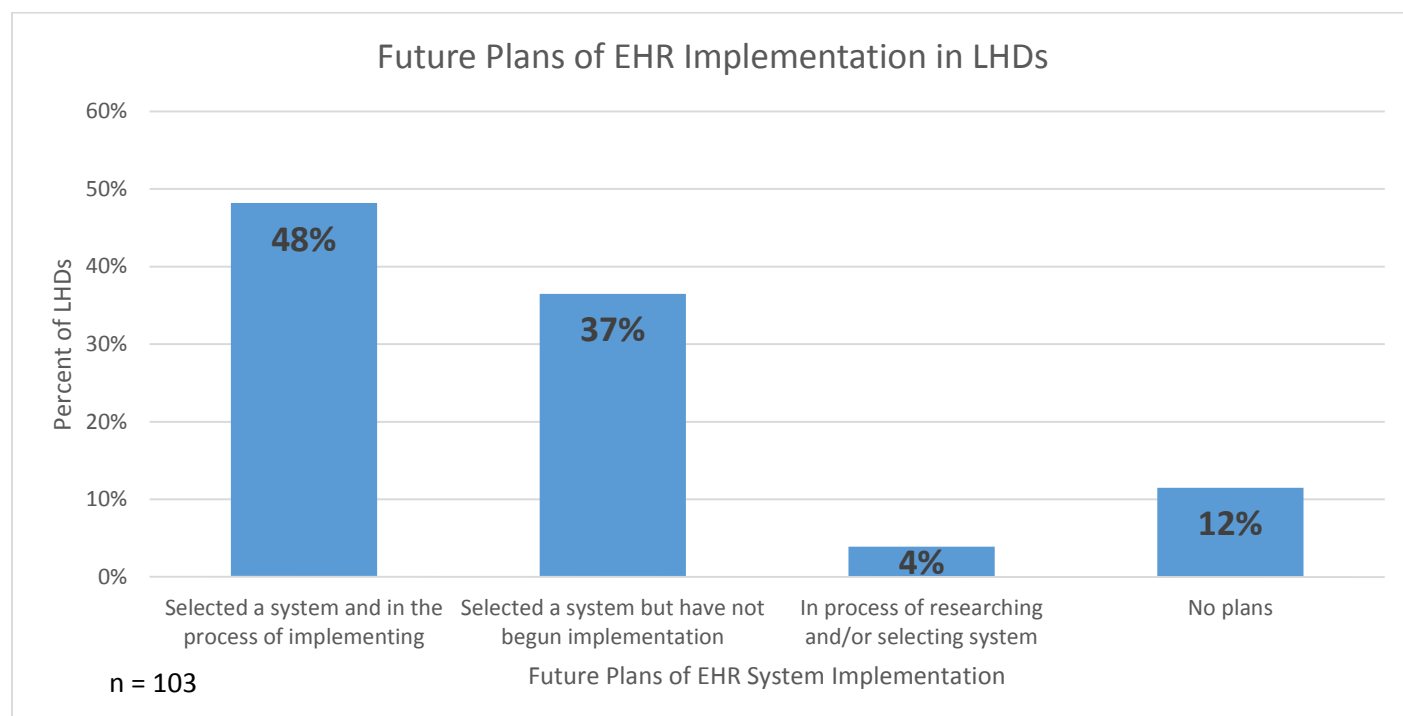
Qualitative	Quantitative
Almost or in process	Selected a system and in the process of implementing
Planning to implement	Selected a system but have not begun implementation
Investigating	In process of researching and/or selecting a system
No activity	No plans

Out of 103 respondents to the question about the future of EHR implementation, 48 percent have selected a system and in the process of implementing, 37 percent have selected a system, but not yet begun to implement, 12% have no plans to implement, and 4% are in the process of researching and/or selecting a system (depicted in Table 4.4 and Figure 4.2).

Table 4.7: Frequency and percent of LHDs by future plans for EHR system implementation

Future Plans	N	Percent
Selected a system and in the process of implementing	45	48.2%
Selected a system but have not begun implementation	40	36.5%
In process of researching and/or selecting system	5	3.9%
No plans	13	11.5%
Not applicable	221	-
TOTAL	324	100%

Figure 4.2: Percent of LHDs by future plans to implement EHR systems



The results of the question about future plans are cross-tabulated (Table 4.5) with the 7-level population category which indicate that the majority of the LHDs with less than 25,000 people have selected a system and have begun implementation (54%), while 34 percent have selected and not begun implementation, and 12 percent have no plans to implement. In the 25,000 to 49,999 category, almost an equal number of LHDs have selected and begun (40%) and selected and not begun implementation (44%). Approximately 8% have no plans, while some are in the process of researching and selecting a plan. Sixty-two percent of the 50,000 to 99,999 category have selected a system and begun implementation, followed by selected and not begun (23%) and research and/or selecting (7%) and no plans (7%). An equal number of LHDs have selected and begun implementation as have selected and not begun implementation in the population category of 100,000 to 249,999 (33%). Twenty-two percent have no plans, while 12 percent are researching and/or searching. In the population category of 250,000 to 499,999, 56

percent of LHDs have selected and have not begun implementation of EHRs, followed by 23 percent have selected and begun, and 10% in process and no plans. All of the LHDs in this data in the 500,000 to 999,999 population category have selected an EHR system and not begun implementation.

Table 4.8. Percent of LHDs with Future Plans of EHR System Implementation by Size of Population

Future Plans	7-level Population Category					
	<25,000	25,000-49,999	50,000--99,999	100,000--249,999	250,000--499,999	500,000--999,999
Selected and begun implementation	53.6%	40%	62%	33.3%	23.1%	0%
Selected and not begun implementation	34.2%	43.6%	23.1%	33.3%	56.4%	100%
In process of researching and/or selecting	0%	8.2%	7.4%	11.7%	10.3%	0%
No plans	12.2%	8.2%	7.4%	21.7%	10.3%	0%

n = 103

The governance categories of local, shared, and state are cross-tabulated with the future plans of EHR system implementation, results are displayed in Table 4.6 and Figure 4.3. The majority of the local-governed LHDs have selected and begun implementation (55%), followed by 33 percent who have selected and not begun, 7 percent with no plans, and 5 percent in process of researching and/or selecting. Approximately 79 percent of LHDs with shared governance have selected an EHR system, but have not begun implementation, however, 22 percent have no plans. For state-governed LHDs, almost half have no plans for implementation (48%), followed by 33 percent which have selected and not begun implementation and 18 percent selected and begun implementation.

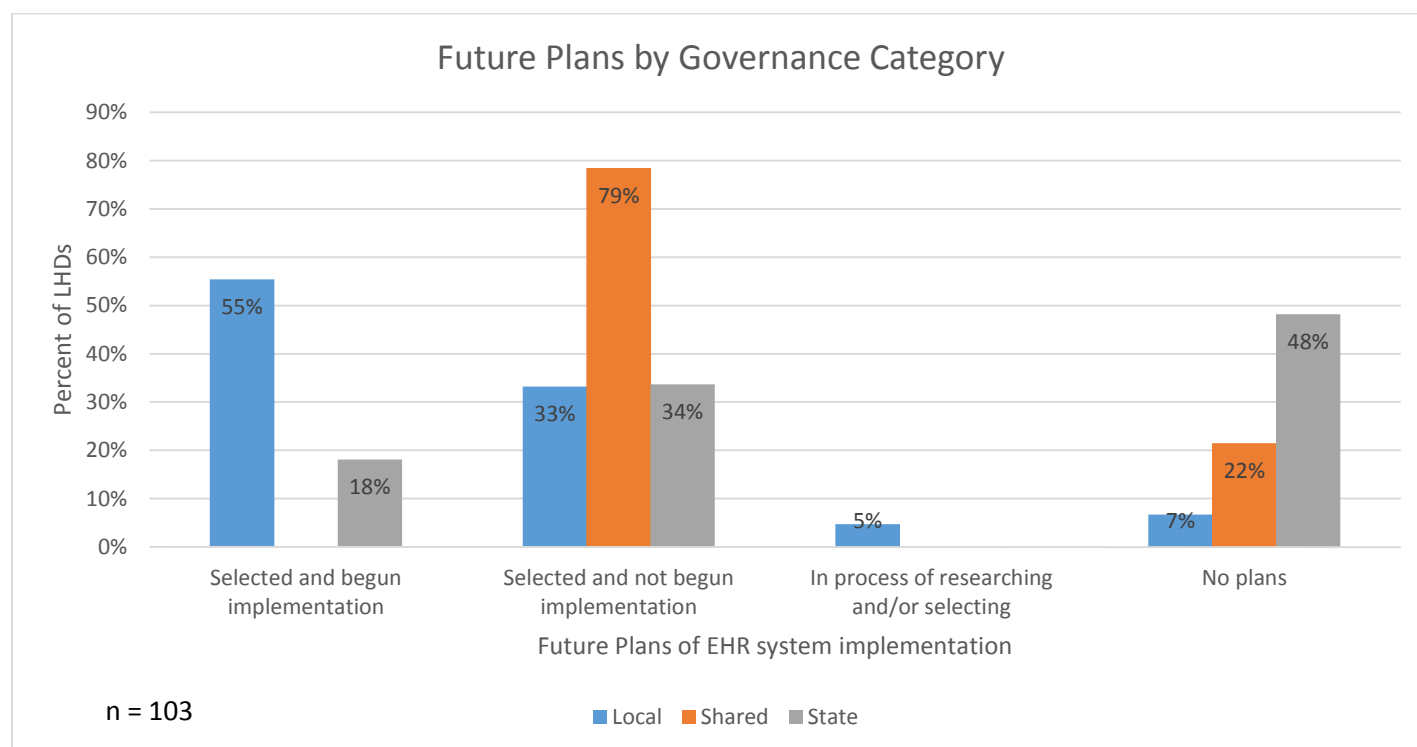
Table 4.9: Future Plans of EHR System Implementation by Governance Category

Future Plans	Governance Category					
	Local		Shared		State	
	N	%	N	%	N	%
Selected and begun implementation	42	55.4	0	0.0	3	18.1
Selected and not begun implementation	31	33.2	6	78.5	3	33.7
In process of researching and/or selecting	6	4.7	0	0.0	0	0.0
No plans	6	6.7	2	21.5	5	48.2
Total	84	-	8	-	11	-

n = 103

Figure 4.3: Percent of LHDs by Future Plans of EHR System Implementation and Governance

type



The state has been integral in assisting some LHDs with EHR platforms, however respondents mentioned that there is no plan to implement an EHR system at the local level. One LHD respondent provided insight, “The only electronic health records that we have are the ones that are included in the state database. We don’t have any local electronic health records, and we

have no intention of beginning one.” The overall level for EHR implementation for both the qualitative and quantitative data are in agreement. The majority of LHDs have no activity or are using non-EHR systems to store their patient information and data. However, the proportion of LHDs who are using EHRs and are in the process is growing, now at approximately 42 percent.

CHAPTER V: SUMMARY DISCUSSION AND CONCLUSIONS

The objectives of this research are to determine the current level and future plans of implementation of EHRs in LHDs while assessing benefits, barriers, and strategies to overcome the barriers to implementation, evaluating LHD characteristics associated with successful EHR implementation, and the future of EHR implementation in LHDs. Using a mixed methods research approach, the Organizational Innovation framework, Resource Dependence theory and triangulation, a comprehensive view of the status of implementation of EHRs is examined. The qualitative, in-depth interviews provide themes and supportive quotes of the research question 1, 1a, 1b, and 1c assessing the level, benefits, barriers, and strategies of EHR implementation from respondents within LHDs, while the quantitative survey supplies the data for research question 1, 2, and 3 for the level of patient health information storage, LHD characteristics, and future plans of implementation of EHRs in LHDs. The mixing of these methods assists in the transformation of the data to clarify issues and gain an integrated view of the implementation of EHRs in LHDs (Creswell & Plano Clark, 2007).

Discussion

This research aims to provide an updated, comprehensive view of the level of EHR implementation in LHDs, to examine the benefits, barriers, and strategies, to determine characteristics associated with EHR implementation, and to assess the future plans of implementation. In alignment with the objectives of Meaningful Use for public health to capture and share data, advance clinical processes, and improve outcomes (Davidson, 2013; Silverman, 2013). Although there were many barriers such as costs, time, staff resistance, leadership in LHDs are optimistic about the benefits and the future of informatics in LHDs. Strategies such as

having a staff “champion”, creating implementation teams are simple approaches, and having clear and open communication with employees can help make EHR implementation smooth.

Confirmed by both qualitative and quantitative data, the majority of the respondents mentioned no activity in the implementation of EHRs, however, this category is followed by the LHDs which have implemented EHRs. Electronic health record systems are implemented in approximately 42 percent of LHDs, however, 58 percent are still using non-EHR systems, such as paper records and spreadsheet files. Although many are facing barriers to achieve implementation, 48 percent of LHDs have selected systems and are in the process of implementation. Only about 12 percent of LHDs have no plans for implementation. As mentioned in the qualitative data, LHDs with no plans of implementation provided reasons such as no clinical services and no control of decision. As evident in the literature, even LHDs with no clinical services will need to be prepared for the quality and quantity of big data soon to come (Foldy et al., 2014).

The benefits of EHR implementation is apparent in the findings with care coordination, quick retrieval of records, and tracking of health outcomes among the most frequently mentioned themes for both LHDs which have implemented EHRs and have not. Greater effectiveness in programs and interventions, appropriate treatment at various locations, and follow-up and continued care of discharged patients. Siloed data are inefficient for patient care and population health, which is supported by the results of this study. There are very few LHDs which do not see a benefit in the implementation of EHRs and mainly due to the lack of clinical services and low priority of leadership. Previous studies confirm the many benefits and barriers of EHRs. Money or the lack thereof is a persistent issue for LHDs, especially among medium and smaller LHDs. However, staff involvement and training can reduce internal barriers in order to

experience benefits, such as care coordination and management of data information for population health.

Although this study did not find any significant LHD characteristics once the p-values were adjusted, individually at the 0.05 level there are some interactions although small. Including LHD organizational activities and control of informatics characteristics in future studies can explain how these factors affect the implementation of informatics in LHDs. In addition, it can provide actionable steps at the organizational level to reaching implementation.

The findings of this study align with the Organizational Innovation framework in describing the influences of individuals, organizations, and environment have on the implementation of EHRs. Individual influences on the implementation are described through the lack of trained staff and resistance of staff to learn new systems and new workflow processes. Organizational influences are observed through governance type differences and the control of informatics and operational activities and decisions. Interoperability of surrounding organizations and the size of the population of LHDs are influences of the environment. Organizational innovation framework serves as a guide to characterize the various responses of the LHD staff.

The lack of financial resources is a difficult challenge to overcome. Prioritization and allocation of funds from state and federal leadership now could lead to better workflow processes and cost efficiencies in the future. Acquiring and sustaining buy-in from these leaders stresses how EHRs would benefit the population in which they serve. Grant funding could alleviate some of the financial pressure of LHDs, such as an ARRA grant which assists with systems and technology functions.

The strategies mentioned by the LHDs are consistent with the literature in that inclusion of stakeholders, including physicians, technology professionals, ethics professionals, administrative personnel, and patients, can reduce risks and overcome barriers to increase the capacity of systems, and train and use quality control (Mercuri, 2010). In addition, teamwork and relationship building through staff involvement and communication in the implementation process was the most frequently mentioned strategy. Having a relationship with board of health and external organizations can assist with securing funding, advocacy, support, and buy-in from stakeholders. Although grant funding is desirable, external assistance and buy-in can garner support which could lead to financial and technical resources. Training, providing computers with Wi-Fi access, and constructing planning or steering committees reduce barriers and assist with the resistance during the transition of technology.

Strengths and Limitations

The strengths of this research is that the qualitative data are based on rich data from 49 interviews provided by professionals who lead or who work with informatics systems on a daily basis. The quantitative data from NACCHO is strong in that they continually conduct numerous studies within the LHD population and regarding informatics and have valid and reliable instruments. In addition, NACCHO's data has been used to publish multiple, peer-reviewed articles. This research captures representation of smaller LHDs, which is unusual in this type of study due to low informatics capacity. In addition, this research is relatively generalizable to LHDs due to the nationally representative sample. Although the data were not collected simultaneously, they were collected from samples of the same population and strengthened by

the research design using triangulation. Finally, this research is based on the most recent data available regarding informatics in local health departments.

The limitations of the 2015 Informatics study include survey fatigue by LHDs, time constraints, and self-reported, unverified information. There is a possibility that respondents answered to complete the survey without fully committing to correct answers and incomplete surveys. The use of a triangulation method for this research is the difficult to replicate, due to the variation of qualitative research (Jick, 1979). There is possibility of an overstress on less significant areas and under-stress on more significant issues. The rank of issues among respondents vary and could bias the data towards certain issues versus the underlying issue. Hesitancy to speak on behalf of use of health informatics within LHDs could have resulted in a limited view of the issues. Although the interviews were conducted with staff who work with or lead departments with health informatics, the lack of a full understanding regarding informatics was a barrier to receiving a full view of LHDs issues regarding informatics. Finally, this research includes limitations of self-reported data, which were not independently verified.

Public Health Implications

Recent updates and changes in policies, such as HITECH, HIPAA, and ACA have helped increase priority of health informatics in the public health sector with implications on improving the processes to affect the health of the populations served. With EHRs in place, public health agendas can include clinical care data and more widely address population level concerns. Interoperability of systems can assist in timely and efficient alerts, emergency response, population research, detailed analysis, refined interventions, future preparations for health, and overall coordination of care for patients.

EHRs have the ability to change how data is collected through improved tools data collection and analysis (Miller & West, 2007). Equity concerns can be addressed through the implementation of EHRs and as a part of the movement for Health in All Policies (Rudolph, Caplan, Ben-Moshe, & Dillon, 2013). Policy changes to address funding could significantly influence the rate of implementation in LHDs. Although there are funding streams for technology implementation, there are few revenues for LHDs, which disproportionately suffer from resource depravity (Willard, Shah, Leep, & Ku, 2012). Through this research areas of lack in LHDs are identified and can be addressed and reduced through strategic planning and prioritization. When addressed through policy and leadership support, can change the way health is delivered in the communities in which LHDs serve.

An interesting phenomena is the changing of the public health workforce as older generations are retiring and transitioning out of certain positions. One respondent mentioned the influence of newer public health practitioners having the training to work with informatics, but there being little informatics capacity available at the LHDs. The new workforce may inevitably push towards informatics in a strong way soon. In order for some of the smaller and medium LHDs to attract and keep new generation workforce where it is needed, an increase in informatics capacity is a necessity.

Recommendations

Recommendations for the future of health informatics in public health are to continually work toward the integration of health care and public health through EHR implementation. In addition, leadership should include staff in the decisions to implement health informatics through positive yet clear communication and continually training to stay current. Although legislation

can motivate change, accompanying funding to increase the ability of LHDs to implement services which can change population health now and in the future. EHRs can provide continuity of care for patients, improve health outcomes, and inform population health interventions and policy.

Future Research

Future research in public health is to conduct a cost-study of EHR implementation in LHDs would be the next step to determine the actual amount versus the perceived amounts of EHR implementation. In addition, a content analysis of LHD strategic plans to assess the level of planning for informatics and funding possibilities to ensure successful implementation. Finally, future research through the application of an EHR toolkit to evaluate the usefulness, efficiency, and eventual distribution of these practices to LHDs seeking to implement EHRs. In addition, this process could assist with accreditation of LHDs and inform policy for funding support to remove barriers to allow LHDs to more efficiently delivery appropriate care to the populations they serve. An assessment of how the new generation of public health workers and technological skill sets available are affecting LHD operations.

Conclusion

The Office of National Coordination for Health Information Technology has a goal to achieve national interoperability and have a person-centered system which continuously improves care, public health, and research through the collection and use of real-time access to data (ONC, 2015a). These goals are planned to be reached through Meaningful Use objectives for immunization registries, syndromic surveillance, electronic lab reporting, and certified

electronic health records in public health agencies (HHS, 2010). Changes in the provision and sustainability of essential public health services with the implementation of EHRs are being experienced in LHDs nationwide. This study characterizes the current use of EHRs in LHDs and illuminates the perceived benefits, barriers, and strategies to overcoming challenges from LHDs who use health informatics. There are substantial barriers to implementation, but some public health agencies are experiencing the benefits of EHRs. Despite financial, technical capacity, and operational constraints in the implementation of electronic health records and health information exchanges, leaders are optimistic about the future of EHRs in local health departments. Strategies, such as teamwork, training, and securing support and buy-in from stakeholders, are fairly simple approaches to improving implementation of new technologies in LHDs. The opportunity for EHRs to improve surveillance and prevention of chronic disease, reduce disparities, and target interventions is a worthy effort (Shah & Sheahan, 2015). Leadership is an essential component in the success of EHR implementation, and should seek to improve the status in LHDs for future efficiencies, continuity of patient care, and overall outcomes in populations served by LHDs.

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Appendix

Appendix A

IRB Approvals and Data Use Agreement Statements

Georgia Southern University Office of Research Services & Sponsored Programs		
Institutional Review Board (IRB)		
Phone: 912-478-0843		Veazey Hall 2021
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Karmen Williams

CC: Charles E. Patterson
Vice President for Research and Dean of the Graduate College

From: Office of Research Services and Sponsored Programs
Administrative Support Office for Research Oversight Committees
(IACUC/IBC/IRB)

Initial Approval Date: 4/4/14

Expiration Date: 3/31/15

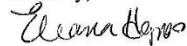
Subject: Status of Application for Approval to Utilize Human Subjects in Research –
Expedited Process

After a review of your proposed research project numbered **H14374** and titled "**Health Informatics Capacity og Local Health Departments in the United States: Barriers and Facilitators**" it appears that (1) the research subjects are at minimal risk, (2) appropriate safeguards are planned, and (3) the research activities involve only procedures which are allowable. You are authorized to enroll up to a maximum of 45 subjects.

*Therefore, as authorized in the Federal Policy for the Protection of Human Subjects, I am pleased to notify you that the Institutional Review Board has approved your proposed research. – **Description:** This project will utilize a mixed methods approach to characterize local health department's use of information technologies by assessing patterns of utilization and investigating perceived barriers to engaging in electronic systems and participation in meaningful use.*

If at the end of this approval period there have been no changes to the research protocol; you may request an extension of the approval period. Total project approval on this application may not exceed 36 months. If additional time is required, a new application may be submitted for continuing work. In the interim, please provide the IRB with any information concerning any significant adverse event, **whether or not it is believed to be related to the study**, within five working days of the event. In addition, if a change or modification of the approved methodology becomes necessary, you must notify the IRB Coordinator **prior** to initiating any such changes or modifications. At that time, an amended application for IRB approval may be submitted. Upon completion of your data collection, you are required to complete a *Research Study Termination* form to notify the IRB Coordinator, so your file may be closed.

Sincerely,



Eleanor Haynes
Compliance Officer

Georgia Southern University Office of Research Services & Sponsored Programs		
Institutional Review Board (IRB)		
Phone: 912-478-0843		Veazey Hall 2021
		P.O. Box 8005
Fax: 912-478-0719	IRB@GeorgiaSouthern.edu	Statesboro, GA 30460

To: Gulzar H. Shah
Kay Lovelance
Karmen Williams

From: Office of Research Services and Sponsored Programs
Administrative Support Office for Research Oversight Committees
(IACUC/IBC/IRB)

Approval Date: 05/21/2015

Subject: Status of Application for Approval to Utilize Human Subjects in Research

After a review of your proposed research project numbered **H15421** and titled **"2015 Informatics Needs Assessment of Local Health Departments"**, it appears that your research involves activities that do not require full approval by the Institutional Review Board (IRB) according to federal guidelines.

According to the Code of Federal Regulations Title 45 Part 46, your research protocol is determined to be exempt from full review under the following exemption category(s):

B2 Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (I) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (II) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.

Any alteration in the terms or conditions of your involvement may alter this approval. *Therefore, as authorized in the Federal Policy for the Protection of Human Subjects, I am pleased to notify you that your research, as submitted, is exempt from IRB approval. No further action or IRB oversight is required, as long as the project remains the same. If you alter the project, it is your responsibility to notify the IRB and acquire a new determination of exemption. Because this project was determined to be exempt from further IRB oversight, this project does not require an expiration date.*

Sincerely,



Eleanor Haynes
Compliance Officer

Data Use Agreement Statements

Staff from the de Beaumont Foundation had previously agreed to allow you to use data from the joint project on LHD informatics for dissertation-related purposes. Please make sure to acknowledge de Beaumont's funding of the project in any published works. Additionally, if you could submit any publications for comment (i.e., not clearance), that would be appreciated. This would not apply to your final defense materials itself, only publications you'd be sending out for peer review.

JP Leider, PhD
Public Health Consultant
Formerly of the de Beaumont Foundation

Yes, you have permission to use this data for your dissertation. Please let me know if you need anything else.

Catherine D. Patterson
Senior Program Officer
de Beaumont Foundation

I confirm that we agreed you would use three questions from the 2015 NACCHO Informatics Assessment for your dissertation and the special issue article in the *Journal of Public Health Management and Practice*. Please let me know if you need anything else.

Lilly Kan
Director, Infectious Disease and Informatics
National Association of County and City Health Officials

Georgia Southern University Office of Research Services & Sponsored Programs		
Institutional Review Board (IRB)		
Phone: 912-478-5465		Veazy Hall 3000
		PO Box 8005
Fax: 912-478-0719	IRB@GeorgiaSouthern.edu	Statesboro, GA 30460

To: Williams, Karmen
Shah, Gulzar

From: Office of Research Services and Sponsored Programs
Administrative Support Office for Research Oversight Committees
(IACUC/IBC/IRB)

Date: 4/20/2016

**Initial
Approval**

Date: 4/19/2016


Subject: Status of Research Study Modification Request – Exempt

After a review of your Research Study Modification Request on research project numbered **H16182** and titled "**A Mixed Methods Assessment of the Implementation of Electronic Health Records in Local Departments.**" it appears that your research modification does not change the conditions of your previous exemption. The research involves activities that do not require approval by the Institutional Review Board according to federal guidelines.

Modification Description: This modification serves to change the title of this project to, "A Mixed Methods Assessment of the Implementation of Electronic Health Records in Local Departments."

Therefore, as authorized in the Federal Policy for the Protection of Human Subjects, I am pleased to notify you that your research is exempt from IRB approval. You may proceed with the proposed research.

Sincerely,



Eleanor Haynes
Compliance Officer