Notifiable Conditions Information Systems in Local Public Health Practice: Applied Informatics Research

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This is to certify that I have examined this copy of a doctoral dissertation by

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Abstract

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Notifiable conditions reporting is an essential component of public health surveillance. Through this process local public health jurisdictions (LHJ) collect information about health events of interest and share this information with state-level public health departments, who then share it with federal public health agencies. Many LHJs make use of electronic information systems to manage, process, and analyze the notifiable conditions data within their jurisdictions. In the midst of state and national-level efforts to standardize notifiable conditions reporting processes, there has been a nation-wide push for LHJs to adopt new notifiable conditions information systems that are capable of online reporting. These systems offer the benefit of faster reporting to state public health departments, and compliance with new standardization efforts. These systems, typically developed by a private vendor or state-level public health department, may not be designed to accommodate the specific work practices that are unique to each local public health jurisdiction. Therefore, the implementation of a new information system in an LHJ may disrupt, or even impede, the work that is required to properly address the health issues that are unique to the region. These impediments include decreased information processing capabilities, decreased analytical capabilities, and additional administrative burdens. This could have serious effects on local public health practice,

and thus on the health and welfare of local communities. The research proposed in this document aims to improve the development and evaluation of notifiable conditions information systems that support the work of local public health jurisdictions.

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DEDICATION

This dissertation is dedicated to my grandparents, Azaria John and Mary Jane Theroux.

Chapter 1 – Introduction to Study

1.1 Problem Statement

Notifiable conditions reporting -- the process of identifying and documenting health events of interest -- is an essential component of public health surveillance [2]. Through this process local public health jurisdictions (LHJs) collect health data and make aggregate reports to state-level public health agencies, which then share this data with federal public health entities. Many LHJs make use of electronic information systems to manage, process, and analyze the notifiable conditions data within their jurisdictions. In the midst of state- and national-level efforts to standardize notifiable conditions reporting processes, there has been a nationwide push for LHJs to adopt new notifiable conditions information systems that are capable of online reporting. Online reporting systems offer the benefit of faster reporting to state public health departments, and compliance with new standardization efforts. These systems, typically developed by a private vendor or state-level public health department, are not necessarily designed to accommodate the specific work practices that are unique to each local public health jurisdiction.

Helmuth Orthner said, "We are building medical information systems just as automobiles were built early in this century, i.e., in an ad-hoc manner that disregarded even existent standards [3]." The same might be said of the notifiable conditions management and reporting systems used by local public health agencies. While efforts to standardize reporting at the state and national levels are underway, new system standards have yet to be developed which specifically consider the work of local public health practitioners. This may be because research clearly describing public health activities has yet to synergize with design efforts, or there may simply be too little research to provide a compelling argument for the incorporation of LHJ information needs in system design.

Our literature review found minimal research describing the use of information systems for managing communicable disease data in local public health practice. Considering this paucity of knowledge of the user environment, designers develop systems considering only a portion of the many stakeholders involved in notifiable conditions reporting. In order to utilize these information systems, LHJs must alter their work practices to facilitate the use of the new systems. If designed without knowledge of the work practices of local public health practitioners, the implementation of new information systems in LHJs may disrupt the work required to properly address the health issues unique to each organization. These impediments may include decreased information processing capabilities, decreased analytical capabilities, and additional administrative burdens. Through exploratory qualitative research, survey research, and the development of an evaluation handbook for local public health practitioners, the research proposed in this dissertation aims to improve the development and evaluation of notifiable conditions information systems that support the management of communicable disease information at the level of local public health.

1.2 Research Questions and Specific Aims

The research presented in this thesis aims to answer the following questions: How do local public health organizations use information systems to manage communicable disease information? Are there differences in the way these groups use information systems? If so, can the differences be attributed to any particular qualities of the group? How do public health agencies evaluate new information systems? How do local public health practitioners respond to a structured model of system evaluation?

Specific Aim 1: To understand the tasks that an information system must support to manage notifiable conditions data in a local public health jurisdiction.

To describe the use of information systems in local public health practice, communicable disease information management activities were observed at a large municipal public health agency. Participant observation and task analysis were used to describe the enacted work of local public health practitioners. The findings from this observation were validated with the participants, and vetted for face validity by public health experts[1].

Specific Aim 2: To characterize the use of information systems for notifiable conditions across a broad spectrum of local public health jurisdictions.

Using the findings from Aim 1 as a qualitative foundation, an online survey was developed and distributed to all local public health jurisdictions in Washington State. Employees responsible for notifiable conditions information management were asked about their work practices and their interaction with information management systems.

Descriptive statistics were used to display the findings and compare the usage of information systems across LHJs of differing size.

Specific Aim 3: To develop, apply, and assess an evaluation strategy for notifiable conditions information systems within local public health agencies.

Participant observation, scenarios of use, and heuristic evaluation were combined to develop an evaluation toolkit for local public health agencies to assess the appropriateness of information systems within their working environment [4].

Working in an intrinsically data-driven field, public health practitioners rely heavily on the collection and analysis of data to improve the health of the populations they serve. Information management systems provide the ability to manage and analyze large amounts of public health data, and facilitate timely disease reporting. Little is known about the use of information systems in managing communicable disease within local public health jurisdictions. The aims presented above seek to improve the design and use of information technology in local public health practice by exploring the current state of information systems for notifiable conditions management in local public health agencies.

1.3 Background

1.3.1 Surveillance, notifiable conditions reporting and communicable disease

Disease surveillance is critical to public health practice because notifiable conditions and communicable diseases have a dramatic impact on population health. One common communicable disease, Hepatitis B, provides a clear example of the individual and public impact of communicable disease. The CDC estimates that there were approximately 60,000 new cases of Hepatitis B in 2004. The disease is caused by a virus, which is transferred by contact with an infected person's blood. Common routes of transmission include sexual contact or needle sharing with an infected person. An acute case of Hepatitis B is often resolved by a person's own immune system. Left untreated, however, Hepatitis B may cause cirrhosis of the liver, jaundice, and abdominal pain. Death from chronic liver disease occurs in 15-25% of infected individuals. Groups at the highest risk for acquiring Hepatitis B are those with multiple sex partners, injection drug users, infants born to infected persons, and men who have sex with men. Hepatitis B can be prevented through vaccination. Educational programs aimed at high-risk groups may also lead to reduced prevalence and incidence of the disease[5].

One of the first documented instances of institutionalized disease surveillance in the United States occurred in 1878, when Congress authorized the collection of communicable disease information of expatriated U.S. consuls. Recognizing the value of this information in the prevention of communicable diseases, Congress authorized the publication of the data for surveillance purposes. This information was then used to quarantine infected individuals, effectively creating a public health intervention. The program was so successful that the federal government, and later state and local governments, began to regularly collect and manage communicable disease information [6]. Over the last 30 years, population health data has become increasingly used for decision making in public health practice, and disease surveillance has been proposed as a separate and distinct discipline [7].

Public health surveillance in the United States is overseen at the federal level by the Centers for Disease Control and Prevention (CDC). The CDC defines public health surveillance as "the ongoing systematic collection, analysis, and interpretation of health data for purposes of improving health and safety [8]." Surveillance for communicable diseases and other conditions of public health significance (referred to throughout this dissertation as "notifiable conditions") is a core function of the public health system. Notifiable conditions reporting falls under the core function of "Assessment," as defined by the Institute of Medicine of the National Academies (IOM)[9]. The data collected during this process are used by public health departments in the assessment and long-term monitoring of health trends, the allocation of resources, the identification of cases and outbreaks requiring further investigation and/or disease control measures, and the prediction of potential epidemics[10]. Health care providers, health care facilities, and schools are typically required by state law to report notifiable conditions to local or state public health departments.

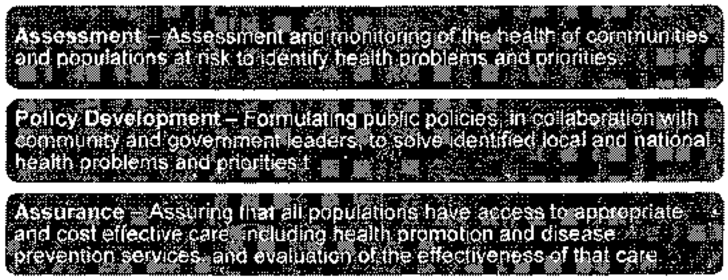


Figure 1 - The Three Core Functions of Public Health [9]

Infectious disease, also referred to as communicable disease, has historically had a dramatic impact on human health. Epidemics of communicable diseases such as smallpox, the bubonic plague, and influenza have prematurely ended many human lives. For example, in the twentieth century, smallpox was the cause of 300-500 million deaths. In the 1950s, over a century after the introduction of the smallpox vaccine, it was estimated that 50 million cases of the disease occurred[11]. Recently, SARS and H1N1 (Avian Bird Flu) ignited public concern about communicable disease, as each illness threatened to develop into an international pandemic.[12] In an effort to reduce the spread of infection and mitigate the impact of disease on individuals, public health professionals monitor these high-profile outbreaks, as well as a host of other diseases. The CDC requests that state public health departments monitor a set of outlined conditions, which include but are not limited to communicable diseases. These diseases, known collectively as "notifiable conditions," are listed in Table 1 [13].

Table 1 - CDC Nationally Notifiable Infectious Diseases [13]

- Acquired Immunodeficiency Syndrome (AIDS)
- Anthrax
- Arboviral neuroinvasive diseases
- Botulism
- Brucellosis
- Chancroid
- Chlamydia trachomatis, genital infections
- Cholera
- Coccidioidomycosis
- Cryptosporidiosis
- Cyclosporiasis
- Diphtheria
- Ehrlichiosis/Anaplasmosis
- Giardiasis
- Gonorrhea
- Haemophilus influenzae, invasive disease
- Hansen disease (leprosy)
- Hantavirus pulmonary syndrome
- Hemolytic uremic syndrome, post-diarrheal
- Hepatitis, viral, acute
- Hepatitis, viral, chronic
- HIV infection
- Influenza-associated pediatric mortality
- Legionellosis
- Listeriosis
- Lyme disease
- Malaria
- Measles
- Meningococcal disease
- Mumps
- Novel influenza A virus infections
- Pertussis
- Plague
- Poliomyelitis, paralytic
- Poliovirus infection, nonparalytic
- Psittacosis
- Q Fever
- Rabies
- Rocky Mountain spotted fever
- Rubella
- Rubella, congenital syndrome
- Salmonellosis
- Severe Acute Respiratory Syndrome (SARS)
- Shiga toxin-producing Escherichia coli (STEC)
- Shigellosis
- Smallpox
- Streptococcal disease, invasive, Group A
- Streptococcal toxic-shock syndrome
- Streptococcus pneumoniae
- Syphilis
- Syphilis, congenital
- Tetanus
- Toxic-shock syndrome (other than Streptococcal)
- Trichinellosis (Trichinosis)
- Tuberculosis
- Tularemia
- Typhoid fever
- Vancomycin
- Varicella (morbidity)
- Varicella (deaths only)
- Vibriosis
- Yellow fever

Communicable diseases constitute a large portion of the CDC's notifiable conditions. Notifiable conditions reporting impacts the health of citizens throughout the United States, for it provides valuable data that are used by local, state, and federal public health departments to assess health trends, identify outbreaks, and predict potential epidemics [10]. When a clinician, laboratory or care facility becomes aware of a notifiable condition, it is their legal responsibility to notify their local public health agency. The legal requirements for reporting vary between states. State law determines which diseases are considered reportable, how soon they must be reported, and the mechanism for information exchange. Local public health jurisdictions are responsible for reporting notifiable conditions to state public health departments, which in turn deliver this data in aggregate form to federal public health agencies[14]. In Figure 2, a simplified depiction of data transfer across these agencies is provided. Laboratories report results directly to clinical practices. If a laboratory also identifies the presence of a notifiable condition, they also report to the local public health agency in their area. The state also relies on this data to monitor and evaluate the health status of individuals in that state [14]. The information is then used to make decisions about how state resources for health interventions will be distributed. Outbreaks of communicable disease readily cross geographical and political boundaries, yet it is state-level health agencies that determine the specific reporting requirements for LHJs in each state. The development of interoperable information systems promises to promote data sharing across state and regional borders during disease outbreak, which will improve information sharing and coordination between public health organizations. By improving these qualities of disease surveillance, it is hoped that the health impact of disease outbreaks will be reduced through more timely and useful information access [15-18]. Assuring that the systems to manage these data are supportive of the tasks performed by public health professionals will optimize the utilization of health-related data in public health decision-making practices.

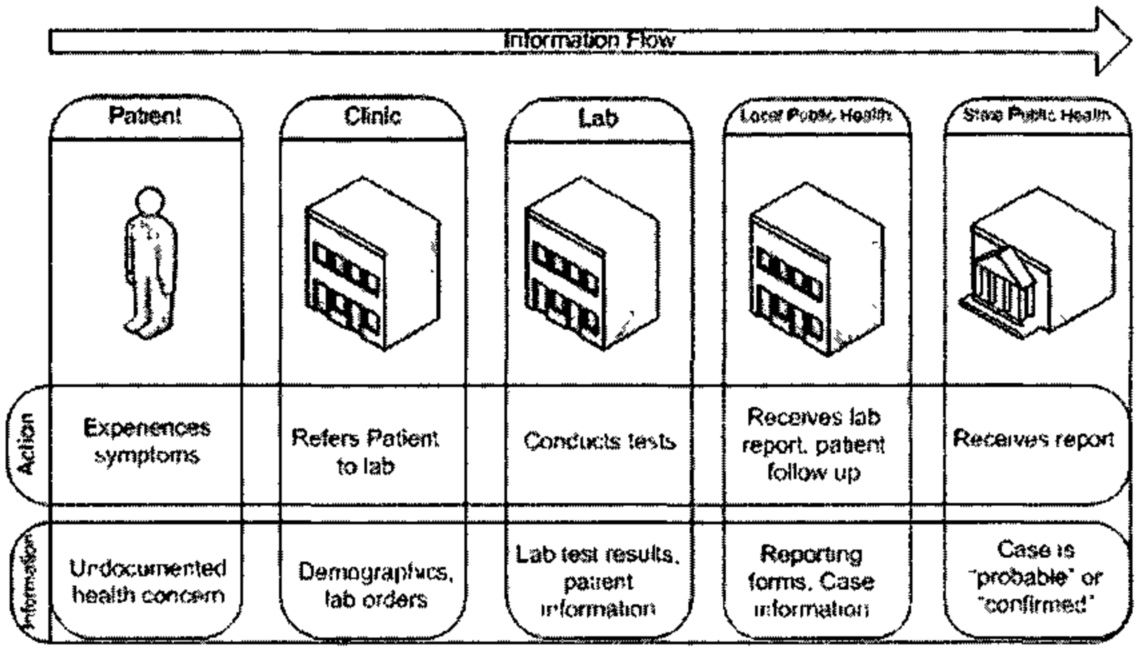


Figure 2 - Information flow of communicable disease from Patient to State

A common phrase among public health administrators is "If you know one public health department, you know *one* public health department" [19]. While the statement is meant to convey a light-hearted recognition of the differences in work practices across public health jurisdictions, LHJs often work with autonomy, shaping their work to address the health concerns of the communities they serve. Consequently, individual LHJs, even in the same state, carry out different work practices and have varying priorities. Within an individual LHJ, communicable disease work is carried out by employees with a broad range of skills. The job roles within and across communicable disease sections vary as well. Table 2 displays the job roles published by Public Health – Seattle & King County's (PHSKC) Communicable Disease, Epidemiology and Immunization Section (CDEIS) [20] and Los Angeles County's Acute Communicable Disease Control Program [21]. Each of these groups is located within a local large municipal public health agency, and they rank 14th and 1st respectively in national population size[22]. Many job roles between the counties are similar. Some job roles, such as "Research Analyst," exist in only one of the counties. Several additional job roles appear to exist in Los Angeles County. This may be due to variation in organizational structure (these additional roles may exist outside of PHSCK's CDEIS) or to the variation in size between the two groups. While the differences in professional roles are discoverable through published, publicly available information, other facets of local public health practice remain unexplored. The differences in notifiable conditions information management work practices across LHJs is one example. Knowledge of the differences and similarities across LHJs will provide important information for numerous stakeholders involved in information management of notifiable conditions, including system designers and public health decision makers.

Table 2 - Job roles in two large municipal public health agencies [20-21]

Job roles in PHSKC Communicable Disease, Epidemiology and Immunization Section[20]	Job roles in LA County's Acute Communicable Disease Control Program [21]
Administrative Specialist II Administrative Specialist III Administrative Specialist IV Chief, Communicable Disease Control Epidemiologist I Epidemiologist II Health Services Administrator I Health Services Supervisor Medical Epidemiologist Program Manager III Project/Program Manager III Public Health Nurse	Administrative Assistant II Administrative Assistant III Assistant Staff Analyst, Health Asst Program Specialist, PHN Biowatch Jurisdictional Coordinator Chief Epidemiologist Chief Physician II Chief, Acute Communicable Disease Control Program Director, Communicable Disease Control Programs EIS Officer, MD Epidemiologist Epidemiology Analyst Epidemiology Intelligence Analyst Health Education Asst Health Educator Information Systems Analyst Aid Information Systems Analyst I Information Systems Analyst II Intermediate Typist Clerk Medical Stenographer Medical Technologist, Data Systems Physician Specialist, MD Physician Specialist, MD Program Specialist, PHN Public Health Nurse Research Analyst I Research Analyst II Research Analyst III Secretary II Secretary III Senior Health Educator Senior Information Systems Analyst Senior Medical Stenographer Senior Network Systems Administrator Senior Physician, MD Senior Secretary IV Senior Staff Analyst, Health Senior Typist Clerk Student Professional Worker

Local public health jurisdictions attempt to solve a growing number of health problems with limited financial resources. While the range of notifiable conditions that LHJs are responsible for is limited, new and emerging health conditions must be monitored and addressed. LHJs are responsible for adhering to state and federal regulations, and they are simultaneously responsible to the communities that they serve. Within these local communities there is often minimal public awareness of the many activities that take place at public health offices.

Each year the CDC's National Notifiable Diseases Surveillance System (NNDSS) publishes a list of nationally reportable notifiable conditions. Since 1992, the number of notifiable conditions has risen from 60 to 100. As this trend continues, the public health work associated with notifiable conditions information management will continue to grow as well [23], as shown in Figure 3.

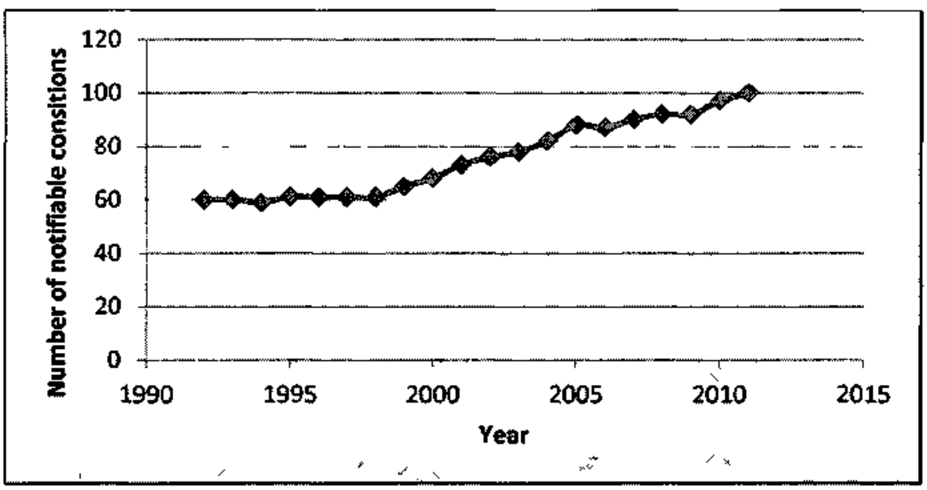


Figure 3 - Nationally notifiable conditions from 1992 to 2011[23]

Recently, a trend in automated health surveillance and data analysis has emerged. Using data from notifiable conditions reports, clinical data, and a variety of other sources, public health practitioners at several levels are aiming to identify emerging health problems before they have significant population health impact. This practice is known as "syndromic surveillance." Syndromic surveillance "uses health-related data that precede diagnosis and signal a sufficient probability of a case or an outbreak to warrant further public health response [24]." There is a strong focus on syndromic surveillance in the research activities of public health informaticians [15, 25-28]. However, the novelty of new technology applications currently overshadows the need to first focus on basic public health activities and their optimal execution. LaPelle and authors have found that many information needs in public health practice, and specifically in communicable disease control, are not being met [29]. Revere and authors have also found barriers to information access for public health practitioners [30]. Identifying the use of information systems in public health practice can increase awareness of the information needs that public health practitioners share. Twose and authors documented the use of data searching tools by public health practitioners, finding that information resources were dispersed in a manner that constrained the use information resources [31].

The information needs of local public health practitioners are often inadequately supported by information systems. To that end, notifiable conditions reporting systems have yet to become a focal point of public health informatics research, although there is a growing commercial market for this type of information system.

Across the U.S., several design efforts have taken place to develop information systems for public health surveillance and disease reporting [18, 24, 28, 32-36]. However, there is an absence of research that describes the use of notifiable conditions information systems in practice. The best methods for identifying solutions to the challenges of disease reporting and management at the local public health level have not been extensively explored. The aim of this research is to provide future information system designers and informaticians with knowledge that will inform the next wave of notifiable conditions information management systems.

In the next section, we review literature related to notifiable conditions reporting at the local, state, and federal levels. We also explore research related to the evaluation of health information systems. We explore this research to contextualize our efforts to identify the uses of information systems in local public health, and to develop an information system evaluation strategy for local public health practice.

1.4.1 Related Research – Reporting systems, national initiatives, and workflow analysis

Current literature suggests that there is a clear need to improve the notifiable conditions reporting process throughout the United States. Notifiable conditions reporting in the U.S. is considered incomplete and untimely [27-28]. Abdool and authors found that physicians view reporting as unimportant. Reasons for the underreporting of notifiable conditions include a lack of feedback from public health groups, a dearth of information about the mechanism and appropriate conditions to report, and physicians' frustration that reporting forms are complicated [29]. Lack of time and sufficient motivation have also been found to be factors associated with underreporting by physicians [30]. The adoption of electronic and automated reporting tools is expected to improve this situation. [2, 17, 31-33] One of Silk's recommended strategies for improving the completeness of notifiable conditions reporting is to increase the use of electronic reporting tools [31]. Other studies also support the positive impact of electronic reporting systems in other public health settings.

The notifiable conditions reporting process is expedited when electronic reporting tools are used. In 1999, Effler and authors conducted a study to measure laboratory reporting data submitted from three statewide clinical laboratories. By comparing reports from electronic reporting systems and conventional reporting methods, the authors found that the electronic reports arrived earlier to their destinations, were sent more regularly, and had less missing data. The estimated completeness of coverage for electronic reporting systems in this study was found to be to be 80%, as opposed to 38% for the conventional systems. This study showed that electronic reporting systems can increase the frequency, timeliness, and completeness of laboratory reporting [18]. Laboratory reports are one of many inputs local public health agencies accept to identify notifiable conditions.

In 1999, Roush and authors conducted a survey of state and local public health organizations to learn more about notifiable conditions reporting throughout the United States. The response rate was 100% from U.S. states. At this time, 58 diseases were recommended for national reporting. National reporting, in this context, describes the process of state and local public health agencies sharing notifiable conditions data with federal public health agencies. Analysis of the survey revealed that 35 of the 58 conditions (60%) were reportable by 90% of the states. The study found significant variability of the reporting requirements in different states. This suggests that while federal efforts attempt to harmonize state-level reporting to promote consistency throughout the U.S., these initiatives may be insufficient to incentivize state governments to adopt standardized reporting practices [14].

In September of 2000, federal funding was offered to provide public health organizations throughout the U.S. to increase their notifiable conditions reporting capacity. Five years later, in April of 2006, 27 state health departments were using online notifiable conditions reporting systems in some capacity. At that time, 23 other states were actively planning the design and implementation of such systems [1, 37]. Many clinical and public health laboratory facilities also use electronic reporting to fulfill their reporting requirements [18, 38]. Online reporting is rapidly being adopted as the preferred reporting method for multiple public health stakeholders.

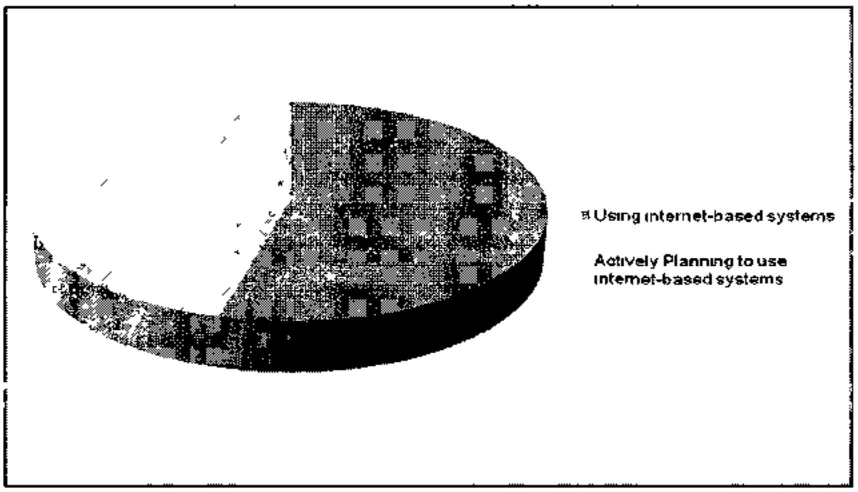


Figure 4 - States' usage of internet-based reporting systems in 2006[37]

There are several national initiatives that aim to create interoperability among public health jurisdictions throughout the United States. The Public Health Information Network (PHIN) has created standards for compliancy that aim to assure interoperability between state and federal public health jurisdictions, and to support preparedness efforts at the local public health level [39, 40]. The National Health Information Infrastructure (NHIN) is a federal initiative that has assigned several organizations with the task of developing use cases to demonstrate the feasibility of developing a national health information infrastructure. One component of this infrastructure will be the ability of public health organizations to adopt electronic reporting methods [40].

In 2001, the CDC developed the National Electronic Disease Surveillance System (NEDSS). This initiative was originally implemented as a series of web-based and local applications designed to accommodate new data standards for clinical and public health information, as set forth by the CDC [41]. A recent survey assessment by the Council of for State and Territorial Epidemiologists (CSTE) found that 68% of state public health departments are currently using NEDSS systems combined with other state and/or commercially available systems to meet their surveillance needs. This report also noted a lack of functional outbreak management systems at the state level, with only 4 of 50 states reporting the presence and use of a functional outbreak management system [42]. Outbreak management systems allow public health practitioners to manage data during the "initial characterization, investigation, response, and containment of an outbreak [35]." Local public health agencies do not necessarily follow state recommendations when selecting information technology or data transfer standards. Local public health jurisdictions were not surveyed in this assessment, and minimal knowledge can be inferred about their information management strategies.

In 2002, Burke and authors conducted a survey to catalog the information technology available to local public health departments across the United States. The stated goals of this survey were:

- To determine what information technology is being used in U.S. local health departments.

- To determine how end users (professional staff members in local health departments) rate the software they use.

- To determine the perceived information technology needs of local health department staff members

Of the 3,131 questionnaires distributed, 344 responses were collected, yielding a response rate of 11.1%. This low response rate, the authors point out, is common when participants are contacted via mail, and without prior contact from the investigators. The survey identified that products from the Microsoft Office Suite, including Microsoft Word, Microsoft Excel, and Microsoft Access were the most commonly reported software tools in use. Respondents ranked improved computer hardware and new software amongst the most needed information technology improvements. This survey did not differentiate between tasks that users may use information systems for, nor did it distinguish between the types of units within a local public health agency [43].

In 2005, Doyle and authors developed the Public Health Surveillance Knowledgebase (PHSKb) to promote the identification of notifiable conditions within clinical environments. Based on the Protégé platform, the system was designed to integrate with clinical information systems to assist in the automation of disease reporting [44]. The system offers an ontology of notifiable conditions and related information, potentially providing assistance to care providers to adhere to reporting regulations. Unfortunately, there is no current data on the use of PHSKb in clinical environments.

The Public Health Informatics Institute (PHII) produced a report in 2006 describing the business processes of local public health jurisdictions throughout the U.S. The Institute trained public health professionals to examine their business processes and report back to a working group, where their findings were consolidated and turned into generalizable context diagrams[45]. The final report describes a series of commonalities among local public health departments. Notifiable conditions reporting is among the many business processes that public health organizations take part in, but the specific tasks for reporting were not documented. The report demonstrates the potential to identify recurrent activities across a broad spectrum of local public health agencies.

There is increasing recognition of the need to identify the commonalities and differences in local public health work [46] [47]. Recent research has bolstered the body of literature related to local public health workflow and tasks. In 2008, Turner and authors documented the workflow of communicable disease activities at Kitsap County, a small county in Washington State. The authors used qualitative analysis methods to document the county's workflow related to notifiable conditions reporting, and subsequently offered recommendations about designing notifiable conditions reporting systems for this environment [48]. Making a further case for exploring the tasks and work practices of local public health practitioners, in 2009 Merrill and authors developed a taxonomy of public health work by extracting key terms through public health document review. Their findings were validated with experts and public health practitioners. The taxonomy presents tasks, knowledge, and resources that are relevant to public health practice. The taxonomy includes the task "Report data to the county or state," which recognizes notifiable conditions reporting as an essential task of local public health practice. Merrill and authors found that the task "Report data" was one of the top-ten tasks reported by local public health practitioners [49].

The value of documenting and describing local public health work has been recognized in order to integrate standards into local public health practice, and to improve the usefulness of information management systems in this context. Notifiable conditions reporting plays an important role in local public health practice, and requires the use of information systems to manage data and to report cases in a timely fashion. Little work has been done to explore the use of information systems in local public health practice, and the work conducted through the use of information systems for notifiable conditions reporting is similarly undocumented. Our work in Aims 1 and 2 focuses on documenting these activities in local public health practice.

1.4.2 Related Research – system evaluation in local public health jurisdictions

Managers of information technology at public health organizations are often called upon to make decisions about the usefulness of new software to carry out public health activities. This requirement reflects the continuous development of new software and the need to assure that the business goals of a public health organization are supported with helpful informational tools. Ideally, managers would be called upon to select new software when it stands to provide a tangible benefit over the existing software. These pre-system and post-system conditions are referred to as "current-state" and "desired-state" by Huamer and authors [50]. As state and national efforts produce new data standards and information systems, the motivation to adopt new software at the local public health level may be based on the need for standardization across multiple public health entities, and not on the needs of an individual organization. In these cases, the impact of adopting a new system may not be clear to either group. In these cases, there is a conflict of organizational priority. Local public health agencies must adopt information systems that support their work activities. In contrast, the organizations responsible for broader public health data analysis (such as state and federal agencies) must prioritize the promotion of standardized data collection. There are several constraints that LHJs may face which make adopting new information systems challenging. For example, LHJs may not always be able to implement a new system for testing purposes. In describing the challenges of evaluating information systems for use in public health practice, Lewis notes that "...the complexity of the evaluation task increases, in most instances, by virtue of the fact that systems implemented in field settings cannot be evaluated by use of traditional experimental methods [51] ." The presence of this challenge in the context of notifiable conditions information systems implementation lead to the development of an evaluation toolkit to assist LHJs in evaluating notifiable conditions information systems, the product of Aim 3 of this dissertation.

There is limited peer-reviewed literature that directly addresses the evaluation of notifiable conditions reporting systems for local public health jurisdictions directly.

Research has been completed on the evaluation of surveillance systems for public health, but many studies focus on the evaluation of the entire surveillance process, not specifically on the information systems used in surveillance.

There are two often-cited published strategies for evaluating public health surveillance systems, one by Thacker and authors, and a more recent one produced and published by the CDC. Each framework for evaluation suggests that it is beneficial to make use of qualitative and quantitative methods [52], [53]. Neither of these evaluation strategies specifically addresses the need to assess the work practices of public health practitioners engaged in the management of notifiable conditions data. Current (and potentially critical) work practices may not be protected in the changeover to a new system for notifiable conditions information management, even when one of the aforementioned evaluation strategies is applied. As new federal public health initiatives create the opportunity for local public health jurisdictions to adopt electronic notifiable conditions reporting systems, there will be an increased need for a lightweight comparative evaluation strategy. The CDC's evaluation guidelines for surveillance systems focus on syndromic surveillance systems, and not on the information systems used for reporting notifiable conditions [2, 7, 52-55].

The Public Health Informatics Institute (PHII) developed a framework for the evaluation of information systems based on available literature in 2005. By describing the specific metrics related to the use of an information system, this evaluation framework presents the opportunity for future research incorporate their model in other evaluations [56].

There are many approaches that can be used to promote the successful adoption and development of information systems. Task analysis has been used to assist in the adoption of healthcare information systems in clinical environments, providing useful information about the potential adoption of new systems [57]. The method is commonly used in evaluation exercises for information systems and computer-based interfaces [58]. Scenarios of use are described as short narratives that describe a work situation, or an instance in which a piece of software will support the goals of a user. Scenarios are commonly used in software design settings to convey user-centric information across multiple stakeholders.[59, 60]. Carroll asserts that scenarios are useful for promoting "work-oriented communication between stakeholders" [60]. In 1998, Haumer and authors proposed the use of rich media to develop scenarios of use for requirements gathering, and for comparing the current-state and future-state of an information system[50]. The authors' data collection strategy took place in an environment where it was possible to create video recordings of user activity. This strategy is useful to account for work where visual imagery alone can be reviewed to determine work practices.

The task-technology fit is a model for assessing the usefulness of an information system, originally proposed by Goodhue [61-63]. This model provides a framework for aligning information systems with user needs by measuring eight specific factors. This theory requires that the proposed system is implemented for the measurement of performance factors and to assess usability. While this method is useful for environments which permit its use, evaluation of notifiable conditions reporting systems may need to take place prior to implementing an information system.

Overall, evaluation studies in local public health have not focused on notifiable conditions information systems, or methods for evaluating them. Where a body of research and literature describes methods and theoretical frameworks that may support this evaluation task, specific research exploring the evaluation of notifiable conditions reporting systems in local public health does not yet exist. The research we conduct throughout this dissertation attempts to address this gap in the research, and also provide local public health practitioners with an evaluation strategy designed to meet the challenge of new information system adoption.

Chapter 2

Aim 1: "To understand the tasks that an information system must support to manage notifiable conditions data in a local public health department."

2.1 Background and Setting

There are nearly 3,000 local public health jurisdictions (LHJs) in the United States[64]. Of those, 23% serve over 100,000 population members. Santerre and authors conducted a study on the spending habits of LHJs according to the size of the jurisdiction's population and found that 77% of LHJs in a nationally representative sample served less than 100,000 population members [65]. This places large municipal public health agencies in the minority across the United States. Washington State, the most Northwestern state in the U.S. [66], is comprised of 39 counties, which contain 35 local public health jurisdictions. The site of the Aim 1 investigation -- Public Health - Seattle & King County (PHSKC) -- serves approximately 1.8 million residents, including those in the Seattle, Washington metropolitan area as well as residents in King County [66]. As the largest local public health jurisdiction in Washington State, PHSKC is also the 10^{th} largest public health jurisdiction in the United States when measured by the size of the served population. In a 2009 population estimate King County ranked the 14^{th} largest county in the United States [22].

The Communicable Disease Epidemiology and Immunization Section (CDEIS) of PHSCK consists of public health practitioners with various training backgrounds, and includes physicians, epidemiologists, public health nurses, case investigators, and administrative staff. CDEIS serves many functions related to communicable disease management. As the central hub of communicable disease and notifiable conditions information processing in King County, CDEIS process approximately 6,000 cases of communicable disease yearly. To meet the challenge of processing this high case volume, the section uses an information system developed and supported internally by software developers from PHSKC. The system is referred to locally as the Communicable Disease Database (CDD). Public health practitioners in CDEIS use the system for a variety of functions, ranging from data entry and retrieval to analysis and reporting.

The CDD was has been periodically redesigned on new software platforms as licenses and development resources became available. As an internally developed information system, the CDD reflects the needs and usage patterns of public health practice in the Seattle Metro region, as well as the work practices and individual talents of the workers in CDEIS. During the time of this study, the system was implemented using Microsoft's SQL Server 2003 database platform and a user interface designed with Microsoft's Visual Basic. The user interface provides a data entry and retrieval portal for individual cases of communicable disease, as well as basic report generation. To execute more complicated queries, users can access the content of the CDD using Microsoft Access installed on their workstations. Once Access has been use to generate a query, the data can be exported to a more robust statistical software suite for additional analysis. By integrating common tools from the Microsoft Office Suite, users of the CDD can approach their work using multiple information management strategies.

The objective of Aim 1 was to observe and document local public health activities related to the use of information management systems, with a specific emphasis on communicable disease and notifiable conditions reporting. With its diverse range of activities, an independently-developed information system, and a history of service to the region, PHSKC's CDEIS provided an ideal location for this type of study. The CDD system at PHSKC reflects a decade-long effort to meet the information management needs of a local public health agency. Observation of this system in use may therefore provide valuable (and potentially generalizable) information for system designers in the future.

2.1.1 Preliminary Work

Prior to commencing Aim 1, the primary investigator met the management and staff at the CDEIS offices through faculty at the University of Washington. As part of a class assignment, the investigator conducted a brief assessment of the CDD using the CDC's model for surveillance system evaluation [52]. It was through this brief assessment that the investigator became familiar with the environment, individuals, and work practices of CDEIS. It is within this context that the concept for this portion of research was identified, and all work described at CDEIS was conducted in partnership with CDEIS management and staff.

2.2 Methods – Aim 1

The methods selected for this investigation reflect the nature of the information we aimed to collect, and the environment where data collection took place. Aim 1 was executed using multiple investigative research techniques (see Figure 5), focusing on the collection and analysis of qualitative data. Participants were initially interviewed to assess basic information management tasks and job roles using a semi-structured interview. Task data were collected through participant observation with an emphasis on information system usage, analyzed using qualitative document content analysis, and subsequently used to develop task descriptions. The tasks identified through this process were verified for accuracy by conducting a focus group with the participant population.

Figure 5 - The primary steps in Aim 1

Participant observation is a qualitative research data collection method wherein the investigator(s) spends time observing research study participants in their environment, often engaging in the activity of study. Participant observation has been used in other information system studies to evaluate environmental factors that contribute to successful information system adoption [67]. In this study, data were collected through observation while being physically present in participants' working environment. To minimize the burden on the working environment, and to avoid any violations of privacy regulation related to the treatment of health information, the investigator did not directly take part in work activities.

Task analysis, as its name suggests, is the investigation of the completion of a task. Go and authors note that: "Task analysis is appropriate for producing a precise, correct description by analyzing the current use of an existing technology [68]." The use of the method has been widely recognized in the field of human-computer interaction and associated literature [1, 57, 58, 68-71]. There are many variations of task analysis, including hierarchical task analysis, the GOMS method (Goals, Operators, Methods, Selection Rules), and scenario-based task analysis. Task analysis provides valuable information for different purposes, including requirements gathering, error detection, systems design, and interface design [69]. The task analysis methods listed above can provide a significant level of detail about a single task. When applying task analysis, researchers must determine how much detail about an activity needs to be captured. In their public health research, the Public Health Informatics Institute refers to this concept as "granularity [45]." Diaper and authors refer to the same concept as levels of "abstraction [69]." In Diaper's text, Limourg suggests that "granularity varies according to the purpose of the analysis [72]." The level of abstraction we selected for this task analysis reflects the amount of available knowledge about the activity we are exploring. Considering the paucity of literature that describes the tasks associated with the use of information systems in notifiable conditions information management, we chose to explore tasks at a high level of abstraction. Our goal was to produce a broad and complete description of notifiable conditions information management work at CDEIS.

To accomplish this, we applied the first four steps in the task-centered system design methodology recommended by Greenberg [73] to identify recurrent tasks associated with notifiable conditions and communicable disease information management and reporting. We chose to apply only the first four steps of Greenberg's recommendations based on the goal of our investigation. Continuing with Greenberg's additional steps would have resulted in identifying user requirements for a new information system, which was not our goal.

Task-centered system design (TCSD) is a user-centered design methodology originally proposed by Lewis and Rieman in 1993 [74]. At its core, TCSD uses task analysis to document users of a system and their work activities, with the goal of eventually identifying information system requirements. In 2004, Greenberg reworked this methodology, providing detailed steps to apply it to human-computer interaction studies[73]. To achieve our goal of identifying and documenting tasks that local public health practitioners engage in while they manage notifiable conditions, we applied the first four steps in Greenberg's description of TCSD, which are:

1. Identification (of the users)
2. Discovering the tasks that users do

3. Develop good task descriptions
4. Validating the tasks[73]

Data collection for this investigation took place in the office space of CDEIS in Seattle, Washington. Through attendance at regular operational meetings, the primary investigator was introduced to the section's staff members. In these meetings participants were informed of the purpose of the investigation and the nature of the data collection process. Data collection lasted approximately nine months and 11 CDEIS employees volunteered to take part in the research. Participants were identified with the help of the chief medical epidemiologist in the section, who assisted in identifying employees who perform information management tasks using the CDD. The job roles of these employees included: administrative staff, case investigators, epidemiologists, public health nurses, and epidemiologic response coordinators. Participants were first approached about their individual participation in the study via email contact. If the participant agreed to take part in the research, a meeting was arranged, and participants were informed of the study protocol, which had been approved by the University of Washington's Institutional Review Board. Participants received a verbal description of the study and their rights as participants. Written consent was obtained from participants before the investigation proceeded, and participants were supplied with a copy of the consent form.

Each observation began with a brief semi-structured interview that was modified by the investigator to match the work of the participant. For example, if the participant was involved in a case investigation of communicable disease, questions related to case investigation of communicable disease were selected from the list of semi-structured interview questions. This initial semi-structured interview also included questions regarding the participant's job role and elicited a description of each participant's use of the CDD.

Following this brief interview, the observational portion of the investigation began. Observation took place during regular work hours while participants conducted work-related activities. The investigator sat with the participant in his or her cubicle, and the participant's computer screen was visible to the investigator. As the participant conducted his or her regular work activities, the investigator took hand-written trigger notes on a password-protected tablet PC. Trigger notes are brief notes collected during data collection and are then reviewed. The decision to collect trigger notes was based on the nature of the data collection process. The majority of data was collected through visual inspection of the participant's activities. This method lends itself better to trigger note collection than to more traditional methods of ethnographic data collection that rely on recording and transcribing interviews. De-identified examples of the trigger notes we collected are shown in Figure 7. Another possible method of data collection for this stage of the research would have been video recording the workers' computer screens for analysis at a later date. Videotaping has been effectively used for the analysis of information system usage in other settings[50]. This method was not selected for this study because video recordings would display on-screen activity, which only constitutes a portion of the information management activity at CDEIS. In addition, privacy concerns contraindicate the use of video recording in a local public health agency, where individuals' health information is regularly the focus of work-related activities.

Observation sessions lasted an average of two hours. At the end of each observation session the investigator reviewed trigger notes for clarity and de-identified the data by assigning a number to each participant. A key linking the participant to the trigger notes was kept on a secured server, which was stored separately from the location of the notes.

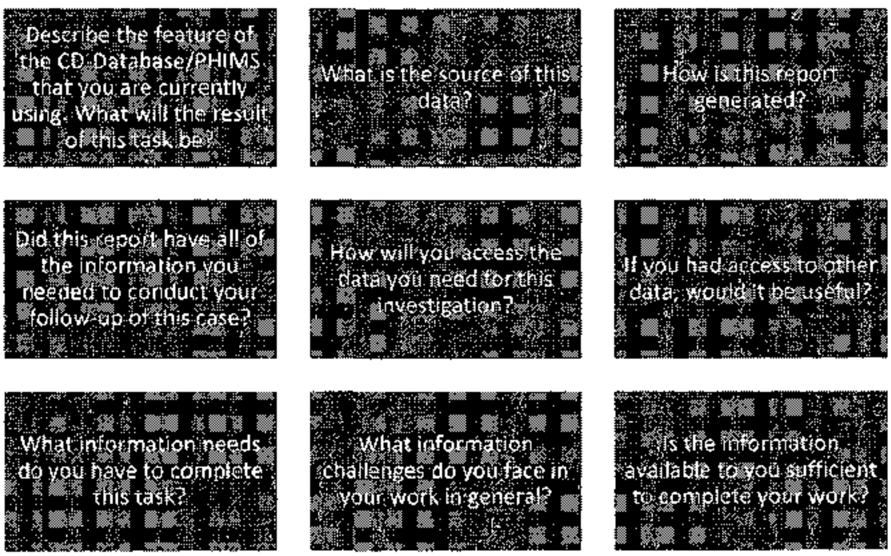


Figure 6 - Example questions asked in the initial semi-structured interview with observation participants

When the investigator believed that data saturation had been reached, eleven participants had taken part in observational analysis. Manifest content identification for this data was found through an iterative review process. We determined saturation based on prior iterations of coding. Once no new tasks at a similar abstraction level surfaced throughout manifest content analysis, we stopped collecting new data. At least one participant from each job role involved in notifiable conditions information management was observed, based on the job roles identified through initial discussions with CDEIS management. Three participants were observed multiple times to capture their broad range of activities. In total, 82 pages of trigger notes were collected, describing the activities of participants as the investigator observed them.

We applied task analysis in this investigation to identify and document the tasks associated with the use of a notifiable conditions information management system within a large municipal local public health agency. To accomplish this, data (in this case, field notes taken during observation) were analyzed to identify manifest content. Berg describes manifest content as an element physically present within the content under analysis[75]. Manifest content can be referred to and located within documentation, and counted if necessary. Manifest content exists in contrast to latent content, which represents the analysts' interpretation of the content.

Qualitative document content analysis was applied to the data with the goal of identifying enacted work (and thereby tasks) documented within the trigger notes collected during observation sessions. We analyzed the data by identifying recurring activities documented in the trigger notes. Through this process, also referred to as thematic analysis, we identified meaning units that described tasks at the abstraction level we had previously selected. The trigger notes from each observation were reviewed three times. The first review was to assess overall meaning and clarity of the notes. In the second review, we underlined potential meaning units relevant to our search for tasks. In the third and final review, which took place toward the end of the investigation, we reread the trigger notes to again look for additional tasks. Throughout this process, a list of potential tasks was maintained. The task list presented in the following results section is the result of our final iteration. Figure 7 provides an example of our manifest content identification process in this investigation.

Example of Manifest Content Identification:

Below are selected trigger notes from three different observations:

"Looks up a case's name, find him in the DB – lname into lname field – find button – finds case"

"Enters name in lname – finds case – verifies BD – updates case"

"Checks last name to see if it's a dupe – it isn't – new case begins"

These three meaning units above contributed to the identification of the following task in the task list:

"Identify a Case or Individual in the Electronic Record"

While the task above has been identified by objective observation, the overarching goal of the task is inferred from knowledge of the notifiable conditions reporting process at PHSKC and of the expressed desire of the participant to avoid entering duplicate records. Thus, the goal the above task is associated with was determined to be:

"Assure that each case is in the electronic record is unique"

Figure 7 - Example of manifest content identification

The manifest content identified in this investigation represents an individual investigator's review of observed work activities. To triangulate this information with the realities of local public health practice, and with the particular group of workers that were observed, a focus group was held to elicit participant feedback on our interpretation of data. This form of member-checking provided feedback on the results, and also produced additional data about the working environment. The focus group was lead by the primary investigator, with a colleague from the University of Washington present to take additional notes. The group consisted of a public health nurse, a case investigator, a member of the administrative staff, and two epidemiologists. This purposive sample of participants included individuals representing each job role that was part of the initial observation study. All focus group members were participants in the initial observation portion of the study, and each indicated a willingness to be contacted again for additional participation following their observation time in the initial informed consent process. The focus group meeting was held at the offices of CDEIS in an available conference room. The goal of the focus group meeting was threefold:

1) To determine the level of completeness of tasks identified through observation according to the participants of the study

2) To create a clear description of the information management cycle of a notifiable conditions case

3) To situate the tasks identified through observation within the information management cycle of notifiable conditions cases.

Prior to the focus group meeting, participants were provided with a copy of the identified tasks and task descriptions. In the meeting they were presented with the same information in paper format. The meeting began with a discussion of this documentation. The primary investigator of the project, who moderated the meeting, guided participants to verbally identify the individuals or group of individuals that would execute each of the tasks, conducting the discussion in a roundtable format. The configuration of this meeting encouraged group discussion, and participants explained who in the department would be responsible for completing each task on the list. Participants were able to do this without "leading" or suggestion from the investigators.

In the next portion of the focus group meeting, participants were guided through a discussion of the management lifecycle of a notifiable conditions case. Using a whiteboard to visually represent the each step, participants were asked to describe the process of managing the information associated with a single, patient-centered case of communicable disease, beginning with initial reporting to CDEIS. Participants described the process for the management of case information, the series of decisions and steps that followed the information related to a notifiable conditions case. The data collected during this step was transcribed from the whiteboard to a workflow diagram.

With the new visualization of the information management lifecycle as a reference, participants were asked to describe a point in the lifecycle where each task identified in the participant observation took place. This exercise served two purposes: (1) It provided a new visual representation of the information management lifecycle of communicable disease within a local public health agency; and (2) It provided an additional form of member-checking.

The meeting concluded with a discussion about completeness of the task list. Participants were asked if there were any tasks that they accomplished with the CDD that were not included in the task list.

2.3 Results – Aim 1

The following results are based on the collection and analysis of 82 pages of trigger notes collected during observation at PHSKC. Results were generated following the qualitative data analysis process and focus group meeting described above. The Task List displays the tasks we identified during our observations. Each task includes a description of the task, written according to Greenberg's recommendations for writing good task descriptions [73].

Task List - Tasks conducted at the CDEIS using the CDD

1. Create new electronic records
2. Assign a case to a staff member
3. Assess case status
4. Maintain/update electronic records
5. Maintain paper records
6. Identify a case or individual in the electronic record
7. Harmonize paper records with electronic records
8. Use the electronic record during patient contact and data collection
9. Data cleaning
10. On-the-fly analysis of disease or trend
11. Review comments for relevant epidemiologic information
12. Create queries
13. Re-use a pre-made query/report
14. Edit a pre-made query/report
15. Export data for analysis with a statistical program
16. Use system to fill out state reporting forms
17. Create new data repositories for disease-specific investigation

Tasks Descriptions

Below are descriptions of each task identified through the observation of users at CDEIS. Participants that were observed held the following job titles: Administrative Staff, Case Investigator, Epidemiologist, Public Health Nurses, and Epidemiologic Response Coordinator. Table 3 shows each job roles' association with the tasks.

Task 1: Create new electronic records

New electronic records are created based on the identification of a new case by staff members of the group, if found not to exist previously in the database. Information about new cases is received through mailings, faxes, and phone calls from providers and laboratories. Staff aim to accurately enter the case in a timely fashion.

Task 2: Assign a case to a staff member

Cases are assigned to staff members within CDEIS according to a protocol that assures that they are attended to by the correct staff member. The CDD allows this assignment to be electronically recorded. Employees may view the cases that they are responsible for using a query or report.

Task 3: Assess case status

Once a new case has a record in the CDD, the amount of time required to "close" or "complete" it varies depending on the amount of time the case requires attention from the public health agency. To assure that cases are attended to in an appropriate amount of time, staff at the CDEIS routinely reviews cases that are "open" to assess their status, verify needed actions, and plan and execute the appropriate steps.

Task 4: Maintain/update electronic records

Electronic records are maintained by updating information about a case within the CDD. Data sources for these updates include data from paper reports, information that is collected over the phone, and information submitted from providers and laboratories. The ability to maintain electronic records rests on the proper execution of some other tasks, such as identifying patients in the electronic records.

Task 5: Maintain/update paper records

The CDEIS Section maintains a paper record of all recorded cases, while simultaneously maintaining an electronic record of the case. Paper records are used within the office as repositories of information that are physically passed from one staff member to the next. As the case is initiated, followed, and eventually closed, several staff members will make use of the paper record. In addition to documents received from associated organizations (including providers, clinics, laboratories and hospitals), paper records include material created by staff when initiating a case. To maintain accurate information about a case, the paper records are updated by printing out new "face sheets," which are paper printouts with information about a disease investigation, when case information has been updated in the CDD. Case investigation at PHSKC is currently bound to the creation and maintenance of paper records, so the CDD's ability to produce the desired reports is essential given the current case investigation processes.

Task 6: Identify a case or individual in the electronic record

When updates, edits, or status changes to a case are required, staff members at CDEIS must be able to quickly identify the appropriate case for a specific individual. While an identification number may be used to identify cases, staff members of CDEIS also search for case records by the subject's last name or other identifying data. This task takes place prior to the creation of any new case record to assure that the individuals do not have duplicate records in the system.

Task 7: Harmonizing paper records with electronic records

Information in the CDD must match its paper counterpart. Depending on the medium used to originally record that information, staff must assure that each record (paper records and electronic records) contain no conflicting information, and that each version of the record is as complete as possible.

Task 8: Use the electronic record during patient contact and data collection

The CDD is used to record new data when staff members are on the phone with patients. Having the contact's electronic record open during a phone call allows staff members to review the case and ask about details to move the case toward closure. The CDD is also used to access patient contact information while following up on cases during phone conversations with patients.

Task 9: Data cleaning

Epidemiologists at CDEIS are responsible for producing annual reports that reflect the trends of disease in the community. Prior to producing these reports, data is cleaned by identifying and correcting data entry errors and resolving inconsistent information. The CDD allows epidemiologists to view and edit the data as needed for data cleaning.

Task 10: On-the-fly analysis of disease or trend

Occasionally, staff members in CDEIS need a quick overview of a disease trend. In addition to queries that produce discrete reports about specific cases, staff members at CDEIS use queries to quickly assess health trends within the community. The year-to-date (YTD) reports are used in this manner. This task is also referred to as "eyeballing" data.

Task 11: Review comments for relevant epidemiologic information

Comments fields in the CDD are used to store potentially useful information about a case when there is no formal field for the data being collected. These fields contain unstructured text that is relevant to the record. Comments fields are used in analysis as a source of information beyond structured fields in a record.

Task 12: Create queries

Reports that have been created previously are regularly reused to review summative information about conditions throughout the community, and new queries are also created to allow more specific data views than a report may offer. Staff created queries to produce specific data views as needed.

Task 13: Re-use a pre-made query/report

Many data retrieval activities recur on a regular basis. Staff members in the CDEIS Section regularly review the same report with the most recent data. Reports can be modified if necessary to display more specific information.

Task 14: Edit a pre-made query/report

Flexible query editing allows staff members to view data in the most useful manner possible. Using Microsoft Access as the primary query builder/editor, staff members in the CDEIS Section are able to arrange data based on any attribute they find helpful. They are also able to add fields to a previously made query if needed.

Task 15: Export data for analysis with a statistical program

Data must be available for analysis once it has been collected, organized, and retrieved. During our observations, data stored in the CDD was regularly exported and analyzed in a separate program, such as Microsoft Excel.

Task 16: Use CDD to fill out state reporting forms

Staff members in the CDEIS Section use the CDD to collect information for completing state forms. By completing state forms during a disease investigation, users are assured that the correct information for state-level reporting is acquired. State reporting requirements are occasionally updated, making form completion a useful tool in adhering to state reporting regulations. This practice applies to conditions that include Pertussis, *Campylobacter*, and animal bite forms.

Task 17: Create new data repositories for disease-specific investigation

Staff members in the CDEIS Section make use of separate database tables that have been created for the investigation of an individual disease. In the event of an outbreak, separate MS Access databases are created for investigation. These databases may be linked to the CDD if necessary. Creating new data repositories on a small scale allows staff to quickly and easily manipulate outbreak investigation data in unique ways. Investigations of this type often require staff to link novel data elements together to identify patterns or trends in the spread of a disease.

Focus Group Meeting Results

During the focus group meeting, participants discussed the task list and descriptions. Participants were able to identify one or more staff members that execute each task in the list, naming the individual both by job role as well as specific individuals. Task descriptions were also reviewed and found to be complete. By identifying individuals in their working environment who executed the tasks in our task list, users validated the accuracy of the list. Brief discussions of possible additions to the task list and task descriptions were resolved with the recognition that many work activities could be described as a subtask of one or more tasks already included in the task list.

Through a facilitated group discussion, participants provided information about the lifecycle of a notifiable conditions case. Beginning at the point where users are made aware of the potential case, through the decisions required to move the case forward, and finally to the end of the information management lifecycle, participants in the focus group meeting shared their knowledge of information management in their environment. Tasks and decisions were first mocked up on a whiteboard, and then the information was written out as a task flow diagram. Finally, users were asked to identify steps in the task flow diagram that included the steps identified in our task list. Going down the list sequentially, users describe when in the information management cycle a task was likely to occur. All of the tasks were mapped to a task flow diagram, providing additional validation that the tasks were accurate and complete according to the participants of the study. The task flow diagram in Figure 8 shows these results

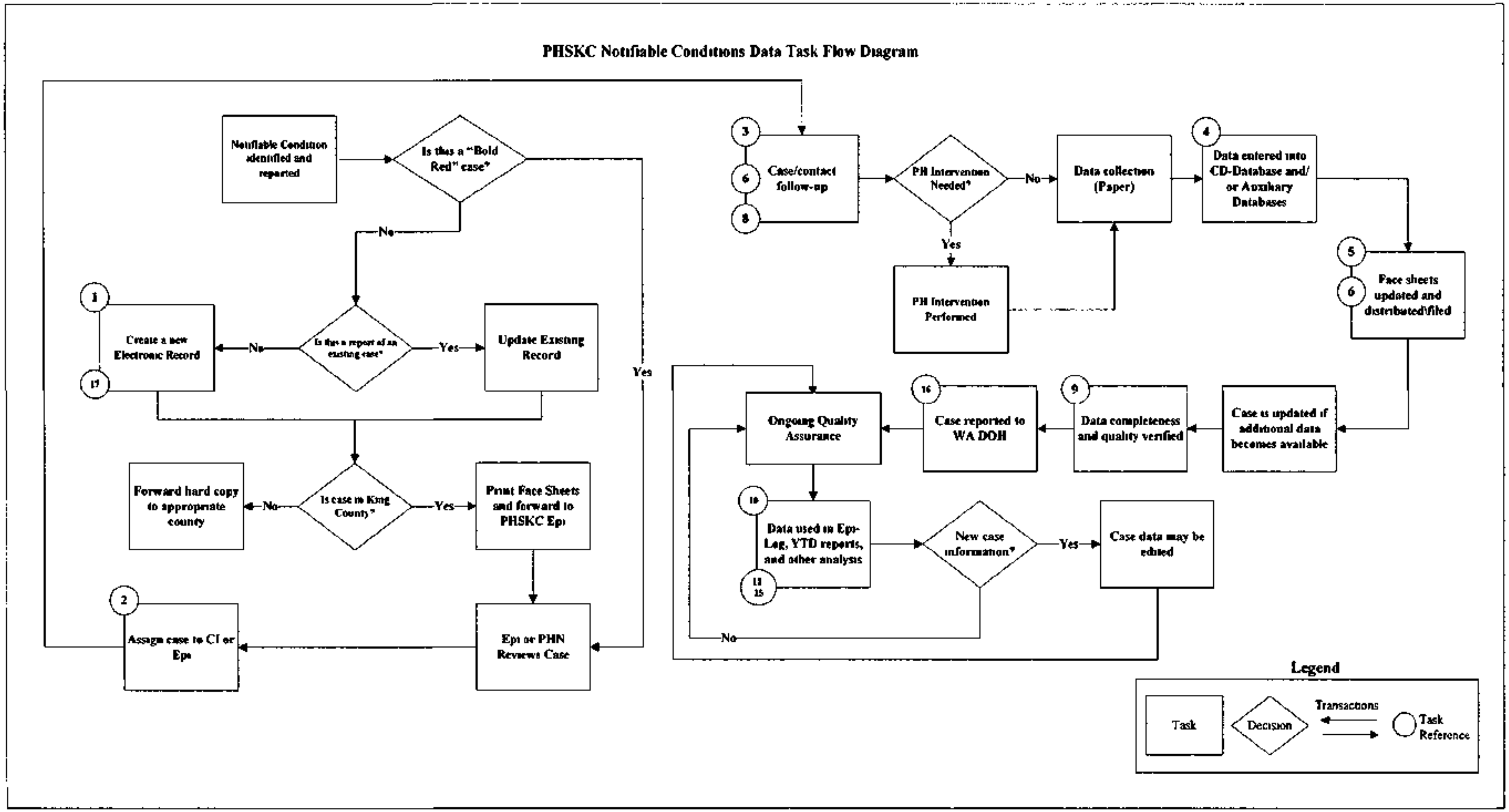


Figure 8 - Task flow diagram of notifiable conditions information [1]

2.4 Limitations

This initial investigation of a single local public health department took place over a nine-month period. Prior research of public health practice suggests that the tasks identified in this investigation may be generalizable to a broad population of local public health agencies, but further investigation is necessary to assess this. This study is limited to one environment and one information system; executing the same research methods in a different environment may produce dramatically different results. It is also possible that the specific information system that was the focus of analysis in this investigation may place constraints on the work of its users. A system with additional features may have allowed more, or different, tasks to be executed. This would have resulted in a different task list. Our findings are temporal, and may have limited value in the future. It is likely that the use of information systems at PHSKC will change as new health challenges emerge. This investigation was completed by a single investigator, with the exception of the focus group meeting where an additional colleague assisted in note-taking during the meeting. This provided consistency in observations and data collection. However, the qualitative data analysis process is subject to the limitations and biases of the individual researcher. To mitigate the potential for this type of bias, we validated the task list, task descriptions, and developed a context diagram with mapped tasks in a focus group meeting. Participants created the context diagram during the meeting. By seeking input their into their own work processes, and then verifying that the tasks in our task list each had a place in the context diagram, we showed that our findings aligned with the work of staff at CDEIS. By triangulating our findings with participants of the study through the focus group meeting, we aimed to eliminate potential bias.

This investigation was completed with the overarching goal of conducting high-quality research while minimizing the impact of the study on the work activities of public health practitioners. The methods used were selected for their potential for accurate data collection as well as their low impact on the work environment. Alternative methods may have provided more resolution in our findings, but were ultimately excluded because they would have required more disruption of work activities.

Table 3 - A crosswalk of tasks and job roles at CDEIS

Task	Administrative Staff	Case Investigator	Epidemiologist	Public Health Nurse	Epi. Response Coordinator
1. Create new electronic records	x	x	x	x	x
2. Assign a case to a staff member	x	x	x	x	x
3. Assess case status	x	x	x	x	x
4. Maintain\update electronic records	x	x	x	x	x
5. Maintain paper records	x	x	x	x	x
6. Identify a case or individual in the electronic record	x	x	x	x	x
7. Harmonizing paper records with electronic records	x	x	x	x	x
8. Use the electronic record during patient contact and data collection	x	x	x	x	x
9. Data cleaning	x		x	x	x
10. On-the-fly analysis of disease or trend			x	x	x
11. Review comments to determine potential causes of disease		x	x	x	x
12. Create queries	x	x	x		x
13. Re-use a pre-made query/report	x	x	x	x	x
14. Edit a pre-made query/report		x	x		x
15. Export data for analysis with a statistical program		x	x		
16. Use CDD to fill out state reporting forms	x	x	x	x	x
17. Create new data repositories for disease-specific investigation			x	x	x

2.5 Discussion

The results of this investigation provide insight into the information management strategies of local public health practitioners in a large, local, municipal public health setting. The CDEIS makes use of a hybrid information system, incorporating a paper-based record-keeping system and an electronic database into their information management strategy. Throughout our observations, we noted the recurrent use of the paper record as a primary tool for data collection within the daily activities of the group. Two of the seventeen tasks we identified involve the use of a paper-based information system, despite the presence of an electronic system. As state and federal efforts aim to improve the speed and reliability of notifiable conditions reporting the identification of hybrid systems in use is an important step toward improving the overall process of disease reporting. Systems designers may benefit from knowing why paper systems are still preferred, even when an electronic information system is available. PHSKC, and the CDEIS, are the largest groups of their kind in Washington State. These groups likely benefit from having more staff, more available resources, and a more robust information technology support infrastructure than other LHJs in the state. If hybrid systems are used in this environment, the same may be true throughout the state. Further research to identify the frequency of hybrid information systems may help to reveal the prevalence of this type of information system strategy, and the manner in which paper-based information systems are used within the local public health context. We explored these questions using survey research, and described our findings in the following chapter of this dissertation.

The paucity of literature investigating the use of information systems for communicable disease reporting and information management in local public health practice provided the inspiration for this qualitative study. However, the investigation also had a local, applied purpose for its execution, which was to provide CDEIS with information about the undocumented uses of the CDD. With this information, the group can make informed decisions about the required features of future information systems.

The CDD is a growing, dynamically used, flexible information system which has been re-developed in newer generations of software over a ten-year period. Its inherently flexible platform (Microsoft Access/SQL/Visual Basic) enables users to access and manipulate the data within the system in many different ways, allowing them to conduct data analysis according to the needs of the group.

This flexibility also allows this system to be used in novel and undocumented ways. Over time, the use of the system shifts as the work of the group adapts to new health concerns in the population. These adaptations also occur in response to higher case volume, a natural effect of the growing population of a major city. To adapt to changing health concerns, new information management practices are formed without necessarily changing the tools with which they are executed. For example, the original developers of the system may not have envisioned the need for the creation of new data repositories to manage a specific outbreak (Task 17). The original system does not have features which facilitate this practice. However, users of the system found it necessary to create these smaller disease-specific data repositories, and forged a path to accomplish this task despite the system's lack of native support for this type of activity.

Other examples of such "work-around" activities are present in the data. For example, the data cleaning efforts of the section are necessary, in part, because the CDD does not allow users to create data input rules in the data entry forms used by staff. Therefore, occasionally erroneous and\or contraindicating data becomes present in the database, and one of the staff's epidemiologists must manually correct it before moving forward with data analysis. If it were possible for staff to create input logic that would eliminate these errors, this step might be minimized or become altogether unnecessary.

The findings from this investigation were used in multiple instances in the applied work of CDEIS following our analysis. Decision-makers at CDEIS used the task list from this investigation when they were considering the purchase of a new information system to manage their notifiable conditions information. It was used to develop a set of heuristics that could be used to compare and evaluate commercially available systems, and provided an updated assessment of the information management tasks of the CDEIS. Our findings were also used in interactions with officials from the Washington State Department of Health assist CDEIS in communicating their information system needs. As Washington aims to improve its online notifiable conditions reporting tools, awareness of the activities of its local public health practitioners may provide valuable insight into system design.

The primary aim of the investigation-- to identify the tasks associated with the use of an information system in a large, municipal local public health agency during communicable disease reporting and notifiable conditions information management-- produced a set of task descriptions that can be carried forward in future research as a resource validated by local public health practitioners. In the development of future information systems for notifiable conditions information management, developers may benefit from reviewing the findings of this investigation. By understanding the usage of current information systems, it may be possible to improve the design of information systems that support local public health practitioners. Task analysis was an effective tool in identifying the use of information systems at CDEIS. Further investigation into the practicality of applying task analysis in other local public health environments may be warranted.

Additional research may carry forward the findings from this investigation to identify any consistencies in notifiable conditions information system usage in local public health agencies. This may contribute to the generalizability of the task list as representative of the larger population of local public health agencies.

Chapter 3

Aim 2: "To characterize the use of information systems for notifiable conditions across a broad spectrum of local public health jurisdictions."

3.1 Background and Setting

The state of Washington is the most northwestern state in the contiguous United States, and is populated by 6,753,369 million residents according to 2010 U.S. Census. The Census Bureau also reports that the population of the state increased by 14.1% between 2000 and 2010 [76]. Washington contains 39 counties and 35 local public health jurisdictions. Two LHJs in Washington serve more than one county, explaining the difference between the number of counties and the number of LHJs. Demographic data from the U.S. Census Bureau, which will contain county-level population data from the 2010 census, was not available at the time of this analysis [76, 77]. Therefore we have used demographic data from the most recent available census data, the 2000 Census, for analyses requiring county-level population data [66].

The Washington State Department of Health (WADOH) is the state's central hub of public health activity. All local public health agencies in Washington report notifiable conditions to WADOH using a state-developed information system named the "Public Health Issue Management System," (PHIMS)[32]. The reporting system uses password and digital certificate authentication to allow local public health workers to create and submit reports of notifiable conditions cases to the state department of health through a web-based, online reporting tool. In 2008, Washington mandated that all LHJs must submit notifiable conditions reports using the PHIMS system. The system is maintained by WADOH's Office of Informatics. The Communicable Disease Epidemiology Section works closely with the informatics team to collect and analyze data related to notifiable conditions[78].

Recognizing that the data collected during Aim 2 of the investigation may have utility in WADOH's work, and particularly in the work of the Office of Informatics and the Communicable Disease Epidemiology Section, the primary investigator collaborated with staff at WADOH throughout the execution of Aim 2. The individuals most active in this collaboration serve in the following professional roles at WADOH: Assistant Secretary, Director of Communicable Disease Epidemiology, Local Health Liaison for WADOH, and Program Manager - Epidemiology Preparedness and Response.

The qualitative research executed during Aim 1 provided insight into the use of notifiable conditions information management systems in a large municipal public health agency. We identified the primary tasks associated with a flexible information system, thereby allowing us to describe the work taking place within an individual local public health agency to manage communicable disease. However, large municipal local public health agencies such as the one examined in Aim 1 account for only a small portion of the local public health agencies within Washington. In 2004, Suen and authors conducted a nationwide assessment of the performance of local public health agencies across the United States. Using national population data, the authors divided local public health agencies into three size categories based on the size of the population that each LHJ served. The authors stratified LHJs according to the following thresholds:

Small LHJ: 50,000 citizens or less

Medium LHJ: Between 50,000 and 250,000 citizens

Large LHJ: 250,001 or more citizens [79]

When stratified according to the same thresholds, Washington is comprised of 20 small counties, 14 medium counties, and five large counties according to data from the 2000 United States Census [22]. Figure 9 shows the distribution of county size by population in Washington.

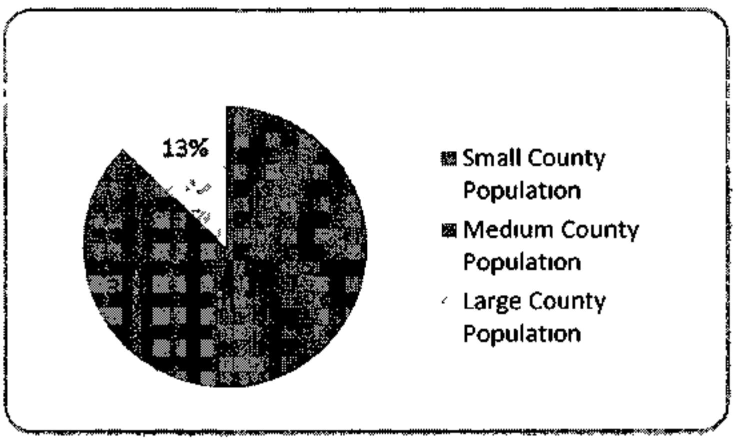


Figure 9 - Percentages of Washington counties in three categories of population size from the 2000 Census[66]

In 2003, Lee and authors used survey research to evaluate the information needs of public health practitioners throughout Tennessee. In their investigation, the authors stratified public health jurisdictions by "Urban" and "Rural" categories, allowing them to make comparisons between jurisdictions. Lee and authors used guidelines established by the state of Tennessee to assess whether each public health jurisdiction as "Urban" or "Rural" [80]. Washington similarly publishes guidelines for using urban-rural classifications in public health research throughout the State. This information is published by WADOH [81]. However, experts at WADOH no longer recommend using the urban-rural classification, stating that "DOH recommends using the 'Metropolitan,' 'Micropolitan' and 'Outside Core-Based Statistical Area' classifications used by the U.S. Office of Management and Budget (OMB) for county-level classification [81]. To align with Washington's current recommendation for county-level classification, we have incorporated the OMB's guideline for stratification of counties in Washington in some of our analyses. We have used the classification that Suen and authors followed for small, medium, and large county populations for the majority of this study, to allow future researchers to make comparisons between our findings and those from other national-level studies, such as those by Suen and authors.

Only a small minority of counties within Washington (13%) have a population large enough to be considered a large county. To increase the generalizability of the findings from Aim 1, the research executed in Aim 2 explores the information management work of LHJs across Washington using survey research and statistical data analysis. Prior studies suggest that LHJs adjust their practices and performance depending on the size of the populations that they serve [65, 79]. To further understand the commonalities and differences in notifiable conditions information management across multiple LHJs, we queried all LHJs in Washington about their information management practices, and their use of information systems.

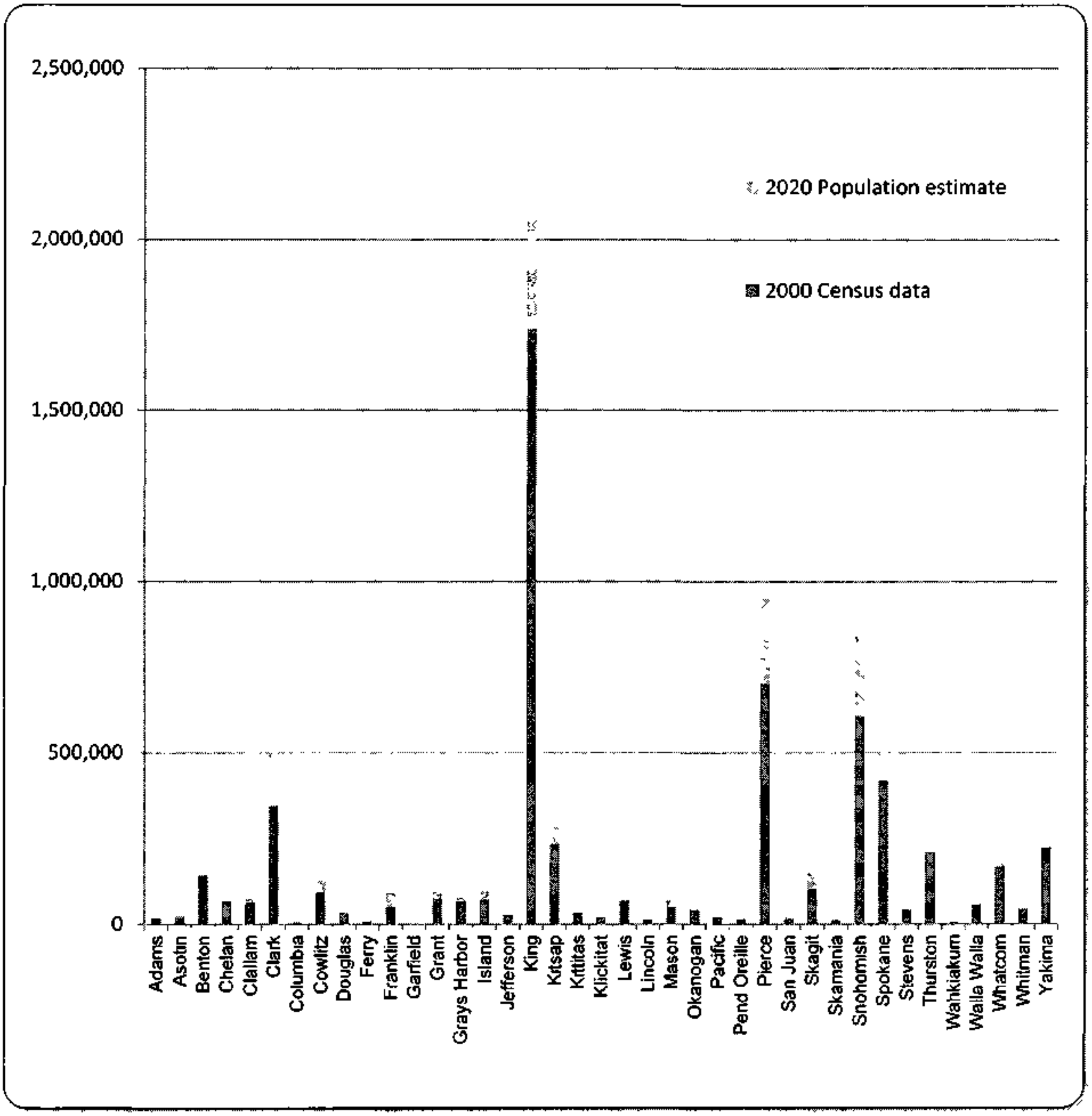


Figure 10 - Histogram comparing responding Washington county populations – 2000 Census and 2020 estimated population [82]

By analyzing the data collected in Aim 1, we produced a list of tasks associated with data management within the communicable disease sections of a large municipal local public health agency[1]. In Aim 2, the same data and task list was used to develop a survey, which was distributed to every local public health agency in Washington. Describing the similarities and differences in the notifiable conditions reporting activities of multiple LHJs across an entire state provides useful information for the future standardization of notifiable conditions reporting currently promoted through federal initiatives. It also serves to place the findings from Aim 1 in the broader context of communicable disease information management in multiple LHJs. As national and state-level efforts aim to standardize communicable disease reporting processes, identifying the variations in information management practices across LHJs will provide insight into the development of information systems for notifiable conditions that can be implemented by LHJs of varying size.

3.2 Methods

3.2.1 Semi-structured interviews with smaller LHJs

Aim 1 focused on the work taking place in PHSKC's CDEIS, which is a large, municipal local public health agency. PHSKC is an anomaly in Washington. With a population of approximately 1.7 million residents, the county has more than twice the number of residents of the next most populous jurisdiction, Pierce County, which has approximately 701,000 residents[83]. In order to develop a questionnaire that accounted for the notifiable conditions information management work taking place in smaller LHJ environments, we conducted semi-structured interviews with communicable disease investigators working in less-populated LHJs. The interviews were conducted with communicable disease investigators in their working environment, and each interview sought to collect data about the use of information systems in the management of notifiable conditions. The semi-structured interview questions were designed to stimulate discussion about notifiable conditions information management in the participant's environment. This information was used to further refine the survey. Semi-structured interviews were conducted during the same meeting with the same participants as pilot testing of the survey.

3.2.2 Development of survey questions

The overarching goal of the survey was to answer the following questions: Are there differences in the way LHJs across Washington use information systems to manage notifiable conditions information? If so, can the differences be attributed to any particular qualities of the organization, such as the size of the jurisdiction's population? To develop a questionnaire that explores these questions, we re-analyzed the data from Aim 1 according to Berg's method for the identification of manifest content in qualitative documents, as described in Chapter 2 [75]. The re-analysis sought to identify the broader goals of information management tasks that took place at PHSKC, as opposed to specific tasks. Tasks represent observable actions that can be documented through observation. Goals are more generalizable than tasks, and are not inherently linked to any particular action in the workplace. This distinction is made by Annett in the author's description of hierarchical task analysis, published in Diaper's textbook "The Handbook of Task Analysis for Human-Computer Interaction[69, 84]". To assure an acceptable level of external validity throughout the questionnaire, we developed goal-focused questions grounded in qualitative research, which has been validated by members of the respondent population.

Figure 11 - Steps in data re-analysis for developing survey questions

Survey questions were based on the data from Aim 1 and were developed following recommendations in Rhea and Parker's text "Designing & Conducting Survey Research, A Comprehensive Guide [85]." Using Rhea and Parker's guidelines for phrasing questions, each question was reviewed to assure that:

- The level of wording for each question was appropriate for the intended audience.
- No ambiguous words or phrases were used
- Each question addressed only a single construct
- Questions were not leading or misinforming
- The responses for each question were complete
- The responses for each question were in the best format to attain the desired data

The survey included three sets of questions based on the task list from Aim 1. Each set focused on the use of different types of information systems LHJs in Washington might use. The three system types were paper-based systems, a state-supplied system for notifiable conditions reporting, and other electronic information systems, including those that were purchased from a vendor or developed within the LHJ. For each system type, nine questions based on the task list from Aim 1 were included. In addition to questions based on Aim 1 data, we also included questions about each LHJ's professional environment, seeking to clearly understand the working conditions, available information management tools, and protocols in place for notifiable conditions work.

3.2.3 Pilot Testing the Survey

Following Rea and Parker's recommendations for designing an effective questionnaire, we developed a survey pretest to assess three areas of the questionnaire: question clarity, question comprehensiveness, and question acceptability. Questionnaire clarity describes the ability of respondents to understand the questions. Questionnaire comprehensiveness describes the capacity of questions and answers to provide a sufficient range of alternatives so that all respondents can answer each question. Questionnaire acceptability describes the degree to which the questionnaire is possible to complete in the environment of the respondent. This final area of assessment can impact the length of the questionnaire as well as survey questions. [85]. Once the initial survey questions had been developed, the survey was pilot-tested with two local public health agencies. The LHJs selected for pilot testing were chosen based on the following inclusion criteria:

- The LHJ is within Washington
- The LHJ is not PHSKC
- One LHJ would be considered "small" based on its population size
- One LHJ would be considered "medium or large," and much smaller than PHSKC based on its population size.
- Individuals at the LHJ engaged in the collection and management of notifiable conditions information are available for pilot testing.

To identify potential participants to pilot test the survey, we collaborated with representatives at WADOH who interact regularly with LHJ staff. WADOH representatives connected us to individuals working in LHJs meeting our inclusion criteria. The LHJs identified in collaboration with WADOH were contacted by e-mail to discuss their participation in the pilot testing of the survey and the semi-structured interview. We scheduled a time and date to meet the individuals who agreed to participate at their office location. Prior to pilot-testing the survey and beginning the interview, informed consent was obtained from participants according to University of Washington's Institutional Review Board (IRB) requirements.

Following the acquisition of informed consent, we conducted semi-structured interviews with participants. The investigator asked questions from the interview guide to open discussion of the work environment. Responses were recorded using trigger notes collected on a password-protected laptop PC, to remain consistent with the data collection methods described in Aim 1. Once the semi-structured interview was completed, participants were given a paper-based copy of the survey and asked to complete it. During this time, the investigator left the room to reduce bias in completing the survey. Participants were timed as they completed the survey. Following the completion of the survey, participants were asked additional questions about the survey. Our questions were selected to assess the participant's experience with the survey and to identify question clarity, question comprehensiveness, and question acceptability.

3.2.4 Pilot test results

Pilot testing was executed with two local public health practitioners. Each practitioner worked in a different county in Washington. The two counties varied in their size, one fitting into the "small" category and one fitting into the "large" category, according to thresholds suggested by Suen [79]. Following the pilot tests, we made modifications to the final questionnaire to produce a more understandable and relevant survey for our survey population. Details on the modifications are presented below in the "Refining the Survey" section. Below, we present the findings from the pilot-test, arranged by Rhea's three suggested areas of pretest assessment [85]. We also present timing the information:

Questionnaire Acceptability

The survey was viewed as appropriate for the selected audience by pilot-test participants. It was clear to participants that the survey was written for local public health practitioners in Washington. Every LHJ in Washington has internet access, making distribution through an online tool appropriate for this population.

Questionnaire Clarity

Respondents reported that the questions were easy to understand. Participants were not confused by the wording or order of the questions. This is supported by our findings of the final survey's Flesch-Kinkaid readability score.

Questionnaire Comprehensiveness

The original survey questions were based on qualitative work that took place at Washington's largest county. Because the questions were designed based on data from a single large county, the original questionnaire did not provide a range of responses to questions that considered the varied work environments of local public health practitioners in Washington. It became clear through this process that additional responses, particularly those that considered the use of paper-based information systems, were needed in the questionnaire.

Timing:

Participants were timed while they completed the questionnaire. Each participant took less than 10 minutes to complete the questionnaire.

3.2.5 Refining the Survey

Using the data collected during the pilot study, recommendations from the literature, and feedback from colleagues at the University of Washington and WADOH, the survey was further refined. Question ordering and wording were the primary modifications. We added responses that were not originally included. For example, we added response options for LHJs that do not utilize an electronic information system to manage communicable disease data. Responses based on the sole use of paper information systems were included. The content area of the survey remained constant throughout the refinement process. While some additional questions were added, the additions served to bolster the initial aim of the survey rather than to collect data in new areas. With the survey questions finalized, we applied the Flesch-Kincaid Readability test to the survey to assess its readability. Once questions were modified, we implemented the survey using an online survey tool.

3.2.6 Measuring Readability

The Flesch-Kinkaid readability test was originally developed in 1948, and is now a common test applied to written materials in order to assess readability. The test uses word, syllable, and sentence counts in a formula to determine the level of readability [86]. Results from this test are commonly reported in terms of grade levels and education. In order to assess the readability of the survey, we applied the test to the text in the survey. All text was included in this process, including text in the introduction letter, informed consent notification, and question responses. We calculated a readability test score of 61.13, making the survey suitable for readers between 13 and 15 years of age.

Word Count	2,038
Syllable Count	3,299
Mean syllables per word	1.62
Mean characters per word	5.21
Sentences	235

$$206.867 - 1015\frac{2038}{235} - 84.6\frac{3299}{2038} = 61.13$$

Figure 12 - Readability calculation for questionnaire

3.2.7 Selecting Participants

The sampling frame for this portion of the study was every local public health jurisdiction that takes part in notifiable conditions reporting to the State of Washington's DOH. Specifically, we endeavored to elicit a survey response from one contact at each local public health agency in Washington State. The scope of the survey was limited to LHJs in Washington to maintain consistency with the original qualitative data from Aim 1, which is the foundation of the survey questionnaire.

In each LHJ, we identified an individual who is regularly responsible for the management of notifiable conditions information management. To identify these individuals for participation in the study, the Director of Communicable Disease Epidemiology for WADOH assisted by selecting individuals from each county who serve as disease investigators. By sharing her expertise and experience working with county-level public health practitioners in Washington State, the Director of Communicable Disease Epidemiology was able to assist us in identifying an employee in each county knowledgeable of the county's notifiable conditions information management practices. The information required to identify such potential participants is publicly available, and most LHJs have a website with staff listings. However, assistance of WADOH in participant selection made the process much faster, and also assured us that we were contacting the main point of contact for disease investigation in each county.

3.2.8 Survey Distribution and Data Collection

The online implementation and distribution strategy for the survey were executed following principles from the tailored design method described by Dillman in his text "Mail and Internet Surveys - The Tailored Design Method[87]." Tailored design focuses on survey development that creates respondent trust and a sense of reward for completing the survey. While implementing our survey questionnaire, these two values were strong considerations. To create respondent trust, an Assistant Secretary from WADOH sent an initial e-mail notification to LHJs describing the survey and WADOH's interest in the findings from the survey. By introducing the survey from a known and trusted individual, the perceived value of the survey among participants may have been increased. This letter is included in the appendix. We addressed participant reward in two ways as the survey was executed. First, we thanked participants for their participation in the study prior to their participation, and then after it. Participants were also rewarded with the promise of a summary of the findings from the survey following the analysis of survey data. This is described in the introductory letter and the final statement that participants see upon completion of the survey.

A key attribute of any survey is the mechanism used to deliver the questionnaire to the participant. We selected an online survey, based on several desirable attributes of this approach. In his text, Dillman describes some of the advantages of online surveys, which include: reduced cost when compared to mail-based surveys, reduced data entry times, and the ability to design the survey with advanced skip patterns. Skip patterns reduce completion time and make questions more relevant to the participant by avoiding questions which do not apply to them [87]. Research by Truell and authors has suggested that response rate and completeness are comparable between internet-based and mail surveys. In addition, the authors point out that in a survey population that is likely to have internet access and an e-mail account (such as an organization or company), response time may be faster[88]. In Washington, every public health employee that works with notifiable conditions has internet access and an e-mail account. Internet and e-mail access is a requirement for using the PHIMS systems. Therefore, selecting an online survey for this population was optimal.

The survey was developed using the University of Washington's web-based survey tool, Catalyst. Implementation in Catalyst facilitated the addition of response-dependant questioning, allowing us to develop a series of skip patterns. Using this feature, participants only see questions that are relevant to them based on their preceding answers. This eliminates unnecessary questions and reduces the amount of time necessary to complete the survey. Data quality was maintained by limiting availability of the online survey to only those individuals whom we contacted through the Catalyst system, a security feature available in Catalyst. Using this feature, a unique link to the online survey was sent to each potential participant's e-mail address, which assures that no duplicate entries are made. Once a participant has submitted their answers to the survey, the link cannot be used again.

Using the list of local public health disease investigators provided by the Director of Communicable Disease Epidemiology at WADOH, an e-mail list of each contact was generated. This list was used to send an e-mail with an introductory letter to each potential participant, describing the survey and inviting them to participate.

3.2.9 Statistical Analysis

Statistical analysis for these data were conducted using SPSS for statistical tests and Microsoft Excel for formatting tables. We calculated descriptive statistics for the majority of data, including frequencies, counts, ranges, and means. Differences in groups were identified using cross-tabulations of variables and likelihood-ratio tests, as well as Kruskal-Wallis tests. Pearson's Chi-Square test is used for evaluating relationships between sets of categorical data. Many of our questionnaire responses were categorical, making Pearson's Chi-Square an appropriate test. Pearson's Chi-Square test compares the observed responses to the expected distribution based on row and column marginals in contingency tables, and does not require an assumption of normally distributed data to be valid. However, Pearson's Chi-Square tests carry an assumption of minimum expected cell counts in a cross-tabulation table. In all of our calculations, this minimum expected cell count was not met. Therefore, we selected the use of likelihood-ratio tests, which SPSS calculates when executing Chi-square calculations [89], to assess difference between groups. Likelihood-ratio tests compare the fit of two models to a dataset, and describe how likely the data are to fit within each model. A p-value is also calculated with the likelihood-ratio statistic, making it useful to identify statistically significant difference between groups. When comparing data that involved more than two ordinal responses, we applied the Kruskal-Wallis test. This test for statistically significant difference assigns a rank to each level of ordinal data, and compares the median ranks of each category. The test does not require an assumption of normally distributed data. In our survey research, participants were not randomly selected, and the overall number of observations is too small to assume or approximate normality of the distribution of the data. Many of our results are visibly skewed when plotted on a histogram. Therefore, we selected tests which do not rely on assumptions of normally distributed data. We used the standard alpha of 0.05 or less to reject a null hypothesis.

Many of the questionnaire items in this investigation were based on qualitative research we conducted exploring the use an information system at PHSKC (Aim 1). Using these data, we developed nine survey items to identify the similarity of usage of information systems in local public health practices across Washington. The questionnaire included three sets of these survey items, applied to three types of information systems (paper systems, non-PHIMS electronic systems, and PHIMS). We applied hierarchical cluster analysis to these three sets of questionnaire items in order to help us visualize relationships between the questions, to see if they correlated with each other in meaningful ways. We applied a "nearest neighbor" clustering method and Euclidean distance interval measures, standardized by z-scores, to generate three dendrograms for our main question sets. These diagrams allowed us to review the responses to different items in relationship to each other, and to identify potential relationships the items have to one another, which we explore in the discussion section of this chapter.

We also calculated a Cronbach's Alpha value for the three sets of task-related items from the questionnaire. Each set contained nine items related to the use of an information system. In this case, Cronbach's alpha was used to determine the similarity of responses for each set of questions by type of information system. A high Cronbach's alpha (larger than 0.7) indicates a high level of similarity across question response, and is often used as a measure of internal consistency.

3.2.10 Data cleaning

The final data contained very few erroneous or missing responses. One data item was corrected when the response was clearly contradictory to other responses in the record. The respondent indicated that the LHJ had a separate communicable disease section, but then indicated that the communicable disease section contained no employees. We contacted the respondent to correct the response. Many variables were transformed from nominal to ordinal scale, according to a coding schema, to facilitate statistical testing within SPSS.

A number of respondents indicated serving in an environmental health role. We consolidated these responses into a job role that was not initially an option in the response list for this question: "Environmental Health Specialist."

3.3 Results

The following results are reported in the order of the survey's questionnaire. We have included some statistical analysis outputs following the summary of findings for each question. The remaining statistical output tables are listed in the appendix.

3.3.1 Response Rate

Of the 35 local public health jurisdictions in Washington that were asked to participate, 32 responded to the survey questionnaire; a response rate of 91.4%. The data collected contains responses from LHJs that collectively serve 99.05% of Washington residents.

The three non-responding counties collectively serve 55,866 of Washington's 5,894,141 residents; approximately 0.95% of the state's population.

3.3.2 Informed Consent

After being presented with informed consent information, 100% of respondents agreed to take part in the study, and 68.8% of participants agreed to be contacted for an additional follow-up by the investigator if necessary.

3.3.3 Job Roles

Respondent job roles included: public health nurse (53.1%), epidemiologist (18.8%), environmental health specialist (15.6%), case investigator (6.3%), clinic nurse (3.1%), and assessment coordinator (3.1%).

3.3.5 Communicable Disease (CD) Sections and CD Staff

Of LHJs in Washington, 53% reported having a separate communicable disease section. Across the three categories of population size, 100% of large LHJs, 64% of medium-sized LHJs, and 25% of small LHJs reported having a separate communicable disease section in their jurisdiction. A likelihood-ratio test identified a statistically significant difference in the responses of participants from Large, Medium, and Small LHJs (p=0.004). We also performed a likelihood-ratio test based on the same items from our questionnaire, but we stratified the LHJs according to Washington's recommended classification published by the U.S. OMB [81]. Stratifying LHJs with this classification, we found a likelihood-ratio p-value of 0.016, showing that there is also a statistically significant difference in the responses of participants when counties are classified into "Metropolitan," "Micropolitan" and "Outside Core-Based Statistical Area" categories.

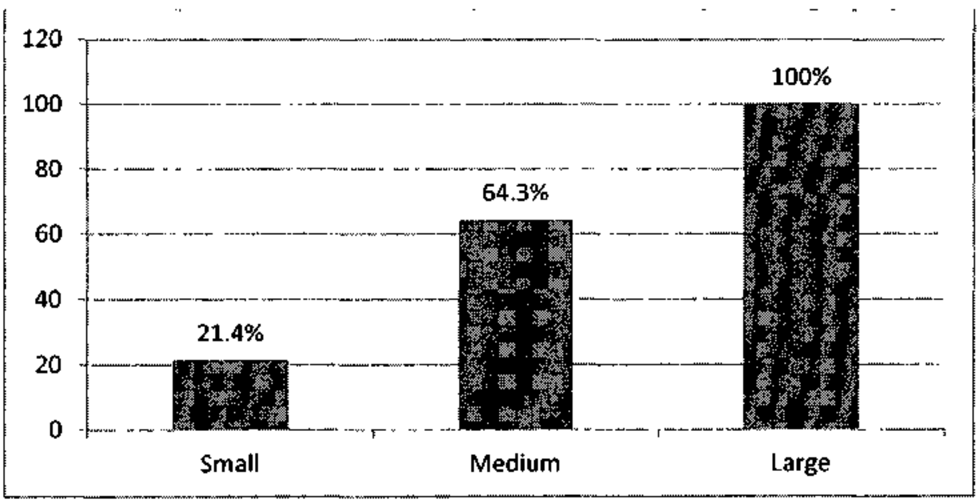


Figure 13 - Percentages of LHJs with a separate CD section - by LHJ size

Of those respondents who reported having a separate communicable disease (CD) section, the number of staff within CD sections ranged from a minimum of 1 to a maximum of 30, for a mean of 6.6 and a median of 5 CD Staff members per LHJ. The number of staff in these roles varied in range across the three different sizes of LHJs. Large LHJs had between 4 and 30 staff members in separate CD Sections, while medium LHJs had between 1 and 8, and small LHJs between had 2 and 6. Of the staff working within a separate communicable disease section, respondents reported a minimum of 1 staff member who directly manages notifiable conditions information, and a maximum of 7 staff members, with a mean number of 3.33, and a median of 3 staff members managing notifiable conditions information in LHJs with separate communicable disease sections. In this context, “managing” notifiable conditions information refers to activities associated with the collection, documentation, and retrieval of information related to cases of notifiable conditions.

We evaluated the number of staff within each of these groups. To assess whether there was a significant difference in the number of staff in the LHJs that have a separate CD section, by LHJ population size, we calculated p-value using the Kruksal Wallis test due to the non-normal distribution of the data. The result of this test was a p-value of 0.062, suggesting a trend toward significance. However, this value is not low enough to reject the null hypothesis that the number of staff in separate CD sections at LHJs does not correlate with the size of the LHJs population. This questionnaire item was measured as a continuous variable (the number of staff present in the CD Section), which suggests that a linear regression calculation is possible. However, the data for this item is highly skewed, as shown in Figure 14, and contains only one covariate. Linear regression does not require normally distributed data, but it would be necessary to use a logarithmic or square-root transformation of the population data to apply the test to this item. In this case, a correlation-type test is appropriate.

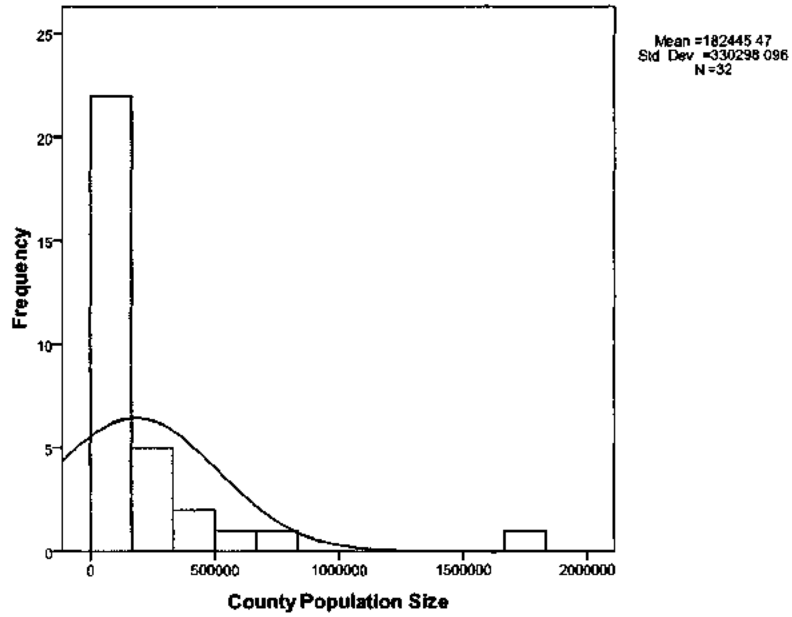


Figure 14 - Histogram showing skew of population data

To further explore the relationship between population size and the number CD staff members present at an LHJ, we calculated a Spearman rank correlation coefficient. This test measures difference based on a rank of observed data instead of the data itself, making it less sensitive to skewed data distributions. We calculated a Spearman R value of .618, indicating a positive relationship between population size of the county and the number of communicable disease staff members within a county. The p-value of this calculation is .006, suggesting that it is statistically significant.

Regardless of the presence or absence of a separate communicable disease section, respondents from all LHJ sizes reported having between 1 and 25 staff members in their entire jurisdiction managing notifiable conditions, with a mean of 4 staff members managing communicable disease within the entire LHJ. We found no significant difference in this item when we compared LHJs of different size.

3.3.6 Paper-based information systems

Paper-based information management systems for notifiable conditions were reported as present and in use in 71.9% of LHJs in Washington, although many of these groups also used the other types of information systems. Across LHJs of different size, these systems exist in 60% of large LHJs, in 71.4% of medium sized LHJs, and in 76.9% of small LHJs. While there is an observable trend in these data (small LHJs report somewhat more frequent use than medium or large groups), a likelihood-ratio test (p=0.780) showed no statistically significant difference between the LHJs of different size for this variable. This was also true when LHJs were categorized according to the U.S. OMB classifications (p=.751).

Goals and tasks in the use of paper-based information systems

The following results are from responses to questions to assess the use of paper-based information systems in LHJs. These questions are based on the task list that was developed in Aim 1. This question set was applied to Washington's three different system types (paper, PHIMS, and other). Responses for each item were listed as a reported frequency of the task or goal. Below we present the findings from LHJs reporting the use of a paper-based information system for local management of notifiable conditions. For example, participants were asked how often they use a paper-based information system to "record information on new cases or suspected cases." The response set asked for a report of frequency of use, including 4 options: Always, Often, Sometimes, and Never.

Internal consistency of questions regarding "Goals and tasks in the use of paper-based information systems"

We measured the internal consistency of this question set by calculating Cronbach's Alpha value using the data from the nine questions within the set. The resulting value was 0.725, suggesting an acceptable level of internal consistency across this portion of the questionnaire.

The tables below show the frequency of responses to nine questions about the use of paper-based information systems. The three tables display the responses divided into LHJ size.

Table 4 - Usage of paper-based systems

Large LHJs with a paper-based system

Use of System	n	Always	Often	Sometimes	Never
New Cases	3	100.0%			
Assess Case Status	3	66.7%		33.3%	
Update Cases	3	100.0%			
Assure Unique Cases	3	66.7%			33.3%
Access for Other System	3	100.0%			
Clean Data	3	66.7%	33.3%		
Retrieve Statistics	3		33.3%	66.7%	
Report to State	3	33.3%		33.3%	33.3%
New Data Repositories	3	33.3%		66.7%	

Medium LHJs with a paper-based system

Use of System	n	Always	Often	Sometimes	Never
New Cases	10	100.0%			
Assess Case Status	9	100.0%			
Update Cases	10	100.0%			
Assure Unique Cases	9	100.0%			
Access for Other System	10	100.0%			
Clean Data	10	20.0%	30.0%	30.0%	20.0%
Retrieve Statistics	10	10.0%	10.0%	50.0%	30.0%
Report to State	10	50.0%	10.0%		40.0%
New Data Repositories	9	22.2%	11.1%	44.4%	22.2%

Small LHJs with a paper-based system

Use of System	n	Always	Often	Sometimes	Never
New Cases	10	70.0%	20.0%	10.0%	
Assess Case Status	10	40.0%	40.0%	10.0%	10.0%
Update Cases	10	20.0%	70.0%	10.0%	
Assure Unique Cases	10	20.0%	40.0%	20.0%	20.0%
Access for Other System	10	40.0%	30.0%	20.0%	10.0%
Clean Data	10	30.0%	10.0%	50.0%	10.0%
Retrieve Statistics	10	10.0%		50.0%	40.0%
Report to State	10	20.0%	10.0%	10.0%	60.0%
New Data Repositories	10	10.0%	20.0%	50.0%	20.0%

A Kruskal-Wallis test applied to these data identified a significant difference in the responses of four questionnaire items across the three different sizes of LHJs. These values are highlighted in the table below.

Table 5 - Paper-based system measures of difference

System Use		Kruskal-Wallis p-value
New Cases		0.118
Assess Case Status		**0.031**
Update Cases		**0.001**
Assure Unique Cases		**0.006**
Access for Other System		**0.007**
Clean Data		0.227
Retrieve Statistics		0.431
Report to State		0.468
New Data Repositories		0.813

Other information systems

All LHJs in Washington have access to an online information system that was developed by the Washington State Department of Health in order to standardize notifiable conditions reporting across the state. Use of the web-based reporting tool, named the Public Health Issue Management System (PHIMS) was mandated by Washington in 2008 [32]. At this time, LHJs were required to submit notifiable conditions reports to WADOH using PHIMS. The management of data at LHJs for their own internal data management is not mandated by the WADOH. In addition to PHIMS, some LHJs use additional information systems to conduct their communicable disease and notifiable conditions information management. These "Other" systems may have been developed locally, purchased, or adopted from a freely available source. The findings presented below are based on questions from the "Other Systems" portion of the questionnaire.

Non-PHIMS information management systems for notifiable conditions were reported as present in 40.6% of LHJs. Across LHJs of different size, these systems exist in 100% of large LHJs, in 21.4% of medium sized LHJs, and in 38.5% of small LHJs. A likelihood-ratio p-value of 0.003 suggests a significant difference between LHJs of different size for this variable.

When we stratified counties according to OMB classifications, our analysis of this item showed no statistically significant difference in the presence of non-PHIMS information systems in “Metropolitan,” “Micropolitan” and “Outside Core-Based Statistical Area” counties. A likelihood-ratio p-value of 0.512 suggests no significant difference. In contrast, when we stratified the data by our original LHJ size categories, we found a significant difference. We suspect that this is due to the increased number of “Metropolitan” counties that exist in Washington when the OMB classification is used. Using the small, medium, and large classifications recommended by Suen and authors, only five counties are classified in the large category, and they all reported having an additional information system. This indicates that the presence of an additional information system is more dependent on the size of the county that the health jurisdiction serves rather than the environment of the county.

When asked to name these “other” information systems four respondents answered that Microsoft Excel was the name of their electronic information system. The other systems listed were NextGen, PowerChart, Insight, and Microsoft Access.

In response to the question, "Which of the following statements best describes why you use an electronic information system other than PHIMS? (Many selections may apply)" participants shared views on the use of an alternate electronic information system.

Of the 12 respondents who answered this question, four selected the option "PHIMS does not offer the tools I need." The remaining eight respondents selected "Other," naming individual reasons that they use a different information system. Four of these responses described legacy information systems in place for local data management, either because they provide functions PHIMS cannot (such as the option for temporary case investigators to enter and retrieve data), or because the jurisdiction mandates the use of another information system.

When asked about the development of the additional system, 75% of respondents from an LHJ where a non-PHIMS information system was present reported that the system was developed by their own jurisdiction, and 25% reported that the system was purchased from a vendor.

When asked "Did you or others from your section have the opportunity to work with developers or vendors as the system was created?" 55.6% of respondents from an LHJ where a non-PHIMS information system was present reported that they worked with developers and\or vendors on their local information management system.

When asked "In general, do you believe that public health practitioners would be willing to participate in the design of notifiable conditions information management systems?" 86.6% of respondents from an LHJ where a non-PHIMS information system was present reported "Yes," 7.7% reported "No," and 7.7% reported "I don't know."

63.6% of respondents from an LHJ where a non-PHIMS information system was present reported that that their local information system was developed on a previously existing software platform (such as Microsoft Access or Excel). 18.2% reported that the system was not developed on an existing platform, and 18.2% did not know.

In response to the question, "To the best of your ability, please describe the software platform the system was developed on," respondents described three platforms used for information system development. Microsoft Access and Microsoft Excel were the main tools used for system development. One respondent described the use of an existing platform in their jurisdiction, "NextGen," which was modified to use for notifiable conditions information management.

The tables below show the frequency of responses to nine questions about the use of non-PHIMS electronic information systems. The three tables display the responses divided into LHJ size. We calculated Kruskal-Wallis values for these responses and found no significant differences in the response set.

Table 6 - Usage of non-PHIMS systems

Large LHJs with a non-PHIMS information system

Use of System	n	Always	Often	Sometimes	Never
New Cases	4	75.0%	25.0%		
Assess Case Status	4	50.0%	25.0%		25.0%
Update Cases	4	50.0%	25.0%		25.0%
Assure Unique Cases	4	50.0%	25.0%		25.0%
Access for Other System	4	75.0%		25.0%	
Clean Data	4	25.0%	25.0%	25.0%	25.0%
Retrieve Statistics	4	50.0%		50.0%	
Report to State	4		25.0%		75.0%
New Data Repositories	4			75.0%	25.0%

Medium LHJs with a non-PHIMS information system

Use of System	n	Always	Often	Sometimes	Never
New Cases	2	50.0%	50.0%		
Assess Case Status	2	50.0%	50.0%		
Update Cases	2	50.0%	50.0%		
Assure Unique Cases	2	50.0%	50.0%		
Access for Other System	2	50.0%	50.0%		
Clean Data	2	50.0%	50.0%		
Retrieve Statistics	2	50.0%		50.0%	
Report to State	2		50.0%		50.0%
New Data Repositories	2			50.0%	50.0%

Small LHJs with a non-PHIMS information system

Use of System	n	Always	Often	Sometimes	Never
New Cases	5	20.0%	40.0%	20.0%	20.0%
Assess Case Status	4	25.0%	50.0%		25.0%
Update Cases	5	40.0%	40.0%	20.0%	
Assure Unique Cases	5	20.0%	20.0%		60.0%
Access for Other System	5	40.0%	40.0%	20.0%	
Clean Data	5	20.0%		60.0%	20.0%
Retrieve Statistics	5	20.0%	20.0%	20.0%	40.0%
Report to State	5	20.0%	20.0%		60.0%
New Data Repositories	5	20.0%		20.0%	60.0%

Internal Consistency of Questions Regarding "Goals and Tasks in the use of non-PHIMS electronic information system"

We measured the internal consistency of this question set by applying a Cronbach's Alpha value using the data from the nine questions within the set. The resulting value was 0.889, suggesting an acceptable level of internal consistency across this portion of the questionnaire.

Use of PHIMS in LHJs

LHJs in Washington have access to PHIMS, and 100% of LHJs reported using it for reporting to WADOH; 81.3% of LHJs reported also using PHIMS for local data management, and 18.8% reported that they did not. No statistically significant difference was found across the different sizes categories of LHJs for this variable.

Table 7 - Usage of PHIMS

Large LHJs that use PHIMS for local data management

Use of System	n	Always	Often	Sometimes	Never
New Cases	5	100.0%			
Assess Case Status	5	60.0%	20.0%		20.0%
Update Cases	5	60.0%	20.0%		20.0%
Assure Unique Cases	5	80.0%			20.0%
Access for Other System	4	25.0%		25.0%	50.0%
Clean Data	5	40.0%	40.0%		20.0%
Retrieve Statistics	5	20.0%		40.0%	40.0%
Report to State	5	100.0%			
New Data Repositories	5			20.0%	80.0%

Medium LHJs that use PHIMS for local data management

Use of System	n	Always	Often	Sometimes	Never
New Cases	14	92.9%		7.1%	
Assess Case Status	14	78.6%	7.1%	7.1%	7.1%
Update Cases	14	85.7%	7.1%	7.1%	
Assure Unique Cases	14	92.9%	7.1%		
Access for Other System	14	50.0%	7.1%	21.4%	21.4%
Clean Data	14	50.0%	28.6%	21.4%	
Retrieve Statistics	14	21.4%	21.4%	50.0%	7.1%
Report to State	14	100.0%			
New Data Repositories	14	14.3%	14.3%	28.6%	42.9%

Small LHJs that use PHIMS for local data management

Use of System	n	Always	Often	Sometimes	Never
New Cases	13	53.8%	46.2%		
Assess Case Status	12	50.0%	50.0%		
Update Cases	12	41.7%	58.3%		
Assure Unique Cases	13	46.2%	30.8%	15.4%	7.7%
Access for Other System	13	30.8%	30.8%	23.1%	15.4%
Clean Data	13	30.8%	15.4%	53.8%	
Retrieve Statistics	13	23.1%	30.8%	7.7%	38.5%
Report to State	13	61.5%	30.8%	7.7%	
New Data Repositories	13	15.4%	7.7%	15.4%	61.5%

A Kruskal-Wallis test applied to these data identified a significant difference in the responses of three of the questions across the three different sizes of LHJs. These values are highlighted in the table below.

Table 8 - PHIMS measures of difference

	Kruskal-Wallis p-value
New Cases	**0.037**
Assess Case Status	0.515
Update Cases	0.12
Assure Unique Cases	**0.031**
Access for Other System	0.467
Clean Data	0.348
Retrieve Statistics	0.565
Report to State	**0.015**
New Data Repositories	0.315

Internal Consistency of Questions Regarding "Goals and Tasks in the use of PHIMS as a local data management tool"

We measured the internal consistency of this question set by calculating a Cronbach's Alpha value using the data from the nine questions within the set. The resulting value was 0.806, suggesting an acceptable level of internal consistency across this portion of the questionnaire.

Case Investigation and Case Reporting

Survey participants were asked to estimate the number of communicable disease and notifiable conditions cases they process per year. We asked about the number of investigations that take place each year, as well as the number of cases reported. In order to reduce the effort required for respondents to answer this question, we asked participants to select an answer from a quintile of responses, each representing a range of investigation frequencies. Respondents selected from the following options: 0-100, 500-1000, 1000-2000, 2000-5000, or over 5000 case investigations and reports. We found a significant difference in both variables across the three different sizes of LHJs. A Kruskal-Wallis p-value below 0.0001 for each question indicates a significant difference in the number of cases each LHJ size category investigates and reports.

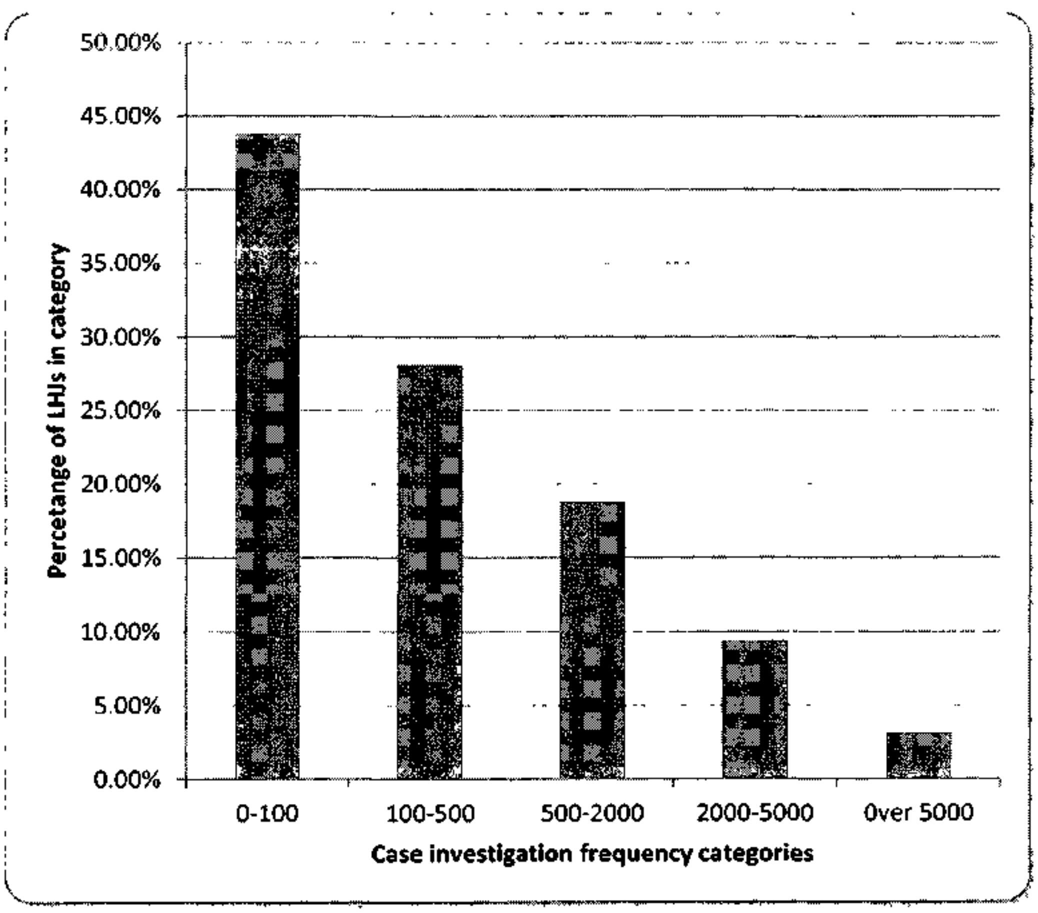


Figure 15 - Case Investigation frequency

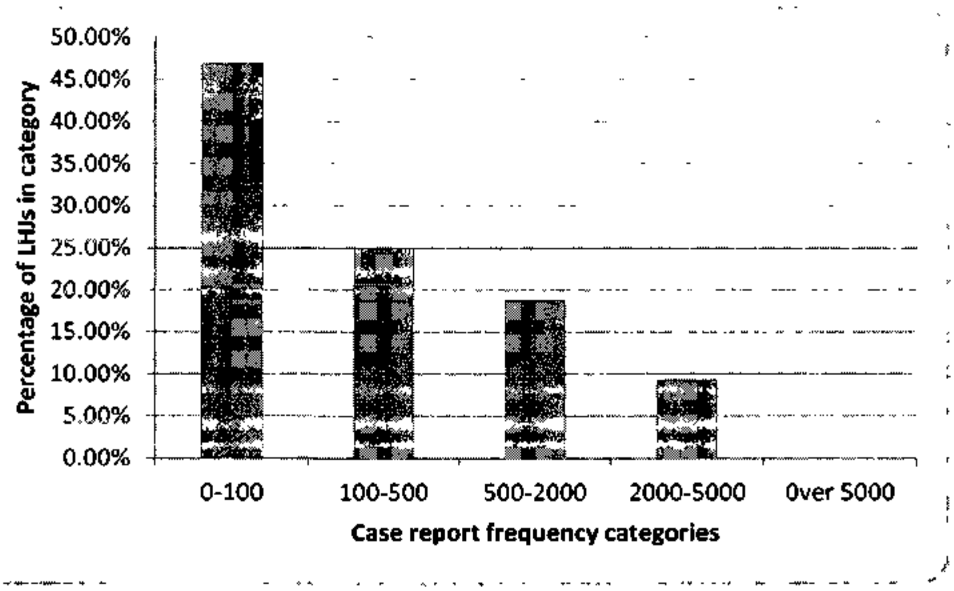


Figure 16 - Case reporting frequency

Standard Evaluation Procedures for Information Systems

Respondents reported at a rate of 62.5% that their LHJ did not have a standard evaluation procedure for notifiable conditions information systems. 34.4% reported that they were unsure, and 3.1% reported having a standard evaluation procedure. A likelihood-ration p-value of 0.357 suggests that there is not a significant difference between the responses to this item from LHJs of different size.

Reviewing system usage goals by system type

In the following table, we dichotomized the data from the three sets of goal-oriented questions on the survey questionnaire. We transformed responses from these items from “Always,” “Often,” “Sometimes,” and “Never” to into two responses; “Yes” and “No.”

The table shows the percentage of respondents that affirmed the use of a system type for each of the goals. This allowed us to see the use of each different system for the goals in our question sets, disregarding how often an LHJ might conduct activities related to the goal, and disregarding the LHJ size. The data show that LHJs use paper-based information systems most frequently to create new data repositories during outbreaks of disease. The data also show that PHIMS is the most frequently used tool to report cases of notifiable conditions to WADOH.

Table 9 - Percentages of system usage goals by system type

	Paper	Other	PHIMS
New Cases	100%	90.9%	100%
Assess Case Status	95.5%	80%	93.5%
Update Cases	100%	90.9%	96.8%
Assure Unique Cases	86.4%	63.6%	93.8%
Access for Other System	95.7%	100%	77.4%
Clean Data	87.0%	81.8%	96.9%
Retrieve Statistics	69.6%	81.8%	75%
Report to State	52.2%	36.4%	100%
New Data Repositories	81.8%	54.5%	43%

Explaining differences in system usage goals by LHJ size and system type

The following table displays the tasks that showed a statistically significant difference in the reported frequency of use. For each goal where there was a difference in the frequency difference identified, we commented on trends in the data that may explain these differences.

Table 10 - System goal summary

	Paper	Other	PHIMS
New Cases			Small LHJs – less often than medium and large
Assess Case Status	Small LHJs – less often than medium and large		
Update Cases	Small LHJs – less often than medium and large		
Assure Unique Cases	Small LHJs – less often than medium and large		Small LHJs – less often than medium and large
Access for Other System	Small LHJs – less often than medium and large		
Clean Data			
Retrieve Statistics			
Report to State			Small LHJs – less often than medium and large
New Data Repositories			

Hierarchical Cluster Analysis

```
Dendrogram using Single Linkage

                        Rescaled Distance Cluster Combine

    C A S E      0         5        10        15        20        25
  Label     Num  +---------+---------+---------+---------+---------+

  NewCases    1   -+-+
  AccessFo    5   -+ |
  AssessCa    2   ---+-----+
  AssureUn    4   ---+     +-----------------------------+
  UpdateCa    3   ---------+                             +---------+
  ReportSt    8   ---------------------------------------+         |
  CleanDat    6   -------------------------+-------------+         |
  Retrieve    7   -------------------------+             +---------+
  NewDataR    9   ---------------------------------------+
```

Figure 17 - Dendrogram of task questions related to the use of paper systems used by LHJs in Washigton State

In this dendrogram, Figure 17, we see a cluster showing likeness in the responses of the following variables from our questionnaire:

How often do you use a paper-based system to:

Record information on new cases or suspected cases?

Access information that will go into other paper-based or electronic records?

Assess the status of a case during investigation?

Assure that each notifiable condition record is unique?

```
Dendrogram using Single Linkage

                         Rescaled Distance Cluster Combine

   C A S E      0         5        10        15        20        25
  Label    Num  +---------+---------+---------+---------+---------+

  AssessCa   2   -+-------------------+
  UpdateCa   3   -+                   +-----------------------------+
  AssureUn   4   -+-------------------+                             |
  CleanDat   6   ---------------------+                             |
  NewCases   1   ---------+---------------+                         |
  AccessFo   5   ---------+               +-------------------------+
  Retrieve   7   -------------------------+                         |
  ReportSt   8   -------------------------------------------+-------+
  NewDataR   9   -------------------------------------------+
```

Figure 18 - Dendrogram of task questions related to the use of non-PHIMS electronic systems used by LHJs in Washigton State

In this dendrogram, Figure 18, we see a cluster showing likeness in the responses of the following variables from our questionnaire:

How often do you use an electronic information system other than PHIMS to:

Assess the status of a case during investigation?

Update case information as the case progresses?

```
Dendrogram using Single Linkage

                         Rescaled Distance Cluster Combine

   C A S E       0         5        10        15        20        25
  Label     Num  +---------+---------+---------+---------+---------+

  AssessCa   2    -+-------+
  UpdateCa   3    -+       +-----------+
  AssureUn   4    ---------+           +-------+
  CleanDat   6    ---------------------+       +---------------+
  Retrieve   7    -----------------+-----------+               +---+
  NewDataR   9    -----------------+                           |   |
  NewCases   1    -------------------------------------------+-+   |
  ReportSt   8    -------------------------------------------+     |
  AccessFo   5    -------------------------------------------------+
```

Figure 19 - Dendrogram of task questions related to the use of PHIMS by LHJs in Washigton State

In this dendrogram, Figure 19, we see a cluster showing likeness in the responses of the following variables from our questionnaire:

How often do you use PHIMS to:

Assess the status of a case during investigation?

Update case information as the case progresses?

Assure that each notifiable condition record is unique?

3.3 Limitations

This investigation had several limitations that should be considered when interpreting the results. In our research, we collected data about the use of information systems in LHJs throughout a single state. The activities of LHJs are affected and governed by state-level government agencies. For example, WADOH publishes the list of diseases considered reportable throughout Washington, thereby impacting the notifiable conditions work of LHJs in Washington. The results presented in this investigation may not be generalizable beyond the LHJs within Washington. The use of information systems for notifiable conditions reporting, and the policies which govern that use, are similarly impacted by the laws and infrastructure of the state government. For example, Washington provides an online information system for LHJs to use for reporting purposes (PHIMS). The system also has limited capabilities as a local information management tool for communicable disease and other notifiable conditions. The presence of PHIMS in Washington, and the mandate which requires its use, may alter the presence and use of other information management systems. Therefore, further investigation would be needed to determine the generalizability of our findings.

To minimize the impact of our investigation on the daily work of LHJs, we targeted only a single representative at each jurisdiction to complete our questionnaire. We worked with disease investigation experts at WADOH to select the appropriate point of contact at each LHJ. While we believe that this practice facilitated the expedient collection of accurate information, it is possible that surveying additional public health practitioners would have produced different results.

The questionnaire we developed was based on a qualitative investigation conducted at a single LHJ (Aim 1). It is possible that tasks relevant to notifiable conditions information management were not executed in this initial LHJ, or were overlooked in our initial investigation.

Our choice to use data from the 2000 census to stratify LHJs into size categories may have limited the generalizability of our analysis. Comparing county-level population data from the 2000 Census [83] to 2011 county-level population estimates from Washington[82], three counties may transition from one size category the next in 2011. Kitsap County may transition from a "Medium" to a "Large" county, Mason County may transition from a "Small" county to a "Medium" county, and Thurston County may transition from a "Medium" to a "Large" county. To assess the impact of using 2011 population estimates instead of 2000 Census data in our analysis, we repeated the Kruskal-Wallis tests used to determine the difference in goal frequency for paper-based information systems. In our original test, we found that four goals occurred in a significantly different frequency. Those four goals were: Assess Case Status, Update Cases, Assure Unique Cases, and Access for other System. We adjusted county size stratification based on 2011 population estimates, and again calculated p-values using the Kruskal-Wallis test. We found that the same four goals occurred in a significantly different frequency, and no new differences in goal frequency. This suggests that the use of 2011 population estimates, when compared to the use of 2000 Census data, does not produce a different result when comparing the frequency of goals associated with the use of paper-based information systems in LHJs across the three size categories. Table 11 shows both sets of p-values calculated using the Kruskal-Wallis test.

Table 11 - Kruskal-Wallis p-values showing the difference in frequency of paper-based information systems in LHJs stratified by small, medium, and large population size using 2000 Census data and 2011 population estimates.

System Use	Kruskal-Wallis p-value (2000 Census[83])	Kruskal-Wallis p-value (2011 population estimates [82])
New Cases	0.118	0.118
Assess Case Status	**0.031**	**0.039**
Update Cases	**0.001**	**0.001**
Assure Unique Cases	**0.006**	**0.007**
Access for Other System	**0.007**	**0.007**
Clean Data	0.227	0.227
Retrieve Statistics	0.431	0.444
Report to State	0.468	0.315
New Data Repositories	0.813	0.572

3.4 Discussion

Potential participants of the questionnaire were selected by leaders at the Washington State Department of Health, who provided us with a list of contacts at LHJs that focus on disease investigation. These individuals were WADOH's primary points of contact for disease investigation at the local public health level. Public Health Nurses comprised 51.3% of the LHJ staff that responded to the survey. This suggests that in Washington the majority of individuals working at LHJs who serve as a primary point of contact with WADOH are Public Health Nurses. Communication between state and local public health agencies is essential to the disease investigation process. Developers working on the design of information systems to support this work may consider that public health nurses are serving an essential role in the information management process within LHJs.

We found that the presence of a separate CD section correlated with LHJ size. The difference in the groups was statistically significant. 100% of large groups reported having a separated CD section, compared to 64.3% of medium-sized groups and 25% in small groups. The presence of a separate CD section may suggest a higher case throughput, more CD-related activity, and more staff members working on CD investigations. The data show a trend where the number of staff in CD Sections increases with the size of the LHJ. Across all groups, the mean number of staff managing notifiable conditions within a CD Section was 3.33, where the mean number within an entire jurisdiction was 4.03. This suggests that within groups that have a CD section, there are additional staff members throughout the LHJ who also work with notifiable conditions information management.

While there appears to be no difference in the frequency of tasks completed using paper-based systems across LHJs of different size, the presence of paper-based information systems throughout Washington is informative. The state has developed an electronic information system that is available to all LHJs, yet paper-based systems are used in 71.9% of LHJs. 31.3% of LHJs have an additional, non-PHIMS electronic information system in addition to a paper-based information system. The presence of "hybrid" information systems across Washington, along with the presence of paper-based systems, suggests a need for additional research into why paper-based systems are so prevalent in the local public health community, even when an electronic option has been made available.

We found that paper-based systems were used for all task-oriented activities we identified in Aim 1. However, not all activities were executed by all LHJs using a paper system. There were statistically significant differences in the use of paper systems in four tasks across the different sizes of LHJs. The four tasks that showed differences across the groups were:

Assessing case status: Small LHJs reported a much lower frequency of using their paper-based information system to assess case status. This could be the result of lower case throughput. If case management is possible without regular triage, the need for this task may be reduced. The number of staff members working on a case simultaneously may also be smaller in the smaller LHJs, where we have seen that staff numbers tend to be lower.

Updating cases: Small LHJs reported less frequent use of a paper-based system to complete this task. This may be the result of lower case throughput. More small LHJs reported completing this task “Often,” referring to once a month, while 100% of Large and Medium LHJs reported executing this task “Always,” referring to at least once a week.

Assure cases are unique: This task is completed less frequently by small LHJs using paper-based systems. This may be the result of lower case throughput – with fewer records to manage there is less risk of duplicating a record. In small LHJs, fewer staff members manage notifiable conditions information. It may be that only a few staff members manage notifiable conditions information for an entire small LHJ, and they rely on communication between staff, and their own memories, to identify duplicate cases. Reducing duplicates in a record is a step that may be completed in the data cleaning stages of data analysis. If small LHJs conduct less of their own data analysis, they may offload de-duplication activities to another public health organization, such a state department of health.

Access data for use in another system: Survey question: *“Please indicate the frequency that you use your paper-based information management system to access information* *that will go into other paper-based or electronic records."* Of large and medium-sized LHJS that use a paper-based information system, 100% responded "Always" on this item. Small LHJs reported much lower frequencies. It may be that Small LHJs do not have another information system (paper or electronic) in use, or this may be explained by lower case throughput.

We found a significant difference in the presence of non-PHIMS electronic information systems across LHJs of different size. Specifically, 100% of Large LHJs reported having such a system, while 21.4% were present in Medium and 38.5% in Small LHJs. These systems are used to manage notifiable conditions information within an LHJ. Most systems were developed locally using common tools such as Microsoft Access and Excel; 63.6% of respondents reported that the additional system was developed using pre-existing software like Microsoft Access or Excel. Respondents reported a range of purposes for additional information systems. Some provide legacy access to information that has been collected in the past, or provide features beyond PHIMS. In one case, temporary case investigators (sometimes recruited during a large disease investigation) could not access PHIMS because they had not registered with Washington as a PHIMS user. The additional system (Microsoft Excel) was used to keep track of information throughout a disease outbreak. Four groups reported that PHIMS did not provide the tools needed to complete their work.

This investigation identified that 75% of groups with an additional information system developed it locally, and 25% purchased the system. Although there are a myriad of commercially available information systems designed to assist local public health practitioners with notifiable conditions information management, only a small portion of LHJs in Washington have elected to purchase a system for this purpose.

Our data showed 33.3% of LHJs that use an additional information system did not have the opportunity to work with developers to produce the tool. However, 84.6% of respondents reported that they believed that local public health practitioners would be willing to take part in the design of notifiable conditions information systems.

We found that 81.3% of LHJs reported using PHIMS for local data management within their LHJ. However, the use of PHIMS varied across LHJs of different size. Among the tasks completed by LHJs with PHIMS, we identified a significant difference in the responses to three of the questions across the three different sizes of LHJs:

New Cases: Small LHJs reported that they create new case records in PHIMS less often than the other two groups of LHJs. This may be due to lower case throughput.

Assure Cases are Unique: As noted previously, small LHJs may conduct less data analysis directly in their department. De-duplicating cases, a step often conducted during data cleaning, may not take place in small LHJs, or it may take place less often.

Report to State: Reduced case throughput most likely describes a reduced frequency of reporting in small LHJs.

We found a significant difference in the number of cases LHJs investigate each year. For example, 71.9% of LHJs estimate that they report fewer than 1000 cases per year, with 43.8% reporting less than 100 case investigations per year. In contrast, only 3.1% of LHJs reported investigating over 5000 cases a year. The number of cases that were estimated to be confirmed and reported to the state followed a similar trend.

Considering many of the findings we have previously pointed out, developing information systems that meet the needs of all LHJs may present a challenge to system developers. The needs of all groups must be considered; however, those needs are likely to be very different. The findings presented in this chapter are an excellent starting point for information system developers to review at the beginning of any major system development. In Chapter 5, we discuss several areas where the findings presented in this chapter may promote the development and assessment of public health information systems.

Three counties did not respond to our original survey questionnaire. In an effort to increase the response rate of the survey, we contacted each of these groups using telephone communication. The individuals we reached were unable to complete the full survey, primarily noting time constraints, but were willing to share some basic information about their use of information systems when managing notifiable conditions data. We collected this information through brief phone conversations. Two of the counties, when stratified by population in categories of size, fit into the "small" LHJ category. These groups reported having no separate communicable disease section.

They each used a paper-based information management system for the collection and management of notifiable conditions and communicable disease data. Each group uses PHIMS for reporting cases of notifiable conditions and communicable disease to the state, and rarely for local data management. They reported no use of additional electronic information systems. They also reported having no standard procedure or protocol for the evaluation of information systems. The third county, when stratified by population in categories of size, fit into the "medium" LHJ category. This LHJ reported having a separate communicable disease section with five employees, who also work in other areas of the LHJ. This group uses a paper-based information management system for the collection and management of notifiable conditions and communicable disease. In addition, the group uses PHIMS for reporting cases of notifiable conditions and communicable disease to the state, and accesses the system weekly for local data management purposes. Excel spreadsheets are used to PHIMS for local data management and analysis needs. This group also reported having no standard procedure or protocol for the evaluation of information systems.

Chapter 4

Aim 3: "To develop, apply, and assess an evaluation strategy for notifiable conditions information systems"

4.1 Background and Setting

To improve the efficiency and completeness of notifiable condition reporting throughout the state, Washington's Department of Health (WADOH) developed an online system for local public health departments to electronically transfer notifiable condition data, the Public Health Issue Management System (PHIMS). In 2008, Washington mandated the use of PHIMS for notifiable conditions reporting throughout the state. The mandate required local public agencies to submit reports of notifiable conditions within their respective counties through the online system, where previously these reports were submitted by fax and paper mail to WADOH[32]. Prior to the implementation of PHIMS, staff members at WADOH would enter data in an electronic database as LHJs submitted reports of notifiable conditions by fax. When PHIMS was implemented, the burden of data entry was no longer placed onto WADOH staff, and instead LHJs would provide data entry services by using the online tool.

When the mandate to use PHIMS was put into effect, public health practitioners at Public Health Seattle King County's (PHSKC) Communicable Disease Epidemiology and Immunization Section (CDEIS) had concerns that PHIMS might not meet their information management needs if used as a local information management tool. For example, CDEIS staff needed to quickly and easily access data, manage cases and schedule follow-up activities, and regularly produce detailed reports describing health trends in the community. At this time, the section already used a locally developed information system, referred to as the Communicable Disease Database (CDD). The CDD was used to manage the case reports of the majority of notifiable conditions in King County, with the exception of HIV/AIDS cases, TB, and Sexually Transmitted Infections (STI). PHSKC has special departments dedicated to these conditions.

With a need to more clearly understand the potential for PHIMS to serve as a complete notifiable conditions data management system, and with the several limitations which contraindicated more traditional system evaluation strategies, we suggested the extended use of our previous task analysis to systematically compare the tasks which are currently fulfilled with the CDD, and compare them with the features available through the PHIMS system through the creation of scenarios. With the tasks objectively identified through observation, and then vetted with the staff at the CDEIS Section through a focus group (through the work completed in Aim 1), we created pairs of scenarios to compare the use of the CDD and PHIMS in the work environment of CDEIS. This effort prompted the development of an evaluation strategy that was applied, tested, and modified, throughout the research we conduct during Aim 3.

The development and application of this evaluation strategy inspired further investigation into the evaluation practices of public health agencies, and the techniques and protocols used in LHJs to select new information systems. In Aim 3, we review these issues in the context of notifiable conditions information systems used by local public health agencies. The evaluation efforts that took place as part of Aim 3, as well as the subsequent research we conducted to modify, assess, and contextualize the evaluation strategy make use of findings from our previous research. In Aim 1, we produced a list of tasks associated with the use of a notifiable conditions information system at PHSKC. In Aim 2, we used survey research to characterize the use of information systems across local public health agencies in Washington, describing their notifiable conditions information management activities, and assessing the need for an evaluation strategy for information systems within LHJs. In Aim 3, we used the findings from Aim 1 to evaluate an information system for notifiable conditions information management. We then used additional data, including survey data from Aim 2, to modify the strategy for future use by public health practitioners and informatics specialists. Finally, we presented the resultant evaluation strategy to LHJs in the form of an evaluation guidebook. In this process, we conducted focus group meetings with communicable disease specialists at two different LHJs to gather feedback on the evaluation guidebook as well as the overall evaluation strategy.

Public health practice is a field that relies on evaluation methodology to assess the effectiveness of public health programs. The 10 Essential Public Health Services, a framework published by the CDC, summarizes public health activity in 10 primary activities. Among them is "Evaluate effectiveness, accessibility, and quality of personal and population-based health services." [90, 91] Public health practitioners ideally apply evaluation methodology in their work. However, based on the findings from Aim 2 and a review of the literature, the use of structured evaluation strategies to assess the information systems used in local public health practice has not yet been widely adopted. Little research has been published to assist LHJs in the selection of notifiable conditions information systems. The evaluation frameworks that may guide LHJs in the evaluation of information systems are not available or presented in a format instructional to a typical local public health practitioner. For example, CDC's recommendations for surveillance system evaluation are directed toward large-scale evaluations of entire surveillance programs, and are not developed to guide small-scale information system evaluations. To address this, following the development and application our evaluation strategy, we developed a guidebook for LHJs wishing to implement our strategy in their own environment, and presented it to LHJs in Washington for review.

Table 12 - The 10 Essential Public Health Services [90, 91]

Monitor health status to identify community health problems
Diagnose and investigate health problems and health hazards in the community
Inform, educate, and empower people about health issues
Mobilize community partnerships to identify and solve health problems
Develop policies and plans that support individual and community health efforts
Enforce laws and regulations that protect health and ensure safety
Link people to needed personal health services and assure the provision of health care when otherwise unavailable
Assure a competent public health and personal healthcare workforce
Diagnose and investigate health problems and health hazards in the community
Inform, educate, and empower people about health issues

This evaluation strategy was developed to accommodate constraints on system evaluation that existed at CDEIS. We believe that similar constraints may also exist across other LHJs. The first constraint identified at CDEIS was that the PHIMS system could not temporarily replace the production version of the CDD for testing purposes. The day-to-day work that was accomplished with the CDD served the population of King County by monitoring communicable disease and minimizing the impact of disease outbreaks. CDEIS staff felt that this work could not reasonably be interrupted for testing purposes. Furthermore, staffing limitations made it difficult to dedicate staff members to system evaluation. The second constraint was that King County is significantly larger than other LHJs in Washington. This made it infeasible to presume that PHIMS performance in King County would be the same as performance in other LHJs across the state. The county with the second-largest population size is Pierce County, which serves less than half of the number of citizens served by PHSKC (PHSKC serves approximately 1,875,519 citizens, Pierce County serves 785,639) [83]. It has been shown that local public health performance and spending both correlate with the population size of the jurisdiction [65, 79]. In our Aim 2 investigation, we similarly observed variation in the frequency of information-management tasks executed at LHJs of different size. Throughout Washington, we can observe a similar pattern of public health spending across counties of different population size. The Washington State Office of Financial Management (OFM) provides an online resource for the public to generate spending reports at the county level through a system named the "Local Government Financial Reporting System" (LGFRS)[92]. We used this tool to review spending on salaries and wages for public health activities in each county. The scatter-plot diagram in Figure 20 shows a positive relationship between public health spending in 2009 and population size of each county in 2009 [82]. King County, with a population many times higher than all other counties, and spending on salaries and wages of $99,723,043 in 2009 [92], was selectively omitted from the scatter plot diagram due to its status as an outlier in this analysis.

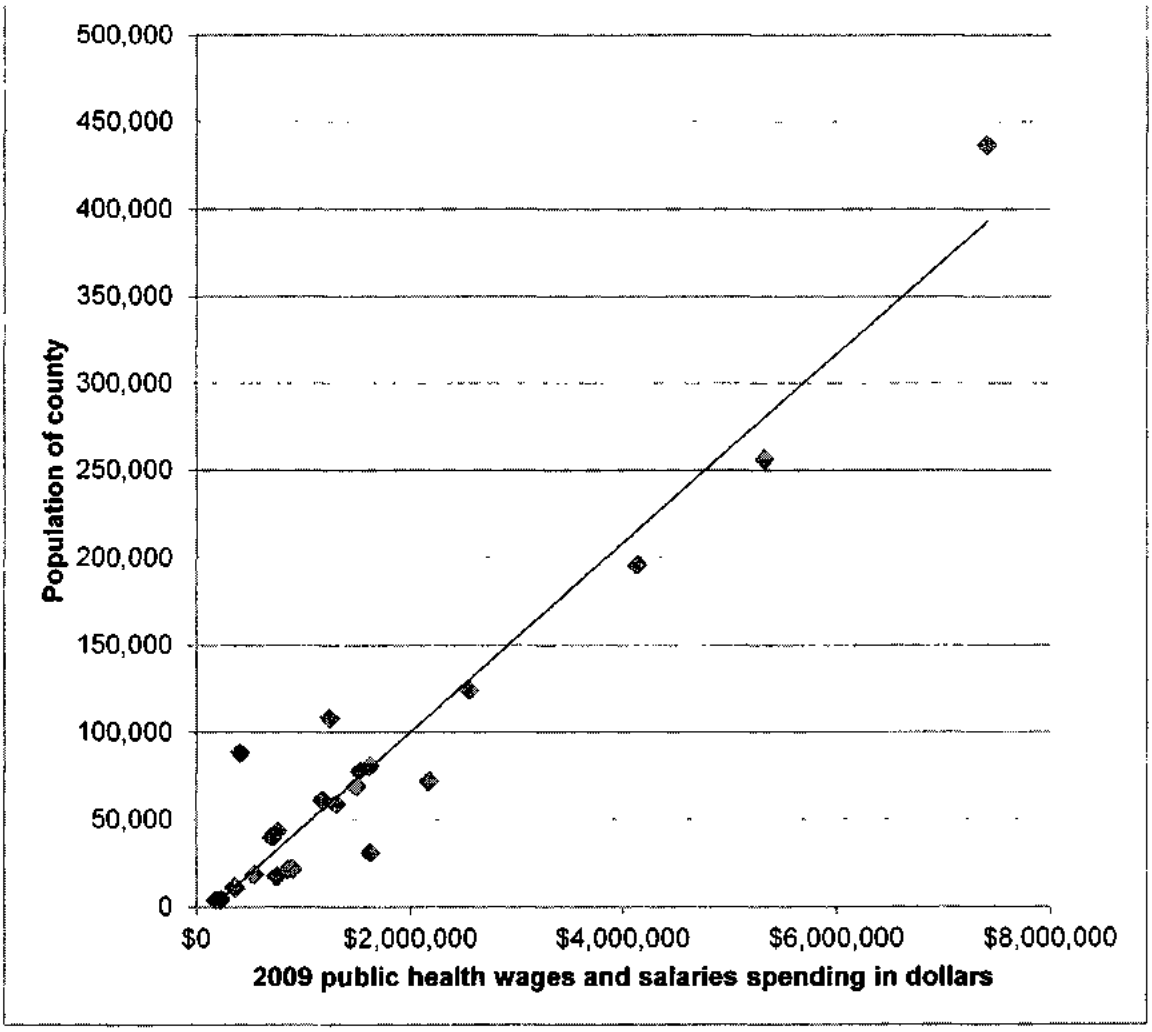


Figure 20 - 2009 public health wages and salaries spending sorted by county population size with a linear regression trendline

4.2 Methods

4.2.1 Developing and applying the evaluation strategy at PHSKC

We developed our evaluation strategy when a real-world informatics challenge arose at PHSKC's CDEIS, as described previously. In this section we present the methods selected, and describe why they were appropriate. For each method presented in this section, we share the corresponding results in the "Results" section of this text.

The evaluation strategy contains several components. Each component was selected for its utility in systems evaluation and appropriateness to the challenges identified at King County, many of which may exist at other LHJs throughout Washington and the United States. Below we describe the components of the evaluation strategy and its contribution to an evaluation effort.

4.2.2 Task Analysis

The basis for this evaluation was the effort we undertook to identify the work activities within CDEIS that were executed using the CDD. This process is described in detail in Aim 1. In Aim 3, we carry forward the task list identified in Aim 1 to conduct an evaluation of the PHIMS system. Task analysis allowed us to develop a list of activities that take place in CDEIS, and provided a starting point for assessing how well PHIMS would integrate into the work of CDEIS. We used the items in the task list to ground the evaluation in the work of CDEIS.

4.2.3 Familiarization with PHIMS

In order to develop scenarios based on the use of PHIMS, it was important to understand the features and capabilities of the software. To acquire this understanding, we gained access to PHIMS's online demonstration system, which Washington makes available for training purposes. The training system is identical in features and functionality, and in look and feel, to the production system that was in use at the time our research was completed. Printed documentation for PHIMS was also thoroughly reviewed. By using PHIMS system to complete data entry and data retrieval tasks as suggested in the training literature, our investigator became familiar with the software and its features. At the time of this analysis, some minor updates to PHIMS were not documented in the available training literature.

4.2.4 Development of Scenarios

In a discussion of scenario-based design, Go and Carroll define use-case scenarios in the following way: "A scenario is a concrete description of work and activities, so it describes a specific instance and usage situation [68]." Following that description, we wrote two scenarios for each of the 17 tasks identified in Aim 1. One scenario was written describing the use of the CDD to accomplish the task by a staff member at CDEIS. An additional scenario was also developed for each task to describe how the same work activity might be accomplished within CDEIS using the PHIMS system. The scenarios presented in this research are based on the implementation of PHIMS that was in use at the time of the analysis, should not be used to assess newer versions or implementations of the system. In some cases the functionality of PHIMS suggested that it would be impossible to complete the task under investigation. In these cases, a description of the limitation was written in place of a scenario. These scenarios, which describe the use of PHIMS at CDEIS, were written based on the primary investigator's understanding of the PHIMS system and the observed work practices of staff within CDEIS.

4.2.5 Validation of CDEIS Scenarios

To minimize the impact of our research on the daily work of CDEIS, we elected to validate the scenarios that described the use of the CDD with leaders working in CDEIS, rather than validate them with specific users. These individuals occupied the job roles of Section Chief and Medical Epidemiologist. They reviewed the scenarios for face validity and found them to be an accurate representation of the work at CDEIS.

4.2.6 Validation of PHIMS Scenarios

In order to validate the scenarios we developed for the PHIMS, we met with three informaticians who worked in the Informatics Division of WADOH. For each of the seventeen tasks, we asked for their feedback regarding the use of PHIMS in the hypothetical context that the system would be used as a primary information management tool at the CDEIS. Through this discussion we identified one method to perform a function we were not aware of: the ability to specify parameters for case status reports. The scenario that described this feature was modified based on this finding. The remaining 16 scenarios were found to be accurate in this meeting.

4.2.7 Identify task-performance challenges

For each task, we compared the scenario describing the use of the CDD to complete the task with the scenario describing the completion of the task using PHIMS. Using a single heuristic, "The task completed with the CDD can be accomplished using PHIMS," we made an assessment of the usefulness of PHIMS in the context of CDEIS's primary tasks.

Heuristic evaluation is a method commonly used in human-computer interaction (HCI) studies to evaluate the usability of a software interface design. The method has been successfully applied in several biomedical informatics contexts [93-96]. In this study, we evaluated the *usefulness* of PHIMS. We were concerned with whether the adoption of PHIMS as a local data management tool would allow staff members at CDEIS to continue to accomplish their tasks without sacrificing the quality of their work.

To simplify this process, we did not consider the usability of the interface or the timing/speed of accomplishing tasks. We compared scenarios and assessed each pair according to the single heuristic noted above.

4.2.8 Questionnaire items about information systems evaluation in LHJs

The questionnaire we distributed to LHJs across Washington in Aim 2 had the primary purpose of identifying LHJs' use of information systems to manage notifiable conditions data. We also included three items on the questionnaire that asked participants about their evaluation of information systems. The data that we collected from these questionnaire items assisted us in the development of the final evaluation strategy.

4.2.9 Presenting the Evaluation Strategy to LHJs in Focus Group Meetings

Guidebook development

Using the evaluation strategy that we applied at PHSKC's CDEIS as a prototype, and incorporating data from the questionnaire, we created a guidebook entitled "Task-Centric Evaluation for Comparing Information Systems – A Guide for Local Public Health Practitioners." The purpose of this guidebook was to assist local public health practitioners in the application of the evaluation strategy (see Appendix). In the following section, we describe our efforts to collect feedback about the guidebook from local public health practitioners.

Presenting the evaluation strategy to LHJs in focus group meetings

We conducted focus group meetings with two LHJs in Washington to review the utility of the guidebook in the local public health context. The methods we used are described below.

Inclusion criteria for focus group meetings

Our criteria for selecting LHJs and individuals for this portion of our investigation are listed below:

* The LHJ was either a large or medium-sized LHJ, and had a minimum of three participants available to for the focus group meeting.

* Individual participants worked with notifiable conditions information at a local public health agency.

Participant recruitment

Our contact at WADOH recommended two LHJs, and referred us to a point of contact at each LHJ meeting our inclusion criteria. Potential participants were contacted by telephone and the purpose of the focus group meeting was described. After agreeing to volunteer in this portion of the study, the point of contact at each LHJ reached out to other staff members working with notifiable conditions and/or communicable disease information management and invited them to take part in the focus group.

Informed consent

This recruitment protocol and the questions asked during the focus group meeting were approved by the University of Washington's Institutional Review Board. At the beginning of each focus group meeting, participants received a verbal description of the study and their rights as participants. Written consent was obtained from participants before the investigation proceeded, and they were supplied with a copy of the consent form.

Focus group meeting content

During the focus group meetings we introduced the evaluation strategy in a brief presentation, outlining it visually on a whiteboard. We described when an LHJ may require such a strategy, and discussed both the benefits of conducting a structured evaluation and how to execute it. The participants, having received a copy of the evaluation guidebook, shared their thoughts and comments about the evaluation strategy and the guidebook through a roundtable discussion. We facilitated discussion with a series of semi-structured discussion questions (See Appendix). Meeting notes were recorded by the primary investigator.

Focus group findings validation

Our notes were written up following the meeting, and a summary of the discussion was e-mailed to the point of contact at each LHJ. We asked the point of contact to review the meeting summary and respond with verification that the summary accurately reflected the major discussion points from the meeting.

4.2.10 Guidebook Revision

The first version of the guidebook was revised based on the feedback that we collected in the focus group meetings with the two LHJs, as well as information from the survey, our literature review and artifact analysis.

4.3 Results

4.3.1 Scenarios and Comments

For each task listed below, we have written two scenarios. One is based on our observations of staff within CDEIS using the CDD, and the second is based on the hypothetical use of PHIMS in the CDEIS, considering the goals and work practices of staff within CDEIS who work with notifiable conditions data. Following each set of scenarios, we offer our comments related to the functionality of PHIMS, and how it may succeed or fail at supporting the task at CDEIS. The scenarios presented below are based on the implementation of PHIMS that was in use at the time of the analysis, should not be used to assess newer versions or implementations of the system. The scenarios below are intentionally written in an active voice, using the present tense. This is the standard writing style for scenarios of use [97].

Task 1 – Create new electronic records

Scenario 1A (CDD):

After completing a search for potential duplicate records (Scenario 6A), staff select an option to create a new record for each case. Standard demographic information is added to the record, along with diagnostic results from tests and other relevant case information. The record must be manually saved using a "Save" button before exiting the CDD.

Scenario 1B (PHIMS):

After completing a search for potential duplicate records (Scenario 6B), PHIMS users select "New Case" from the "Case Management" menu option and add standard demographic information, diagnostic results from tests, and other relevant case information. The record must be manually saved using a "Save LHJ" button before exiting.

Comments: Both systems have adequate functionality for creating new electronic records.

Task 2: Assign a case to a staff member

Scenario 2A (CDD):

Initial case assignment takes place during the creation of a new electronic record (Scenario 1A). Cases are assigned by inserting the appropriate staff initials into a field of a table accessible through the CDD data-entry interface. The table may be viewed by staff members. Case assignment is also noted on the paper record.

Scenario 2B (PHIMS)

Initial case assignment takes place during the creation of a new electronic record (Scenario 1B). Cases can later be re-assigned as necessary through the case administration interface. PHIMS provides drop-down menus that offer counties and employees from which to select. This may reduce data entry errors during case assignment.

Comments: Case assignment is managed well by both systems. PHIMS' drop-down menus may help to eliminate data entry errors during this process.

Task 3 - Assess case status

Scenario 3A (CDD):

The CDD supports this task by offering a report that allows employees to view cases, and to identify the staff member assigned to each case. Case status is assessed through records in the CDD. Queries are available which show open cases, closed cases, and cases assigned to specific staff members. There are specific pre-made queries that display case status to a user. Users may update the status of the case through the CDD's interface.

Scenario 3B (PHIMS):

PHIMS' "Investigation Status" feature displays the status of a singular case status. "Case Management Reports" may be generated which display cases based on their status. These reports are delivered to users in PDF format. Open cases are displayed to the user at logon. Case status is also included in the "Core Export" option within PHIMS.

Comments: If users would like to sort the data by a field name (such as staff member or disease type) from a "Case Management Report" using PHIMS, it is necessary to import data from a PDF file into another data management tool (such as Microsoft

Access or Excel). This additional step would require extra time. A similar step would be required when using a tab-delimited text file from a "Core Export" of PHIMS data.

Task 4: Maintain/update electronic records

Scenario 4A (CDD):

Cases are located through a search feature that accepts name, date of birth, case ID, and other variables (Task 6A). Staff may create their own queries if a specific search is required. Information about the case is added and saved. Fields vary according to the disease that is being recorded. Data must be manually saved by selecting the "Save" option. Data input screens are configured so that all options can be accessed using the "Tab" button.

Scenario 4B (PHIMS):

Cases are located by completing Task 6B. Information about the case is added or changed, and data must be manually saved by selecting the "Save" option.

Comments: This task is well supported by both systems.

Task 5: Maintain/update paper records

Scenario 5A (CDD): Paper records are used throughout the notifiable conditions case management process to collect and record information about a case in a central location, a paper bundle. The paper bundle associated with a case is transported between staff members during the case's active lifecycle, and may be accessed for analysis at a later date once the case is closed. The CDD includes pre-made reports based on queries that serve as "face sheets" for these paper bundles. Face sheets are regularly reprinted as new information about a case becomes available and is entered into the CDD. Face sheets are available with one click from a menu in the CDD, facilitating frequent updates.

Scenario 5B (PHIMS): PHIMS includes a "Case Detail Report" which may fulfill the face sheet requirement. This report produces a printout of the entire case, including blank fields that have not been used. The report is accessed through the "Reports" feature of PHIMS, and then selecting the appropriate case. The report then enters a queue, is generated, and must be downloaded as a PDF file and opened with a separate piece of software. Finally, the report is printed. It is not configurable.

Comments: The Case Detail Report that PHIMS generates is not in the same format as the face sheets PHSKC uses. It is also not configurable. One central server generates reports through PHIMS, and the system is therefore limited to producing one report at a time throughout the state. It would not be possible for more than one PHSKC staff member to print face sheets to update paper records at the same time. This may increase the amount of time administrative staff members in CDEIS require to process paper case report updates. Furthermore, in the event of a statewide disease outbreak, the PHIMS report server may become over-utilized as it is charged to process multiple requests, thereby reducing performance.

Task 6: Identify a case or individual in the electronic record

Scenario 6A (CDD):

Cases are located through a search feature that accepts name, date of birth, case ID, and other variables. Staff may create their own queries if a specific search is required. Once the query has been executed, users may organize the results according to any column that was included in the search. For example, users may arrange the data according to the date of birth of the patient using Microsoft Access' sort-by-column feature.

Scenario 6B (PHIMS):

Cases are located using a search tool located in the "Case Management" menu called "Find a Case." Similar variables are available for users to select inclusion criteria for the search. Cases are limited to fifteen per page, and the maximum number of results per search is 75 cases.

Comments: It may be burdensome for PHSKC staff members using PHIMS to have limited views per page. During observations it was documented that some searches for individuals begin with very little information, such as a date and disease type. Therefore, initial searches may contain multiple pages of case data. Additionally, the inability to sort multiple records by various field names reduces the usefullness of PHIMS's case identification interface.

Task 7: Harmonize paper records with Electronic records

Scenario 7A (CDD):

Harmonization between paper records and electronic records is bidirectional, in that data may be collected on either medium first, and then must be transferred to the other. To update data on a paper record from the CDD, staff must identify a case (Task 6) and then print out a new updated report. To update the electronic record from paper documents staff members identify a case (Task 6) and then update the record (Task 5).

Scenario 7B (PHIMS):

PHIMS users must similarly identify a case (Task 6) and then print out a new and updated report using the "Case Detail" report feature. To update the electronic record from paper documents, staff members identify a case (Task 6) and then update the record (Task 5).

Comments: The "Case Detail" report available in PHIMS is more complicated to produce, and less configurable than the CDD's reporting features (See Scenario 6B).

Task 8: Use the electronic record during patient contact and data collection

Scenario 8A (CDD): To update the electronic record during patient contact, staff must identify the patient in the CDD (Scenario 6A) and update the electronic record as new information becomes available throughout the communication (Task 4).

Scenario 8B (PHIMS): PHIMS users must similarly identify the patient (Task 6) and update the information in the electronic record (Task 4). Information is on one continuous page.

Comments: A tabbed interface facilitates data entry during phone conversations using the CDD's data entry interface. PHIMS uses a single-page design for data entry. While this design choice was recommended by the PHIMS Users Group, PHIMS' single-page data entry interface may be burdensome when looking for a particular field.

Task 9: Data Cleaning

Scenario 9A (CDD): For a given disease, data can be viewed based on SQL queries that staff create, either by writing original SQL statements or by using Microsoft Access's Query Builder. Data can also be viewed by organizing it according to a specific data field that has been included as part of the query. For example, staff may choose to arrange cases by opening date, or by the zip code of the patient. Data may then be viewed for completeness, errors, and contradictions. To prevent data corruption, data may not be edited through query viewing. If changes need to be made to a record, staff must access the record by identifying the case through the CDD's primary interface (Task 6), and then updating the record appropriately (Task 4).

Scenario 9B (PHIMS): Data cleaning in PHIMS requires case records to be exported for viewing. Prior to export, data must first be selected based on the needed criteria for the data cleaning task. This selection may be accomplished in two ways: either by exporting all of the data in PHIMS into a local database that can then be queried, or by using one of the selection tools available within PHIMS. Records can be exported into PDF format or into a space delimited text file. Data cleaning is performed by a single analyst reviewing multiple records at once; therefore, viewing the list in PDF format where the data is flattened is undesirable. Using PHIMS's search features, data may be narrowed to the desired records to be cleaned, and then exported. Once data is exported from PHIMS, it can then be viewed using other analysis tools such as Microsoft Access, Excel or SPSS.

Comments: There are two problems with using PHIMS for data cleaning. First, the whereas CDD was designed to collect and manage data relevant to notifiable conditions within King County, PHIMS collects only what is needed for reporting and analysis at the state level. The result is that PHIMS may not enable structured collection and storage of the data needed for local case investigation. For example, the CDD facilitates the collection of Hepatitis A data the state does not require, and therefore cannot be collected in PHIMS. Secondly, staff members will not be able to view the edits they make to a record during the data cleaning process because it must be re-exported to reflect any new changes, making the process prohibitively time consuming.

Task 10: On-the-Fly Analysis of disease or trend

Scenario 10 (CDD): Staff members in CDEIS have direct access to all of the data contained within the CDD. For an epidemiologist to investigate her suspicion of a disease trend, she creates a query that references the relevant tables and records using a query designed in Microsoft Access or written in SQL and executed through Microsoft Access. Data collected through such a query may then be exported to another tool for analysis, or simply viewed in Access. Visualization of the data using graphs or charts may be conducted through one of the Microsoft Office tools such as Excel.

Scenario 10B (PHIMS)

PHIMS's reporting features allow "YTD Three Year" and "Monthly" summaries, which can be limited based on multiple attributes, including case status, case classification, patient gender, county, dates, and condition. These reports are delivered as PDF files after the report rendering process is complete. This provides the quickest method for conducting on-the-fly analysis.

Comments: Using PHIMS, staff would have to take extra steps in order to export similar data into a format that can be visualized in graphs and charts. Specifically, the PHIMS "Core Export" functionality would be required to create queries in the same level of detail currently possible with the CDD.

Task 11: Review comments for relevant epidemiologic information

Scenario 11A (CDD):

To view comments fields, staff may create queries that display notes based on multiple selection criteria using Microsoft Access's query builder or by writing SQL statements. Using these tools, comments can be searched through using common search functions.

Comments can be viewed on a single page to help staff identify epidemiologically relevant factors from the notes section. Note length is restricted.

Scenario 11B (PHIMS):

To review the comments fields within a case, staff must return to the "Case Administration" page for each individual case to review the free-text notes. Notes are not included as part of the "Surveillance Export" or the "Core Export." Note length is adequate.

Comments: Notes in PHIMS cannot be viewed concurrently in reports or queries. There is no way to export the notes section of multiple cases so they can be viewed together, used as a basis for searching, or used to find epi-linkages between cases.

Task 12: Create queries

Scenario 12A (CDD): Queries are created using Microsoft Access's query builder or by creating SQL statements and running them in Microsoft Access. Any field in the CDD may be selected as part of the query, and staff members may select the inclusion criteria for each field. Conditional constraints such as wildcards, equivalencies, and calculations may be used as part of the inclusion criteria. Queries access the entire range of data available through the CDD.

Scenario 12B (PHIMS): PHIMS features an array of report features specifically designed to provide access to the data contained within the PHIMS database. Reports are accessed through either the “Reports” or “Export” menus. To build queries with the same flexibility as observed in Scenario 10A, PHIMS users must export the data before limiting views using queries. This is accomplished using the “Core” and “Surveillance” export features available in the “Export” menu of PHIMS. Each export feature offers an opportunity to narrow the records by selecting dates, case status, and other options. Once the data is exported it would then need to be imported into another analysis tool (most likely Microsoft Access or Excel) for it to be searchable in a manner familiar to staff.

Comments: PHIMS does not have fields for all of the data the department collects for its disease investigation. Even with the core export feature there will be important data elements that will not be available for analysis.

Task 13: Re-use a Pre-made Query/Report

Scenario 13A (CDD): Preparing queries for future use is accomplished by saving the query with Microsoft Access's query design tool. Queries can be saved by individual users for later use, and they can be shared with other staff members if necessary. Reports can also be saved, and are useful when preparing reports for publication and staff meetings to discuss ongoing cases and disease trends.

Scenario 13B (PHIMS): PHIMS does not offer the functionality of saving reports and export requests. Each of the report types offers a standard set of attributes that can narrow the report. However, selections made to narrow the reports cannot be saved. The same is true for export functions.

Comments: We documented frequent use of pre-made queries during our observations with CDEIS. Using PHIMS would require staff to spend significant time re-creating queries that have already been used several times.

Task 14: Edit a Pre-made Query or Report

Scenario 14A (CDD): Editing queries and reports that have been saved is possible using Microsoft Access's query design tool. Fields may be added or removed from the query, and the inclusion criteria may be edited to include or exclude the desired records.

Scenario 14B (PHIMS): PHIMS has no functionality to save reports or exported data sets. Data that has been exported from PHIMS and imported into another data management tool (such as Microsoft Access) may be queried after it is formatted appropriately.

Comments: Data would have to be frequently exported from PHIMS and re-imported into a data analysis tool when using to a pre-established query, as re-querying an old data set does not provide the most accurate reflection of data available to staff members. This would be time consuming and create the potential for data corruption through frequent transformations.

Task 15: Export data for analysis with a statistical program

Scenario 15A (CDD): Users are able to export data into a comma or tab-delimited file which can then be imported into another analysis tool, such as Microsoft Excel, STATA, or SPSS. Microsoft Excel is commonly used at CDEIS for analysis of small data sets. Using Excel provides a convenient synergy between data storage and analysis software, because the results of queries can be imported directly into Excel in a format that is ready for analysis.

Scenario 15B (PHIMS): The export features within PHIMS provide users with the ability to export data as a tab-delimited text file. Some fields (such as comments and notes) are excluded from export. This data can then be used for analysis with a statistical analysis tool.

Comments: PHIMS's surveillance export feature provides limited inclusion criteria selection. While the feature provides support for typical surveillance queries, such as counting the number of cases of a particular disease in a county, complex narrowing of data would not be possible using exports of this kind. Arranging data into a format that can be analyzed will require additional work.

Task 16: Use system to fill out State Reporting Forms

Scenario 16A (CDD): Staff use the CDD to complete forms issued by WADOH for some notifiable conditions. Staff members identify the appropriate case and transcribe data from the electronic record to the paper form. The electronic record is viewed through the CDD's Microsoft Access interface, or by viewing queries that contain the record. General notifiable conditions reporting to the state is completed by printing case records from the CDD and faxing them to WADOH.

Scenario 16B (PHIMS): There is no need to complete state-requested paper forms. PHIMS electronically delivers the required information to the state.

Comments: PHIMS provides an electronic method for delivering case information to the state with minimal delay. Without the need to print and fax each case, administrative work would be reduced, and the need to fax cases would be eliminated.

Task 17: Create new data repositories for disease-specific investigation

Scenario 17A (CDD): Using Microsoft's implementation of the Open Database Connectivity standard (ODBC), staff are able to create new databases with Microsoft Access and link them with the CDD. For example, demographic information in the CDD is linked to a separate Microsoft Access database created to track MRSA infections. Users are also able to request that new tables within the CDD are created for these purposes. Once IT support staff have received the request, it is reviewed and implemented.

Scenario 17B (PHIMS): PHIMS users do not have access to the system's underlying database tables; therefore creating dynamic linkages to the data within them is not possible. It is possible to export the data and then import it into a new database or database tables. However, the data will not be dynamically updated as changes and updates are made to the case records.

Comments: Exporting data from PHIMS and then importing it into another database makes it possible to create multiple instances of a record which are not dynamically synchronized with each other, creating the potential for data corruption.

4.3.2 – Summarization of functional assessment of PHIMS at CDEIS

Following the development of the scenarios, we reviewed each pair to assess the potential usefulness of the PHIMS system if it were to be adopted by CDEIS as its main notifiable conditions information management system. Table 13 displays our assessment of the usefulness of PHIMS for this purpose, and includes comments that describe the basis for our assessment. We used the single heuristic to assess PHIMS's usefulness in this context: "The task completed with the CDD can be accomplished using PHIMS."

Table 13 - Summarization of functional assessment of PHIMS at CDEIS

Task	Usefulness at CDEIS	Comments
Create new electronic records	Satisfactory	PHIMS provides similar functionality to the CDD
Assign a case to a staff member	Satisfactory	PHIMS provides drop-down menus to assign staff
Assess Case Status	Unsatisfactory	PHIMS cannot format views of status output
Maintain\update Electronic Records	Satisfactory	PHIMS provides similar functionality to the CDD
Maintain Paper Records	Unsatisfactory	PHIMS is unable to format "Case Detail" report and can only process one report at a time across the state.
Identify a Case or Individual in the Electronic Record	Satisfactory with limitations	A limited number of cases are displayed in each search.
Harmonizing paper records with Electronic records	Unsatisfactory	PHIMS is unable to format "Case Detail" report and can only process one report at a time across the state.
Use the electronic record during patient contact and data collection	Limited	Single-page data entry interface may be burdensome.
Data cleaning	Unsatisfactory	Required data is not collected by PHIMS. Data needs to be re-exported frequently to reflect updates.
On-the-Fly Analysis of disease or trend	Limited	Additional formatting and exporting required for "eyeballing" data.
Review comments to determine potential causes of disease	Unsatisfactory	Notes in PHIMS cannot be viewed concurrently in reports or queries.
Create queries	Unsatisfactory	Limited reporting and exporting features.
Re-use a Pre-made Query/Report	Unsatisfactory	Unable to save inclusion criteria for reports and exports.
Edit a Pre-made Query/Report	Unsatisfactory	Reports and queries cannot be saved or edited.
Export data for analysis with a statistical program	Limited	Additional work required to format data for searching, limited inclusion criteria.
Use CDD to fill out State Reporting Forms	Satisfactory	PHIMS electronically delivers NC information to the state.
Create new data repositories for disease-specific investigation	Unsatisfactory	Users have no access to dynamically link new databases or sub-tables with the data in PHIMS.

4.3.3 Survey research results:

Three items in the questionnaire described in Aim 2 related to the evaluation strategies that LHJS in Washington use to select information systems. 62.5% of respondents reported that their LHJ did not have a standard evaluation procedure for notifiable conditions information systems. 34.4% reported they were unsure, and 3.1% reported having a standard evaluation procedure.

Table 14 - Frequency of standard evaluation procedures in LHJs

Standard Evaluation Process?	Frequency	Percent
I don't know	11	**34.4**
No	20	**62.5**
Yes	1	**3.1**
Total	32	100.0

Of the responses, 96.9% did not report a specific evaluation protocol used to evaluate new information systems. One respondent (3.1%) described the use of CDC guidelines to evaluation information systems within the respondent's LHJ. The skip logic built into the online survey forwarded participants answering "No" or "I don't know" to the question "Does your section have a standard procedure for evaluating new information systems?" to another question asking participants describe how they envision an information system evaluation might take place in their LHJ, in the absence of any formal protocol or procedure.

Participants envisioned a range of evaluation strategies that might be used in their environment. Below are the major themes that emerged in their responses:

- End-users should take part in the evaluation.

- IT support staff for LHJs are involved in decision making, and may play an essential role in the selection of an information system.

- Decision making should be collaborative and should include LHJ staff.

- LHJ leadership should be consulted in any selection of an information system, particularly when new funds are appropriated for this purpose.

- A single staff member may take the lead for the evaluation and present it to the rest of the group.

- One respondent replied that their LHJ would prefer that the state make decisions about information management tools.

4.3.4 Focus group meeting results

The focus groups lasted approximately two hours each, and took place on location in a conference room at each LHJ. The following statements are summaries of the notes we captured during discussions with the focus groups. These summaries were emailed to our point of contact at each LHJ for verification of their accuracy. The point of contact from each LHJ reviewed our summary of the focus group meeting and confirmed the notes were an accurate reflection of the discussions in the meeting.

4.3.4.1 Focus group comments about the evaluation strategy:

- Focus group participants recognized the high cost of information system failures, and reported that a structured evaluation methodology, like the one presented here, would help to reduce the risk of failure at implementation.

- Participants reported that the evaluation strategy could be executed by a communicable disease/notifiable conditions worker, but resources would need to be allocated to their position so they could have time to execute the evaluation without their daily work falling behind.

- Participants not only work with notifiable conditions information, they also have other responsibilities within the LHJ. Some participants referred to themselves as "multi-taskers." Inviting a student, intern, or consultant to execute some or all of the work may be the best way to execute the evaluation without interrupting daily activities.

- Participants expressed the decision to adopt a system was not theirs alone. Instead, it was described as being made by decision makers at higher levels of the organization. Their input is often sought at the later stages of information system selection.

- Participants agreed that it was valuable to be introduced to the evaluation strategy, and it may influence their future decision making process.

- Participants expressed the need to evaluate the work of exterior organizations they collaborate with, in addition to their own work, to evaluate information systems. In Washington, those organizations include county-level government, WADOH, and perhaps CDC.

4.3.4.2 Focus group comments about the guidebook document:

- There is a need for a brief summary of the evaluation strategy in addition to the guidebook so that users and decision makers can quickly review the steps of the evaluation and understand the time commitment involved in executing it.

- Participants requested that further explanation of the evaluation methods be added by referencing scientific literature. However, the document should be as brief as possible.

- Participants agreed the written descriptions of the evaluation strategy steps were helpful, and that additional graphics/charts would also be useful.

4.3.5 Modifying the evaluation strategy

Our evaluation strategy, as it was applied at PHSKC and described in our evaluation guidebook is summarized in the following diagram:

Figure 21 - Original evaluation strategy recommendations

Based on the feedback we received from participants in our focus group meetings, there was one essential component of the evaluation strategy that was missing: the need to simultaneously have the external organizations go through the process of identifying their work through task analysis and use the same evaluation strategy to evaluate the new information system. For most LHJs, a new information system will be provided by a state department of health, which suggests that a state department of health may benefit from taking part in task-centric evaluation of an information system prior to implementing or adopting a new system. As expressed in our focus group meetings, a LHJ will need to assure that any new system will simultaneously meet its internal needs for data management as well as the needs of external organizations. Whether the system is provided by an external organization, or the LHJ is considering the new tool on its own, having both groups evaluate the system will help assure that the needs of both organizations are considered in the development, implementation, or adoption of an information system. This may prevent failed system implementations and provide an amiable transition for both parties. The new evaluation strategy we recommend is summarized in the following diagram.

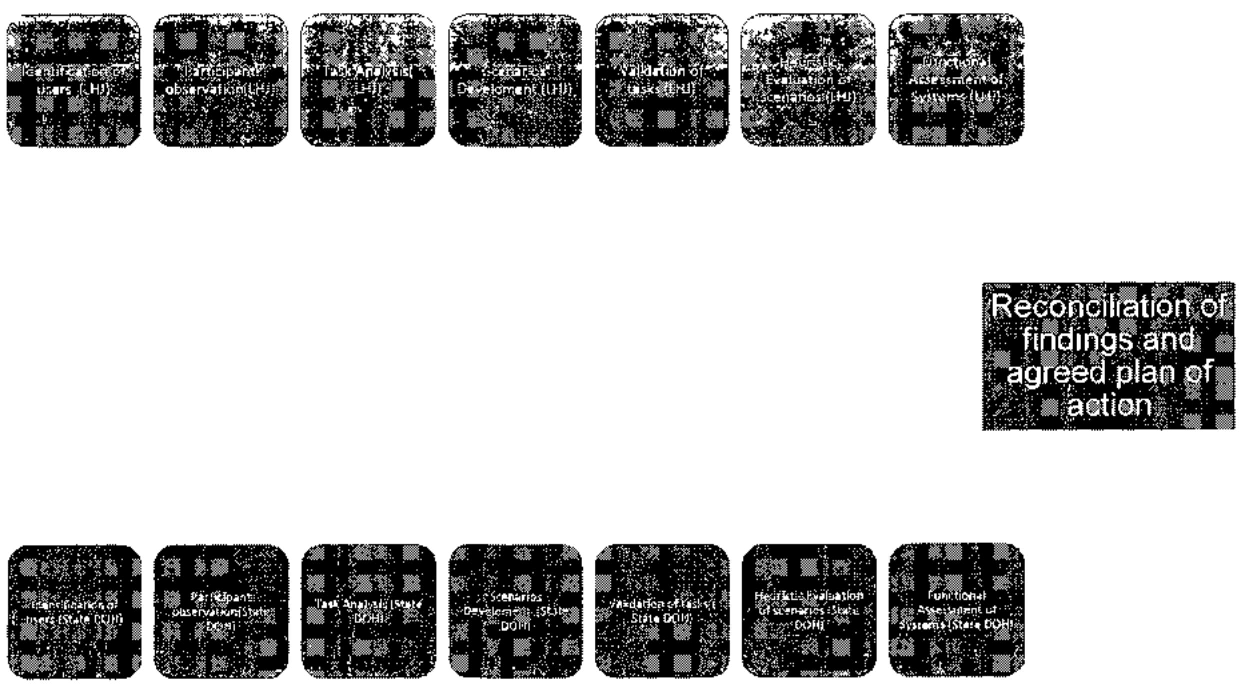


Figure 22 - Revised evaluation strategy recommendations

4.4 Limitations

Several limitations must be considered when reviewing the findings from this investigation. The evaluation strategy was developed and executed only one time in a single LHJ, which limits the generalizability of the investigation. As Aim 3 draws heavily on data collected from Aim 1 and Aim 2, the limitations of those investigations permeate through Aim 3, and must also be considered when reviewing the findings. The primary investigator, who executed the evaluation at CDEIS, is an experienced information system designer with years of evaluation experience. The successful completion of the evaluation may have been facilitated by the investigator's level of experience, and suggests that further research is required to explore the use of the methods by individuals with different backgrounds and training. The evaluation guidebook we developed was reviewed by local public health practitioners at two LHJs. Although our research in Aims 1 and 2 show some similarities in the use of information systems in LHJs, the small size of this sample limits the generalizability of our findings. The single heuristic we used to compare scenarios is not designed to capture tasks which by their completion in PHIMS might have obviated or removed the need for a task in the CDD. Tasks of this nature must be identified by the evaluator.

4.5 Discussion

The evaluation strategy we have proposed was developed to assist a local public health agency in the assessment of a new information system that became available through its state department of health. Friedman describes the challenges associated with evaluating information systems in biomedical informatics as being linked to three already complex and diverse areas of study: medicine and healthcare delivery, computer-based information systems, and evaluation methodology[98]. Similarly, evaluating information systems in local public health practice is challenged by the complexity of the three domains that intersect in this area: information science and computer science, evaluation methodology, and public health practice. Evaluation at the local public health level is further complicated by the multiple levels of organizational structure a local public health jurisdiction operates within. In addition to being responsible to the population it serves, an LHJ must also satisfy the needs of its county and state governments, abide by federal regulations for reporting, coordinate with healthcare providers, and work with other regional public health agencies.

Given the diverse range of activities that take place within a LHJ, and the multiple stakeholders potentially impacted when a new information system is adopted, it is not surprising that we found most LHJs in Washington reported having no standard evaluation procedures in place to assess new information systems. In our focus group meetings we presented a structured evaluation strategy to local public health practitioners, and they responded positively. Each group referenced a past system implementation failure and discussed how a structured evaluation strategy might have spared them the difficulties associated with system and implementation failures. Additionally, the groups recognized the value of having the evaluation strategy focus on their specific work practices.

In addition to the positive responses we received in focus group meetings, and the data collected through our survey, current trends in public health practice suggest a need for better evaluation tools at the local public health level. Several federal funding initiatives have focused on improving the reporting practices of state and local public health agencies, and those monies have funded an increased effort to develop or purchase online reporting systems that can be used by state and local public health agencies [1, 33, 37]. This suggests that there is, or will be, a new wave of online reporting tools (like PHIMS) that LHJs will be asked to adopt. CSTE reports that 68% of state public health departments are currently using NEDSS systems combined with other state and/or commercially available systems to meet their surveillance needs. [42]. As federal monies in these new initiatives are delegated to state public health agencies, it is at the state level that development and decision making for these types of systems is likely to take place. LHJs, and local public health practitioners, as expressed in our focus group data, seem to be asked to adopt systems following decisions made at higher organizational levels.

The phenomenon of information system selection taking place at the state level extends beyond the U.S. to other countries as well. In 2003, the Health and Emergency Medical Services Committee, a Canadian committee based in Ontario, recommended the adoption of a new information system to provide province-wide reporting of notifiable conditions using a web-based information system. The committee elected to implement the new system in a large LHJ for testing purposes. To test the system in a production environment, York Region (a large regional municipality in Ontario) was selected to implement the system and conduct double-data entry through the testing phase. Three additional staff members were hired to conduct the data entry through the three-month testing period [34]. Through this testing process, the committee was able to determine an appropriate implementation strategy for the system. However, testing a production system in this manner is not always possible, as we observed through our work with PHSKC. Canada's single-payer healthcare system may also play a role in Ontario's ability to provide funding for testing purposes. In the U.S., LHJs may not receive the fiscal support required to test an information system in this manner. It is in this context that our evaluation strategy, which can be executed independently by an LHJ, may have the most value.

In 2007 Hu and authors developed and evaluated an infectious disease information system, using a controlled experiment to test the system outside of its production environment. The evaluation recruited graduate student subjects to use the system to accomplish hypothetical public health tasks. Compared to typical spreadsheets for data analysis and retrieval, the results of the evaluation showed higher levels of user satisfaction when the infectious disease information system was used[33]. Evaluation of this type, while rigorous and thorough, may not be possible in all local public health contexts.

There is a clear need to keep local public health practice in the purview of decision makers at higher organizational levels. For example, recent funding efforts have been dedicated to provide LHJs an opportunity to express their needs, and to work with larger public health organizations to assure that local public health practice is recognized as a foundational component of the public health system. From 2005 to 2009, the Robert Wood Johnson Foundation (RWJF) funded the initiative "InformationLinks: Connecting Public Health with Health Information Exchanges," to assure the presence of local public health within the context of health information exchanges. They state that "RWJF awarded 21 one-year grants from June 2005 through December 2006 to state and local health departments and public health institutes to help them secure a 'seat at the table' in health information exchanges as they develop[99]."

The application of systematic evaluation strategies can also assist in bringing the local public health perspective to decision makers at higher organizational levels. The results of our evaluation at CDEIS were used by leaders at PHSKC and CDIES to convey their funding needs with city and state decision makers. The data helped to make a business case for the procurement of funds from the King County City Council for the continued developed of the CDD.

There are many evaluation methodologies used in biomedical informatics research. The evaluation strategy we have presented in this research was designed to meet the needs of a specific local public health agency in the evaluation of a new information system. The strategy can be used in the presence of constraints that limit the valid use of some common evaluation methods. Friedman, referencing House, refers to this as a "Decision Facilitation Approach" to evaluation, recognizing the goal is to support decision making about the use or acquisition of an information system or resource [98, 100]. Of particular interest in this context was the ability to evaluate the information system without implementing it, and with minimal interruption to the daily work of staff at the LHJ.

Following our investigation, we contacted the respondent at the single LHJ where a standard evaluation protocol to evaluate information systems was reported. In our discussion, we learned that the county used CDC's recommendations for the evaluation of surveillance systems to evaluate portions of their surveillance system. The evaluation included an assessment of the reporting rates of several diseases including E-Coli, Pertussis, Chlamydia, Meningitis and Salmonella. Using data from PHIMS, PHRED, and provider reporting data, they were able to identify under-reporting by providers of several diseases. The evaluation was lead by a fellow from the Council of State and Territorial Epidemiologists (CSTE), and was supported by leadership at the county level. In our focus group meetings, local public health practitioners noted that evaluations may be more successful if additional personnel were made available for evaluation purposes. Our discussion with this participant confirmed the value of allocating specific resources for information system evaluations.

Our evaluation strategy is similar to the task-centered design process. We followed the same techniques to acquire and document information about the work of local public health practitioners. However, we applied the method only as far as needed to collect this information, and then diverted from the typical task-centered design process [101],[102]. We did this because our goal was to assess the usefulness of an information system that had already been designed. Our efforts aimed to determine whether an information system would allow a specific group to continue its work, were the system replaced. This aim is different than the traditional use of task-centered design. In our divergence, we took tasks, descriptions, and scenarios and used these findings to compare two different information systems in a single environment. We used a single heuristic to assess the usefulness of each system for the tasks we identified. Alternatively, we might have selected to use a more general form of heuristic evaluation, where specific heuristics are pre-selected and experts review the tool based on them. For example, we might have used Molich and Nielsen's nine heuristics for user interfaces to evaluate the design of PHIMS. In this process, we would review PHIMS according to the following[103]:

1. Simple and natural design
2. Speak the users language
3. Minimize the user's memory load
4. Be consistent
5. Provide feedback
6. Provide clearly marked exits
7. Provide shortcuts
8. Provide good error messages
9. Error prevention

Assessing the user interface of PHIMS using heuristic evaluation may have provided meaningful feedback to designers about the usability of the user interface. However, the goal of the evaluation we conducted at CDEIS, and our evaluation strategy, was different. Molich and Nielsen's heuristics are meant to provide system designers with feedback that can be incorporated into a future iteration of the system. Our evaluation strategy was developed so LHJs can evaluate a system when they don't necessarily have the intention of redesigning it, but would like to compare it to another information system. It is also useful when access to the original designers of the system is limited. Our strategy has a more acute focus than Molich and Nielsen's heuristic evaluation. The purpose of the evaluation at CDEIS was to assess the potential challenges and benefits of adopting a new information system in a specific environment. We designed our evaluation strategy to meet this need.

Informatics research has recognized the value of task identification and the need to align information systems with the work they are designed to support. Goodhue and authors, when describing their model of task-technology fit suggests that "...for an information technology to have a positive impact on individual performance, the technology: (1) must be utilized and (2) must be a good fit with the tasks it supports [63]." In our evaluation at CDEIS, and in the evaluation strategy we outline in our guidebook, we have taken task analysis and used it to review the usefulness (or fit) of an information system.

The recent availability of multiple proprietary information systems to manage notifiable conditions information may also play a role in the requirement for a structured evaluation process for LHJs. Currently there are several information systems developed by commercial companies which market their software to leaders at LHJs. Often referred to as "Commercial Off The Shelf" (COTS) systems, these provide LHJs with a software solution to manage notifiable conditions, along with a series of other related features such as data analysis, report generation, and geographic information system connectivity. These systems, despite marketing to LHJs, are priced in such a manner that only a state-level department of health could reasonably afford to select and purchase them. For example, leading software from Atlas Development Corporation and Consilience Software range in cost from approximately $280,000 to $650,000 for a three-year contract with technical support [104, 105]. While these costs are calibrated well for statewide deployment, and for large municipal LHJs (such as Los Angeles County, where Atlas Public Health is deployed), purchasing at this level is prohibitively expensive for most small and medium LHJs. As Santerre and colleagues showed, spending within LHJs is proportional to the size of the population that is served [65]. This suggests that small and medium-sized LHJs are unlikely to have the financial capacity to purchase their own commercial information system. However, commercial systems are in place in several states.

The mission of the public health system is guided by several overarching frameworks that define the discipline and set goals for public health practitioners. Among these are the 10 Essential Public Health Services [90], the three core functions of public health [106], and the public health intervention wheel [107]. Each framework contains within it a description of public health work. The evaluation strategy we have recommended for LHJs to apply when evaluating information systems is guided by the observed work of local public health professionals. Their work is executed within a discipline guided by the principles contained within these three frameworks. The tasks we identified at PHSKC, for example, can be mapped directly to these three frameworks. In Figure 23, we have selected examples from each framework, and then show where the tasks we identified through the first portion of this evaluation are present across all three.

	Public Health Intervention Wheel			10 Essential Services			Core Functions of Public Health
	Surveillance	Disease & Health Event Investigation	Case Management	Monitor	Diagnose and Investigate	Inform and Educate	Assessment
1. Create new electronic records	x	x	x	x	x		x
2. Assign a caseTo a staff member			x		x		
3. Assess Case Status	x	x	x	x			
4. Maintain/update Electronic Records	x	x					
5. Maintain Paper Records	x	x	x				
6. Identify a Case or individual in the Electronic Record	x	x	x	x	x		x
7. Harmonizing paper records with Electronic records							
8 Use the electronic record during patient contact and data collection	x	x	x				
9 Data cleaning	x			x			
10. On-the-Fly Analysis of disease or trend	x	x		x	x		x
11. Review comments to determine potential causes of disease	x	x		x	x		x
12. Create queries	x	x	x	x	x	x	
13. Re-use a Pre-made Query/Report						x	
14. Edit a Pre-made Query/Report						x	
15. Export data for analysis with a statistical program						x	
16 Use CDD to fill out State Reporting Forms	x	x	x	x	x	x	x
17. Create new data repositories for disease-specific investigation	x	x		x	x		

Figure 23 - Task analysis findings mapped to three public health frameworks

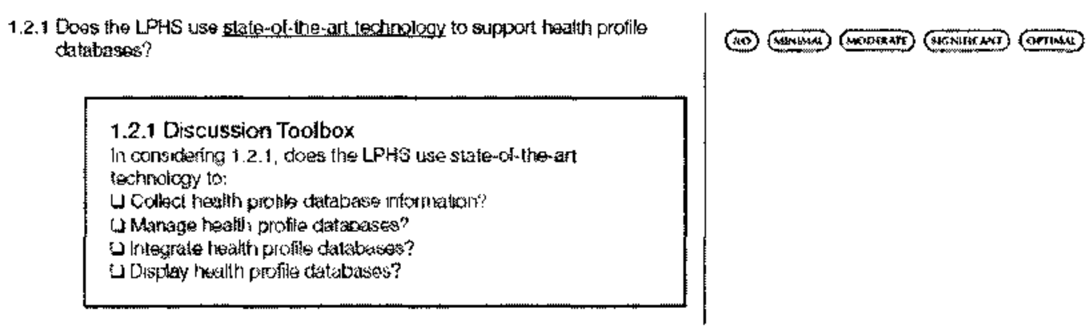
Chapter 5 - Discussion and Conclusions

The research described throughout this dissertation aligns with many recent research efforts in public health and informatics. There are multiple research studies and national-level information management initiatives which might be informed by the findings that we have presented in our research.

5.1 Discussion of Aim 1 & Aim 2 Findings

The Centers for Disease Control and Prevention (CDC) has developed and deployed a series of instruments aimed at identifying the extent to which the national public health system is capable of executing its mission, using the 10 Essential Public Health Services as the overarching framework to guide the investigation[108]. This program, the National Public Health Performance Standards Program (NPHPSP), uses assessment tools that are distributed to state public health systems, local public health systems, and local public health governance organizations throughout the United States. In 2002, the instrument designed for local public health jurisdictions was found to have sufficient face and content validity for use in the local public health environment [109]. From 2000 to 2009, several research studies analyzed the data collected through the initiative, and described the development of the assessment tools used for data collection [109-123]. Of the three assessment instruments developed through the NPHPSP, the assessment tool, named "Local Public Health System Performance Assessment," is particularly relevant to the research presented in Aims 1, 2, and 3 of this dissertation because it was designed to assess the capabilities of local public health agencies [124]. Contained within the assessment tool is a section called "LPHS Model Standard 1.2: Current Technology to Manage and Communicate Population Health Data." This section asks public health practitioners at LHJs to describe how they use technology in their efforts to communicate health information to the public.

There are no questions in the CDC's assessment tool that relate directly to the use of notifiable conditions information management systems, as our survey research did in Aim 2. However, some of the items in the tool suggest that our findings have relevance to this national effort. For example, the Local Public Health System Performance Assessment asks participants about their use of technology to communicate population health data. As shown in the item below, which is from the Local Public Health System Performance Assessment, participants are asked if they maintain health profile data using a state-of-the-art database[124]. Community health profiles are created by combining data from multiple areas of public health practice to describe the health of the community. Data from communicable disease and notifiable conditions investigations are an essential input for creating community health profiles.


1.2.1 Does the LPHS use state-of-the-art technology to support health profile databases?

NO | MINIMAL | MODERATE | SIGNIFICANT | OPTIMAL

1.2.1 Discussion Toolbox
In considering 1.2.1, does the LPHS use state-of-the-art technology to:
- ❑ Collect health profile database information?
- ❑ Manage health profile databases?
- ❑ Integrate health profile databases?
- ❑ Display health profile databases?

Figure 24 – Item 1.2.1 from the Local Public Health System Performance Assessment [124]

In Aim 1 of our research, we used task analysis to assess the use of an information management system in a local public health agency. We identified 17 primary tasks associated with data management related to notifiable conditions reporting. Several of the identified tasks contributed to the maintenance of a community health profile and the production of annual reports that are used to share health trends within King County. For example, tasks such as data cleaning, creating and re-using queries, and exporting data for statistical analysis contribute to the production of the annual reports which PHSKC makes available on paper and online each year. Examples of PHSKC's reports can be found on their website [125]. Our identification of tasks conducted at CDEIS allowed us to later survey the entire State of Washington to identify the degree to which those tasks were generalizable across the state. Through this process, we explored a more specific use of the "state-of-the-art" technology described in the NPHPSP in question 1.2.1 (see Figure 24). Future iterations of the CDC's assessment instrument may be improved by using our findings to update the instrument to reflect the identification of more specific tasks in LHJ work, such as communicable disease information management.

The presence of standard written protocols in local public health practice suggests an important connection between the LHJ's activities and adherence to internal and external standards. The Local Public Health System Performance Assessment asks participants about the presence of written protocols for communicable disease investigation. Similarly, one of the items in our survey (described in Chapter 3) asks whether the LHJ maintains a standard procedure for information system evaluation. We found that very few groups have such a procedure in place. This is another example of the alignment of the Local Public Health System Performance Assessment survey instrument, and the related content in our survey questionnaire.

Please answer the following questions related to Model Standard 2.2:

2.2.1 Does the LPHS maintain written protocols for implementing a program of case finding, contact tracing, source identification, and containment for communicable diseases or toxic exposures? (NO) (MINIMAL) (MODERATE) (SIGNIFICANT) (OPTIMAL)

Figure 25 - Item2.2.1 from the Local Public Health System Performance Assessment [124]

In their description of a hierarchical schema for taxonomy of public health work [sic], Merrill and authors include public health tasks as an essential component of the taxonomy. The authors identified essential public health tasks using public health document analysis and the extrapolation of keywords from public health documentation. These tasks were validated using expert evaluation [49]. Through this process, the authors identified a set of 44 tasks that describe the broad range of activities that take place in a local public health department. Our findings from Aim 1, a list of 17 primary tasks executed while managing notifiable conditions information, focused on a finite scope of public health activity. Where Merrill and authors sought to describe all of the work of local public health agencies, we aimed to describe the tasks associated with a specific type of work within local public health practice. We later found that these same activities take place in other LHJs throughout Washington. In Table 15, we compare our findings with those of Merrill and authors'. There is congruence in the tasks that each research project identified. For each of Merrill's tasks in the table, one or more of our tasks correspond to the public health work identified by Merrill and authors. Merrill and authors explored the work of local public health work on a larger scale than our investigation, yielding more tasks, and tasks that cover more of the overall work of LHJs. However, our research identified tasks related to the specific use of an information system, a level of granularity not found in Merrill and authors' investigation. As described in Chapter 4, tasks associated with the use of a current information system may serve as direct inputs into system design and information system decision-making. We followed a task-centered design methodology in our investigation with the hope that our work may inform future design and evaluation work [74]. By showing the congruence between our work and Merrill's, we demonstrate how our research supports the hypothesis made by other public health informatics researchers; that local public health agencies in different counties and states conduct similar work, and that there is value to identifying those similarities [45, 126].

In 2007, Perry and authors developed a matrix of skills and activities needed to carry out effective responses to outbreaks of disease in Africa. Using document reviews (as Merrill and authors did) and semi-structured interviews, Perry and authors developed a matrix highlighting the various levels of health stakeholders involved in the detection and response of priority diseases. Their work describes the role of each stakeholder in the disease detection and response process [70]. The matrix displays several activities executed by stakeholders, and shows that the "District, State, Province" stakeholder plays an important role in the activity "Analyze and Interpret." This activity refers to the analysis and interpretation of data regarding priority diseases in the area. Two of the diseases used in Perry's matrix, cholera and malaria, are reportable conditions in both the United States and in Washington, where our task analysis for Aim 1 was executed

[127]. The "Analyze and Interpret" activity described in Perry's matrix specifies actions that are carried out by the "District, State, and Province" stakeholder. These activities include:

- Define denominators and obtain data for ensuring accurate denominators
- Aggregate data from health facility reports
- Analyze case-based data by person, place and time
- Calculate rates and thresholds
- Compare current data with previous periods
- Prepare and periodically update graphs, tables and charts to describe time, person and place for reported diseases and conditions
- Make conclusions about trends, thresholds, and analysis results
- Describe risk factors for priority disease or conditions[70]

Many of these activities could be supported by the notifiable conditions information system in use at the "District, State, Province" level. Used in combination with Perry's findings, our task list from Aim 1 may inform the integration of information systems in the WHO African Region. Public health practitioners in these areas may use information about the use of notifiable conditions information systems to determine whether such a system is appropriate for their environment. Additionally, our recommendations for task-centered evaluation of systems in public health practice (as described in Chapter 4) may provide a suitable strategy to evaluate information systems in this context.

The CDC have used business process analysis in many efforts to help define work which takes place within the public health system. In 2004, the Division of Sexually Transmitted Disease Prevention hired contractors to model the business processes of the division. In a 2004 report describing this initiative, Capgemeni, the organization contracted to execute the analysis, described the hierarchy of business process models. They suggest five levels of business processes which make up the CDC's analysis: Mega Processes, Major Processes, Sub Processes, Activities, and Tasks, "Tasks" are defined in the report as "A workstep performed to complete an activity. A number of worksteps may be required to complete an activity[128]." The evaluation strategy we have proposed in this research uses a similar definition of "task:" LHJs that apply our evaluation strategy would have useful input to offer in the work of larger business process analysis efforts. The tasks identified and validated through our evaluation strategy fit directly into other models of evaluation, such as the business process analysis model proposed by Capgemini, and the model used by PHII in their "Taking Care of Business" report[45]. Similarly, the results from Aims 1 and 2 may provide input into larger evaluations of public health activity. The overall use of business process analysis has been emphasized in several organizations and national efforts involving public health research [45, 128-130]. The method provides an opportunity for organizations to review their work in manageable, discrete units which can be modified through a process called business process re-engineering. By documenting the work of organizations, work practices can be altered or re-arranged to make optimal use of resources.

Table 15 - Tasks Identified in Aim 1 compared to tasks identified by Merrill and authors [49]

Tasks identified by Merrill and authors[49]	Tasks identified in Aim 1[1]
Manage files, prepare reports and/or correspondence	Maintain/update electronic records Maintain paper records Harmonize paper records with electronic records
Schedule services and inspections	Assess case status
Register and enroll clients	Identify a case or individual in the electronic record Create new electronic records Use the electronic record during patient contact and data collection
Review medical records	Identify a case or individual in the electronic record Review comments to determine potential causes of disease
Conduct community assessments	Data cleaning Export data for analysis with a statistical program
Investigate health problems, including environmental health	On-the-fly analysis of disease or trend Review comments to determine potential causes of disease Create queries Re-use a pre-made query/report Edit a pre-made query/report Export data for analysis with a statistical program Create new data repositories for disease-specific investigation
Report data to the county or state	Use CDD to fill out state reporting forms
Take part in public health research	Create queries Re-use a pre-made query/report Edit a pre-made query/report Export data for analysis with a statistical program

Following our investigation, CDEIS began work with information system developers at PHSKC to develop specifications for a new version of the CDD. The two groups developed a report which describes the features required in the updated version of the CDD[131]. In Table 16 below, we describe some of the major requirements for the new system, and comment on how the results of our task analysis may have facilitated the identification of the requirement.

Table 16 - Relationship of updated CDD requirements [131] to tasks and scenarios

New feature to include in CDD (summary)	Related task(s) identified in our investigation[1]	Relationship of tasks, scenarios, and new feature
Retain functionality of current CDD	All tasks indentified in our study	The functionality of the original CDD, which is captured through our task list, remained essential in the redesigned system.
Configure data input logic	Data cleaning	Data cleaning efforts can be reduced through the use of input logic which constrains data entry forms to only allow data in the correct format. We described this in our scenarios.
Identify duplicate records	Identify a case or individual in the electronic record Data cleaning	Our observations revealed regular searching in the CDD to assure that cases did not already exist in the database.
More free text in comments	Review comments for relevant epidemiologic information	Comments (which are stored as free text in the CDD) were limited in the original CDD, requiring abbreviations and limited notation within a case record. We documented this in our scenarios.
Outbreak investigation	Create new data repositories for disease-specific investigation	Outbreak investigation was not an integrated feature of the original CDD. Outbreak databases were created separately during an investigation and data was incorporated following the investigation. Our scenarios described this work-around.

5.2 Discussion of Aim 2 Findings

Surveys are widely used as a data collection method in public health research. Several public health studies that use survey research have focused on the performance of public health agencies in an effort to assess the ability of LHJs to effectively carry out the mission of public health. Some of these surveys include items that address the use of information systems in public health practice.

The 10 Essential Services of Public Health have been used as an overarching framework for measuring public health agency performance in the NPHPSP [108, 124]. Prior to the research conducted through the NPHPSP, Turnock and authors assessed the performance of local public health agencies using the three core functions of local public health as a framework to develop questions related to LHJ performance [132]. Turnock and authors found that LHJ performance was not yet at the desired level, and called for enhanced performance and capacity building at the LHJ level. In chapter 4, we showed how our task analysis produced tasks that can be mapped to each of the aforementioned public health frameworks.

In 2008 Erwin conducted a review of the literature addressing performance within local public health agencies. The term "performance" was used in Erwin's study to refer to an LHJ's ability to deliver public health services to the community. Erwin's systematic literature review identified a relationship between size of LHJs and their level of performance: "Higher performance was generally noted for LHDs that are larger, serve larger populations, and have higher expenditures [133]." We similarly found several items on our survey instrument where responses varied significantly based on LHJ size. We also found that some responses varied based on the size and presence of a separate communicable disease section.

In 2003, Burke and authors described their findings from a national survey of local public health departments [43]. The report, "Information Technology Survey Report For the Turning Point National Excellence Collaborative for Information Technology," was based on an information technology questionnaire developed for LHJs. The survey had three research objectives:

- To determine what information technology is being used in U.S. local health departments
- To determine how end users, meaning professional staff members in local health departments, rate the software they use
- To determine the perceived information technology needs of local health department staff members[43]

The response rate of the survey was 11%. Of the 3,131 questionnaires mailed out, 349 were returned with responses. This response rate, considered relatively low by the authors, was attributed to three primary factors:

- An overly complex survey
- The use of "cold" interviewing, i.e., they didn't always have personal contact with someone at the LHJ before sending out the survey

- The complaint by potential participants that they already respond to too many surveys [43]

We used this information to achieve an optimal response rate as we developed a deployment strategy for the survey research in Aim 2. We ensured that the survey was easy to complete by writing text with an acceptable Fleish-Kinkaid readability score. We also communicated directly with potential participants via email, and collaborated with the Washington State Department of Health in identifying appropriate participants meeting our inclusion criteria. As a result, we achieved an optimal response rate. Future research concerning public health information system research may consider replicating the methods we used to achieve acceptable response rates.

Several findings from Burke and authors' questionnaire align with findings from the questionnaire that we distributed in Aim 2. For example, Burke and authors found that the Microsoft Office suite was the most frequently mentioned software product in the survey. While Burke and authors asked LHJs to report about the software used for all tasks in local public health, our instrument exclusively asked about software used for notifiable conditions information management. However, we identified a similar trend in the use of Microsoft Office products. When an electronic information system was used for notifiable conditions information management, participants from our study reported frequent use of Microsoft Office products, specifically Microsoft Excel. Given the congruency of these findings, further investigation into the use of Microsoft Office tools in local public health practice may be warranted. In our task analysis (Aim 1) we also found that Microsoft Access and MS-SQL were the primary tools used for information management at PHSKC. We hypothesize that the flexible nature of these tools and their wide use among technology support staff may afford LHJs the ability to frequently customize them to meet the changing and dynamic information management tasks involved in notifiable conditions information management. An additional hypothesis may be that these tools are more readily available than software tools specifically designed for notifiable conditions information management because they do not require additional software licensing fees.

In discussing the specialized software suites available to participants from LHJs, Burke and authors explained, "most are off-the-shelf commercial programs or specialized programs provided by the State." Our questionnaire asked participants about their use of COTS systems, as well as an online information management system offered by WADOH. Our questionnaire also aimed to identify the *tasks* that are completed with the systems. Burke and authors documented the systems used in LHJs across the U.S., but did so with a larger scope (inquiring about many types of systems). They described user satisfaction with the software available and the information technology needs of LHJs. Burke and authors summarized their findings of LHJ information system needs, saying: "The needs reported by health departments primarily dealt with better equipment, new or better software, training, and Internet access[43]." In response to our questions about the use of electronic information systems, participants similarly described a need for software that more closely aligned with their information management needs.

Identifying common information systems in public health practice is a strategy that can address gaps in public health informatics literature. In 2009, Uscher-Pines and authors surveyed state epidemiologists throughout the U.S. to identify the presence and usage of syndromic surveillance systems throughout the country. The authors report the specific systems used, the percentage of states that used them, and the overall use of syndromic surveillance systems throughout the U.S. [134]. In our survey research, we similarly identified the presence, usage, and type of systems used in local public health agencies to execute notifiable conditions information management tasks. Uscher-Pines and authors also pointed out that of each of the responding states used one of two syndromic surveillance systems (Rods or BioSense), with the occasional use of an additional system to execute their syndromic surveillance activities. Although LHJs and their work activities are not uniform in all aspects, we found some commonality across LHJs in their selection and usage of information systems. Uscher-Pines and authors' study and our research findings described here contribute to the growing body of literature which describes the commonality that exists within public health information management and information systems.

Efforts to identify the similarities that exist in the working environments of public health agencies are slowly building a literature base to support the development of public health information systems. The "Common Ground" initiative, funded by the Robert Wood Johnson Foundation and directed by the Public Health Informatics Institute (PHII), provided support for 15 state and local public health agencies to collaborate with two major goals:

- Analysis and redesign of public health business processes
- Defining collaboratively a set of information system requirements for technology to strengthen public health agencies[126]

Through the "Common Ground" initiative, Turner and authors documented the workflow of communicable disease activities at Kitsap County, a small county in Washington [48]. Through their investigation, the authors present a communicable disease workflow diagram similar to the workflow diagram that we presented in Chapter 2. Our workflow diagram, in comparison to Turner and authors', focuses on the information lifecycle of a communicable disease case and is specifically tied to the actions taking place with an information system at PHSKC [1, 48]. Turner and authors present the communicable disease work of a local public health agency broadly. Our results specify the use of information systems in that context. Through our survey research conducted in Aim 2, we found that the information management tasks we identified in Aim 1 were executed at nearly all of the LHJs in Washington, including Kitsap County, the site of Turner and authors' investigation.

The Public Health Informatics Institute (PHII) produced a report in 2006 that aimed to identify common business practices across local public health agencies. The report, entitled "Taking Care of Business: A Collaboration to Define Local Health Department Business Processes," describes task identification (recognizing and documenting tasks) and task description (documenting how tasks are executed) as essential components of the group's business process analysis strategy. Specifically, the report identifies the concepts "Describe tasks and workflow" and "Identify common task sets" as steps that are taken during business process analysis. By working with several local public health agencies throughout the U.S., PHII identified a business process called "Communicable Disease and Clinical Intervention & Treatment," which included the following tasks:

- Perform assessment
- Provide health counseling
- Provide information & referrals
- Perform client intake (history, determine need, obtain consent)
- Prepare inventory (assemble, store medication)
- Communicate risks as needed
- Administer treatment/medication[45]

The task "Perform Assessment," which refers to the steps taken to identify health challenges in the community, provides the starting point for our investigation into the use of information systems in local public health jurisdictions. By identifying LHJs that are commonly involved in the assessment of health threats (including communicable disease and other notifiable conditions), and naming the business process in which these activities take place, PHII provided a platform from which our investigation of the use of information systems can inform public health practice.

The "Taking Care of Business" report also provides what the authors refer to as an "Operational definition of a local health department." They explain that a "functional local health department" takes part in several specific activities. Upon review of this list, we selected a portion of those activities our research findings support. We have presented those activities in the list below, where we have also suggested how our findings may support the activities that PHII describes.

- Investigates health problems and health threats.

  Our research described the use of information systems during disease investigation, and identified uniformity across Washington's LHJs during these investigations.

- Prevents, minimizes, and contains adverse health effects from communicable diseases, disease outbreaks from unsafe food and water.

  The majority of the work we observed during our task analysis in Aim 1 (which later provided the basis for our survey in Aim 2) was related to the investigation of communicable disease.

- Serves as an essential resource for local governing bodies and policymakers on up-to-date public health laws and policies.

  The evaluation strategy we present in Aim 3 can assist LHJs in guiding policymakers when allocating resources toward information system expenditures.

- Provides science-based, timely, and culturally competent health information and health alerts to the media and to the community[45].

  Several of the tasks we identified in Aim 1 (and later enumerated in Aim 2) are associated with an LHJ's ability to communicate health-related messages to the general public.

The International Society for Disease Surveillance (ISDS) has launched an initiative to define the meaningful use of information in public health syndromic surveillance systems. Bringing together state-level public health practitioners, consultants, and academic experts in public health, the group recently published a preliminary report entitled "Core Business Model and EHR Requirements for Syndromic Surveillance[129]." The purpose of the document is "...to provide a comprehensive description of PHSS (Public Health Syndromic and explain why certain data elements are valued and included as part of the recommended minimum syndromic surveillance message.[129]" In the report, ISDS members, working with the PHII, applied methods similar to those used in PHII's "Taking Care of Business" report to identify the core business processes and task sets of syndromic surveillance in public health practice. The group used the resultant information to describe the data that is needed from various health-related entities (providers, public health clinics, laboratories, etc.) to conduct syndromic surveillance. The context diagram below shows the group's view of syndromic surveillance activities. As it relates to our work, it is important to note that the diagram shows "Local, Regional, or State Public Health Authority or Designees" as the central entity.

Syndromic surveillance depends on various types of data to predict health concerns in order to give emergency services and public health agencies time to prepare for an emerging (or emergent) health concern. One major source of data for this type of analysis is Emergency Department (ED) data from hospitals and other providers. This data is different from the typical data used during communicable disease surveillance, which tends to be diagnosis or notification of a suspected notifiable condition. Although the data used in the ISDS report is different from that used here, our research into the use of information systems for notifiable conditions information management may facilitate future work in syndromic surveillance. As local public health agencies are one of the central entities working with syndromic surveillance, the information systems used to conduct notifiable conditions information management in local public health departments may become integrated with information systems used to conduct syndromic surveillance. Commercial communicable disease investigation information systems such as Atlas Public Health are marketed as having syndromic surveillance capabilities [104]. Additionally, it is likely that the communicable disease specialists at LHJs will be the individuals using and executing syndromic surveillance activities. The tasks that we identified in Aim 1 may provide a starting point for reviewing the use of information systems for syndromic surveillance activities in LHJs. In our survey research, we found that the majority of respondents in Washington believed local public health practitioners would take part in the design of notifiable conditions information systems. ISDS may take note of this finding to support the inclusion of local public health practitioners in the development of their syndromic surveillance models.

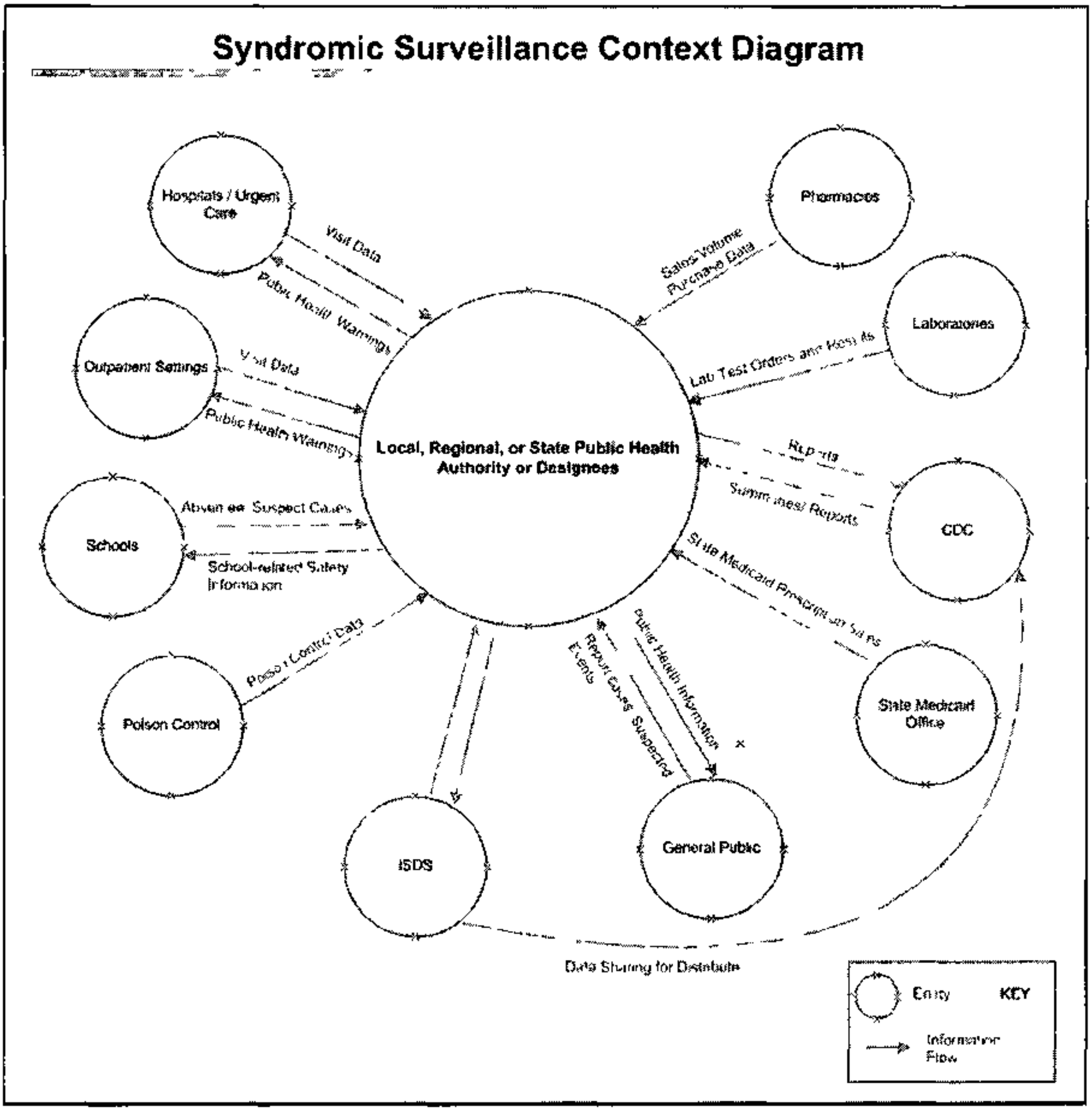


Figure 26 - Business context diagram for PHSS [128]

5.3 Discussion of Aim 3 Findings

Integrating new information systems into local public health practice is challenging. In 2005, public health stakeholders in North Carolina met to discuss data management and analysis capacity following a natural disaster. Miranda and authors summarized the meeting: "It was determined that local health departments (LHDs) lacked the skills, resources, and infrastructure necessary to use sophisticated information management systems, particularly those that incorporated spatial dimensions of public health practice [135]."

As we discussed in Chapter 4, the evaluation of information systems in public health practice is a complex activity. Within the public health informatics literature there are some existing strategies that apply to the evaluation of information systems in public health practice. Our strategy shares some similarities with the available evaluation strategies published by public health agencies and researchers. However, there are some key differences that may make our strategy useful in local public health practice settings. We explore those similarities and differences below.

The purpose of an evaluation guides the types of data that are collected, and the environment where an evaluation takes place has a strong influence on the methods used to collect the data. In our review of the literature, we found few peer-reviewed articles that described the evaluation of an information system for notifiable conditions information management in a local public health department. One study reported by the Health and Emergency Medical Services Committee in Canada [34] described the evaluation of a public health information system. However, the evaluation took place with significant resources allocated to testing in a real-world environment. At PHSKC, where we applied our evaluation strategy, and perhaps other LHJs throughout the U.S, this type of evaluation is not possible due to resource constraints and staffing challenges. In our focus group meetings, which we describe in chapter 4, the public health practicioners that we met with had neither the time nor the resources to to execute the evaluation strategy on their own.

Communicable disease surveillance is a major component of disease surevillance systems. In 1988, Thacker and authors, working with the CDC, proposed a structured evaluation method for public health surveillance systems that addressed the need to measure the overall quality of a surveillance system by several attributes [53]. In 2001, German and authors updated the original guide and described four new parameters not accounted for in the original surveillance recommondations. German and authors published this report in the CDC's MMWR [52]. The authors describe the need for four additional factors to be considered in surveillance system evaluation:

- The integration of surveillance and health information systems
- The establishment of data standards
- The electronic exchange of health data
- Changes in the objectives of public health surveillance to facilitate the response of public health to emerging health threats (e.g., new diseases)[52]

German and authors developed their evaluation strategy with a slightly different purpose than our evaluation strategy. They state that, "The purpose of evaluating public health surveillance systems is to ensure that problems of public health importance are being monitored efficiently and effectively[52]." Our evaluation strategy is meant to identify the benefits and challenges associated with adopting a new information system in local public health practice, and to do so with minimal impact on the ongoing work of the public health agency. However, the data generated through our evaluation strategy may provide information which can be used directly in other models of evaluation, which may take place at a higher organizational level than local public health practice.

Thacker and authors' original evaluation recommendations, as well as the updated version developed by German and authors, were designed to evaluate an entire surveillance system, as opposed to a specific information system within a surveillance system. However, the evaluation strategy that German and authors propose contains several attributes which align with the evaluation strategy that we have described through our research in Aim 3, and there are some important differences between the two. In Table 17 we show the evaluation tasks German and authors recommend, and map the steps we have outlined in our evaluation strategy to German and authors'. We also describe important similarities and differences between the two strategies.

Table 17 - Comparison of CDC's evaluation strategy for surveillance systems with our task-centered evaluation strategy

Primary evaluation tasks recommended by German and authors	**Steps in our evaluation strategy**	**Similarities between the two strategies**	**Differences between the two strategies**
Engage the Stakeholders in the Evaluation	Identification of users	Meetings and conversations with leaders and stakeholders are used to identify individuals to work with throughout the evaluation	German suggests reaching out to all stakeholders. Our strategy involves identifying users of a specific information system, or those who may access data from the system
Describe the Surveillance System to be Evaluated,	Participant observation and task analysis	The goal in each of these steps is to clearly specify what the surveillance system is meant to do. German and authors state that in this step evaluators should: Describe the purpose and operation of the system. Describe the resources used to operate the system.	Our recommendation is to use participant observation to identify uses of an information system. German and authors describe multiple methods to describe the surveillance system
Focus the Evaluation Design	N/A	N/A	As a general evaluation framework for surveillance systems, German and authors suggest that evaluators define the purpose of the evaluation clearly, and state the use of the evaluation data as well as the methods that will be used. Our evaluation strategy is designed specifically for comparing information systems in local public health. We have pre-selected the purpose and methods of the evaluation.
Gather Credible Evidence Regarding the Performance of the Surveillance System	Scenarios development & Validations of tasks and scenarios	Data regarding system usage and performance is collected. German and authors recommend that evaluators "Indicate the level of usefulness." Both evaluation strategies include a method for verifying the data collected with end users and participants	Our evaluation strategy allows tasks associated with the use of an existing information system to specify how well a new system would integrate into a LHJ. German and authors recommend the following indicators as measures of system usefulness; Simplicity, flexibility, data quality, acceptability, sensitivity, predictive value positive, representativeness, timeliness, and stability.
Justify and State Conclusions, and Make Recommendations	Heuristic evaluation of the scenarios and functional assessment of the systems	In this step, the data collection ends and assessments are made using the data.	Our evaluation strategy describes a specific method for data analysis. German and authors offer multiple possibilities for analysis depending on the purpose of the assessment.
Ensure Use of Evaluation Findings and Share Lessons Learned	Reconciliation of findings and agreed plan of action	Findings are shared with stakeholders and decision makers.	N/A

In 2005, PHII designed an evaluation framework to assess the value of integrating data from different health information sources in public health practice. To display the evaluation framework's components, PHII developed a logic model that shows the inputs, types of quality, uses, and impacts system integration may provide. The model presents an evaluation strategy that is very comprehensive, including nine "dimensions" of evaluation criteria to evaluate an information system in public health. The model describes areas of public health work typically supported by an information system, such as "tracking patients" and "tracking population indicators," and provides a guide to evaluators when considering the components of an evaluation that may be appropriate when evaluating an information system in a public health context [56].

Our evaluation strategy differs from PHII's in that it provides recommendations for the methods that can be used to execute the evaluation. Where PHII's framework provides overarching guidance to evaluators, our evaluation strategy provides step-by-step recommendations for comparing information systems in a specific context, which we described in Chapter 4. Despite the different purposes of each evaluation strategy, there are many similarities between PHII's work and the research described here. PHII includes a category in their framework named "Use," which includes the sub-categories "Individual use," "Epidemiological use," and "User Satisfaction." In our evaluation strategy, task analysis and participant observation allow an evaluator to document the important uses of a system, as observed during user activity in the actual work environment. As we observed and reported in Chapters 2 and 4, many of the tasks identified were associated with epidemiological investigations, described by PHII as

"Epidemiological use." Applying our evaluation strategy, those uses are revealed in the context of daily workflow in local public health.

As a general comment on evaluation, PHII notes that "...proven evaluation metrics must be developed for public health agencies to apply, in a consistent manner, to their information systems[56]." Our research provides an opportunity for public health agencies to use a standard model of evaluation to compare information systems. The comparisons are executed using metrics developed specifically for an LHJ's working environment, and compared systematically using scenarios.

5.4 Conclusions

The research presented throughout this dissertation has the potential to inform public health practice and public health informatics research in several areas.

Through the research presented in Chapter 2, we produced documentation describing the use of a notifiable conditions information management system in a large, municipal public health agency. Our findings address a gap in the literature where the tasks associated with the use of notifiable conditions information systems in local public health practices has not been explored. Our list of the 17 primary tasks associated with the use of a notifiable conditions information system was validated by public health practitioners. Future system developers and public health stakeholders may use this to inform their selection of information systems for their environment. Similarly, our findings may assist in designing new information systems. By understanding the role of information systems in notifiable conditions information management, decision makers, technical supervisors, and users in public health practice have the opportunity to consider their own information system needs. Our work carries forward the findings of several studies which investigated workflow and information systems in local public health practice, and it provides additional information about the use of information systems in an important area of surveillance: communicable disease and notifiable conditions reporting [1].

In Aim 2 we built on our findings from Aim 1 by developing a questionnaire to assess the generalizability of our initial findings. We collected information about the use of information systems in notifiable conditions information systems across LHJs in Washington, achieving a response rate of 91.4%. We found that tasks identified in Aim 1 are regularly conducted in other LHJs throughout Washington. The frequency that some tasks were executed with varied by the size and case throughput of the LHJ. Paper-based information systems are in use in 71.9% of LHJs in Washington, suggesting that although electronic systems are available, there may be some notifiable conditions information management tasks public health practitioners prefer to execute using a paper-based information system. We found no significant difference in the presence of paper-based systems across LHJs of different size. However, in the case of four specific tasks, small LHJs reported using a paper-based system at a significantly lower frequency than large and medium-sized LHJs; 40.6% of LHJs reported using an additional electronic information system (in addition to PHIMS) to manage notifiable conditions information, 75% of which were developed within the LHJ. Our research shows that both electronic and paper-based information systems are used by LHJs throughout Washington, and the frequency of tasks associated with the use of each system type varies according to the size of the LHJ and the number of case investigations. The implication of this data for system design is that information systems for notifiable conditions information management in local public health departments should be designed according to the expectation that all LHJs execute similar tasks with an electronic information system. However, the frequency of the tasks they execute varies according to the size and case throughput of the jurisdiction. Specific system functionality may be needed to complete high-frequency tasks in LHJs that are larger in size and that maintain higher case throughput. With much higher case throughput, these groups may suffer greater consequences if their needs are not met by the information systems they depend on.

In Aim 3, we used the results from Aim 1 to execute an evaluation that compared two information systems that were available to a local public health agency[4]. Following the completion of that evaluation, we developed a handbook written for other local public health practitioners to assist them in the execution of the same evaluation strategy. Using input from focus group meetings with local public health practitioners, evaluation literature in informatics research, and our experience with executing the evaluation, we refined the original evaluation model and modified the handbook accordingly.

The evaluation strategy we proposed can play an important part in future information system design efforts in public health. In addition to satisfying evaluation needs at the local public health level, the data collected through our evaluation process may have extended use. Reeder and authors argue for a reusable design approach to public health information system design. They suggest that the knowledge acquired from smaller design and evaluation efforts can contribute to large-scale design when the results are collected and shared in a standardized manner[136]. In our evaluation strategy, we propose a structured series of methods for evaluating information systems at the local public health level. While further investigation is needed to identify an optimal method for sharing design knowledge throughout the public health community, structured evaluation methods such as the one we propose may play an important role in harmonizing design efforts throughout the U.S.

References

1. Pina, J., et al., *Task analysis in action: the role of information systems in communicable disease reporting.* AMIA Annu Symp Proc, 2009. **2009**: p. 531-5.
2. McNabb, S.J., et al., *Conceptual framework of public health surveillance and action and its application in health sector reform.* BMC Public Health, 2002. **2**: p. 2.
3. Orthner, H., *Series Preface*, in *Evaluation Methods in Medical Informatics*, C. Friedman, Editor. 2000, Springer: New York. p. xi.
4. Pina, J., Turner, A, Kwan-Gett, T. *The Evaluation of Notifiable Conditions Reporting Systems for a Large Municipal Local Public Health Agency.* in *PHIN* 2008. Atlanta, GA.
5. Centers for Disease Control and Prevention. *Hepatitis B fact Sheet.* 2010; Available from: http://www.cdc.gov/ncidod/diseases/hepatitis/b/fact.htm
6. MMWR, *Historical Perspectives Notifiable Disease Surveillance and Notifiable Disease Statistics.* MMWR Morb Mortal Wkly Rep, 1996. **45**(25): p. 530-536.
7. Declich, S. and A.O. Carter, *Public health surveillance: historical origins, methods and evaluation.* Bull World Health Organ, 1994. **72**(2): p. 285-304.
8. Centers for Disease Control and Prevention. *Surveillance at NIOSH.* 2010 [cited 2010 6-2010]; Available from: http://www.cdc.gov/niosh/topics/surveillance/.
9. Institute of Medicine of the National Academies, *The Future of Public Health.* 1988.
10. Parsons, D.F., et al., *Status of electronic reporting of notifiable conditions in the United States and Europe.* Telemed J, 1996. **2**(4): p. 273-84.
11. World Health Organization. *Smallpox - Historical Significance.* 2010 [cited 2010 September, 2010]; Available from: http://www.who.int/mediacentre/factsheets/smallpox/en/.
12. Lombardo, J. and D. Buckeridge, *Disease Surveillance: A Public Health Informatics Approach*, ed. J. Lombardo. 2007, Hoboken: Wiley.
13. Centers for Disease Control and Prevention, *Nationally Notifiable Infectious Diseases.* 2009, CDC.
14. Roush, S., et al., *Mandatory reporting of diseases and conditions by health care professionals and laboratories.* Jama, 1999. **282**(2): p. 164-70.
15. Wu, T.S., et al., *Establishing a nationwide emergency department-based syndromic surveillance system for better public health responses in Taiwan.* BMC Public Health, 2008. **8**: p. 18.
16. McNabb, S.J., D. Koo, and J. Seligman, *Informatics and public health at CDC.* MMWR Morb Mortal Wkly Rep, 2006. **55 Suppl 2**: p. 25-8.
17. Jajosky, R.A. and S.L. Groseclose, *Evaluation of reporting timeliness of public health surveillance systems for infectious diseases.* BMC Public Health, 2004. **4**: p. 29.
18. Effler, P., et al., *Statewide system of electronic notifiable disease reporting from clinical laboratories: comparing automated reporting with conventional methods.* Jama, 1999. **282**(19): p. 1845-50.

19. Menkens, A.J., et al., *Local public health department accreditation: thoughts from North Carolina.* J Public Health Manag Pract, 2009. **15**(5): p. 443-5.
20. King County. *Epidemiology/Communicable Disease & Immunizations Group Detail.* 2010 [cited 2010 September]; Available from: http://directory.kingcounty.gov/GroupDetail.asp?GroupID=16670.
21. County of Los Angeles. *ACUTE COMMUNICABLE DISEASE CONTROL PROGRAM - Organizational Chart.* 2008 [cited 2010 September]; Available from: publichealth.lacounty.gov/acd/.../ACDC-OrgChartRevised%209-03-08.pdf.
22. United States Census Bureau. *Resident Population Estimates for the 100 Largest U.S. Counties Based on July 1, 2009 Population Estimates: April 1, 2000 to July 1, 2009.* County Population Estimates [cited 2010; Available from: http://www.census.gov/popest/counties/CO-EST2009-07.html.
23. Centers for Disease Control and Prevention. *Nationally Notifiable Conditions.* 2011; Available from: http://www.cdc.gov/ncphi/disss/nndss/nndsshis.htm.
24. Eysenbach, G., *Infodemiology: tracking flu-related searches on the web for syndromic surveillance.* AMIA Annu Symp Proc, 2006: p. 244-8.
25. Yih, W.K., et al., *Evaluating real-time syndromic surveillance signals from ambulatory care data in four states.* Public Health Rep, 2010. **125**(1): p. 111-20.
26. Osemek, P., J. Kocik, and K. Pasnik, *[Syndromic surveillance in circumstances of bioterrorism threat--the essence, application abilities and superiority over a traditional epidemiological surveillance].* Pol Merkur Lekarski, 2009. **27**(162): p. 535-40.
27. Hripcsak, G., et al., *Syndromic surveillance using ambulatory electronic health records.* J Am Med Inform Assoc, 2009. **16**(3): p. 354-61.
28. Dunbar, P.J., I.S. Painter, and L. Lekness, *Development of a multi-jurisdictional syndromic surveillance system.* AMIA Annu Symp Proc, 2007: p. 947.
29. LaPelle, N.R., et al., *Identifying strategies to improve access to credible and relevant information for public health professionals: a qualitative study.* BMC Public Health, 2006. **6**: p. 89.
30. Revere, D., et al., *Understanding the information needs of public health practitioners: a literature review to inform design of an interactive digital knowledge management system.* J Biomed Inform, 2007. **40**(4): p. 410-21.
31. Twose, C., et al., *Public health practitioners' information access and use patterns in the Maryland (USA) public health departments of Anne Arundel and Wicomico Counties.* Health Info Libr J, 2008. **25**(1): p. 13-22.
32. Washington State Department of Health. *Public Health Issue Management System.* [cited 2010 September]; Available from: http://www.doh.wa.gov/EHSPHL/Informatics/phims.htm.
33. Hu, P.J., et al., *System for infectious disease information sharing and analysis: design and evaluation.* IEEE Trans Inf Technol Biomed, 2007. **11**(4): p. 483-92.
34. Health and Emergency Medical Services Committee, *INTEGRATED PUBLIC HEALTH INFORMATION SYSTEM (IPHIS) PILOT PROJECT.* 2003.
35. Council of State and Territorial Epidemiologists, *A Brief Report: Outbreak Management System (OMS).* 2010.
36. Terry, T.J., Jr., *A system for electronic disease reporting and management. Determining the extent/spread of problems and minimizing consequences*

through rapid reporting and dissemination of critical information. IEEE Eng Med Biol Mag, 2002. **21**(5): p. 86-99.
37. MMWR, *Progress in improving state and local disease surveillance--United States, 2000-2005.* MMWR Morb Mortal Wkly Rep, 2005. **54**(33): p. 822-5.
38. Nguyen, T.Q., et al., *Benefits and barriers to electronic laboratory results reporting for notifiable diseases: the New York City Department of Health and Mental Hygiene experience.* Am J Public Health, 2007. **97 Suppl 1**: p. S142-5.
39. Loonsk, J.W., et al., *The Public Health Information Network (PHIN) Preparedness initiative.* J Am Med Inform Assoc, 2006. **13**(1): p. 1-4.
40. Kass-Hout, T.A., et al., *NHIN, RHIOs, and Public Health.* J Public Health Manag Pract, 2007. **13**(1): p. 31-4.
41. Centers for Disease Control and Prevention, *National Electronic Disease Surveillance System (NEDSS): a standards-based approach to connect public health and clinical medicine.* J Public Health Manag Pract, 2001. **7**(6): p. 43-50.
42. Centers for Disease Control and Prevention, *Status of state electronic disease surveillance systems--United States, 2007.* MMWR Morb Mortal Wkly Rep, 2009. **58**(29): p. 804-7.
43. Burke, M. and D. Evans, *Information Technology Survey Report For the Turning Point National Excellence Collaborative for Information Technology* 2003.
44. Doyle, T.J., et al., *PHSkb: a knowledgebase to support notifiable disease surveillance.* BMC Med Inform Decis Mak, 2005. **5**: p. 27.
45. Public Health Informatics Institue, *Taking Care of Business: A Collaboration to Define Local Health Department Business Processes.* 2006, Public Health Informatics Institute: Atlanta, GA.
46. Lenaway, D., et al., *Public health systems research: setting a national agenda.* Am J Public Health, 2006. **96**(3): p. 410-3.
47. Merrill, J., J.W. Keeling, and K.M. Carley, *A Comparative Study of 11 Local Health Department Organizational Networks.* J Public Health Manag Pract, 2010.
48. Turner, A.R., J., Lee S., *Connecting Public Health IT Systems with Enacted Work: Report of an Ethnographic Study.* AMIA Annu Symp Proc, 2008.
49. Merrill, J., J. Keeling, and K. Gebbie, *Toward standardized, comparable public health systems data: a taxonomic description of essential public health work.* Health Serv Res, 2009. **44**(5 Pt 2): p. 1818-41.
50. Haumer, P., K. Pohl, and K. Weidenhaupt, *Requirements Elicitation and Validation with Real World Scenes.* IEEE Trans. Softw. Eng., 1998. **24**(12): p. 1036-1054.
51. Lewis, D., *Evaluation for Public Health Informatics*, in *Public Health Informatics and Information Systems*, P. O'Carroll, Editor. 2003, Springer: New York. p. 239-250.
52. German, *Updated Guidelines for Evaluating Public Health Surveillance Systems.* MMWR, 2001 **50(RR13)**: p. 1-3.
53. Thacker, S.B., R.G. Parrish, and F.L. Trowbridge, *A method for evaluating systems of epidemiological surveillance.* World Health Stat Q, 1988. **41**(1): p. 11-8.
54. May, C., *A rational model for assessing and evaluating complex interventions in health care.* BMC Health Serv Res, 2006. **6**: p. 86.

55. Buehler, J.W., et al., *Framework for evaluating public health surveillance systems for early detection of outbreaks: recommendations from the CDC Working Group.* MMWR Recomm Rep, 2004. **53**(RR-5): p. 1-11.
56. Public Health Informatics Institute, *Towards Measuring Value: An Evaluation Framework for Public Health Information Systems.* 2005: Decatur, GA. p. 8.
57. Baxter, G.D., et al., *Using cognitive task analysis to facilitate the integration of decision support systems into the neonatal intensive care unit.* Artif Intell Med, 2005. **35**(3): p. 243-57.
58. Stanton, N.A., *Hierarchical task analysis: developments, applications, and extensions.* Appl Ergon, 2006. **37**(1): p. 55-79.
59. Carroll, C., et al., *Involving users in the design and usability evaluation of a clinical decision support system.* Comput Methods Programs Biomed, 2002. **69**(2): p. 123-35.
60. Carroll, J.M. *Five Reasons for Scenario-Based Design.* in *International Conference on System Sciences.* 1999. Hawaii
61. Ammenwerth, E., C. Iller, and C. Mahler, *IT-adoption and the interaction of task, technology and individuals: a fit framework and a case study.* BMC Med Inform Decis Mak, 2006. **6**: p. 3.
62. Maruping, L.M. and R. Agarwal, *Managing team interpersonal processes through technology: a task-technology fit perspective.* J Appl Psychol, 2004. **89**(6): p. 975-90.
63. Goodhue, D.L.T., Ronald L., *Task-technology fit and individual performance.* MIS Quarterly, 1995. **19**(2): p. 213-236.
64. NACCHO, *2008 National Profile of Local Health Departments.* 2008, National Association of County and City Health Officials: Washington, DC.
65. Santerre, R.E., *Jurisdiction size and local public health spending.* Health Serv Res, 2009. **44**(6): p. 2148-66.
66. United States Census Bureau. *Washington QuickLinks.* 2008 [cited 2008 2008]; Available from: http://quickfacts.census.gov/qfd/states/53000lk.html.
67. Pina, J., *Using participant observation for organizational discovery and systems analysis: global AIDS program Uganda.* AMIA Annu Symp Proc, 2006: p. 1064.
68. Go, K. and J. Carroll, *Scenario-Based Task Analysis*, in *The Handbook of Task Analysis for Human-Computer Interaction*, D. Diaper, Editor. 2004, Lawerence Erlbaum: London.
69. Diaper, D. and N.A. Stanton, *The Handbook of Task Analysis for Human-Computer Interaction.* 2004, London: Lawerence Erlbaum.
70. Perry, H.N., et al., *Planning an integrated disease surveillance and response system: a matrix of skills and activities.* BMC Med, 2007. **5**: p. 24.
71. Hackos, J.T. and J. Redish, *User and task analysis for interface design.* 1998, New York: Wiley. xix, 488 p.
72. Limbourg, Q., *Comparing Task Models for User Interface Design*, in *The Handbook of Task Analysis for Human-Computer Interaction*, D. Diaper and N.A. Stanton, Editors. 2004, Lawerence Erlbaum: London. p. 135.
73. Greenberg, S., *Working Through Task-Centered System Design*, in *The Handbook of Task Analysis for Human-Computer Interaction*, D. Diaper, Editor. 2004, Lawerence Erlbaum: London.

74. Lewis, C. and J. Reiman, *Task centered user interface design: A practical introduction*. 1993, Boulder, CO: University of Colorado.
75. Berg, B.L., *Qualitative Research Methods for the Social Sciences*. 4th ed. 2001, Needham Heights: Allyn and Bacon.
76. Washington State Office of Financial Management. *Census 2010 data products - Summary for Washington State*. 2011; Available from: http://www.ofm.wa.gov/pop/census2010/default.asp.
77. Redmond Library. *Washington State by the Numbers: The 2010 Census Results*. 2011 [cited 2011; Available from: http://redmondlibrary.blogspot.com/2010/12/washington-state-by-numbers-2010-census.html.
78. Washington State Department of Health, *Communicable Disease Epidemiology Section*. 2010.
79. Suen, J. and C. Magruder, *National profile: overview of capabilities and core functions of local public health jurisdictions in 47 states, the District of Columbia, and 3 U.S. territories, 2000-2002*. J Public Health Manag Pract, 2004. **10**(1): p. 2-12.
80. Lee, P., N.B. Giuse, and N.A. Sathe, *Benchmarking information needs and use in the Tennessee public health community*. J Med Libr Assoc, 2003. **91**(3): p. 322-36.
81. Washington State Department of Health. *Guidelines for Using Rural-Urban Classification Systems for Public Health Assessment*. 2009; Available from: http://www.doh.wa.gov/data/guidelines/RuralUrban1.htm.
82. Washington State Office of Financial Management. *Washington state growth management population projections for counties: 2000 to 2030*. 2011 [cited 2011; Available from: http://www.ofm.wa.gov/pop/gma/projections07.asp.
83. U.S. Census Bureau. *State & County QuickFacts - Washington State*. 2010 [cited 2010; Available from: http://quickfacts.census.gov/qfd/states/53000.html.
84. Annett, J., *Hierarchical Task Analysis*, in *The Handbook of Task Analysis for Human-Computer Interaction*, D. Diaper, Editor. 2004, Lawerence Erlbaum: London.
85. Rhea, L. and R. Parker, *Designing and Conducting Survey Research: A Comprehensive Guide*. Third Edition ed. 2005, San Francisco: Jossy-Bass.
86. Flesch, R., *A new readability yardstick*. J Appl Psychol, 1948. **32**(3): p. 221-33.
87. Dillman, D., *Mail and Internet Surveys - The Tailored Design Method*. 2000, New York: Wiley.
88. Truell, A.D., J.E. Bartlett, 2nd, and M.W. Alexander, *Response rate, speed, and completeness: a comparison of Internet-based and mail surveys*. Behav Res Methods Instrum Comput, 2002. **34**(1): p. 46-9.
89. SPSS Statistics. *SPSS Statistics Base 17.0 User's Guide*. 2010 [cited 2011; Available from: http://support.spss.com/ProductsExt/SPSS/Documentation/SPSSforWindows/index.html.
90. America Public Health Association. *10 Essential Public Health Services*. 2010 9/2010]; Available from:

http://www.apha.org/programs/standards/performancestandardsprogram/resexxentialservices.htm.
91. National Public Health Performance Standards Program, *10 Essential Public Health Services*, Centers for Disease Control and Prevention, Editor. 2010.
92. Washington State Office of Finance and Management, *Local Government Financial Reporting System*. 2011.
93. Allen, M., et al., *Heuristic evaluation of paper-based Web pages: a simplified inspection usability methodology*. J Biomed Inform, 2006. **39**(4): p. 412-23.
94. Bright, T.J., S. Bakken, and S.B. Johnson, *Heuristic evaluation of eNote: an electronic notes system*. AMIA Annu Symp Proc, 2006: p. 864.
95. Thyvalikakath, T.P., et al., *Comparative study of heuristic evaluation and usability testing methods*. Stud Health Technol Inform, 2009. **143**: p. 322-7.
96. Yen, P.Y. and S. Bakken, *A comparison of usability evaluation methods: heuristic evaluation versus end-user think-aloud protocol - an example from a web-based communication tool for nurse scheduling*. AMIA Annu Symp Proc, 2009. **2009**: p. 714-8.
97. Kulak, D. and E. Guiney, *Use cases : requirements in context*. 2000, Reading, Mass: Addison-Wesley. xvi, 329 p.
98. Friedman, C., *Evaluation Methods in Medical Informatics*. Computers and Medicine, ed. O. Orthner. 2000, New York: Springer.
99. Robert Wood Johnson Foundation. *Evaluation of InformationLinks: Connecting Public Health with Health Information Exchanges*. 2008 [cited 2010; Available from: http://www.rwjf.org/pr/product.jsp?id=25231.
100. House, E., *Evaluating with Validity*. 1980, Beverly Hills: Sage.
101. Tam, J. *Task-Centered System Design*. Foundations of HCI - Course Material 2010].
102. Lewis, C. and J. Rieman *Task-Centered User Interface Design - A Practical Introduction*. 2010]; Available from: http://hcibib.org/tcuid/.
103. Molich, R. and J. Neilsen. *Improving a human-computer dialogue : What designers know about traditional interface design*. in *Communication of the ACM*. 1990.
104. Atlas Development Corporation. *Infectious Disease Surveillance and Case Management*. 2010; Available from: http://www.atlaspublichealth.com/products/index.php.
105. Consilience Software. *Maven Disease Surveillance and Outbreak Management* 2010; Available from: http://consilweb.com/cms/index.php?option=com_content&task=view&id=17&Itemid=1.
106. Institute of Medicine, *The future of public health*. 1988, Washington, DC: National Academy Press.
107. Keller, L.O., et al., *Population-based public health interventions: practice-based and evidence-supported. Part I*. Public Health Nurs, 2004. **21**(5): p. 453-68.
108. Centers for Disease Control and Prevention. *National Public Health Performance Standards Program*. 2010; Available from: http://www.cdc.gov/nphpsp/.

109. Beaulieu, J. and F.D. Scutchfield, *Assessment of validity of the national public health performance standards: the local public health performance assessment instrument.* Public Health Rep, 2002. **117**(1): p. 28-36.
110. Brooks, R.G., et al., *Aligning public health financing with essential public health service functions and National Public Health Performance Standards.* Journal of public health management and practice, 2009. **15**(4): p. 299-306.
111. Keeling, J. and J. Merrill, *A re-examination of performance dimensions using data from the National Public Health Performance Standards Program V.1 instrument.* AMIA Annu Symp Proc, 2008: p. 999.
112. Beckett, A.B., et al., *The forgotten instrument: analysis of the national public health performance standards program governance instrument.* Journal of public health management and practice, 2008. **14**(4): p. E17-22.
113. Barron, G., J. Glad, and C. Vukotich, *The use of the National Public Health Performance Standards to evaluate change in capacity to carry out the 10 essential services.* J Environ Health, 2007. **70**(1): p. 29-31, 63.
114. Corso, L.C., et al., *Building a bridge to accreditation--the role of the National Public Health Performance Standards Program.* Journal of public health management and practice, 2007. **13**(4): p. 374-7.
115. Joly, B.M., et al., *Use of national public health performance standards to assess Maine's diabetes system.* Journal of public health management and practice, 2007. **13**(1): p. 68-71.
116. Erwin, P.C., et al., *The Local Public Health System Assessment of MAPP/The National Public Health Performance Standards Local Tool: a community-based, public health practice and academic collaborative approach to implementation.* Journal of public health management and practice, 2006. **12**(6): p. 528-32.
117. Ellison, J.H., *National Public Health Performance Standards: are they a means of evaluating the local public health system?* Journal of public health management and practice, 2005. **11**(5): p. 433-6.
118. McClellan, C.S., *Utilizing a national performance standards local public health assessment instrument in a community assessment process: the Clarendon County Turning Point Initiative.* Journal of public health management and practice, 2005. **11**(5): p. 428-32.
119. Baird, J.R. and K.J. Carlson, *National Public Health Performance Standards assessment: first steps in strengthening North Dakota's public health system.* Journal of public health management and practice, 2005. **11**(5): p. 422-7.
120. Mays, G.P., et al., *Identifying dimensions of performance in local public health systems: results from the National Public Health Performance Standards Program.* Journal of public health management and practice, 2004. **10**(3): p. 193-203.
121. Potter, M.A., G. Barron, and J.P. Cioffi, *A model for public health workforce development using the National Public Health Performance Standards Program.* Journal of public health management and practice, 2003. **9**(3): p. 199-207.
122. Beaulieu, J.E., F.D. Scutchfield, and A.V. Kelly, *Recommendations from testing of the National Public Health Performance Standards instruments.* Journal of public health management and practice, 2003. **9**(3): p. 188-98.

123. Reid, W.M., et al., *National Public Health Performance Standards: workforce development and agency effectiveness in Florida.* Journal of public health management and practice, 2001. **7**(4): p. 67-73.
124. Centers for Disease Control and Prevention. *Local Public Health System Performance Assessment.* 2010; Available from: http://www.cdc.gov/nphpsp/documents/local/Local.BookletA.pdf.
125. Public Health - Seattle and King County. *Data, publications and reports - 2008 Communicable Disease Summary* 2008 [cited 2010; Available from: http://www.kingcounty.gov/healthservices/health/data.aspx.
126. Public Health Informatics Institue. *Common Ground.* 2010 [cited 2010; Available from: http://www.phii.org/programs/CommonGround.asp.
127. Centers for Disease Control and Prevention, *Summary of Notifiable Diseases --- United States, 2008*, Morbidity and Mortality Weekly Report, Editor. 2010.
128. Centers for Disease Control and Prevention, *Business Process Management Modeling Initiative*, D.o.S.T.D. Prevention, Editor. 2004.
129. The International Society for Disease Surveillance, *Core Business Processes and EHR Requirements for Syndromic Surveillance.* 2011.
130. Brogan, C. and K. Chester, *The Importance of Business Process Analysis in Health IT Project Planning and Implementation*, Public health informatics Institue, Editor. 2009.
131. Communicable Disease Epidemiology & Immunization Section, *Communicable Disease Database (CDD) Upgrade Requirements Summary.* 2009: Seattle. p. 30.
132. Turnock, B.J., A.S. Handler, and C.A. Miller, *Core function-related local public health practice effectiveness.* Journal of public health management and practice, 1998. **4**(5): p. 26-32.
133. Erwin, P.C., *The performance of local health departments: a review of the literature.* Journal of public health management and practice, 2008. **14**(2): p. E9-18.
134. Uscher-Pines, L., et al., *A survey of usage protocols of syndromic surveillance systems by state public health departments in the United States.* J Public Health Manag Pract, 2009. **15**(5): p. 432-8.
135. Miranda, M.L., et al., *Building geographic information system capacity in local health departments: lessons from a North Carolina project.* Am J Public Health, 2005. **95**(12): p. 2180-5.
136. Reeder, B., et al., *Solutions to Public Health Informatics challenges: The case for reusable design.* BMC Public Health, 2011. **11**(116).

APPENDICES

Interview Guide

Improving Communicable Disease Reporting through Applied Informatics Research
Small and Medium Local Public Health Agencies

Interview with Small and Medium-sized LHA, and survey questionnaire pilot

To be conducted with LHA staff involved in the management of notifiable conditions data management

1. Can you describe your duties and job role?

2. Can you talk a little bit about the other staff roles in your workplace (besides yourself) that are responsible for managing communicable disease cases?

3. What are the steps involved in managing a case, beginning at the first point of contact with a provider or laboratory?

4. How do you use a computer system to assist you in managing these cases?

5. Is there more than one computer system that you might use while going through those steps? Can you describe those systems?

6. Did (do) you have any input into the design of the information system(s) that you use to manage notifiable conditions cases?

7. What would you like about those systems to change?

8. Can you describe any mandates or protocols you follow to manage a notifiable conditions case?

9. What are some of the most the most prevalent communicable diseases in your region?

10. Do any of these diseases require special information management services? If so, what kinds of services do they require?

11. Are other technologies or tools you use to manage notifiable conditions data?

(Hand subjects a copy of the pilot survey questionnaire and ask them to complete it)

12. What was it like to answer the questions in this survey?

13. Were any of the questions unclear in their wording?

14. Were any of the questions irrelevant to your work?

15. Were there any questions you that you expected but did not appear?

University of Washington Consent Form

Assessing the use of information systems for notifiable conditions information management

Investigators:

Jamie Pina, MSPH	Academic Affiliation: Department of Medical Education and Biomedical Informatics	UW College: School of Public Health and Community Medicine
Telephone: 206-508-2980	E-mail: jpina@u.washington.edu	

**Please note, we cannot ensure the confidentiality of information sent via e-mail.*

Investigators' statement

We are asking you to be in a research study. The purpose of this consent form is to give you the information you will need to help you decide whether or not to be in the study. Please read the form carefully. You may ask questions about the purpose of the research, what we will ask you to do, the possible risks and benefits, your rights as a volunteer, and anything else about the research or this form that is not clear. When all your questions have been answered, you can decide if you want to be in the study or not. This process is called 'informed consent.'

PURPOSE OF THE STUDY

The purpose of this study is to determine how computer systems are used to manage notifiable conditions data in local public health agencies.

STUDY PROCEDURES

We will ask you questions about the information system(s) that are available to you as you manage data related to notifiable conditions, and your specific use of those systems. We will take notes based on your responses, but your name will not be associated with these notes and they will not be made publicly available. We will also ask you to complete a paper-based survey, which will take approximately 10 minutes, and then ask you a short series of questions about your experience taking the survey.

RISKS, STRESS, OR DISCOMFORT

Some people feel that providing information for research is an invasion of privacy. I have addressed concerns for your privacy in the section below. Some people feel self-conscious when they are asked questions about their work.

ALTERNATIVES TO TAKING PART IN THIS STUDY

Taking part in this study is voluntary. You can stop at any time, or choose not to participate.

BENEFITS OF THE STUDY

State and federal public health agencies are working to develop information systems which will standardize notifiable conditions reporting. This means that systems are being developed with the expectation that local public health agencies will use them.

However, these systems are often designed without local public health participation. We hope the results of this study will assure that the voice of local public is heard by system designers, and thereby help future information systems meet the needs.

OTHER INFORMATION
Information about you is confidential. We will code the study information. We will keep the link between your name and the code in a separate, secured location for 1 year. Then we will destroy the link. If the results of this study are published or presented, your name will not be used.

Government or university staff sometimes review studies such as this one to make sure they are being done safely and legally. If a review of this study takes place, your records may be examined. The reviewers will protect your privacy. The study records will not be used to put you at legal risk of harm.

We may want to re-contact you to clarify information from your interview. In that case, I will contact you for a convenient time to ask you additional questions closely related to your interview. Please indicate below whether or not you give your permission for me to re-contact you for that purpose. Giving your permission for me to re-contact you does not obligate you in any way.

____

Signature of investigator Printed Name Date

Participant's statement

This study has been explained to me.
_____ I volunteer to take part in this research.
_____ I DO NOT volunteer to take part in this research.
I have had a chance to ask questions. If I have questions later on about the research I can ask one of the investigators listed above. If I have questions about my rights as a research subject, I can call the University of Washington Human Subjects Division at (206) 543-0098.
I will receive a copy of this consent form.
I give my permission for the researcher to re-contact me to clarify information.
Yes _______ No _______

____

Signature of subject Printed name Date

Letter of support from WADOH

Dear LHJ Leaders,

I'm writing to give you a heads up about an e-mail that will be sent to your lead communicable disease staff person inviting them to participate in a web-based survey. This survey should only take 12 minutes.

Jamie Pina is a doctoral candidate at the University of Washington. He is conducting research to better understand the needs of public health practitioners with regard to electronic reporting systems. He has consulted with the DOH Communicable Disease Epidemiology team to identify potential respondents in local health jurisdictions.

Some of the findings from this survey will be submitted for publication in peer-review literature in aggregate form. Summary findings from the survey will also be shared with The Washington State Department of Health, Communicable Disease Epidemiology Section. And Jamie plans to provide a report describing the findings of the survey to each respondent.

Electronic information systems play an important role in public health and can help professionals efficiently manage a large volume of data. I am writing to ask that you support your staff in completing this survey.

If you have any questions or comments about the survey, please contact the investigator, Jamie Pina, at jpina@uw.edu.

Thank you for supporting this work.

Sincerely,

D2

Dennis M. Dennis, PhD, RN
Assistant Secretary
Washington State Department of Health
Epidemiology, Health Statistics, and Public Health Laboratories
101 Israel Road, SE
Tumwater, WA 98501
360-236-4204

"Public Health - Always working for a safer and healthier Washington"

Survey questionnaire

Information Systems Used During Communicable Disease Management Survey Questionnaire

Dear Public Health Professional,

Your expertise is needed. State and federal public health agencies across the United States are working to develop information systems which will standardize notifiable conditions reporting with the expectation that local public health agencies will use them. Therefore, it is important to obtain input from local public health professionals about their use of information systems.

My name is Jamie Pina, and I am a doctoral student at the University of Washington working with the Center for Public Health Informatics, and the Division of Biomedical Informatics. My research focuses on the use of information systems in local public health agencies, with a specific emphasis on communicable disease data management. The next phase of my research is to use the findings from a previous study to explore the use of information systems in local public health agencies across Washington through an online survey.

I consulted with The Washington State Department of Health to assist me in identifying potential respondents for this research, and they provided me with a list of public health professionals whose work in communicable disease might inform and benefit from this survey. I hope that you will take *12 minutes* to complete the following online survey.

There are no correct or incorrect answers; all of your feedback is valuable. Results will be reported only in aggregate form and only the primary investigator will have access to individual surveys. Some of the findings from this survey will be submitted for publication in peer-review literature in aggregate form. Summary findings from the survey will also be shared with The Washington State Department of Health, Communicable Disease Epidemiology Section. Finally, I will provide a report describing the findings of the survey to you and your local public health jurisdiction.

My hope is that the results from this survey will provide other local public health agencies, system developers, and researchers with a better understanding of the use of computer systems in local public health practice. Thank you for your dedication to your profession, and to improving the quality of future information systems.

Sincerely,

Jamie Pina, MSPH
Doctoral Candidate
Division of Biomedical and Health Informatics
Center for Public Health Informatics
University of Washington
jpina@uw.edu
206-508-2980

Question 1

UNIVERSITY OF WASHINGTON CONSENT FORM
Assessing the use of information systems for notifiable conditions information management

INVESTIGATOR'S STATEMENT
We are asking you to be in a research study. The purpose of this consent form is to give you the information you will need to help you decide whether or not to be in the study. Please read the form carefully. If you have questions about the purpose of the research, what we ask you to do, the possible risks and benefits, your rights as a volunteer, or anything else about the research, please contact Jamie Pina, the primary investigator. When all your questions have been answered, you can decide if you want to be in the study or not. This process is called 'informed consent.'

PURPOSE OF THE STUDY
The purpose of this study is to determine how computer systems are used to manage notifiable conditions data in local public health agencies.

STUDY PROCEDURES
You will be asked a series of questions about your work as a public health professional. Please answer the questions on each page and then click the "Next" button at the bottom of the page. The Survey takes approximately 12 minutes to complete.

RISKS, STRESS, OR DISCOMFORT
Some people feel that providing information for research is an invasion of privacy. We have addressed concerns for your privacy in the section below. Some people feel self-conscious when they are asked questions about their work.

ALTERNATIVES TO TAKING PART IN THIS STUDY
Taking part in this study is voluntary. You can stop at any time, or

choose not to participate.

BENEFITS OF THE STUDY
State and federal public health agencies are working to develop information systems which will standardize notifiable conditions reporting. This means that systems are being developed with the expectation that local public health agencies will use them. However, these systems are often designed without local public health participation. We hope the results of this study will provide a voice for local public health that is heard by system designers, and thereby help future information systems meet the needs of those working in public health practice.

OTHER INFORMATION
Information about you is confidential. We will code the study information. We will keep the link between your name and the code in a separate, secured location for 1 year. Then we will destroy the link. If the results of this study are published or presented, your name will not be used.

Government or university staff sometimes review studies such as this one to make sure they are being done safely and legally. If a review of this study takes place, your records may be examined. The reviewers will protect your privacy. The study records will not be used to put you at legal risk of harm.

We may want to re-contact you to clarify information from your interview. In that case, I will contact you for a convenient time to ask you additional questions closely related to your interview. Please indicate below whether or not you give your permission for me to re-contact you for that purpose. Giving your permission for me to re-contact you does not obligate you in any way.

If you have additional questions about your rights as a research participant, you may also contact the University of Washington Human Subjects Division at (206) 543-0098.

I volunteer to take part in this research
I give my permission for the researcher to re-contact me to clarify information if needed

---

Question 2
Which local public health jurisdiction do you work in?

Adams

Asotin
Benton-Franklin
Chelan-Douglas
Clallam
Clark
Columbia
Cowlitz
Flathead
Garfield
Grant
Grays Harbor
Island
Jefferson
King
Kitsap
Kittitas
Klickitat
Lewis
Lincoln
Mason
NE Tri
Okanogan
Pacific
Pierce
San Juan
Skagit
Skamania
Snohomish
Spokane
Thurston
Wahkiakum
Walla Walla
Whatcom
Whitman
Yakima

Question 3

Please select the job role that best describes your work:

Epidemiologist
Administrative Support Staff
Case Investigator
Public Health Nurse
Section Chief

Medical Epidemiologist
Other:

Question 4

Does your public health jurisdiction have a separate communicable disease section?

Logic destinations

Yes	Don't skip (default)
No	Question 7: Approximately how many publ...
Other:	Don't skip (default)
/No response/	Don't skip (default)

Question 5
Approximately how many people work in the communicable disease section?

Question 6
Approximately how many public health professionals manage notifiable conditions data in your communicable disease section?

Question 7
Approximately how many public health professionals manage notifiable conditions data in your jurisdiction?

Question 8
Do you use a *Paper-based system* to manage communicable disease and notifiable conditions information?
/
Example: A paper record system is used to collect information, track suspected cases of disease, or store information for future use./

Logic destinations

Yes	Don't skip (default)
No	Question 10: Do you use an electronic in...
/No response/	Don't skip (default)

Question 9

You indicated that you use a *paper-based information management system* to manage notifiable conditions information.

For each of the tasks below, please indicate the frequency that you use your *paper-based information management* system to complete the described task:*
*

Rows

Record information on new cases or suspected cases.
Assess the status of a case during investigation.
Update case information as the case progresses.
Assure that each notifiable condition record is unique.
Access information that will go into other paper-based or electronic records.
"Clean" data? (i.e. correct errors in the data)
Retrieve data for statistical analysis
Report notifiable conditions to your state department of health.
Create new data repositories during acute outbreaks of disease that are under investigation.

Never
Sometimes (at least once a year)
Often (at least once a month)
Always (at least once a week)

Question 10
Do you use an *electronic information system other than PHIMS* to manage notifiable conditions data within your own section?/

Example: You use a software tool to manage communicable disease and notifiable conditions information. This may include a system that your jurisdiction purchased, developed, or received from another source.

Note: If you use more than one additional information system, please answer this question based on the primary information system you use to manage notifiable conditions information///

Logic destinations

Yes	Don't skip (default)
No	Question 19: Do you use PHIMS for report...
/No response/	Don't skip (default)

Question 11
If you use an electronic information system other than PHIMS, What is the name of this system?

Question 12
Which of the following statements best describes why you use an electronic information system other than PHIMS? (Many selections may apply)

The use of the additional system is mandated by my jurisdiction
PHIMS is adequate, but the other system has extra features
PHIMS does not offer the tools I need
Other (Please Explain):

Question 13
How was the system developed?

By your section
Purchased from a vendor
Adopted from another Public Health Agency
I'm not sure

Question 14
Did you or others from your sectionhave the opportunity to work with developers or vendors as the system was created?

Yes
No
I don't know
Other:

Question 15
In general, do you believe that public health practitioners would be willing to participate in the design of notifiable conditions information management systems?

Yes
No
I don't know

Question 16
Was the system developed on an existing software platform available to you, such as Microsoft Access or Excel?

Yes

No
I don't know
Other:

Question 17
To the best of your ability, please describe the software platform the system was developed on:

Question 18
You indicated that you use an *electronic information system other than PHIMS* to manage notifiable conditions information.

For each of the tasks below, please indicate the frequency that you use your *electronic information system other than PHIMS *to complete**the described task*:
*

Rows

Record information on new cases or suspected cases.
Assess the status of a case during investigation.
Update case information as the case progresses.
Assure that each notifiable condition record is unique.
Access information that will go into other paper-based or electronic records.
“Clean” data? (i.e. correct errors in the data)
Retrieve data for statistical analysis
Report notifiable conditions to your state department of health.
Create new databases during acute outbreaks of disease that are under investigation.

Never
Sometimes (at least once a year)
Often (at least once a month)
Always (at least once a week)

---

*You have completed over half of the survey already! Thank you very much for answering these last few questions.
*

Question 19
Do you use*PHIMS for reporting*?

Example: /We use PHIMS for reporting notifiable conditions to WA State/

Yes
No

Question 20
Do you use *PHIMS for local data management*

/Example: We use PHIMS to manage notifiable conditions data within our own //section//./

Yes
No

Question 21
For each of the tasks below, please indicate the frequency that you use *PHIMS *to complete**the described task*:
*

Rows

Record information on new cases or suspected cases.
Assess the status of a case during investigation.
Update case information as the case progresses.
Assure that each notifiable condition record is unique.
Access information that will go into other paper-based or electronic records.
"Clean" data? (i.e. correct errors in the data)
Retrieve data for statistical analysis
Report notifiable conditions to your state department of health.
Create new databases during acute outbreaks of disease that are under investigation.

Never
Sometimes (at least once a year)
Often (at least once a month)
Always (at least once a week)

Question 22
Approximately how many *suspected cases* of communicable disease and notifiable conditions did your jurisdiction investigate in the past year?

0-100 cases per year
100-500 cases per year

500-2000 cases per year
2000-5000 cases per year
Over 5000 cases per year

Question 23
Approximately how many cases of communicable disease and notifiable conditions did your jurisdiction *report to Washington State* in the past year?

0-100 cases per year
100-500 cases per year
500-2000 cases per year
2000-5000 cases per year
Over 5000 cases per year

Question 24
Are there extra features you would like PHIMS or your other information systems to have?

Please describe these features below:

Question 25
Does your section have a standard procedure for evaluating new information systems?

Logic destinations

Yes	Question 26: You indicated that your sec...
No	Question 27: Although your section does ...
I don't know	You have reached the end of...
/No response/	Don't skip (default)

Question 26
You indicated that your section has a standard procedure for evaluating information systems, could you briefly explain the procedure?

Logic destination

You have reached the end of...

Question 27
Although your section does not have a standard procedure for evaluating information systems, please you briefly explain how you believe

decisions would be made about integrating new information systems in the space below:

----

*You have reached the end of the survey, thank you very much for your responses.

Please be sure to click the "Submit Responses" Button below.

*In the coming months a summary of the results of this survey will be sent to you.

If you have any questions or comments about the survey, please feel free contact the primary investigator, Jamie Pina.

Thank you, *

*Jamie Pina, MSPH
Doctoral Candidate
Division of Biomedical and Health Informatics
Center for Public Health Informatics
University of Washington
jpina@uw.edu
206-508-2980

Statistical analysis - output from SPSS

Cross tabulation – The presence of a separate CD section in the LHJ arranged by the population size of the jurisdiction

			LHJ_Sep_CD_Sec		
			No	Yes	Total
PopSizeofCounty	Large	Count	0	5	5
		% within PopSizeofCounty	.0%	100.0%	100.0%
	Medium	Count	5	9	14
		% within PopSizeofCounty	35.7%	64.3%	100.0%
	Small	Count	9	3	12
		% within PopSizeofCounty	75.0%	25.0%	100.0%
Total		Count	14	17	31
		% within PopSizeofCounty	45.2%	54.8%	100.0%

Pearson Chi-Square Tests - The presence of a separate CD section in the LHJ arranged by the population size of the jurisdiction

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.936[a]	2	.011
Likelihood Ratio	10.939	2	.004
Linear-by-Linear Association	8.639	1	.003
N of Valid Cases	31		

a. 2 cells (33.3%) have expected count less than 5. The minimum expected count is 2.26.

Chi-Square Tests - The presence of a separate CD section in the LHJ arranged by the population size of the jurisdiction, LHJs classified by WA State's OMB classification

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	7.567[a]	2	.023
Likelihood Ratio	8.260	2	.016
Linear-by-Linear Association	7.007	1	.008
N of Valid Cases	31		

a. 2 cells (33.3%) have expected count less than 5. The minimum expected count is 3.87.

Descriptive Statistics – How many staff in CD Section?

	N	Minimum	Maximum	Mean	Std. Deviation	Variance
How_many_in_CD	18	1	30	6.61	6.740	45.428
Valid N (listwise)	18					

Descriptive Statistics – How many staff manage NC in CD Section?

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
How_many_manage_NC_Data_in_CD	18	6	1	7	3.33	1.782	3.176
Valid N (listwise)	18						

The number of staff members working in a separate CD section, arranged by population size of the county

Count

		PopSizeofCounty			
		Large	Medium	Small	Total
How_many_in_CD_Section	1	0	1	0	1
	2	0	1	2	3
	3	0	2	0	2
	4	1	0	1	2
	5	0	2	0	2
	6	1	1	1	3
	7	0	1	0	1
	8	0	1	0	1
	10	1	0	0	1
	15	1	0	0	1
	30	1	0	0	1
Total		5	9	4	18

Test Statistics[a,b] – A Chi-Square test to assess the difference in the number of staff in LHJs of different population size

	How_many_in_CD
Chi-Square	**5.576**
df	2
Asymp. Sig.	**.062**

a. Kruskal Wallis Test

b.Grouping Variable: PopSizeofCounty

Correlations – A Spearman Rank Correlation Coefficient comparing the number of communicable disease staff members in an LHJ and the county's population based on 2000 census data.

			How_many_in_CD	CountyPop2000Cen
Spearman's rho	How_many_in_CD	Correlation Coefficient	1.000	.618**
		Sig. (2-tailed)	.	.006
		N	18	18
	CountyPop2000Cen	Correlation Coefficient	.618**	1.000
		Sig. (2-tailed)	.006	.
		N	18	32

**. Correlation is significant at the 0.01 level (2-tailed).

Descriptive Statistics – How many staff manage NC in your entire jurisdiction?

	N	Minimum	Maximum	Mean	Std. Deviation
How_many_manage_NC_Data_in_Juris	32	1	25	4.03	4.193
Valid N (listwise)	32				

PopSizeofCounty * Paper_Based_System Crosstabulation

			Paper_Based_System		
			No	Yes	Total
PopSizeofCounty	Large	Count	2	3	5
		% within PopSizeofCounty	40.0%	60.0%	100.0%
	Medium	Count	4	10	14
		% within PopSizeofCounty	28.6%	71.4%	100.0%
	Small	Count	3	10	13
		% within PopSizeofCounty	23.1%	76.9%	100.0%
Total		Count	9	23	32
		% within PopSizeofCounty	28.1%	71.9%	100.0%

Pearson Chi-Square Tests – Populations size of county measured by the presence of a paper-based information system

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.514[a]	2	.773
Likelihood Ratio	.497	2	.780
Linear-by-Linear Association	.468	1	.494
N of Valid Cases	32		

a. 4 cells (66.7%) have expected count less than 5. The minimum expected count is 1.41.

Paper_Based_System * CountyOMBclasstrans Crosstabulation

Count

		CountyOMBclasstrans			
		1	2	3	Total
Paper_Based_System	No	3	4	2	9
	Yes	9	7	7	23
Total		12	11	9	32

Chi-Square Tests - Paper_Based_System * CountyOMBclasstrans Crosstabulation

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.582[a]	2	.747
Likelihood Ratio	.573	2	.751
N of Valid Cases	32		

a. 3 cells (50.0%) have expected count less than 5. The minimum expected count is 2.53.

Presence of Non-PHIMS Information Systems

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	19	59.4	59.4	59.4
	Yes	13	40.6	40.6	100.0
	Total	32	100.0	100.0	

Reliability Statistics - Internal Consistency of Questions Regarding "Goals and tasks in the use of paper-based information systems"

Cronbach's Alpha	N of Items
.725	9

ElecSysNotPHIMS * PopSizeofCounty Crosstabulation

			PopSizeofCounty			Total
			L	M	S	
ElecSysNotPHIMS	No	Count	0	11	8	19
		% within PopSizeofCounty	.0%	78.6%	61.5%	59.4%
	Yes	Count	5	3	5	13
		% within PopSizeofCounty	100.0%	21.4%	38.5%	40.6%
Total		Count	5	14	13	32
		% within PopSizeofCounty	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests ElecSysNotPHIMS * PopSizeofCounty Crosstabulation

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	9.472[a]	2	**.009**
Likelihood Ratio	11.358	2	.003
N of Valid Cases	32		

a. 2 cells (33.3%) have expected count less than 5. The minimum expected count is 2.03.

Chi-Square Tests ElecSysNotPHIMS * PopSizeofCounty Crosstabulation

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	9.472[a]	2	.009
Likelihood Ratio	11.358	2	.003
N of Valid Cases	32		

Presence of Non-PHIMS electronic information systems stratified by OMB Classification

		CountyOMBClass			Total
		Metropolitan	Micropolitan	Outside	
ElecSysNotPHIMS	0	6	8	5	19
	1	6	3	4	13
Total		12	11	9	32

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.305[a]	2	.521
Likelihood Ratio	1.338	2	.512
N of Valid Cases	32		

3 cells (50.0%) have expected count less than 5. The minimum expected count is 3.66.

How was the Non-PHIMS system developed?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Section	6	18.8	75.0	75.0
	Purchase	2	6.3	25.0	100.0
	Total	8	25.0	100.0	
Missing	System	24	75.0		
Total		32	100.0		

Did you or others from your section have the opportunity to work with developers or vendors as the system was created?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	3	9.4	33.3	33.3
	Yes	5	15.6	55.6	88.9
	Other	1	3.1	11.1	100.0
	Total	9	28.1	100.0	
Missing	System	23	71.9		
Total		32	100.0		

LHJ staff belief of participation in information system design

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	1	3.1	**7.7**	7.7
	Yes	11	34.4	**84.6**	92.3
	DK	1	3.1	**7.7**	100.0
	Total	13	40.6	100.0	
Missing	System	19	59.4		
Total		32	100.0		

Was your local information system developed on an existing platform?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	2	6.3	**18.2**	18.2
	Yes	7	21.9	**63.6**	81.8
	DK	2	6.3	**18.2**	100.0
	Total	11	34.4	100.0	
Missing	System	21	65.6		
Total		32	100.0		

Reliability Statistics - Internal Consistency of Questions Regarding "Goals and Tasks in the use of non-PHIMS electronic information system"

Cronbach's Alpha	N of Items
.889	9

PHIMS used for local data management

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	6	**18.8**	18 8	18 8
	Yes	26	**81.3**	81 3	100 0
	Total	32	100 0	100 0	

PHIMS used for local data management Chi-Square Tests

	Value	df	Asymp Sig (2-sided)
Pearson Chi-Square	168[a]	2	**.920**
Likelihood Ratio	170	2	918
Linear-by-Linear Association	099	1	753
N of Valid Cases	32		

a 4 cells (66 7%) have expected count less than 5 The minimum expected count is 94

Reliability Statistics - Internal Consistency of Questions Regarding "Goals and Tasks in the use of PHIMS as a local data management tool"

Cronbach's Alpha	N of Items
.806	9

Does your section have a standard procedure for evaluating new information systems?

Standard Evaluation Process?	Frequency or responses	Percent of responses
I don't know	11	**34.4**
No	20	**62.5**
Yes	1	**3.1**
Total	32	100.0

Chi-Square Tests – Standard evaluation procedures stratified by LHJ population size

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	6.009[a]	4	.198
Likelihood Ratio	4.377	4	.357
N of Valid Cases	32		

a. 7 cells (77.8%) have expected count less than 5. The minimum expected count is .16.

Interview Guide

Improving Communicable Disease Reporting through Applied Informatics Research
Small and Medium Local Public Health Agencies

Interview with LHA staff regarding the evaluation material

Can you describe your duties and job role?

How do you interact with communicable disease information?

Can you talk a little bit about the other staff roles in your workplace (besides yourself) that are responsible for managing communicable disease cases?

How many people share this kind of work? Are they all in one department?

Have you been responsible for evaluating an information system in your job role?

How might you typically approach evaluating a new information system?

After reviewing this material, please explain how you might approach evaluating and information management system?

If you were to use the strategy described in this material, who would complete the evaluation from your group?

How might you change the evaluation strategy to meet the needs of your organization?

University of Washington Consent Form

Assessing the use of information systems for notifiable conditions information management

Investigators:

Jamie Pina, MSPH	Academic Affiliation: Department of Medical Education and Biomedical Informatics	UW College: School of Public Health and Community Medicine
Telephone: 206-508-2980	E-mail: jpina@u.washington.edu	

**Please note, we cannot ensure the confidentiality of information sent via e-mail.*

INVESTIGATOR'S STATEMENT

We are asking you to be in a research study. The purpose of this consent form is to give you the information you will need to help you decide whether or not to be in the study. Please read the form carefully. You may ask questions about the purpose of the research, what we will ask you to do, the possible risks and benefits, your rights as a volunteer, and anything else about the research or this form that is not clear. When all your questions have been answered, you can decide if you want to be in the study or not. This process is called 'informed consent.'

PURPOSE OF THE STUDY

We developed a document which guides local public health practitioners through an evaluation of information systems. The purpose of this study is collect information which will make the documentation more useful to local public health practitioners.

STUDY PROCEDURES

We will ask you questions about your opinion of the evaluation strategy document. We will take notes based on your responses, but your name will not be associated with these notes and they will not be made publicly available.

RISKS, STRESS, OR DISCOMFORT

Some people feel that providing information for research is an invasion of privacy. We have addressed concerns for your privacy in the section below. Some people feel self-conscious when they are asked questions about their work.

ALTERNATIVES TO TAKING PART IN THIS STUDY

Taking part in this study is voluntary. You can stop at any time, or choose not to participate.

BENEFITS OF THE STUDY

State and federal public health agencies are working to develop information systems which will standardize notifiable conditions reporting. This means that systems are being developed with the expectation that local public health agencies will use them.

However, these systems are often designed without local public health participation. We designed an evaluation strategy to help local public health agencies evaluate these new systems on their own. Your feedback will help us to modify the strategy and documentation so that it is more useful to local public health professionals.

OTHER INFORMATION
Information about you is confidential. We will code the study information. We will keep the link between your name and the code in a separate, secured location for 1 year. Then we will destroy the link. If the results of this study are published or presented, your name will not be used.

Government or university staffs sometimes review studies such as this one to make sure they are being done safely and legally. If a review of this study takes place, your records may be examined. The reviewers will protect your privacy. The study records will not be used to put you at legal risk of harm.

We may want to re-contact you to clarify information from your interview. In that case, I will contact you for a convenient time to ask you additional questions closely related to your interview. Please indicate below whether or not you give your permission for me to re-contact you for that purpose. Giving your permission for me to re-contact you does not obligate you in any way.

____

Signature of investigator Printed Name Date

<u>Participant's statement</u>

This study has been explained to me.
_____ I volunteer to take part in this research.
_____ I DO NOT volunteer to take part in this research.
I have had a chance to ask questions. If I have questions later on about the research I can ask one of the investigators listed above. If I have questions about my rights as a research subject, I can call the University of Washington Human Subjects Division at (206) 543-0098.
I will receive a copy of this consent form.
I give my permission for the researcher to re-contact me to clarify information.
Yes _______ No _______

____

Signature of subject Printed name Date

Task-centered evaluation for comparing information systems

a guide for local public health practitioners

By Jamie Pina, PhD (Cand.), MSPH

Task Analysis | Familiarization | Scenarios | Comparison

Contents

Introduction

Local public health practitioners often use electronic information systems to manage the health information within their agencies. However, the design and evaluation of these systems is often left to technology specialists, whom may not be familiar with specific details and work practices of a local public health organization.

This guide has been developed to assist local public health practitioners in the comparison of information systems. If you are a local public health practitioner, or you support those who work in public health, you may need to select an appropriate information system for this unique working environment. You may have the option of purchasing a system from a software company, or you may adopt an information system for free from another organization. The system may have been developed by a private group, another local public health jurisdiction, or a state or federal agency. In local public health practice, resource constraints often limit the amount of time that can be devoted to evaluating new information systems. However, the cost of purchasing and implementing a system only to find later that it does not meet your needs can waste valuable time and resources. Therefore, we have developed this guide to assist you in comparing the information systems available to you in a structured way. You can use the information you collect to make the best choice, and you can present your work to others to justify your decision.

Local public health practice has information management needs beyond that of the typical office. To keep track of individual cases, interventions, health outcomes, and outbreaks, you must manage large amounts of data. Analyzing and reporting that data can also be a big responsibility. Computerized information systems can help you with your work. Selecting the right system for your goals is crucial to your success. The motivation for this guide came about during a research project at the University of Washington. While investigating the use of computer systems in a communicable disease section of a local public health agency, we identified a need for a general evaluation guide to support local public health agencies. We applied several informatics and information science methods in an evaluation of our own, and decided to make this guide based on the success of the evaluation.

Approach

There are many approaches that can be used to compare information systems. In this guide we recommend a task-centered approach. *Task-centric evaluation* focuses on collecting information about the *tasks*, or work-related activities, which public health practitioners in your environment execute. This approach is very useful in a local public health environment, because public health agencies across the United States execute their work in different ways. The health concerns of the community you serve are unique, and it is likely that your strategies for addressing them are the result of those unique needs. The recommendations we make in this guide have been selected to minimize the impact of the information system comparison on the daily work of local public health agency, but still provide robust information that will help you to assess a new information system.

Steps

The evaluation strategy we recommend can be summarized in four basic steps. First, you will document the work that your group does through a process called *task analysis*. Then you will take some time to review one or more information systems that you are considering. If possible, you will acquire a copy of the software to try out. Next, you will describe, in a series of short narrative paragraphs, how the features of each information system might be used to complete the tasks that you documented. Finally, you will compare the scenarios for each task, and make an assessment about whether the system under consideration will meet your needs. Your documentation will provide a reference for those unfamiliar with your work environment.

Why spend time evaluating an information system?

The evaluation strategy we recommend requires time and resources to complete. It may sound challenging to collect the required data, analyze it, and report the findings through documentation. However, there is a strong argument to be made for taking part in this process. Information system implementations can easily fail. When a system implementation fails, valuable time and resources are wasted. The potential for failure can be reduced by carefully reviewing the system in a structured way before it is implemented. By documenting the work in your environment, and understanding how an information system would support it, you can become aware of many of the benefits and challenges of each option available to you.

When to use this guide

This guide may be helpful in several different situations. Below are a few examples:

- You have an information system that works in your setting but you need to replace it due to a regulation or mandate, and you want to know if the new system will meet your needs.

- You are trying to select an information system to purchase from the commercial market, but you are unsure of whether the systems you are reviewing meet all of your needs.

- You have the opportunity to adopt a new information system, and you want to know if the new system will meet your needs.

Who should use this guide

- Local public health practitioners with an interest in comparing information systems (Example roles: Epidemiologist, Public Health Nurse, Disease Investigator)

- Technical/IT workers with a need to strategically compare information systems in a local public health setting (Example roles: CTO, technical support staff, programmers)

Extended Uses

The information you collect may have additional uses in your efforts to improve information management in your workplace. These used may include:

- Identifying requirements for a new information system design
- Writing a business case to secure funding for an information system upgrade
- Sharing information about your LHJ's work practices with other stakeholders

Before you begin:

To compare information systems using the strategy in this guide, you should have access to the following:

- The group of individuals that will use the system being evaluated
- Printed, or on-line documentation and instruction manuals of the system being evaluated
- A trial or demo version of the software (i.e. the system) you are evaluating
- Supporting documents from the work environment describing protocols and procedures related to information management (if available)

Step 1 – Identify users

Task analysis is the process of identifying and documenting activities. It may seem like a simple step, but through this first process you will build the foundation of your system comparison, and it is essential to your success. Using task analysis, you will collect information about the work that takes place in your local public health agency. Specifically, you will document the current work of individuals who will use the new system. Your goal is to objectively describe their procedures and activities, especially those related to information management.

Before you begin collecting this kind of data, you'll want to identify the people in your organization that will use the information system. Throughout the rest of this document, we will refer to those individuals as "users." Speaking with the management of the department can help you identify users. For example, if you are working within a communicable disease section, speaking with the section chief may provide insight into the individuals you should work with to collect task data. You may also want to look at a current organizational chart of the group to get a full view of the employees and their roles. Focus on finding out who will use the information system in question. By the end of this process, you should have a list of the individuals you will want to work with to identify the tasks of the group. Refer to Worksheet #1 to complete this step.

Step 2 – Identify Tasks

Once you have identified the individuals that will be the focus of your task analysis, your next step is to document their work activities. There are different techniques you can use to collect this information. We have summarized them below:

Participant Observation: Participant observation involves you spending time with each employee and observing them in their typical work environment. As you observe them, you will take notes about the actions you observe. Then you will use your notes to describe tasks that occur regularly. This technique has the benefit of allowing you to collecting data about work as it occurs. Users are not always aware of the broad range of tasks that they take part in. Over time work activities becomes second-nature, and users may not recognize the extent of the work that they do. Observation reduces the risk of overlooking important tasks. See worksheet #2 for a guide to using participant observation.

Interviews: If participant observation is not possible, interviewing the users is another good option. If you choose to use interviews exclusively, we recommend semi-structured interviews, which use a combination of pre-written questions and open-ended discussion. In Worksheet #3, we provide some sample questions and a guide for conducting interviews. Interviews are a powerful tool if they are executed properly.

Questionnaires:

There are some situations where a questionnaire about user activity may be your best choice. If you don't have direct access to the users, and arranging phone interviews is not possible, distributing a questionnaire will allow you to collect data from users about their work. Developing a questionnaire that elicits the right information can be challenging. Questionnaire development is not extensively covered in this guide. However, we recommend using a combination of open-ended and multiple choice questions if you choose to use a questionnaire.

Review procedural documents

Some local public health agencies maintain procedural documents which describe their work; some may even contain great detail about tasks and procedures for a specific work activity. It is worth asking to see if any such documents are available. If the organization you work with maintains such documents, be sure to review them. Having an awareness of the protocols and procedures that guide public health practitioners' work habits will provide you with valuable insight. It should be noted that procedural documents related to information management often become outdated quickly, and the documentation available to you may be out-of-date. For this reason we recommend reviewing procedural documents in addition to one of the other methods for identifying tasks.

Step 2.5 – Write tasks and task descriptions

No matter which method you select to identify the tasks within your organization, creating appropriate documentation to share your findings is an essential part of this process. The documentation you create will provide a foundation for your evaluation of the information system(s), and also allow you to share your findings with others.

Once you have collected data using one or more of the options listed above, you will have to identity the tasks which are present within the organization or group you are working with. Using the data from your participant observation, interviews, questionnaires, and\or procedural document review, you will create list of tasks that describe the work activities within your organization. Producing a *task list* is the first step in this process, where you will document the names of the task. Following the completion of the task list, you will write a description of each task. This can be accomplished in two to four sentences, and describes the task in a more narrative form than can be conveyed in a list alone. Below are some of the properties of good task descriptions, originally written by Greenberg[73]:

1. It describes the user's goal, but not how the user accomplishes the goal
2. It is very specific
3. It describes a complete job
4. It says who the users are and reflects their real interests

Here is an example of a task we identified in a local public health agency, and its description:

Task: Create New Electronic Records
New electronic records are created based on the identification of a new case by staff members of the group, if found not to exist previously in the database. Information about new cases is received through mailings, faxes, and phone calls from providers and laboratories. Staff aim to accurately enter the case in a timely fashion.

Step 3 - Familiarize yourself with the systems\software

In this step, you will learn about the features each information system you are evaluating. To complete this activity, it will be helpful to have a copy of the software you are evaluating, and documentation which describes it s use. You will need to install the software on your computer, or ask your IT Department for assistance in setting up Reviewing the documentation of the software will help to understand the capabilities of the software, and it will allow you to make decisions about how a task you identify in task 2 might be supported by the system you are evaluating. We recommend executing this step while you are executing Step 2, so that you can begin the subsequent steps immediately once you complete Step 2.

Step 4 – Write scenarios describing the execution of each task

Now that you have developed documentation of the tasks in your organization, and you also have gained sufficient knowledge of the new system you are evaluating, you will write scenarios that describe how each task is (or would be) executed in your organization with each system. Scenarios are brief chunks of narrative text which describe *how* a task is accomplished. Go and Carroll, two experts in scenario-bsed design, define use case scenarios by stating that "A scenario is a concrete description of work and activities, so it describes a specific instance and usage situation. [68]" In your work, your scenarios should describe what a user must do, using the systems you are comparing, to complete the task. If it is helpful for you, you may label the systems "System A" and "System B." Below is an example of a scenario describing the task "Create a new electronic record," using a database in a local LHJ. This scenario describes an activity accomplished by a staff member working with notifiable conditions and

Scenario: Create a new electronic record (System A)
After completing a search for potential duplicate records, staff select an option to create a new record for the case. Standard demographic information is added to the record, along with diagnostic results from tests and other relevant case information. The record must be manually saved using a "Save" button before exiting the database.

The first set of scenarios you write will be based on your task analysis. You will use the notes from your observations, interviews, questionnaires, and documentation to describe how tasks are accomplished.

The second set of scenarios you write will be based on your knowledge of the system you are evaluating, and your knowledge of the work environment in your organization. Writing these scenarios can be challenging, because you must envision the use of a system that is not actually in use in your environment. For each task, describe *how* the task would be completed using the system you are evaluating, which is not currently implemented in your organization.

By the end of this step, you should have two scenarios for each task; one that describes the use of the current information system in your organization, and one that describes how you imagine the task being completed using the new system. Worksheet #4 will assist you in the writing your scenarios.

Step 5 – Compare the scenarios and make functional assessments

In this step, you will compare the scenarios for each task to each other, and determine whether the system you are considering will be able to adequately support each task. To do this, ask yourself the following questions *"is the new system capable of supporting the task? If so, will using the system for this task create any new challenges, or present any new benefits?"*

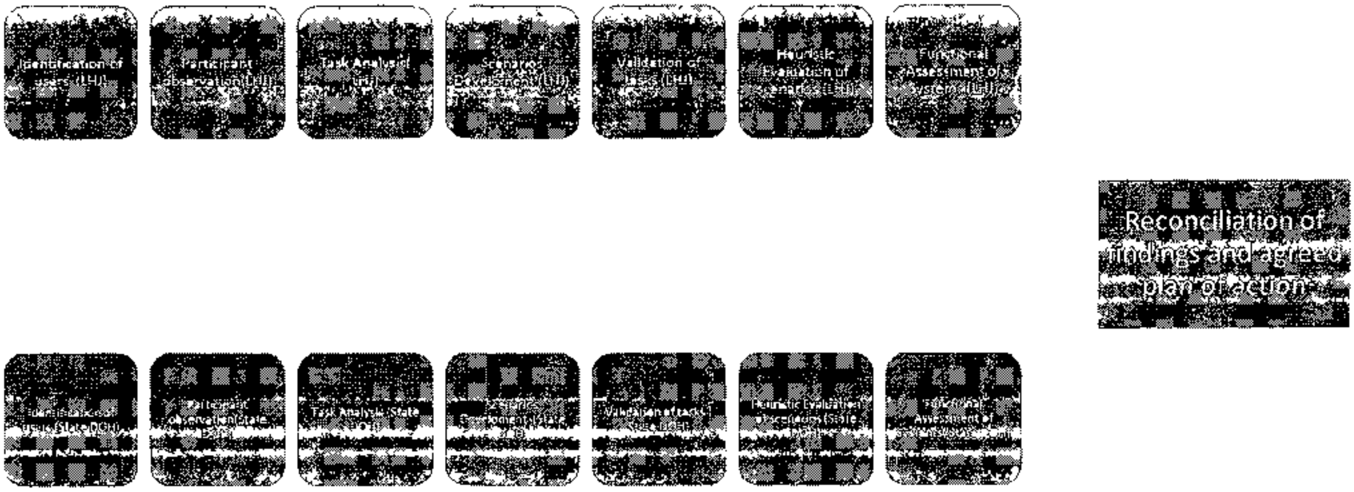
Review each pair of scenarios with these questions in mind. In a spreadsheet, like the one shown on Worksheet #5, document your comments. At the end of this process, you may choose to stop and offer your documentation to others, allowing them to make a decision about each task and then make a conclusion about the adoption of the new system, or you can make those conclusions yourself and document them on the spreadsheet in Worksheet #5. In the past, we have found it effective to provide decision makers with a "functional assessment" of each task. That is, we rate the new system's usability for task on a three-point scale; including "Satisfactory, "Satisfactory with limitations", and "Unsatisfactory." Provide functional assessments allows decision makers to quickly review the results of your evaluation to

Step 6 – Share your documentation

Congratulations, you have created a powerful tool that will help your organization determine whether the information system under evaluation will adequately support the needs of staff members. The documentation you have created can be shared with decision makers at all levels of your organization, or to outside stakeholders that may have an interest in your evaluation. Examples of stakeholders may include your state's department of health, city council members, and other local officials.

Step 7 – Executing the evaluation in multiple organizations

This evaluation strategy was developed to assist LHJs in determining the "fit" between a new piece of software and their current work activities, and compare the system to a previously existing system. The process we have outlined in this guidebook will provide local public health practitioners with an opportunity to express their needs in the context of new system adoption. In many situations, however, LHJs are not the only stakeholder concerned with the adoption of a new information system. In situations where a new system has been mandated for use by an external entity that the LHJ works with (such as a state or federal public health agency), there is a need to identify the benefits and challenges of system adoption in more than one setting. In these cases, it may be worthwhile to have the external entity evaluate their use of the information system following this guidebook. If both groups execute the strategy outlined in this guidebook, you will have comparable results to discuss following your evaluations.


Identification of users (LHJ)
Participant observation (LHJ)
Task Analysis (LHJ)
Scenarios Development (LHJ)
Validation of tasks (LHJ)
Heuristic Evaluation of scenarios (LHJ)
Functional Assessment of Systems (LHJ)
Reconciliation of findings and agreed plan of action

1. Greenberg, S., *Working Through Task-Centered System Design*, in *The Handbook of Task Analysis for Human-Computer Interaction*, D. Diaper, Editor. 2004, Lawerence Erlbaum: London.
2. Go, K. and J. Carroll, *Scenario-Based Task Analysis*, in *The Handbook of Task Analysis for Human-Computer Interaction*, D. Diaper, Editor. 2004, Lawerence Erlbaum: London.

Worksheet 1 – Identifying Users

In the spaces below, write down the name and job role of each individual that will use the system. If you work in a large group you may want to focus on one individual per job role, instead of aiming to work with every single user.

Name	Job Role or Title	Brief Description of Work	Availability

In the space below, describe your strategy for identifying users of the system(s):

Worksheet 2 – Participant Observation

Before you begin
Follow this checklist to use participant observation for data collection:

- **Complete Worksheet 1** Identify users of the systems you are comparing using Worksheet 1.

- **Identify the work habits you would like to observe** If you are comparing information systems which assist during a disease outbreak, you will want to observe workers completing tasks related to that activity.

- **Scheduling** Participant observation takes place in a user's working environment, typically in an office or cubicle. You'll want to schedule a time when it is convenient for them to be observed. When make scheduling the appointment, express an interest in a broad range of their work activities, with a focus on information management activities

- **Prepare a notepad** You will collect "trigger notes" throughout your observation. Trigger notes are short bits of text which will later jog your memory about what you observed.

During the Observation
Situate yourself within the participant's workspace, with a clear view of the computer screen and with a notepad on your lap. You may begin by asking the participant a few questions about the work they are doing to orient you to their activities. Some sample questions are listed below:

- Please describe your job role and your general responsibilities
- Can you tell me more about the way you manage information using the system?
- Could you describe the features that you are currently using? What will the result of this task be?
- What is the source of this data?
- How is this report generated?
- Did this report have all of the information you needed to conduct your follow-up of this case?
- How will you access the data you need for this investigation?
- If you had access to other data, would it be useful?
- Is the information available to you sufficient to complete your work?

As you speak with the participant, collect trigger notes that will later remind you of the participant's responses. These brief interviews also allow you to understand what the goals of the participant are before you begin your observation.

Once the brief interview is complete the participant may begin executing his/her regular work. You will observe their work and take notes as they execute tasks associated with the information system you are assessing. At this point, you should make a note of all activities. Later on as you review your data you will identify patterns and recurring themes in your notes. At this point, collecting more information, rather than less, is ideal.

Question	Participant Response

Task or work activity	Description

Worksheet 3 – Interviews

Before you begin
Follow this checklist to use interviews for data collection:

- **Complete Worksheet 1** Identify users of the systems you are comparing using Worksheet 1.

- **Develop questions** The questions you ask during your interview should focus on the work activities of you participants. There are some standard questions you may want to include, but you should also leave time for open-ended discussions about their work habits.

- **Scheduling** Interviews can take place in an office, conference room, or other office. It is helpful if the interview can take place away from other staff members in the office, to avoid disruption.

Here are some sample questions you can ask to get your interview started:

16. *Can you describe your duties and job role?*
17. *Can you talk a little bit about the other staff roles in your workplace (besides yourself) that are responsible for managing communicable disease cases?*
18. *What are the steps involved in managing a case, beginning at the first point of contact with a provider or laboratory?*
19. *How do you use a computer system to assist you in managing these cases?*

Initial Questions	Participant Response

Worksheet 4 – Writing scenarios

In the spaced below, describe how each task will be accomplished using both of the systems in your evaluation. "System A" refers to the current system, so you will describe how the task is currently executed using the information system that is already installed. "System B" refers to the information system that you are evaluating, or the "new system" that is under consideration. As you write your scenarios, keep in mind that a scenario is a short paragraph of text and it:

5. It describes the user's goal, but not how the user accomplishes the goal
6. It is very specific
7. It describes a complete job
8. It says who the users are and reflects their real interests[73]

Task	Scenario for System A	Scenario for System B

Worksheet 5 – Comparing scenarios and making a functional assessment

In the spaced below, describe how each task will be accomplished using both of the systems in your evaluation. "System A" refers to the current system, so you will describe how the task is currently executed using the information system that is already installed. "System B" refers to the information system that you are evaluating, or the "new system" that is under consideration. As you write your scenarios, keep in mind that a scenario is a short paragraph of text and it:

1. It describes the user's goal, but not how the user accomplishes the goal
2. It is very specific
3. It describes a complete job
4. It says who the users are and reflects their real interests[73]

Task	Scenario - System A	Scenario - System B	Comments	Functional Assessment

CURRICULUM VITAE

Jamie Michael Pina, PhD, MSPH

Summary of Professional Experience

Jamie Pina has 12 years of experience developing, implementing, and evaluating information management solutions to support practice and research in public health and biomedicine. Dr. Pina has experience working with international, federal, state, and municipal public health agencies, and has graduate training in biomedical informatics and public health informatics. He also has an extensive background in information technology and has project management experience with short- and long-term complex projects.

Education

PhD, Biomedical Informatics, University of Washington, Seattle, WA, 2011.
MSPH, Public Health Informatics, Emory University, Rollins School of Public Health, Atlanta, GA, 2006.
BA, Psychology, University of Massachusetts, Boston, MA, 2001.
Certificate Program in Management Information Science, 1999.

Selected Project Experience

BioSense Redesign Project (2011 to present)—*Research Scientist.* Conduct qualitative analysis of user need. Present information to developers and assure integration of features.

Professional Experience

2011 to date	RTI International, Waltham, MA.
	<u>Research Scientists</u> for the Center for the Advancement of Health Information Technology. Develop and execute user-centered design initiatives for the BioSense Redesign Project.
2010 to 2011	American Medical Informatics Association, Bethesda, MD.
	<u>Informatics Consultant</u>. For Global Partnerships Program, defined tasks and roles of clinical staff in resource-constrained countries. Developed informatics training program for clinical staff and developed training assessment tools.
2007 to 2010	Center for Public Health Informatics, Seattle, WA.
	<u>Predoctoral Research Fellow</u>. Developed methodologies and wrote multiple grant applications. Developed business strategy and communication plans for public health informatics research. Conducted outreach with public health partners.

2008 to 2009	Public Health Seattle & King County—Communicable Disease and Immunization Section, Seattle, WA. Informatics Consultant. For the Creating a Business Plan for Communicable Disease Information Systems project, identified current and future needs for an information system. Met and negotiated with vendors and technical personnel. Coordinated with WA State Department of Health to harmonize future data exchanges. Wrote detailed project plan for review by city council to assure future IT funding.
Jan to May 2006	Public Health Informatics Institute, Decatur, GA. Public Health Analyst. Facilitated communication and interaction between public health professionals and business analysts to produce a standard set of business processes for local public health departments. Assisted in developing a report contextualizing the project in terms of several public health frameworks.
Sept to Jan 2005	Northrop Grumman Health Solutions, CDC Programs, Atlanta, GA. Public Health Analyst. Coauthored white paper updating the National Agenda for Public Health Informatics. Wrote section on data standards and vocabulary in public health. Managed project timelines and guided group by publishing project schedule and enforcing deadlines.
July to Sept 2005	Centers for Disease Control and Prevention, Global AIDS Project, Entebbe, Uganda. Systems Analyst. Conducted systems analysis for HIV/AIDS clinic partnered with CDC. Produced report to guide future systems development in Uganda. Assisted informatics team with redesign of Ministry of Health database's entity relationship diagram.
2004 to 2005	Centers for Disease Control and Prevention, Department of HIV and AIDS Prevention, Methods Branch, Atlanta, GA. Public Health Analyst. For EZ-Text Version 4.0, conducted quality assurance of updated software release. Worked with users to determine new features and requirements for software. For the Seattle Area Men's Study, assisted in statistical analysis of qualitative data; performed qualitative analysis and data coding.
2001 to 2004	Antigenics, Inc., Lexington, MA. Junior Network Administrator. Maintained and supported server environment, local and wide area networking, telephone systems, and user workstations in a 300 user environment. Developed patient contact database for Pharmacovigilance group. Served as technical supervisor for Bioinformatics Group. Implemented system for local use of NIH Genebank database.

1999 to 2002	Vinfen Corporation, Boston, MA.
	Case Manager. Acted as a liaison between patients with severe mental health disorders and health care providers. Worked on clients' behalf to attain state funded housing and federal financial subsidies.
2001	Cambridge Health Alliance, Cambridge, MA.
	Database Consultant. Designed and implemented The Massachusetts Schizophrenia Inpatient Abstract Database using SQL, Access, and Visual Basic. Trained data entry staff and supported usage throughout project.
1999 to 2001	Harvard Medical School, Department of Social Medicine, Cambridge, MA.
	Research Assistant. Developed coding database to manage and analyze qualitative data. Designed electronic data collection tools for field research of HIV-ARV adherence study. Conducted field research using ethnographic data collection techniques. Worked with biostatisticians to complete data analysis.
1999 to 2006	Boston Bicycle Repair, Boston, MA.
	Owner. Founded business and managed operations including service and sales. Direct wholesale purchasing, accounting, and public relations.
1996 to 1998	Logal Software, Cambridge, MA.
	Quality Assurance Assistant Manager. Supervised quality assurance team. Wrote and compiled reports for software development team.

Honors and Awards

CDC Public Health Informatics Fellowship (awarded), 2009
University of Washington Top Scholars award, 2006
Delta Omega Society—Phi Chapter member, 2006
National Library of Medicine Biomedical Informatics Fellowship, 2006–2009
O.C. Hubert Fellowship in International Health, 2005
Merrell Scholarship, 1999

Professional Associations

Public Health Informatics Institute. Applied Public Health Informatics Curriculum (APHIC) Advisory Committee Member, 2009

Professional Service

Judge, annual poster competition, Public Health Informatics Network Annual Symposium, 2009
Facilitator for Privacy and Confidentiality group, Northrop Grumman's Public Health and Prevention Roundtable Seminar, AMIA 2005 Annual Symposium, 2005

Computing Committee member: served as student representative for faculty group that makes computing decisions for Biostatistics Department, Rollins School of Public Health, Emory University, 2005

Student government representative, Biostatistics Department, Rollins School of Public Health, Emory University, 2004 to 2005.

Attended seminars and participated in workshops. Identified Uganda as an ideal location to conduct thesis research, XV International AIDS Conference, Bangkok, Thailand, 2004

Web design and hosting of www.omhin.org, Designed Web site. Provide Web space for site on personal Linux server, McGill HIV/AIDS Interdisciplinary Network, Montreal, QC, 2003 to 2006

Seminars and Courses Taught

Annual guest lecturer in Public Health Informatics graduate course. Taught classes on data standards in public health, University of Washington, Department of Biomedical and Health Informatics, 2007–2009

Peer-Reviewed Journal Articles

Reeder, B., Hills, R., Pina, J., & Demiris, G. Reusable design: A proposed approach to Public Health Informatics system design *BMC Public Health, 2011, 11:116* http://www.biomedcentral.com/1471-2458/11/116/abstract

Pina, J., Turner, A., Kwan-Gett, T., & Duchin, J. (2009). Task analysis in action: The role of information systems in communicable disease reporting. *American Medical Informatics Association Annual Symposium Proceedings, 2009*, 531–535. Available from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2815487/

Presentations and Proceedings

Hills, R., Reeder, B., Pina, J., Demiris, G., *Reusable Design Methods for Public Health Information Systems.* Washington State Journal of Public Health Practice,, 2010. **3**(1). http://www.wsphajournal.org/V3S1TOC.htm

Pina, J. (2008, November). Competitively selected to present *Evaluating notifiable conditions reporting systems*. American Medical Informatics Association 2008 Annual Symposium—Pre-Conference RWJ Fellows Meeting.

Pina, J. (2008, August). *The evaluation of notifiable conditions reporting systems for a large municipal local public health agency*. Presented at the PHIN 2008 Annual Symposium. Available from: http://cdc.confex.com/cdc/phin2008/webprogram/Paper17321.html

Pina, J. (2007, November). *The evaluation of notifiable conditions reporting systems for a large municipal local public health agency.* Presented poster at the AMIA 2007 Annual Symposium—Pre-Conference RWJ Fellows Meeting.

Pina, J. (2007, August). *Comparing notifiable conditions reporting systems for a municipal public health organization*. Presented at the IPHIE Master's Class—Hall, Austria.

Pina, J. (2006, November). *Using participant observation for organizational discovery and systems analysis: Global AIDS program, Uganda.* Poster presented at the American Medical Informatics Association 2006 Annual Symposium. http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1839513