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Characterizing Information Needs for Public Health Continuity of Operations: A Scenario-Based Design Approach

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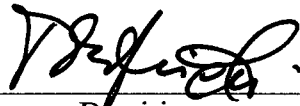and that any and all revisions required by the final
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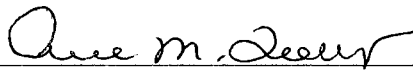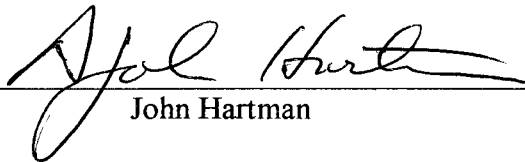
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Abstract

Characterizing Information Needs for Public Health Continuity of Operations: A Scenario-Based Design Approach

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Chair of the Supervisory Committee
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Medical Education and Biomedical Informatics

Public health field nurses play a critical role in the community during disasters and emergencies. Continuity of operations planning (COOP) is a recognized part of any emergency management strategy and technology should support the elements of public health COOP through support of routine work activities. However, the work of public health field nurses is characterized by multiple, disparate digital and paper-based information systems that require duplicate data entry, reduce efficiencies in the performance of daily work and create issues during emergencies.

This research project characterized the information needs of public health nurses and nurse supervisors through three specific aims. The first aim consisted of an information needs assessment through a systematic literature review for technology support of public health continuity of operations planning and semi-structured interviews with public health practitioners in two local health jurisdictions. The second aim used scenario-based design and persona

creation to develop a conceptual design of an integrated information system that supports the work of public health nurses and nurse supervisors. The third aim used focus groups with public health nurses and other public health staff to validate the information system design in both local health jurisdictions.

Focus group participants validated the conceptual information system design in the following thematic areas: the need for a dynamic, flexible system, support for client service and documentation, workload tracking, staff management, one-time data entry, real-time documentation, communication and data exchange between divisions, integrated scheduling and communication with external providers. Focus group participants corrected perceived errors in design and made additional design recommendations.

The results of this research highlight the importance of involving public health practitioners in the design process for technology that supports their information needs and work activities and can support them during emergencies. In addition, this research shows it is possible to validate and reuse design concepts across local health jurisdictions that have different organizational structures. Reusable design knowledge is an important goal for public health informatics efforts to increase efficiencies through support of standard work practices, reduce the costs of information system projects and maintain service delivery at all times of operations.

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Acknowledgments

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Dedication

This dissertation is dedicated to my mother, Evelyn Nora Reeder, for letting me do what I wanted even when she knew it was a bad idea and I didn't, my father, Douglass Wyman Reeder III, for the stubborn, angry work ethic I have when I work on my bad ideas, and my late uncles Benny Wayne Bennett and Earl Frank Owens for showing me that the right people can help you build good things out of bad ideas if you are willing to be a little patient. As for the bad ideas themselves, those are mine and mine alone. Mostly this dissertation is dedicated to my wife, Rhiannon Lee Reeder, for sticking with me throughout this whole process. Being married to someone in a Ph.D. program is probably just as trying and complicated as completing the Ph.D. program itself, if not more so. She has been very patient.

Chapter 1: Introduction

The threat of epidemics such as the one represented by the H1N1 influenza virus and the recent earthquakes in Haiti and Chile have created a sense of urgency for public health emergency preparedness. Prior to that, disasters such as Hurricanes Katrina and Rita of 2005 and the terrorist attacks of September 11, 2001 raised awareness of the public health role in emergency management in the United States. Delivery of essential services to the community is part of public health responsibilities during an emergency. However, these service delivery efforts compete with response efforts for organizational resources during emergencies. Continuity of operations planning (COOP) is defined as actions taken before, during and after an emergency to maintain delivery of prioritized services. Support of prioritized service delivery during an emergency should be facilitated by an in-place and up-to-date continuity of operations plan but before such a plan can be effective, work activities performed during times of normal operations must be documented, understood and appropriately supported by integrated technology design. Put another way, in order to support public health continuity of operations during emergencies, a local health jurisdiction must first appropriately support operations during times of normalcy. By this token, the design, development, deployment and evaluation of information systems that appropriately support routine work practices should be considered part of any organization's COOP efforts.

Public health field nurses who do home visitations to clients are representatives of local health jurisdictions (LHJs) in the community and play a crucial role during emergencies[1, 2]. Their core responsibilities are to diagnose, investigate, inform, educate and link people to needed services

[1]. Traditionally, nursing information systems in hospitals have not been well-integrated[2] and this situation is also true with regard to public health information systems[3]. Turner et al. assert the need to understand public health nursing roles and information needs in context to inform design of information systems that fit the public health work environment[4].

Our research with the Community Health Services Division at Public Health – Seattle and King County since January 2008 confirms a lack of technology designed to support public health operations through integrated information systems[5]. In particular, there is a gap in technology to support staff management and workload tracking for staff that provide direct services to clients, facilitate remote work for social isolation during infectious disease outbreaks and support work from alternate facilities in the event of public health center closures due to facility damage. Some of the reasons for this gap in technology support for efficient public health operations include the complexity of public health information needs[6], work activities and organizational behaviors with regard to delivery of services[7] and multiple disconnected information systems that require duplicate data entry[8].

We undertook this study with three specific aims to advance understanding and technology design in support of operations for public health practice. First, we conducted a systematic literature review for technology support of continuity of operations planning. Using participatory design methods, we documented public health field nurse information needs and the tasks they perform to deliver services to clients during home visitations. In addition, we documented public health nurse supervisor information needs for staff management and program planning. We then conceptualized and validated an information design to support public health field nursing efforts

via remote work to improve efficiencies during normal operations and emergencies. The value of this research is the documentation of public health field nurse information needs and tasks for use by future researchers and system designers, and the proposal and validation of an integrated information system design that can serve as a blueprint for systems to support the delivery of services by public health nurses and the supervisors who manage the public health field nurse workforce.

Specific Aims and Background

The three specific aims of this study are described below.

1.1 Specific Aim 1

To assess the information needs for public health continuity of operations based on a systematic review of scientific indexed literature and feedback from public health practitioners

1.2 Specific Aim 2

To conceptualize and propose an information system design that addresses specific needs based on documented activities performed by public health field nurses and nurse supervisors to deliver services during normal and emergency operations

1.3 Specific Aim 3

To validate the proposed system design with public health nurses and nurse supervisors from different local health jurisdictions

1.4 Background

In the following section, we discuss emergency management, continuity of operations planning, support for daily operations and remote work in the context of public health to demonstrate the need for integrated technology support for day-to-day work processes as a way to facilitate continuity of operations. We then provide an overview of information needs and technology research with regard to public health and public health nursing to demonstrate the gap for this type of technology support. Finally, we provide an overview of design methods that can be used to create an information design that meets the needs of this identified gap.

1.4.1 Public Health and Emergency Management

The role of public health in emergencies is well recognized. Even prior to the World Trade Center attacks of September 11, 2001, Gallo and Campbell recognized the role of public health in disaster preparedness and the need to strengthen local health jurisdictions to prepare for the threat of bioterrorism[9]. Logue observes that the role of public health is something that is not new but that is again being recognized[10]. Kizer notes that most activities that save lives happen through local action before and immediately after a disaster[11] while Polivka observes the critical need for the identification of public health nurse (PHN) competencies for surge events to ensure their ability to respond effectively when disaster strikes[13]. Rebmann notes that some of the major gaps in public health response have included infectious disease control, communication and coordination with external agencies[12]. In a 2002 state-by-state assessment of public health preparedness, Lucky et al. note the need to involve public health in emergency management

planning for evacuations[13] while Morse cites the need to strengthen relationships between local,

federal and state organizations [14]. Mann et al. find that state disaster plans are common but

policies, training programs, equipment and integrated communications systems necessary for

their success are absent[15]. Davis et al. cite the need for up-to-date contact information during

emergencies to facilitate communication[16]. Kizer notes that information management and

communication systems are crucial but are often weakly integrated in the response process[11].

1.4.2 Continuity of Operations Planning

Continuity of operations planning (COOP) is recognized as an important part of any disaster

preparedness and response strategy by emergency management experts[17-19]. A COOP -- also

known as a Business Continuity Plan (BCP) -- provides guidelines for an organization to sustain

delivery of essential services before, during and after a crisis. According to Rozek and Groth, "a

BCP is no longer just a phase or project to be implemented when time and resources allow. It

must be an ongoing program implemented to protect data, and ensure the integrity and security

of the total organization"[17]. Grimaldi notes that a COOP strategy should include all the different

units of an organization in planning[20]. However, Somers finds that minimal work has been done

to document local government COOP efforts and emphasizes the important role of information

and communications technology to support government operations and public safety[19]. In

addition, Adkins et al. in a study of COOP and communications state that they "found that this

area has received lip service but not much else"[21].

Dawes et al. interviewed individuals involved in response after the World Trade Center attacks

of September 11, 2001 and reported "those who worked in the best prepared organizations

emphasized the need for greater investment in business continuity and disaster recovery efforts"[18]. Although Van de Walle and Turoff cite the need for recognition of continuity of operations planners and emergency managers as professions in both public and private organizations[22], COOP may not carry as high a profile as it should within many emergency management programs. As an indication of this, the Journal of Business Continuity and Emergency Planning, a peer-reviewed journal dedicated to COOP topics, is relatively new and launched only in September 2006[23]. In contrast, the journal Disasters[24] has been published since 1977, the journal Prehospital and Disaster Medicine[25] has been published since 1985, the Disasters: Preparedness & Mitigation in the Americas[26] newsletter has been available online since 1995 and prior to that was published in hard copy since the early 1980's and the Journal of Contingencies and Crisis Management[27] has been available since 1993.

1.4.3 Support for Daily Operations and Remote Work

There is ample evidence that support for continuity of operations planning should be part of daily work processes[19, 20, 22, 24, 30, 31]. Alesi outlines best practices based on experiences where COOP is integrated into routine daily operations[28]. Dawes et al. learned that that there was little difference between normal and emergency operations other than scale and their study participants reported that improvements to information systems used on a daily basis would increase response capability during emergencies while improving efficiencies in day-to-day operations[18]. Van de Walle and Turoff argue for the integration of routine operations with the function of emergency response systems that are used on a day-to-day basis to eliminate the need for training[22]. Stone et al. found that the use of public health survey data from a dashboard application was useful even one year after Hurricane Katrina[29].

As part of the recognized need to integrate COOP support into daily operations, remote tool support may improve the reliability of daily work. Whitworth reports that federal policy allows for support of remote work through virtual or mobile offices that rely on laptops, mobile phones and satellite technology to maintain continuity of operations[30]. Alesi asserts that a COOP program should include all employees and support them with remote tools[28]. Weiner and Trangenstein conclude that informatics can increase efficiency during disasters and provide remote support for medical caregivers[31]. Taken together, these findings indicate a need for integrated technology designed to support operations during normal and emergency times across divisions of local health jurisdictions (LHJs).

1.4.4 Public Health Information Needs and Technology

The lack of standard work practices within local health jurisdictions is well-recognized[32] and Swearingen notes that limited knowledge exists about the work practices of the current public health nursing workforce[33]. Lack of standards and knowledge about work practices complicate integrated information system design for the support of public health operations. The Public Health Informatics Institute (PHII) recently documented a set of standard business processes for bio-preparedness and chronic disease monitoring activities common to all local health jurisdictions[34] and Merrill has developed a taxonomy of common public health work tasks, knowledge and resources[7] that help address this gap. Revere et al. conducted a systematic review that investigates the information needs of public health practitioners for a knowledge management system that supports information seeking and access[6]. O'Carroll et al. discuss the diverse roles and information needs among public health practitioners and health policy

makers[35]. Rambo conducted group interviews in Washington state with 70 participants among a diverse group of public health practitioners that included nursing directors to assess information needs and uses across general categories[36]. Turner et al. note the need to understand context for public health nursing roles, work and information needs[4]. Sustersic et al. developed and evaluated a community nursing information system prototype for documentation to reduce workload and improve outcomes[37]. Staes et al. advocate the use of grid architecture in a federated data approach to integrating public health information systems[3]. However, further research must be done to document the specific information needs and work tasks of public health nurses and other practitioners within local health jurisdictions. Research in this area is critical to the design of technology that supports the work of diverse roles during normal and emergency operations because these practitioners are not currently supported by integrated information systems.

1.4.5 Challenges of a Resource-Constrained Environment

Public health is systematically and seriously underfunded[38]. Public health practitioners face the daily reality of many disparate systems that do not interoperate and require duplicate data entry[3, 8]. This situation obtains largely from categorical program funding that supports the development of information systems that meet specific program aims but not the integration of specific program data across multiple systems[8]. The need for integrated information system support of public health operations is clear, however, public health practitioners operate in a resource-constrained environment that has seen repeated budget cuts in recent years[8, 39]. Although infrastructure investment following the attacks of September 11, 2001 resulted in some strengthening of core public health functions[40], other research has shown that local health

jurisdictions lack the staff, resources and technology to manage multiple responsibilities for preparedness and recovery[18, 41]. Fraser cites recent public health budget cuts and a lack of standard preparedness measures and assessment criteria that lead him to conclude that the United States may not be ready for a pandemic or disaster[39]. Grimaldi notes that cost-reduction campaigns can eliminate COOP efforts within organizations[20]. These findings indicate the need for, and a lack of, integrated technology resources designed to support public health continuity of operations and maintain public health readiness.

1.4.6 Capturing Information Needs and Scenario-Based Design

To address identified gaps in information needs, work activities and technology to support public health operations, qualitative methods using semi-structured interviews in a naturalistic setting[42-44] provide powerful tools to capture information needs of multiple stakeholders in complex situations. Specifically, one type of participatory design methodology called scenario-based design[45-57] has potential to create descriptions of public health activities that can be implemented as reusable design knowledge[60-63] in different local health jurisdictions.

Friedman defines his Fundamental Theorem of Biomedical Informatics as: "A person working in partnership with an information resource is 'better' than that same person unassisted."[58] Davis defines perceived usefulness as "the degree to which a person believes that using a particular system would enhance his or her job performance."[59] In the study of information behavior, Case defines an information need as "recognition that your knowledge is inadequate to satisfy a goal that you have"[60]. In scenario-based design, Carroll asserts that the design of information resources "is fundamentally about envisioning and facilitating new ways of doing things and new

things to do."[46] We draw on these prior works for a definition of the concept of *information need* for use in informatics design work as:

>
> *A person's recognition that an information resource should help him or her know something, learn something or do something better than without that information resource.*

Scenario-based design is a methodology that places the focus of system design on the activities of the people who use an information system rather than the system itself or the capabilities of technology[45, 46, 55]. It is participatory in that it solicits the needs and values of work practitioners by bringing them directly into the design process. Scenario-based design takes a participatory approach to creating new designs by soliciting descriptions of existing work practices from the people who will use a system[55].

Simply put: "Scenarios are stories. They are stories about people and their activities."[46] Scenarios are concrete and easily understood by people who perform work in non-technical domains and thus provide a design vocabulary for laypersons involved in the design process[56]. The use of everyday language to describe narratives of use makes scenario-based design a practical methodology when applied in a variety of contexts, including that of public health. Though scenarios have been used in a variety forms in system design for years, efforts to formalize scenario-based design as a methodology became wide-spread in the mid-1990's[45, 48, 50, 51, 56, 57, 61-63] when it became "paradigmatic"[55]. Recent efforts of the past few years have seen the use of scenario-based design to capture work processes in the design of shared home care

technology[54] and in the design and development of digital libraries[53, 64, 65]. Our prior work has shown that scenario-based design is effective in both conceptual design[5] [66] and prototyping[67] with different groups of public health practitioners.

1.4.7 Reusable Design Knowledge

Whittaker et al. propose the notion of shared tasks called "reference tasks" for use by designers in different application domains to describe and share knowledge about common problems[68]. Scenario-based design is one means to accomplish the goal of creating reference tasks in the public health domain that can be abstracted and categorized by designers for reuse in similar design situations[46]. In addition, Wahid has proposed the reuse of claims about activities that are part of scenario-based design[69] while Sutcliffe has done considerable work to advance the effective reuse of scenarios[70-72].

In summary, the goals of continuity of operations planning should be intrinsically integrated into the daily work of public health practitioners to ensure uninterrupted delivery of services during emergencies. However, we know that even daily public health work is not currently well-supported by integrated technology and this is in part due to lack of budget. Public health practice is rife with numerous siloed systems that do not communicate between divisions of local health jurisdictions let alone with external partners and collaborators and this is in part caused by the funding mechanisms for existing systems. As we have discussed, projects concerning standard business processes shared between local health jurisdictions, a general taxonomy of public health work tasks and a variety of general information needs studies have been conducted. However, very little research has been done concerning specific information needs and work

activities that can inform integrated design of operational support systems for public health practitioners who provide direct services to clients and managerial workload management tools. Participatory design and scenario-based design methods are well suited to capture these information needs and work activities in order to create standard information designs that can be reused in those local health jurisdictions that have common processes.

1.4.8 Significance and Innovativeness

In this project, we assessed the information needs of public health nurses and nurse supervisors for the delivery of services to clients and the management of workload. In addition, we validated a conceptual information system design for public health nursing services to support continuity of operations during times of normal and emergency operations. This work is innovative in the following ways:

- Our approach includes public health practitioners to support them in their actual work activities and increases the likelihood of future system adoption by learning from the lessons of failed informatics projects that did not include target audiences during the design process[8]
- Scenario-based design is a proven methodology for information system design but has not been applied widely within the public health domain
- Our research seeks to document reusable knowledge to inform the design of necessary public health information systems
- Public health continuity of operations planning is a critical part of public health emergency management and there are few systems that support public health COOP

1.4.9 Description of Chapters and Appendices

Chapter 1 (Introduction) is an introduction to the problem area, a list of the three specific aims of this study, a description of the background and significance of the problem area including our related prior work, an outline of the significance and innovativeness of this study and our approach as well as this description of the chapters. Chapter 2 (Research Design and Methods) includes a description of our study design, the study setting, the study participants and our research methods. Chapter 3 (Results) presents detailed information regarding deliverables and findings of our three specific aims. Chapter 4 (Discussion) gives a detailed discussion of our findings with conclusions, implications and suggestions for future work in this area of research. Appendices A, B & C include the interview guide, the qualitative codebook and the focus group protocol used to collect and analyze our data.

Chapter 2: Methods

Research Design and Methods

As stated in Chapter 1, this study followed three specific aims. In the following we describe the methods used for each of these study aims.

2.1 Assessing Information Needs

The first study aim was to broadly assess the information needs for public health continuity of operations based on a systematic review of scientific indexed literature and feedback from public health practitioners. For this aim, we assessed the information needs of public health practitioners that must be supported to maintain public health continuity of operations in two ways: through a systematic review of scientific indexed literature about technology projects that support public health continuity of operations and semi-structured interviews with senior public health operations staff in two different local health jurisdictions. Our definition of an information need from Chapter 1 is:

> *A person's recognition that an information resource should help him or her know something, learn something or do something better than without that information resource.*

This definition is intentionally broad and applied in two different ways. For the literature review, it is applied to categories of information areas or processes that could be supported by an information resource. For the interviews, it is applied to practitioner recognition of tasks and activities that could be supported by an information resource.

2.1.1 Systematic Literature Review

The aim of this systematic review was to find and assess published studies of information systems and technology projects that address public health continuity of operations planning information needs and to review emergency management information systems that support public health operations. The systematic review of the literature was guided by search terms from general information needs suggested by prior work published in peer-reviewed journals and our prior research experience. A search of indexed databases of scientific literature was conducted using key words from these search terms to identify technology projects and approaches that support public health continuity of operations planning. Studies were included based on criteria from the information needs suggested by prior work and inter-rater agreement between the principal investigator (PI) and two other reviewers about inclusion for each study. Technology projects from included studies were assessed for useful features and characteristics. Figure 1 illustrates the process flow followed for the systematic review. This figure originally appeared in a peer-reviewed publication entitled "Use of Technology to Support Information Needs for Continuity of operations Planning in Public Health: A Systematic Review" as published in the Online Journal of Public Health Informatics[73].
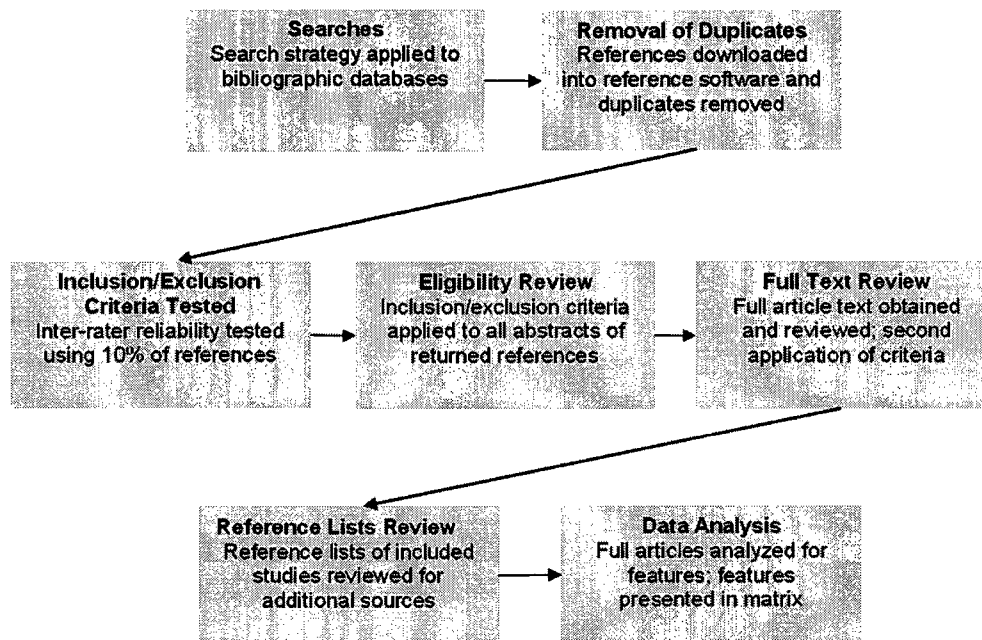
Figure 1. Process flow of literature survey methods from search strategy to data analysis[73]
(as originally published in the Online Journal of Public Health Informatics)

Information systems must meet the broad information needs of public health COOP planners and

public health practitioners to support their work activities. To assess technology support of

public health continuity of operations planning through a systematic review, we compiled a list

of search terms from prior work in public health knowledge management[74], COOP planning[20,

30, 39, 75], post-disaster studies of health care worker information needs[12, 76], public health

preparedness[9, 14, 15, 77, 78] and disaster planning[79-81]. The categories of search terms on this list

are included based on our familiarity with the information needs of public health practitioners

and COOP planners gained through fieldwork and our experiences with the general corpus of

literature in these broad areas from our academic research. The list of search terms represents

broad information need areas for public health COOP. This list may not be exhaustive of all

possible information need areas available from the literature but was sufficient to provide wide

coverage during searches. The list of search terms includes:

- synthesized information[74]

- centralized data access[74]

- coordination/incident command support[9, 12, 14, 15, 20, 30, 39, 75-81]

- staff training/education[9, 12, 14, 15, 20, 30, 39, 75-81]

- planning/plan testing/exercise support[9, 12, 14, 15, 20, 30, 39, 75-77, 80, 81]

- interoperable external communication/alerting[9, 12, 14, 15, 30, 39, 75-81]

- internal communication/alerting[9, 12, 14, 15, 30, 39, 75-77, 79, 81]

- staff attendance/contact list management[9, 14, 15, 30, 39, 75-77, 79, 81]

- resource tracking/capacity management[9, 14, 15, 30, 39, 76, 77, 79-81]

- collaboration[9, 12, 14, 15, 30, 74, 76, 79-81]

- remote work/portable data[14, 30, 39, 78, 79, 81]

- geographic data[30, 76]

Past technology projects in the public health domain can help identify information system features that support public health operations during times of normal and emergency operations. In addition, it is critical to document systems, approaches and challenges to inform the design of future public health operations support systems.

Projects for public health continuity of operations planning technology and information systems have not been studied extensively. In order to achieve broad coverage in our search, we used the categories of search terms compiled from publications about private continuity operations

planning and public emergency management. These search terms were used in combination with the following general terms during the search:

- public health

- disaster

- emergency

- technology

- information system

- informatics

- decision support

In January of 2009, we conducted an initial search of the Medline and EBSCOhost bibliographic databases, covering the period from January 1990 to January 2009, using the same term combinations for both databases. Our combined search returned a results set that included a total of 469 articles (Medline: 213, EBSCOhost: 256). Because of its specialized focus, we also reviewed the table of contents for all issues of the Journal of Business Continuity and Emergency Planning since its inception in 2006. All citations for the results set were imported into a commercial reference manager and duplicates were removed. The final number of articles in the search results set was 313. Over the course of the next year, search results were analyzed for inclusion based on criteria as outlined in the data analysis section below. We repeated the search using the same terms and methodology in the same bibliographic databases in February 2010 to provide coverage for the period from January 2009 to February 2010. The final number of articles in the updated search results set was 320.

To ensure a large enough number of studies for analysis, inclusion criteria were defined in a way that included systems developed specifically for continuity of operations planning as well as other more general emergency management systems. Inclusion criteria are as follows:

- studies of technologies that were developed specifically to support continuity of operations information needs
- studies of technologies developed for emergency management purposes with features that could support continuity of operations information needs
- studies of technologies that implemented approaches that could support continuity of operations information needs

Our search strategy was necessarily broad in order to return search results that included studies of information system and technology projects in this relatively unexplored area. As a result, the list of exclusion criteria is detailed and specific.

Exclusion criteria were as follows:
- articles that focus mainly on public health data stores and registries
- articles that focus on general technology infrastructure
- articles that discuss general public health policy, emergency management policy or continuity of operations planning but do not reference or evaluate a specific system or systems
- articles that discuss studies, reports and evaluations of public health interventions
- articles that focus on live training exercises and general computer training

- articles that focus on efforts to improve quality of service lines or safety monitoring

- articles that focus on studies of disease surveillance

- articles that discuss clinical or laboratory information systems

- articles that discuss workflow in specific settings not related to public health

Inclusion criteria

An information system or technology was deemed to satisfy a broad information need area by applying the following criteria:

- *Synthesized information* - the system or project pulled information from two or more sources and presented a new or integrated view of that data

- *Centralized data access* - the system or project was designed or used as an easily available single point of information access for multiple data sources to variety of non-technical practitioner roles

- *Coordination/incident command support* - the system or project was designed or used for coordination of individuals or different groups of people

- *Staff training/education* - the system or project was designed or used to educate staff

- *Planning/plan testing/exercise support* - the system or project was designed and used for planning, plan testing and/or exercise support

- *Interoperable external communication/alerting* - the system or project was designed and used for communication to entities outside an organization

- *Internal communication/alerting* - the system or project was designed and used for communication to entities within an organization

- *Staff attendance/contact list management* - the system or project was designed and used specifically for staff attendance and staff contact information

- *Resource tracking/capacity management* - the system or project was designed for resource tracking or to make capacity management decisions

- *Collaboration* - the system or project was designed or used for collaborative work activities between co-workers

- *Remote work/portable data* - the system or project provided for remote work capabilities and remote access to data

- *Geographic data* - the system or project implemented geo-spatial data or geo-spatial visualization features

Thirty-two article abstracts (ten percent) were selected at random and rated by three reviewers to test inter-rater reliability and validate inclusion/exclusion criteria. Articles were coded based on independent review of abstract content and application of defined inclusion/exclusion criteria by each reviewer. Coded results for each article were recorded in individual spreadsheets. Results were then aggregated into a master spreadsheet with columns for reference data, article abstract and individual reviewer rating for each article so that composite sets of rating results could be compared side-by-side in the context of abstract content (see Figure 2). During analysis of inter-rater reliability, an agreement status (inter-rater level of agreement about whether to include or exclude a particular article) was assigned to each composite set of ratings. The agreement status was recorded in an agreement status column in the master spreadsheet. Use of this spreadsheet approach facilitated the resolution of rating discrepancies between reviewers during a face-to-

face meeting and expedited understanding of how the inclusion/exclusion criteria should be

formally applied to the rest of the search results.

	A	B	C	D	E	F
1	REFERENCE	ABSTRACT	REVIEWER 1	REVIEWER 2	REVIEWER 3	Status
2	Lee, E. K., S. Maheshwary, et al. (2006). "Decision support system for mass dispensing of medications for infectious disease outbreaks and bioterrorist attacks."	Abstract A simulation and decision support system, RealOpt©, for planning large-scale emergency dispensing clinics to respond to biological threats and infectious disease outbreaks is described. The system allows public health administrators to investigate clinic design and staffing scenarios quickly. RealOpt© incorporates efficient optimization technology seamlessly interfaced with a simulation	INCLUDE: Studies of emergency management information systems that implement technologies and approaches that	INCLUDE: Studies of emergency management information systems that implement technologies and approaches that	INCLUDE: Studies of emergency management information systems that implement technologies and approaches that	Include Agreement

Figure 2. Example view of aggregate reviewer results in a master spreadsheet for testing inter-rater
reliability of inclusion/exclusion criteria

An article was excluded if it fit at least one of the exclusion criteria, noting that many articles fit

many of the exclusion criteria. Overall, there was a high degree of inter-rater agreement with

regard to decisions about which articles to exclude. Twenty-one of thirty-two articles were

excluded.

After validation of inclusion/exclusion criteria, the PI reviewed the abstracts of the remaining

articles in the results set. For those articles whose abstracts met criteria for inclusion, the full

article text was retrieved and given a more detailed assessment for inclusion. For those articles

that met inclusion criteria after a detailed review of the full text, the reference list of each was

review for additional potential studies to include. In addition, information systems discovered

during the full-text review of each article were noted and searches for studies of these systems

were conducted.

2.1.2 Semi-Structured Interviews

Interviews following the principles of participatory design[43, 44] were conducted with a convenience sample of nineteen senior clinical and clerical staff at two local health jurisdictions. Interviews focused on public health practitioner information needs and activities necessary to deliver public health services as well as the information systems and barriers involved in their work processes. We documented existing needs and processes to identify gaps in support of these processes. In addition, we solicited design recommendations for information systems from study participants. The interview guide was developed from the information needs suggested by prior work in the scientific literature, from documents pertaining to continuity of operations planning from the Community Health Services Division of Public Health – Seattle and King County and our prior fieldwork at PHSKC. A version of the interview guide was piloted during nine interviews at PHSKC in 2009. See Appendix A – Interview Guide for a list of interview questions.

Each interview was conducted by the PI and audio-recorded using a digital recorder. Interviews lasted from between about 60 minutes to 90 minutes. For some of the interviews, the PI was assisted by a second interviewer based on second interviewer availability. Interviews were transcribed by the PI or through a paid transcription service. Transcription of all nineteen interviews resulted in 608 pages of textual content.

Setting

The study setting for the interviews consisted of two different local health jurisdictions in Washington State: The Spokane Regional Health District (SRHD) and Public Health – Seattle

and King County (PHSKC). The Spokane Regional Health District (SRHD) has approximately 250 employees and serves a population of more than 400,000 in Spokane County[82]. PHSKC is the 10th largest local health jurisdiction in the United States, has 1900 employees[83] and services a population of approximately 1.8 million in King County. The Community Health Services Division at PHSKC is the organizational subunit that agreed to participate in this study while Community and Family Services and all other divisions at SRHD agreed to participate.

Participants

With the endorsement of the Spokane Regional Health District and Public Health – Seattle and King County, we enrolled a convenience sample of nineteen participants who held senior-level clinical or clerical positions at the sponsoring organizations at the time of the study. Fourteen interviews were conducted at the Spokane Regional Health District while five interviews were conducted at Public Health – Seattle King County. Fewer interviews were conducted at PHSKC since we conducted nine interviews at PHSKC in 2009 and have been involved in fieldwork at that site since early 2008. More interviews were conducted at SRHD than PHSKC in order to familiarize ourselves with SRHD as a field setting. Interviews were conducted by approval of the University of Washington Institutional Review Board under Certification of Exemption #37644 "Characterizing Information Needs for Public Health Continuity of Operations: A Scenario-Based Design Approach".

The target population was drawn from a group of practitioners and administrators with a variety of backgrounds who participate in the delivery of public health services within the local health jurisdictions and who possess specific experiential knowledge relevant to this area of study.

More importantly, the members of this study group represent the workforce who will use, or supervise the workforce who will use, the proposed system design that supports the information needs and work activities documented by this study.

Participant Inclusion Criteria

- Currently hold or have held a senior clinical or clerical position at a local health jurisdiction
- Currently involved in or past experience with activities related to the delivery of public health services at a local health jurisdiction
- Adult (over the age of 21)

Twelve of nineteen interviews were chosen to inform information system design after an initial read-through and assessment of all interview transcripts by the PI. Inclusion criteria for interviews to inform information system design were those participants involved in the provision of public health services to clients or supervision of practitioners who delivered public health services to clients. Criteria for exclusion included those participants involved in support roles, administrative or executive roles or other roles that did not support the provision of relevant services to clients. We note that it was necessary to conduct all interviews to grasp a larger understanding of the context of each local health jurisdiction and participant roles within each LHJ.

Twelve interviews were thematically coded[42, 84] for information needs to inform information system design. Of these, seven interviews from the Spokane Regional Health District were

included for analysis while all five interviews from Public Health – Seattle & King County were included. The list of participant roles that were included for coded data analysis were two division directors, four nurse supervisors, three public health nurses, one clinical supervisor, one senior health administrator and one program manager. We included one director from a division that did not provide direct services to clients based on the advanced state of automated electronic processes within his division. Participant roles excluded from coded data analysis were three executive administrators, two information technology professionals, one nutritionist and one laboratory director. Interviews were thematically coded using the NVivo 8 software from QSR International[85].

Thematic coding was data-driven and performed by two coders according to line-level and thematic coding practices as described by Boyatzis[84] and Miles and Huberman[42]. Starting with no codes, transcripts were reviewed and each coder created codes during iterative coding sessions. Utterances were assigned to existing codes or new codes as necessary. See Appendix B – Code Book for instructions about how to apply codes.

Three interviews were selected at random and thematically coded by the PI and a second coder as a test for inter-rater reliability[42, 84]. The second coder also participated as the second interviewer in twelve of the nineteen interviews. Both researchers coded the first interview transcript independently. After coding, the two researchers met to reconcile codes. Where there was disagreement about a code, a discussion of how and when to apply the code was made until agreement was reached and the criteria for code application was documented. This process continued until consensus was reached about all codes for the first interview transcript. Both

researchers then coded the second interview transcript independently and the code reconciliation

process was repeated.

After the first and second interview transcripts were coded and reconciled for inter-rater

reliability, the complete list of codes was assessed by a third researcher as a test for face

validity[42, 43, 84]. This individual was familiar with the study and subjects as he participated as the

second interviewer in two of the interviews. The complete list of codes generated from the first

and second coded transcripts was positively validated by the third researcher. Following the

positive test for face validity, the third and final interview transcript was coded and reconciled

for inter-rater reliability following the same process as employed for the previous two transcripts.

See Appendix B –Code Book for a list of codes generated during the coding process.

2.2 Conceptualizing an Information System Design

The second study aim was to conceptualize and propose an information system design that

addresses specific needs based on documented activities performed by public health field nurses

and nurse supervisors to deliver services during normal and emergency operations. We created

an information system design to support the work of public health nurses and public health nurse

supervisors. The information system design is intended to improve efficiencies during normal

operations and help maintain delivery of services during times of emergency operations.

2.2.1 Design Specification

We implemented activity design according to scenario-based design methodology as developed by Carroll and others[45-47]. Fictional public health practitioner personas[86-92] were created as identified from the coded interview data. A persona represents a hypothetical individual that designers use as a concrete reference during the design process to envision ways a particular individual might use an information system. Narrative scenarios of use that describe optimal work processes for service delivery were created as part of the design process with the goal of increased efficiency and integration of activities based on identified barriers and design recommendations from the interviews. This process was informed by both new data from interviews and from our prior work in activity design at PHSKC[6, 72, 73].

Scenarios of use are artifacts that concretize the activities of a system user and can be assessed by the target audience of an information system before system development begins. An example persona and scenario of use is shown below. A version of this persona and scenario originally appeared in publication as part of "Building the PHARAOH Framework Using Scenario-Based Design: A Set of Pandemic Decision-Making Scenarios for Continuity of Operations in a Large Municipal Public Health Agency" in the Journal of Medical Systems[5].

Persona
Bill is a senior-level administrator at a large local health jurisdiction and the Continuity of operations Manager for a subunit of the organization. His job is to direct the day-to-day service delivery operations for several public health clinics. In addition, he is responsible for development and management of the COOP plan for his sites for pandemics, earthquakes and other emergencies. During an emergency, Bill must assess the facility, staff and supply situation to make staff management decisions for his sites.[5]

Scenario of Use
Scenario Name: See a roster for staff attendance at a selected public health
site

Scenario Description: The local health jurisdiction is managing the effects of
a flu pandemic. Bill must run a report for staff attendance as reported by the
site manager at the Location A Public Health Center facility. Bill needs to see
the job class and skills of each employee at Location A in order to cope with
staff reductions.[5]

2.3 Validation of the System Design

The third study aim was to validate the proposed system design with public health nurses and

nurse supervisors from different local health jurisdictions. We conducted an exploratory

evaluation of our system design with study participants via focus groups.

2.3.1 Focus Groups

Mini-focus group sessions[93, 94] were conducted by the PI and a second researcher with four

participants at Spokane Regional Health District and five participants at Public Health – Seattle

& King County. Focus group participants were public health nurses, public health nurse

supervisors and other public health staff. Each focus group session was audio-recorded using a

digital audio recorder and lasted between 60-90 minutes. The PI served as moderator for each

focus group and the second researcher served in an observer/note taker capacity. At the start of

the focus group, the PI introduced himself and the second researcher along with their roles,

stated the purpose of the focus group and then asked each participant to identify herself and her

job role. Prior to and at the start of each session, focus group participants were given printed

versions of information needs, scenarios of use, persona descriptions and a list of reports that

comprised the proposed information system design. Participants were asked questions about the

accuracy, usefulness, benefits and concerns of the conceptual information system design. In addition, participants were solicited for suggestions about improvements to the conceptual design, opinions about whether they would use such a system and their impressions about participation in the design process. An e-mail was sent to each participant after the focus group thanking them for participation and as a follow-up for thoughts each participant may have had about the conceptual information system design after the session. See Appendix C – Focus Group Guide for questions asked of focus group participants.

Participant Inclusion Criteria

Focus group participants were a convenience sample of professionals working within each local health jurisdiction. Subjects were recruited through managers and peers within each local health jurisdiction. Each subject was given the opportunity to opt out of the study at any time for any reason whatsoever. Inclusion criteria for the study were employment or affiliation with a local health jurisdiction in the study and a job role with responsibilities that would use the conceptualized information system if it were developed and deployed. Exclusion criteria for the study were not having employment or affiliation with a local health jurisdiction in the study. Focus groups were conducted by approval of the University of Washington Institutional Review Board under Certification of Exemption #38788, "Characterizing Information Needs for Public Health Continuity of Operations: A Scenario-based Design Approach".

The PI transcribed audio recordings of the focus groups. Transcripts of the focus groups were then analyzed and results were compared between the two groups to evaluate system design for reliability, usefulness and acceptability of the proposed design on the part of participants and the

reusability of design knowledge. Focus group data were transcribed, managed and analyzed using the NVivo 8 software from QSR International[85] and Microsoft Word documents. Data were analyzed with regard to participant perception of the information system design to support the activities described in the scenarios of use and then grouped according to themes by the PI. Similarities and differences between the two groups were noted. The researcher who served as observer/note taker during both focus groups reviewed results of analysis as a test of face validity for coded themes.

Chapter 3: Results

Results of Specific Aims

In the following section, we describe the results for each of our three study aims.

3.1 Assessing Information Needs

3.1.1 Results of Systematic Literature Review

Twenty publications from the final search results set were included in the review after assessment against the inclusion/exclusion criteria. Included studies of information system and technology projects were published between 1995 and 2008. Included studies originated from the following countries in the following numbers: United States (13), Greece (2), Canada (1), Mexico (1), Spain (1), Turkey (1) and the United Kingdom (1).

A quick summary of inter-rater agreement after initial application of the inclusion/exclusion criteria shows that twenty-one articles were agreed upon for exclusion unanimously by all three raters, three articles were agreed upon for inclusion unanimously by all three raters and eight articles were the subject of inter-rater disagreement with regard to inclusion/exclusion. Reconciliation of inter-rater disagreement regarding eight articles was resolved through discussion in a face-to-face meeting of all three reviewers. Reconciliation of the inter-rater disagreement resulted in the exclusion of three of the eight disputed articles and inclusion of five of the eight disputed articles.

The results set of articles returned from our literature search is by no means a comprehensive list of all such studies of information systems and technology projects worldwide but rather it is a list of projects that have been published in peer-reviewed, indexed literature and that met our defined

inclusion criteria after a formal search of digital document repositories. Table I presents the

details of design and implementation for these studies with a short description of each

information system or technology project. University affiliation has been listed as the funding

source in those instances where the study did not explicitly note a sponsor. In all studies where

the funding source was noted, the sponsoring agency is a government agency or a combination of

such agencies. A version of this table originally appeared as part of a peer-reviewed manuscript

entitled "Use of Technology to Support Information Needs for Continuity of Operations

Planning in Public Health: A Systematic Review" as published in the <u>Online Journal of Public

Health Informatics</u>[73].

Table I. Selected System Features and Details - a version of this table originally appeared in OJPHI[73]

System Name & Study Authors	Pub. Year	System Features and Details	Level of Implementation	Method or Technique	Funding Source
Emergency Computer Communications Network (CDC Wonder/PC) O'Carroll, et al.[95]	1995	• Possibly the first electronic public health system of its kind in a disaster relief operation • Local data entry with secure e-mail transmission of database files • Demonstrated the effectiveness of digital communication in reducing the impact of a disaster	Operational System	CDC conducted consultations with Iowa local health jurisdiction officials about implementation. 11 two person teams installed systems and trained staff for 99 county installations.	Stafford Act funds authorized by the Federal Emergency Management Agency
EPEDAT Eguchi, et al.[96]	1997	• Integrates real-time and historical earthquake data • Provides loss-estimation methods for earthquake damage • Applicable to a variety of regions and users	Partially functional system	Iteratively links earthquake data source parameters and damage algorithms. Displays output using GIS technology.	California Governor's Office of Emergency Services
ICEM-SE Project Bedard, et al.[97]	2003	• Integrates GIS with OLAP (On-line Analytical Processing) for decision support • Developed for environmental health interventions and outcomes • Could be applied to any planning data source for COOP planning	Prototype	Integrates commercially available software to simplify geographic visualization of environmental health data and then analyzing prototypes by comparing task steps	Several Canadian Government funding agencies
GEPIMI Ptochos, et al.[98]	2004	• Developed to establish a public health network in Greece, Bulgaria, Albania, and Turkey • Integrates medical, epidemiological and environmental data with GIS technology • Accesses and standardizes information from numerous systems	Pilot System	Integrates multiple data sources using many different technologies and provides data display via the Web and GIS.	Greek Ministry of Health and Welfare and the European Commission
NCCPHP Training Web Site (US) Horney, et al.[99]	2005	• Implements distance learning • Developed for training public health staff in preparedness • Evaluations show user satisfaction	A website for training public health practitioners in emergency preparedness	Short, web-based training modules on a variety of public health preparedness topics offered for free	University of North Carolina at Chapel Hill School of Public Health

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Table I. Selected System Features and Details - a version of this table originally appeared in OJPHI[73]

System Name & Study Authors	Pub. Year	System Features and Details	Level of Implementation	Method or Technique	Funding Source
Maxi-Vac Washington, et al.[100]	2005	• Developed for mass vaccination planning support through simulations • Can be used in a variety of settings • Facilitates staff management based on service demand	Operational system for a small-pox vaccination scenario in a hypothetical clinic developed with user input	Integrates several commercially available modeling tools, data sources and expert opinion to determine staff utilization	Centers for Disease Control
Arcview 3.2 with 2000 Census data Waring, et al.[101]	2005	• GIS technology applied to rapid needs assessment for disasters in the Houston, TX • A method of using existing GIS software tools and data sources • First study of its kind in the Houston area	Pilot system tested during the aftermath of a tropical storm	Employs an integrated GIS and data methodology that combines commercial software with available year 2000 census data	University of Texas Center for Public Health and Policy Studies (CHAMPS)
DSS-DM Aleskerov, et al.[102]	2005	• Flexible simulation of various earthquake disaster scenarios based on different inputs • Developed for planning and mitigation purposes • Provides micro-level estimates of human losses and damage for better decision support	Proposed system developed and tested with user involvement	Uses PC-based commercial software (MS Access and Delphi) and data from district and sub-district administrators to produce micro-level loss estimations for building clusters	Bogaziçi University, Istanbul, Turkey
RealOpt Lee, et al.[103]	2006	• Rapid simulation system for infectious disease disaster scenario effects on populations for real-time decision support about resource allocation • Allows for flexible "what-if" configuration • Allows users to create floor plans and specify inputs	Operational system implemented with staffing information from an Anthrax field exercise.	Tests simulations of staffing for medication dispensing in small pox scenarios and compares the results against a commercial system that uses the same model	Institute of Technology, Atlanta, GA/ Centers for Disease Control
ACCESS Grid Hauenstein, et al.[104]	2006	• Demonstrates Access Grid videoconferencing as an approach to transnational communications • Addresses public health business continuity collaboration information need • Requires more installations and testing to be a full solution	Operational system	Evaluated during a 210 minute test of a video-conference platform through participation of Network (APEC EINet) on January 19, 2006.	APEC, IBM and the Global Health and Securities Initiative, NTI

Table I. Selected System Features and Details - a version of this table originally appeared in OJPHI[73]

System Name & Study Authors	Pub. Year	System Features and Details	Level of Implementation	Method or Technique	Funding Source
ToxMap Hauenstein, et al.[105]	2006	• NLM system that integrates EPA hazardous chemical data with GIS data • Creates dynamic maps of chemical releases, trends, facility locations and superfund sites • Provides links to relevant information	Operational system available online at http://toxmap.nlm.nih.gov/toxmap/main/index.jsp	Integrates Toxic Release Inventory (TRI) data and Web-based GIS technology	National Library of Medicine
AID-N Hauenstein, et al.[106]	2006	• Allows data access through Web services • Implements data standards for disaster information exchange • Designed with real-time communication in mind	Test bed shared data model	Creates federated data models housed in a central server. Exposes data through web services architecture.	National Library of Medicine
HERDS Gotham, et al.[107]	2007	• State-wide All-Hazards Preparedness System in New York State • Archetypal Public Health Preparedness System • Provides flexible functionality during planned drills and real events	Operational system used in actual health events including a blackout and a hurricane readiness activation.	Uses a collaborative development across local health jurisdictions. Employs an all-hazards approach. Establishes a single data reporting stream built upon existing infrastructure.	New York State Department of Health
SAFE Chronaki, et al.[108]	2007	• Integrates multiple modes of communication including satellites with a mobile coordination center • Uses satellite video as one means of collaboration • Models work flow of user groups during a typhoid outbreak	Proposed architecture	Integrates satellite communications with existing health information data sources, videoconferencing and GIS technology	SAFE consortium and the European Space Agency (ESA)
EXPLORIS Marti, et al.[109]	2008	• Prototype developed to estimate earthquake damage on Tenerife (Canary Islands) • Uses a deterministic simulation model of a volcanic eruption • Creates a vulnerability map for casualties and fatalities using spatial analysis and GIS	Prototype tested for a number of specific sites in Europe (all sites not disclosed in study)	Integrates volcanic hazard, building typology and population data to estimate casualties and fatalities during eruptions.	European Union

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Table I. Selected System Features and Details - a version of this table originally appeared in OJPHI[73]

System Name & Study Authors	Pub. Year	System Features and Details	Level of Implementation	Method or Technique	Funding Source
DDSS Lozano-Fuentes, et al.[110]	2008	• Inexpensive GIS solution to increase public health capacity • Developed for decision-support in combating vector-borne disease • Incorporates high resolution satellite imagery with disease data to display city infrastructure information	Pilot demonstration	Uses satellite imagery and Google-Earth feature-making tools to develop city infrastructure layers and visualize vector-borne disease data	Innovative Vector Control Consortium
BRFSS + GIS Technology Holt, et al.[111]	2008	• Developed with needs assessment of vulnerable populations in mind • Integrates population and GIS data available from the CDC • Flexible for use in different disaster scenarios like hurricanes and influenza outbreaks	Sample Assessment	Integrates BRFSS data and GIS technology to visually display a derived risk assessment for a hurricane landfall along the East and Gulf coasts	Centers for Disease Control
HAZUS-MH Ding, et al.[112]	2008	• Models flooding, hurricanes and earthquakes • Provides for standard and customized estimations • Developed to answer needs of government officials to estimate disaster damage	Operational system that has been in use since the late 1990s	Validates the flood model in HAZUS-MH during the Harris County Risk Assessment Program (HCRAP) in Harris County, Texas by comparing outputs against local analyses	Federal Emergency Management Agency
EPIMS Senior and Copley[113]	2008	• Developed to manage, assess and monitor information during emergencies • Allows for internal and external communication • Visualizes incident response and allows access to planning documents	Operational system used during actual emergencies	Integrates disparate data sources to allow data and communication access to all users through Web, GIS and database technologies	Rotherham Metropolitan Borough Council
BCMS Sheth, et al.[114]	2008	• Strictly focuses on continuity of operations planning • Provides an integrated view of data from multiple sources • Industry independent and flexible for use during different scenarios	Proposed system based on user needs and involvement	Technology independent model based on software maturity/capability models	State of Maryland Judiciary

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Patterns in Information Need Support

Table II shows a matrix of information needs supported by technology projects and information

systems from the included studies. A version of this table originally appeared as part of a peer-

reviewed manuscript entitled "Use of Technology to Support Information Needs for Continuity

of Operations Planning in Public Health: A Systematic Review" as published in the Online

Journal of Public Health Informatics[73]. The list of supported features for each system or project

was compiled through analysis by the PI of the full text of each study document in relation to the

list of search terms. All studies reported support for the need for synthesized information. Studies

of systems that support the need for coordination/incident command also support the need for

collaboration. Studies of systems that support the need for centralized data access also supported

the need for remote work access. With the exception of two studies, all studies were published

after September 11, 2001. Studies of the Emergency Computer Communications Network[95] and

EPEDAT[96]) were published in 1995 and 1997, respectively. Most systems supported the need

for planning/plan testing/exercise support. at Training Web site[99] and AID-N framework[106] did

not support the planning need. All systems but one supported the need for resource

tracking/capacity management. The NCCPHP Training Web site[99] did not support resource

tracking or capacity management. Only HERDS[107] and SAFE[108] of the twenty included studies

supported all of categories of information needs from our list of search terms. HERDS is a fully

operational system while SAFE is a proposed framework.

Table II. Public Health Continuity of Operations Information Needs Supported by Included Systems - a version of this table originally appeared in OJPHI[73]

Author	System Name (Location)	Year of Pub.	Synthesized Information	Centralized Data Access	Coordination and Incident Command Support	Staff Training and Education	Planning, Plan Testing and Exercise Support	Interoperable External Communication /Alerting	Internal Communication /Alerting	Staff Attendance and Contact List Management	Resource Tracking and Capacity Management	Collaboration	Remote Work and Portable Data	Geographic Data
Sheth, et al.[114]	BCMS (UK)	2008	X	X	X	X	X				X	X		
Holt, et al.[111]	BRFSS (US)	2008	X					X			X			X
Lozano - Fuentes et al.[110]	DDSS (MX)	2008	X								X			X
Senior and Copley[113]	EPIMS (UK)	2008	X	X	X		X	X	X		X	X	X	X
Marti, et al.[109]	EXPLORIS (ES)	2008	X					X						X
Ding, et al.[112]	HAZUS-MH (US)	2008	X					X			X			X
Gotham, et al.[107]	HERDS (US)	2007	X	X	X	X	X	X	X	X	X	X		X
Chronaki, et al.[108]	SAFE (GR)	2007	X	X	X		X	X	X			X	X	X
Kimball, et al.[104]	ACCESS Grid (US)	2006			X		X	X				X	X	
Hauenstein, et al.[106]	AID-N (US)	2006	X	X	X			X				X	X	X
Lee, et al.[103]	RealOpt (US)	2006	X				X	X			X			
Hochstein, et al.[105]	ToxMap (US)	2006	X											X
Waring, et al.[101]	Arcview 3.2 with 2000 Census data (US)	2005	X					X		X	X			X
Aleskerov, et al.[102]	DSS-DM (TR)	2005	X				X	X						
Washington, et al.[100]	Maxi-Vac (US)	2005	X					X			X			
Horney, et al.[99]	NCCPHP Training Web Site (US)	2005	X			X						X		
Ptochos, et al.[98]	GEPIMI (GR)	2004	X	X			X	X			X	X		X
Bedard, et al.[97]	ICEM-SE Project (CA)	2003	X	X				X			X			X
Eguchi, et al.[96]	EPEDAT (US)	1997	X											X
O'Carroll, et al.[95]	Emer. Computer Comm. Net. (US)	1995	X	X				X	X			X	X	

Categories of Systems

We grouped information systems and technology projects from the twenty included studies into

four categories based on common patterns of information needs support. The four categories are:

- Risk assessment decision support tools

- Networked and communications-enabled decision support tools

- Dedicated training tools

- Dedicated video-conferencing tools

Systems from included studies are listed in Table III by category and information needs support

features. A version of this table originally appeared as part of a peer-reviewed manuscript

entitled "Use of Technology to Support Information Needs for Continuity of Operations

Planning in Public Health: A Systematic Review" as published in the <u>Online Journal of Public</u>

<u>Health Informatics</u>[73].

Table III. Categories of Systems and Projects Grouped by Information Needs Support - a version of this table originally appeared in OJPHI[73]

Category	Supported Information Needs	System Name
Risk assessment decision support tools (n = 12)	Risk assessment decision support tools typically support the following set of information needs: synthesized information, planning/plan testing/exercise support, resource tracking/capacity management and geographic data	EPEDAT[96] ICEM-SE Project[97] Maxi-Vac[100] Arcview 3.2 with 2000 Census data[101] DSS-DM[102] RealOpt[103] ToxMap[105] EXPLORIS[109] DDSS[110] BRFSS + GIS Technology[111] HAZUS-MH[112] BCMS[114]
Networked and communications-enabled decision support tools (n = 6)	Networked and communications-enabled decision support tools typically support the following set of information needs: synthesized information, centralized data access, coordination/incident command support, planning/plan testing/exercise support, interoperable external communication/alerting, resource tracking/capacity management, collaboration, remote work/portable data	Emergency Computer Communications Network (CDC Wonder/PC)[95] GEPIMI[98] AID-N[106] HERDS[107] SAFE[108] EPIMS[113]
Dedicated training tools (n = 1)	These tools are dedicated specifically to training	NCCPHP Training Web Site[99]

Access Grid[104] |
| Dedicated video-conferencing tools (n = 1) | These tools are dedicated specifically to maintaining a video-conference platform | |

3.1.2 Results of Interview Transcript Analysis

Below we discuss the results of content analysis of the twelve interview transcripts to describe

the information needs of public health nurses and other practitioners across two local health

jurisdictions. 359 pages were analyzed for all twelve interview transcripts.

Inter-rater Agreement about Information Needs between Coders

Two coders independently coded and reconciled three randomly selected transcripts to develop a

qualitative code book. Percentages and kappa coefficients as measures of inter-rater agreement

about information needs are presented below in Table IV. Percentages and kappa coefficient

values are shown before and after meetings between coders to reconcile codes and themes

following independent review of the three selected transcripts.

Table IV. Percentages and Kappa Coefficients for Inter-rater Agreement between Coders

	Percentage Agreement Before Reconciliation	Percentage Agreement After Reconciliation	Kappa Coefficient Before Reconciliation	Kappa Coefficient After Reconciliation
PH Interview	96.93	98.50	0.32	0.66
PH Interview	98.10	98.69	0.58	0.77
PH Interview	96.73	99.08	0.51	0.91
Average PH and PH Interviews	97.25	98.76	0.47	0.78

Data analysis of interview transcripts resulted in eighty-nine information needs specific to the

work of the job roles of public health nurses and public health nurse supervisors. Each

information need is grouped by category into one of seven activity types. The information need

activity types are:

1. Administrative - Self

2. Client Service/Documentation

3. Management of Referrals

4. General Communication

5. Administrative - Workforce

6. Emergency Communication

7. Continuity of Operations Planning

Table V shows information needs derived from interview transcripts in a matrix grouped by activity type and the job role to which each pertains. In many instances, one information need pertains to both the public health nurse and public health nurse supervisor role. Activities in Table V represent current or envisioned work as identified from transcripts. Referring to our earlier definition of an information need, the lists activities and information needs in Table V are intended to represent a recognition by a practitioner that she should be able perform them better if appropriately supported by an information resource. Our definition of an information need follows:

A person's recognition that an information resource should help him or her know something, learn something or do something better than without that information resource.

Table V. Information needs from analyzed interviews grouped by activity type and job role

No.	Activity Type	Information Need	Public Health Nurse	Nurse Supervisor
1	Administrative - Self	Access office network remotely	X	X
2	Administrative - Self	Archive "to do" list	X	X
3	Administrative - Self	Check in/check out electronically	X	X
4	Administrative - Self	Delete "to do" list	X	X
5	Administrative - Self	Edit "to do" list	X	X
6	Administrative - Self	Fill out travel form	X	X
7	Administrative - Self	Create a "to do" list	X	X
8	Administrative - Self	Prioritize items on "to do" list	X	X
9	Administrative - Self	Check an item off a "to do" list	X	X
10	Administrative - Self	Request time off	X	X
11	Administrative - Self	See completed items from past "to do" lists	X	X
12	Administrative - Self	Send a message to central office at the end of the day	X	X
13	Administrative - Self	Communicate personal status (for example: work from home", "vacation" or "sick")	X	X
14	Administrative - Self	Update personal profile information in a directory	X	X
15	Administrative - Self	Update personal training information	X	X
16	Client Service/ Documentation	View a chart for a client	X	
17	Client Service/ Documentation	View child client record from parent client record	X	
18	Client Service/ Documentation	View client contact information	X	
19	Client Service/ Documentation	View client insurance information	X	
20	Client Service/ Documentation	View client pharmacy information	X	
21	Client Service/ Documentation	View notes about client from all providers	X	
22	Client Service/ Documentation	View electronic medical record from clinic	X	

Table V. Information needs from analyzed interviews grouped by activity type and job role (continued)

No.	Activity Type	Information Need	Public Health Nurse	Nurse Supervisor
23	Client Service/ Documentation	View information from Child Profile	X	
24	Client Service/ Documentation	View information about services that can be provided to client	X	
25	Client Service/ Documentation	View lab results for client	X	
26	Client Service/ Documentation	View logged information about a client from an external provider	X	
27	Client Service/ Documentation	Document client information about insurance	X	
28	Client Service/ Documentation	Document first time visit data during home visit	X	
29	Client Service/ Documentation	Document research data during field visit	X	
30	Client Service/ Documentation	Document a plan for client	X	
31	Client Service/ Documentation	Create client record - child	X	
32	Client Service/ Documentation	Create client record - parent	X	
33	Client Service/ Documentation	Document client visit (assessment, problems, behavior, client request for services)	X	
34	Client Service/ Documentation	Download information for daily field work	X	
35	Client Service/ Documentation	Find out who a client communicated with at the WIC program	X	
36	Client Service/ Documentation	Document the times and reasons why protocol is not followed when following protocol would not be appropriate.	X	
37	Client Service/ Documentation	Print standardized forms	X	
38	Client Service/ Documentation	Generate map and directions to client house in the field and on-the-fly	X	
39	Client Service/ Documentation	Geographically visualize clients with contact and other information	X	
40	Client Service/ Documentation	Import e-mail as a client note	X	
41	Client Service/ Documentation	Link client records	X	
42	Client Service/ Documentation	Link scanned document to client record	X	
43	Client Service/ Documentation	Document information about communications or referrals made on behalf of the client	X	

Table V. Information needs from analyzed interviews grouped by activity type and job role (continued)

No.	Activity Type	Information Need	Public Health Nurse	Nurse Supervisor
44	Client Service/ Documentation	Document a plan for nurse	X	
45	Client Service/ Documentation	Schedule a client visit	X	
46	Client Service/ Documentation	Schedule client for appointment	X	
47	Client Service/ Documentation	Upload information for daily field work	X	
48	Client Service/ Documentation	View data from CIMS	X	
49	Client Service/ Documentation	Write an incident report	X	
50	Client Service/ Documentation	Find a client	X	
51	Client Service/ Documentation	View list of scheduled client visits	X	
52	Client Service/ Documentation	Export client data to external systems		X
53	Management of Referrals	View referral source	X	X
54	Management of Referrals	Assign client to a program	X	X
55	Management of Referrals	Close referral	X	X
56	Management of Referrals	Find contact information for a referral	X	X
57	Management of Referrals	Create new referral	X	X
58	Management of Referrals	Document a referral to another organization or provider	X	X
59	Management of Referrals	Document a referral to another division at the local health jurisdiction	X	X
60	General Communication	Communicate remotely via secure messenger	X	X
61	General Communication	Send a fax	X	X
62	General Communication	Receive a fax	X	X
63	General Communication	View staff contact information in order of preference for contact type (example: home phone, mobile, text)		X

Table V. Information needs from analyzed interviews grouped by activity type and job role (continued)

No.	Activity Type	Information Need	Public Health Nurse	Nurse Supervisor
64	Administrative - Workforce	View a mapped visualization of staff location		X
65	Administrative - Workforce	View a map of all client appointments as scheduled for all staff members		X
66	Administrative - Workforce	Assign a client to a staff member		X
67	Administrative - Workforce	Automate quarterly requests that staff members update their personal profile information		X
68	Administrative - Workforce	Change status for staff member		X
69	Administrative - Workforce	Check attendance trends for staff		X
70	Administrative - Workforce	Contact nurse who hasn't sent a message at the end of the day		X
71	Administrative - Workforce	Document reflective management with nurses regarding clients		X
72	Administrative - Workforce	Document hiring interviews		X
73	Administrative - Workforce	Request a meeting based on schedule availability		X
74	Administrative - Workforce	Find out who is scheduled for a meeting		X
75	Administrative - Workforce	Manage attendance roster		X
76	Administrative - Workforce	Schedule an interpreter		X
77	Administrative - Workforce	See schedule for all staff for all programs for all clients		X
78	Administrative - Workforce	See staff competencies		X
79	Administrative - Workforce	See staff informal skills and experience		X
80	Administrative - Workforce	See staff licensure (from HR)		X
81	Administrative - Workforce	Send reminder about a work item (and automatically log it)		X
82	Administrative - Workforce	View staff documentation practices		X

Table V. Information needs from analyzed interviews grouped by activity type and job role (continued)

No.	Activity Type	Information Need	Public Health Nurse	Nurse Supervisor
83	Emergency Communication	Receive staff alert notification	X	X
84	Emergency Communication	Respond to an alert notification	X	X
85	Emergency Communication	Send staff alert notification		X
86	Continuity of Operations Planning	View continuity of operations plan to determine what services to deliver during an emergency		X
87	Continuity of Operations Planning	Reorganize workload during mass vaccination efforts		X
88	Continuity of Operations Planning	See which employees are willing to make calls during an emergency		X
89	Continuity of Operations Planning	Set up operating plan during an emergency based on available staff members and their skill sets		X

3.2 Conceptualizing an Information System Design

3.2.1 Results of Information Design Work

This section contains design recommendations and barriers to information work as identified

from analyzed interview transcripts. Following that, we include two personas for public health

practitioners and a conceptualized information system design. A list of reports based on

practitioner feedback is presented.

Design Recommendations

Sixteen themes for design recommendations by participants were identified from content

analysis of the interview transcripts. Most design recommendations were repeated themes

supported by many participants. However, in the spirit of inclusiveness in the design process, if a

design recommendation was made by at least one participant, it has been included. In addition,

some participants had prior experience in information system design from past experience at their current work sites or a prior work setting. Participant experience in this area lent a degree of sophistication to the design process.

The *integrated system with different modules* recommendation refers to a system with different modules or packages of features that can be installed and customize according to the needs of different groups of people. *Better reports* refers to a report feature that offers standardized reports for commonly requested information and the ability to customize reporting based on ad hoc reporting requirements. *Electronic (paperless) system* is a recommendation to go digital in the support of work practices wherever possible. *Support for remote work* is a recommendation to allow access from locations other than the main office or work site. The recommendation of *support for one-time data entry* indicates a desire to enter any data only once and then the ability to access it from anywhere in the system. The *integrated scheduler* recommendation is a request for a scheduler that combines all scheduling needs and information in one place. *Simple search capability* is a recommendation for the ability to search for anything from anywhere in the system and return targeted results. *Set flags for safety concerns* is a recommendation to allow for setting alerts or flags with regard to dangerous behavior on the part of a client. Similarly, *set workload alerts* would allow for alerting if a staff member's case load climbed to high within certain parameters. The recommendation of *see client information from external entity* indicates a desire to be able to see a holistic view information about a client as aggregated from all providers that the client has seen. Likewise, *communication with external entities* is a recommendation for the ability to communicate information from within the system to other providers. *See staff skill set* is a recommendation to allow for program planning and emergency

staffing based on staff skills and experience. *Send emergency alerts to mobile phones* is a recommended feature to allow alerting from within the system to predefined groups. *Support via handheld device* is a recommendation that features of the information system be made available on smart phones, personal digital assistants (PDAs) and other handheld devices. *Visualize staff location on a map* is a recommendation for a locating feature that allows a geographic view of selected staff on a map. *Access to technical support* is not an intrinsic feature of the system itself but a recommendation for ready access to support staff with knowledge of the system.

1. Integrated system with different modules
2. Better reports
3. Electronic (paperless) system
4. Support for remote work
5. Support for one-time data entry
6. Integrated scheduler
7. Simple search capability
8. Set flags for safety concerns
9. Set workload alerts
10. See client information from external entity
11. Communication with external entities
12. See staff skill set
13. Send emergency alerts to mobile phones
14. Support via a handheld device
15. Visualize staff location on a map
16. Access to technical support

See Table VI for a list of design recommendations grouped by category with quotes from participants drawn from interview transcripts.

Table VI. Design Recommendations from Public Health Practitioners by Category with Quotes

Participant	Design Recommendations with Participant Quotes
	1. Integrated system with different modules
PH02: (Administrator)	*The perfect, ideal, public health client billing that would have all of it in it... capturing outcomes in our system so that you can actually pull out the TB program and this percentage completed their treatment. You know of this percentage of clients in the home, this percentage is smoking, not following whatever. And in six months this is where we've moved those clients. So the system that can actually capture, not only outcomes but also do they have a provider? Do they have insurance? Have they been in the hospital? So it's connected to the hospital system.*
PH11: (Public Health Nurse)	*So if I need to do a visit for somebody, I'd like to be able to get in, see what they've done already, and kind of read about the client. So I would think all of the nurses on the team would need access, our two clerical staff probably, for sure our supervisor, and the Director of Nursing.*
PH12: (Nurse Supervisor)	*It has be a system that has to be user friendly. It has to be a system that will allow communication between divisions. It has to be basically easily allow me to access reports or information without having to go through three different people to get it.*
PH14: (Public Health Nurse)	*It would be really nice to know what WIC staff are telling my clients because there are sometimes that I don't understand what they're saying.*
PH15: (Administrator)	*I would like a system that could have just everything about client registration, scheduling, patient charting, you know you can go to a different section and provide a scanned chart, this "e-records" attached to that system if possible, and then bill.*
PH16: (Administrator)	*I would like to see a system that from the moment you schedule an appointment with somebody all the way through to giving them their lab results, it's something that cross populates, that's not a matter of, I could pull up John Doe and make an appointment and with only click know what the lab results are from last visit, with one click be able to look at the last notes from the provider visit.*
PH17: (Nurse Supervisor)	*I think it would take all of the multiple layers and components of the things that we do now and combine it into one.*
PH18: (Nurse Supervisor)	*The organization either needs to develop a software system that is going to meet the needs of the organization or try to find a product that has been designed for public health that will allow different modules to be - you know a module type system might be appropriate for this organization. So they can have a public health nursing piece, they can have a clinic piece, they can have a epidemiology piece and ideally they should all talk to each other.*
PH19: (Public Health Nurse)	*But something that gives a synopsis of - so that what you want ideally is to have a little idea of where that patient is on a holistic level. And the best thing that I've seen so far in Seattle is Mindscape for that. So something like that for Public Health would be great.*

Table VI. Design Recommendations from Public Health Practitioners by Category with Quotes (continued)

Participant	Design Recommendations with Participant Quotes
	2. Better reports
PH02: (Administrator)	*Oh yeah. And a description of who we're serving. How many clients are we serving? What are their demographics?*
PH08: (Nurse Supervisor)	*I want not only the number of visits by type of visit by client profile but I also want what were the interventions we did, what were the effectiveness of those interventions. I want to be able to group that by client profile.*
PH11: (Public Health Nurse)	*I'd like to be able to print out all the caretaking parenting from the very first visit so that I can follow through and it makes sense then instead of getting 100 million pages of things we don't need to see to go to court.*
PH12: (Nurse Supervisor)	*I would like to be able to know the date that the client was enrolled and really whether or not they were visited within ten days.*
PH17: (Nurse Supervisor)	*I do a lot of hand counting too so anything that could run reports would be really nice.*
PH18: (Nurse Supervisor)	*I really want to know what's the population in that area, I want to know, I want to be able to look at a better glimpse at who's coming and for what reasons because as a public health person my mind goes what are we not doing to bring these people in or to serve these people.*
	3. Support for remote work
PH04: (Program Manager)	*More direct. Maybe more direct and less complicated to get information out to the people that work in the off-site locations.*
PH08: (Nurse Supervisor)	*If this building burned, the nurses should be able to...continue to provide the services that they normally provide because it's in the system and you should be able to still have access to that data if you have backup systems somewhere.*
PH12: (Nurse Supervisor)	*I should be able to link into my system and pull up my desktop from home so I can continue to do my work.*
PH14: (Public Health Nurse)	*Ideally I can hook up to any Wi-Fi service as long as it's secure and do an upload from wherever I'm at in the community, I don't have to keep coming back here to do it. Because that way at the end of the day I'm done.*
PH16: (Administrator)	*To be able to have that access from home to be able to call somebody and say hey we've got an earthquake and north public health doesn't exist anymore, and here's where you can go.*
PH17: (Nurse Supervisor)	*what would be really nice is to have some kind of Wi-Fi or something where you could get in contact with the nurses and you could document live. When they were out in the field they could do documentation and be done with it and not have to worry about uploading and downloading data and things like that.*

Table VI. Design Recommendations from Public Health Practitioners by Category with Quotes (continued)

Participant	Design Recommendations with Participant Quotes
	4. Electronic (paperless) system
PH08: (Nurse Supervisor)	*You do not design an electronic system based on a paper charting system, you design it based on the functions you want, not on how it looks on paper.*
PH11: (Public Health Nurse)	*I would love to just have the whole thing be electronic instead of having written notes.*
PH17: (Nurse Supervisor)	*I think it should be electronic medical records but it's all paper so it's hard to find. Do we have this consent form?*
	5. Support for one-time data entry
PH08: (Nurse Supervisor)	*Oh, boy, I'd really like a web-based system of some sort where data is readily ... I mean as soon as I enter it everybody who needs to see it could see it and I could see whatever I needed to see.*
PH11: (Public Health Nurse)	*I don't know exactly what that would look like. I guess what I would like to see, though, is somehow only do it once so that I'm not taking notes and then rewriting.*
	6. Integrated scheduler
PH11: (Public Health Nurse)	*It would help to see, "Oh, I know there's a nutritionist's appointment open at this location on this day. I'll just schedule you right now during this visit, and that will be taken care of."*
PH16: (Administrator)	*Another scheduler would be terrific. And I understand that's on the agenda but you know they've been saying that since I started here.*
PH18: (Nurse Supervisor)	*I've created my own Excel files for doing things like scheduling and creating a sense of, a lot of things I create on my own that it would be great to maybe have something that worked better for me.*
	7. Simple search capability
PH14: (Public Health Nurse)	*The populations are different so the documentation piece is going to be a little bit different. But accessing information shouldn't be different, reporting information shouldn't be different. It needs to be user friendly.*
PH16: (Administrator)	*No and I just think that if you integrate all that human resource stuff into it and have just one system that you could type in a search word and whatever it is would come up and very easy to use.*
PH17: (Nurse Supervisor)	*Whatever you're looking for. If you're looking for a person. I was just assuming you would have different tabs that you could go into. That you could go into your personnel tab and you could search for a person. Or you could go into the service, search for the service. You could into the client database and search for a client and see where they've been seen. What services, what meds, whatever.*

Table VI. Design Recommendations from Public Health Practitioners by Category with Quotes (continued)

Participant	Design Recommendations with Participant Quotes
	8. Set flags for safety concerns
PH15: (Administrator)	*Say for instance a violent, a difficult client comes in and has behavioral problems, and then you can't go into the system and put a red flag that everybody regardless of where that client finds himself tomorrow can immediately catch to say hey, be mindful, this client has these issues.*
PH16: (Administrator)	*One of the clerk's was stabbed and she's lucky to be alive. She was blinded and so she's on permanent disability. And the sad part of this whole thing is that this client was a jail client and she was being seen by a community psychiatric. And the community psychiatric folks decided that they were going to decrease her medication for whatever their reason was. And she had a psychotic break. And so she just attacked my clerk. But my point is it would be nice to have this communication and she had been acting out before at the shelter's and stuff but there was no communication with us that she was acting badly and she was deteriorating. And the rest is history.*
	9. Set workload alerts
PH08: (Nurse Supervisor)	*We could capture it by a number of factors so you could actually begin to look at patient assignment by acuity level. You could look in a nurse's case load and determine if they had inappropriate of high acuity patients versus somebody else's case load so you could use that data to then make assignments because if you had a high acuity patient and you had a nurse with an already overburdened high acuity case load you wouldn't necessarily want to give them that client. You could put alerts which was especially important in TB, has missed X number of doses of medication, could be potentially infectious again so the first thing that came up on a screen when they logged on to that patient was that kind of alert so then they knew if they found the client at home then they knew they needed to get a mask on them until we determined if they were or were not infectious.*
	10. See client information from external entities
PH17: (Nurse Supervisor)	*It would be really nice to look up a client and say look here's all their issues that happened while they were in jail and be able to address all those issues.*
	11. Communication with external entities
PH17: (Nurse Supervisor)	*You should be able to communicate with fire, police or rescue workers or whatever.*
	12. See staff skill set
PH17: (Nurse Supervisor)	*It would be nice to have access to current trainings that the nurses have attended. So this person can do WIC certifications or they can do a health assessment. They are proficient in this because they have had this training. Or even maybe some comments on their skills from a performance evaluation. It would be really nice to be able to see.*

Table VI. Design Recommendations from Public Health Practitioners by Category with Quotes (continued)

Participant	Design Recommendations with Participant Quotes
	13. Send emergency alerts to mobile phones
PH14: (Public Health Nurse)	*I have an iPhone. If you could alert me on my iPhone, it lives in my purse. The only way you're gonna get my phone away from me is to pry it from my cold dead hands. Yeah, that would be it, you'd always know where I was at. So those kinds of just emergency stuff, what's needed, where am I supposed to be.*
	14. Support via a handheld device
PH11: (Public Health Nurse)	*I would love to have some sort of handheld something to do appointments on.*
	15. Visualize staff location on a map
PH18: (Nurse Supervisor)	*It would be great to have a program that showed me a visual of who's where.*
	16. Access to technical support
PH11: (Public Health Nurse)	*I could pick up the phone and say, "This is what it's doing and I can't figure out how to get to where I need to go or get entered what I need to enter".*

Barriers

Table VII shows a list of barriers to public health information as identified from coded interview transcripts. This table indicates instances where participants talked about not being able to perform work duties when technology or information systems were involved. These barriers stem largely from the existence of multiple systems that do not communicate and poor design that does not match current or optimal work processes. In some cases, feelings about information systems were recognized as barriers by participants.

Table VII. Categories of Barriers to Information Work at Local Health Jurisdictions

	Categories of Barriers to Public Health Information Work
1	Additional job stress due to information systems that do not work properly
2	Data that cannot be deleted
3	Data that cannot be edited
4	Data that cannot be shared between systems
5	Data that is not trustworthy
6	Data whose meaning is not clearly represented
7	Difficulty in finding information in an information system
8	Inability to do client documentation properly and efficiently
9	Inability to document client-related safety issues for public health employees
10	Inability to schedule clients for needed services
11	Inability to track workload and personnel resources
12	Inattention paid to the negative impact of information systems and technology
13	Incompatibilities between versions of software, information systems or technology
14	Incomplete information in information systems
15	Information systems that are hard to learn
16	Information systems that are hard to use
17	Information systems that create more work
18	Information systems that do not communicate or share data between divisions or external partners
19	Information systems that do not match or support current work processes
20	Insufficient reports
21	Lack of access to an up-to-date emergency plan
22	Lack of access to information for program analysis, evaluation and policy making
23	Lack of belief in organizational change
24	Lack of control over technology
25	Lack of remote work access
26	Lack of secure e-mail
27	Lack of synthesized data
28	Lack of technical support
29	Lack of training
30	Lack of trust in information systems
31	Lost or corrupt data due to poorly designed information systems or processes
32	Mixed digital and paper processes that create problems as data and work is translated between systems
33	Policy that mandates the use of an information system for a purpose other than its original design
34	Poorly designed information systems
35	Processes that require duplicate data entry
36	Separate systems that support the same processes
37	Technology and information systems that become substitutes for face-to-face communication
38	Too many steps to accomplish work goals in systems
39	Too much data to be managed
40	Too much time spent to accomplish goals in information systems
41	Translation/Interpretation problems for spelling of immigrant names
42	Unclear, undocumented or non-standard processes
43	Work around processes because technology does not function properly
44	Work interruptions due to information system malfunctions

Public Health Nurse and Public Health Nurse Manager Personas

Two fictional named personas developed by the PI from information in the interview transcripts are presented in Figure 3 and Figure 4. Personas are meant to typify the practitioners who will use the information system design conceptualized in this dissertation. Designers use personas to make concrete the idea of the person who will use an information system and to aid design efforts. The persona "Marcella" is a public health nurse. The persona "Victoria" is a public health nurse supervisor. Marcella and Victoria are matched to the activities and information needs that the conceptualized information system supports.

MARCELLA - PUBLIC HEALTH NURSE PERSONA

Background
Marcella is a public health nurse who does home visitations to provide maternal child health services to low-income, at-risk mothers. She holds a bachelor's degree in nursing and has 15 years experience as a nurse. Prior to her career as a public health nurse, Marcella worked as a nurse in a hospital setting.

Responsibilities
Marcella's responsibilities as a public health nurse include:
- Daily home visitations
- Relationship building with clients
- Health care coordination for expecting mothers
- Documentation of client encounters
- Scheduling and managing her own personal work
- Collaboration with internal entities such as the WIC program and clinic services
- Collaboration with external entities such as child protective services, the courts and research partners

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Figure 3. "Marcella" – a public health nurse persona and description

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VICTORIA - PUBLIC HEALTH NURSE MANAGER PERSONA

Background
Victoria is a public health nurse manager who coordinates the work of a team of public health nurses who do home visitations to provide maternal child health services to low-income, at-risk mothers. Victoria is a registered nurse and holds an MPH degree. Victoria has 20 years experience in public health and has been a supervisor for over a decade. Victoria has held various positions in the local health jurisdiction in addition to having work experience in other health care settings. Victoria has a strong background in maternal child health and has had formal management training.

Responsibilities
Victoria's responsibilities as a public health nurse supervisor include:
- Supervise a team of public health nurses during times of normal and emergency operations
- Coordinate team development and organizational culture
- Manage home visitation programs that provide demand services to clients
- Solicit input from public health nurses about how programs are working
- Track the workload of her direct reports for balance and adjust for staffing shortages as necessary
- Evaluate program compliance based on documentation of client encounters by public health nurses
- Report program outcomes to division leadership
- Create plans to correct performance if a program is out of compliance
- Manage payroll and other personnel issues using information systems
- Scheduling and managing her own personal work
- Collaboration with internal entities such as the WIC program and clinic services
- Collaboration with external entities such as child protective services, the courts and research partners

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Figure 4. "Victoria" – a public health nurse manager persona and description

Information Needs and Scenarios of Use

The descriptions of information needs and activities to be supported by a conceptualized information system for public health field nursing and nursing supervision are presented below in Table VIII. In general, the conceptualized system is designed to support secure, remote work and secure communication through a variety of means and devices, facilitate the actual activities of public health nurses and nurse supervisors as they provide and document direct services to clients and help to manage workload and resources during normal and emergency operations. The proposed design is meant to support the entry of referral and client documentation once into a single, integrated system that allows the sharing of that data across divisions within a local health jurisdiction as well as to external partners. In addition, the design is meant to allow the import of referral and client data from external partners with compatible systems.

Table VIII. Information needs and scenarios of use grouped by activity type and persona

No.	Activity Type	Marcella Persona	Victoria Persona	Information Need	Activity Scenario
1	Administrative - Self	X	X	Access office network remotely	Marcella needs to download some files from her personal folder on the network. She logs on to the office network remotely, finds the files she needs and transfers them to her laptop.
2	Administrative - Self	X	X	Archive "to do" list	Marcella logs into the information system and navigates to the "to do" list feature. She has finished everything on the list so she checks off all items and archives the "to do" list. The list will be available for search if she wants to see what she has done later.
3	Administrative - Self	X	X	Check in/check out electronically	Marcella is leaving the office so she logs into the information system and changes her location status to "out of office".
4	Administrative - Self	X	X	Delete "to do" list	Marcella chooses not to work from a "to do" list today. She logs into the information system and deletes the one she has started.
5	Administrative - Self	X	X	Edit "to do" list	Marcella's work has changed from what she anticipated that she would do for the day. She logs into the information system and removes items from her "to do" list. These items will not be archived or searchable later.
6	Administrative - Self	X	X	Fill out travel form	Marcella needs to fill out a travel form so she downloads it from the forms area of the information system, fills it out electronically and forwards it to her supervisor for approval.
7	Administrative - Self	X	X	Create a "to do" list	Marcella wants to write up a list of things "to do" for the day so she logs into the information system and goes to the "to do" list feature. The "to do" list is automatically populated with some items based on schedule client visits. She deletes some items and adds others. As she works throughout the day, she can check things off the list and these will be archived and searchable for historical purposes.
8	Administrative - Self	X	X	Prioritize items on "to do" list	Marcella needs to update her "to do" list. She logs into the information system and goes to the "to do" list feature. She prioritizes items on her "to do" list in order of importance and saves the list.

Table VIII. Information needs and scenarios of use grouped by activity type and persona (continued)

No.	Activity Type	Marcella Persona	Victoria Persona	Information Need	Activity Scenario
9	Administrative - Self	X	X	Check an item off a "to do" list	Marcella finishes a task she added to her "to do" list. She logs into the information system and goes to the "to do" list feature. In doing so, she realizes that there are two other items she has finished. She checks them off as well and saves the list. The checked items will be archived and searchable if Marcella wants to see what she has done at a later date.
10	Administrative - Self	X	X	Request time off	Marcella needs to request time off so she downloads the appropriate form from the forms area of the information system, fills it out electronically and forwards it to her supervisor for approval.
11	Administrative - Self	X	X	See completed items from past "to do" lists	Marcella wants to verify whether she completed a task she wanted "to do" from a few weeks ago. She logs into the information system and goes to the "to do" list feature. She searches the archives of checked items from past "to do" lists and finds what she was looking for.
12	Administrative - Self	X	X	Send a message to central office at the end of the day	Marcella is done for the day but is not going back to the office. After her last visit, she logs into the information system and sends a message to the central office to acknowledge that she is safe and at home.
13	Administrative - Self	X	X	Communicate personal status (for example: "work from home", "vacation" or "sick")	Marcella is working from home before she goes out to visit clients and won't be going into the office because she has all the materials she needs and the client is close to her house. She remotely logs into the information system and sets her personal status to "working from home" and a trigger to set it to "out of the office" in two hours.
14	Administrative - Self	X	X	Update personal profile information in a directory	Marcella has moved to a new house. She logs into the information system and updates her personal address.
15	Administrative - Self	X	X	Update personal training information	Marcella recently completed continuing nursing education for disaster and environmental health nursing. She logs into the information system and updates her personal training information.

Table VIII. Information needs and scenarios of use grouped by activity type and persona (continued)

No.	Activity Type	Marcella Persona	Victoria Persona	Information Need	Activity Scenario
16	Client Service/ Documentation	X		View a chart for a client	Marcella is viewing the options for information that is available for a client in the information system and wants to see what she wrote in her last visit. Marcella opens up the client's chart and reads her notes.
17	Client Service/ Documentation	X		View child client record from parent client record	Marcella has opened a client record in the information system and wants to see the notes she has written for the client's baby in her last visit. Marcella opens up the baby's chart directly from the mother's client record and reads her notes.
18	Client Service/ Documentation	X		View client contact information	Marcella is scheduling a visit with a client and needs the client's contact information. She finds the client in the information system and opens up the client's contact information. Marcella calls the client.
19	Client Service/ Documentation	X		View client insurance information	Marcella wants to make sure that the client is eligible for a program. She finds the client in the information system and views the client's insurance information.
20	Client Service/ Documentation	X		View client pharmacy information	Marcella needs to see a client's prescription information as part of her visit. She finds the client in the information system and views the client's pharmacy information.
21	Client Service/Documentation	X		View notes about client from all providers	Marcella has not seen a particular client in a while and wants to get up to speed on the client's history. She finds the client in the information system and views all notes about the client from all providers since the client started with the local health jurisdiction.
22	Client Service/ Documentation	X		View electronic medical record from clinic	Marcella is seeing a client who has questions about the date and details of a recent visit to the clinic. Marcella finds the client in the information system, opens up the client electronic medical record and answers the client's questions.
23	Client Service/ Documentation	X		View information from Child Profile	Marcella is seeing a client who has questions about the date of her child's last vaccinations. Marcella finds the child's record in the information system and views vaccination information from CHILD Profile to answer the client's questions.

Table VIII. Information needs and scenarios of use grouped by activity type and persona (continued)

No.	Activity Type	Marcella Persona	Victoria Persona	Information Need	Activity Scenario
24	Client Service/ Documentation	X		View information about services that can be provided to client	Marcella is seeing a client who has questions about other services that are available from the local health jurisdiction and other community organizations. Marcella views a list of services available through community organizations and councils the client about her eligibility.
25	Client Service/ Documentation	X		View lab results for client	Marcella is seeing a client who has questions about her lab results related to a visit to the public health clinic. Marcella finds the client in the information system and views the client's lab results. She explains the lab results to the client.
26	Client Service/ Documentation	X		View logged information about a client from an external provider	Marcella is seeing a client who has seen other health care providers in the community. Marcella finds the client in the information system and sees that these providers use a system that exchanges information with the local health jurisdiction's information system. Marcella is better able to provide services to her client because she has a more holistic picture of the client's health care history.
27	Client Service/ Documentation	X		Document client information about insurance	Marcella is seeing a new client and has created a new record for her but still needs to enter information about the client's insurance. Marcella opens the insurance area of the client record and enters insurance information as reported to her by the client.
28	Client Service/ Documentation	X		Document first time visit data during home visit	Marcella is on her first visit to a new client and must document first time visit data. She creates a record for the client in the information system and enters information related to due date, prenatal care start date, client income goals, client relationship status, other community services the client is accessing, drug and alcohol use, domestic violence and mental health
29	Client Service/Documentation	X		Document research data during field visit	Marcella is on a visit to a client that is enrolling in one of the local health jurisdiction's research programs. Marcella finds the client record in the information system and records the required research data for the client.

Table VIII. Information needs and scenarios of use grouped by activity type and persona (continued)

No.	Activity Type	Marcella Persona	Victoria Persona	Information Need	Activity Scenario
30	Client Service/ Documentation	X		Document a plan for client	Marcella is working with a client during a visit. She finds the client record in the information system and documents a behavior plan with client goals including money management and education.
31	Client Service/ Documentation	X		Create client record - child	Marcella is on a home visit to a client with a new baby. The baby hasn't been entered into the information system. Marcella finds the client in the information system. From the client record, she creates a new record for the baby that is linked to that of the mother's record.
32	Client Service/ Documentation	X		Create client record - parent	Marcella is working with a new client that has opted to enter a program after referral and evaluation. Marcella creates a new record for the client and populates it with contact information.
33	Client Service/ Documentation	X		Document client visit (assessment, problems, behavior, client request for services)	Marcella is on a home visit with a client. The client discusses a health issue that has come up since their last visit together. Marcella finds the client record in the information system and documents the problem, naming the problem according to the local health jurisdiction's naming taxonomy (for example: Omaha). Marcella documents the client's behavior, physical symptoms and the client's requests for additional information about services provided by the local health jurisdiction. Marcella documents what she had communicated to the client.
34	Client Service/ Documentation	X		Download information for daily field work	Marcella has created the route of client visits for the next day. Although she can work remotely and access the information system using her laptop and a wireless connection, it is quicker to download everything over the wired network at the office. She logs in to the information system at her desk and then securely and quickly transfers all the files she will need for the following day.
35	Client Service/ Documentation	X		Find out who a client communicated with at the WIC program	Marcella is visiting a client and the client references a conversation with a WIC representative at the local health jurisdiction. Marcella is unclear about what the client is telling her so she finds the client record in the information system and checks the notes from the client's most recent visit to the WIC office.

Table VIII. Information needs and scenarios of use grouped by activity type and persona (continued)

No.	Activity Type	Marcella Persona	Victoria Persona	Information Need	Activity Scenario
36	Client Service/Documentation	X		Document the times and reasons why protocol is not followed when following protocol would not be appropriate.	Marcella is in a situation where following protocol with a client would not be appropriate to what the client needs for care. Marcella finds the client record in the information system and writes her reasons for the appropriate care she has provided to the client.
37	Client Service/ Documentation	X		Print standardized forms	Marcella has created the route of client visits for the next day. Although most of her work is done in the visitation information system, she still needs some hardcopy paperwork during her visits. She logs in to the information system at her desk and prints the forms she will need for the next day.
38	Client Service/ Documentation	X		Generate map and directions to client house in the field and on-the-fly	Marcella is out in the field and needs directions to a new client's house. She logs into the information system on her laptop and finds the client record. Marcella creates a map and directions to the client's house from her current location.
39	Client Service/ Documentation	X		Geographically visualize clients with contact and other information	Marcella wants to see the next day's appointments on a map. She logs into the information system, selects the next day's list of clients and goes to the mapping option. The day's clients are visualized with pins on a topographic map along with boxes that show their contact information. This feature could be used as a training application for new nurses.
40	Client Service/ Documentation	X		Import e-mail as a client note	Marcella has had a secure e-mail exchange with another health care provider that is external to the local health jurisdiction. She wants to make sure that this information is not lost so she opens the visitation information system, finds the client record and selects the "import note" option. Her e-mail is configured to integrate with the information system and she is shown her inbox. Marcella selects the e-mail(s) that she wants to import at client notes.

Table VIII. Information needs and scenarios of use grouped by activity type and persona (continued)

No.	Activity Type	Marcella Persona	Victoria Persona	Information Need	Activity Scenario
41	Client Service/ Documentation	X		Link client records	Marcella is working with a client and finds that one of the client's children is in the information system but their records are not linked. Marcella finds the client record in the information system, chooses the "link family member" option, finds the child's client record and links the two records.
42	Client Service/Documentation	X		Link scanned document to client record	Marcella has some paper forms from the client's hard copy file that she would like to access from within the information system. She first scans the paper files to a digital format. Marcella opens the information system, finds the client record and chooses the "link documents" option. Marcella navigates to the scanned documents and links them to the client record.
43	Client Service/ Documentation	X		Document information about communications or referrals made on behalf of the client	During a home visit, Marcella has made a phone call on behalf of a client for information from another local health care provider. She finds the client record in the information system and documents the phone call.
44	Client Service/ Documentation	X		Document a plan for nurse	Marcella is helping a client set a plan for their next visit together. She finds the client record in the information system and documents the client plan. While Marcella does this, she also sets goals for herself in relation to the client's goals.
45	Client Service/ Documentation	X		Schedule a client visit	Marcella is working with a client during a visit. They agree upon a date and time for their next visit together. Marcella finds the client record in the information system, opens the scheduling feature and schedules the client visit. The scheduling feature automatically updates other calendars that Marcella uses.

Table VIII. Information needs and scenarios of use grouped by activity type and persona (continued)

No.	Activity Type	Marcella Persona	Victoria Persona	Information Need	Activity Scenario
46	Client Service/ Documentation	X		Schedule client for appointment	Marcella is working with a client during a home visit. The client says that she needs to take her children in for flu vaccinations. Marcella finds the client record in the information system and opens up the appointment calendar for the clinic at the public health center. She finds a free time slot on a day that works and schedules the client. The information system logs Marcella's actions.
47	Client Service/ Documentation	X		Upload information for daily field work	Marcella has finished her work for the day. Although she can chart in real-time when a wireless connection is available, Marcella was working with clients in an area where she had no connectivity. Now that Marcella has connectivity, she logs into the information system and automatically uploads the work she has done. The system logs the upload activity.
48	Client Service/Documentation	X		View data from CIMS	Marcella is seeing a client who has questions about her WIC account. Marcella finds the client record in the information system and views the client's WIC information from CIMS to answer the client's questions.
49	Client Service/ Documentation	X		Write an incident report	Marcella is having difficulty with a client. After her visit, she finds the client record in the information system and writes a formal incident report detailing what happened for the safety of her coworkers and other care providers. The incident report is automatically available to other providers who use compatible systems that accept imports from the visitation information system.
50	Client Service/ Documentation	X		Find a client	Marcella is visiting a client and must chart new information for the mother and her baby. Marcella searches for the client by name in the information system. The client's name is returned as a result of the search. Marcella is shown options to view contact, charting and other information that is available for the client and the client's children.

Table VIII. Information needs and scenarios of use grouped by activity type and persona (continued)

No.	Activity Type	Marcella Persona	Victoria Persona	Information Need	Activity Scenario
51	Client Service/ Documentation	X		View list of scheduled client visits	Marcella wants to see the list of clients she is scheduled to see for the next day. She logs into the information system and goes to the scheduling feature. She selects the date and sees her schedule.
52	Client Service/ Documentation		X	Export client data to external systems	An external (authorized) partner has requested data for joint grant-writing purposes. Victoria logs into the information system and goes to the export utility. She selects the data range of information with the appropriate fields and does an export to a standard format to send to the external partner. If the external partner is running a compatible information system, Victoria can just create a feed for the selected information and the external partner can pull the data directly from the information system at the local health jurisdiction.
53	Management of Referrals	X	X	View referral source	Marcella wants to see the referral source for a particular client. She logs into the information system, finds the client record and views the referral history.
54	Management of Referrals	X	X	Assign client to a program	A client wants to sign up for a program. Marcella logs into the information system and finds the client records. She converts the client from referral status and assigns her to the desired program for which the client is eligible.
55	Management of Referrals	X	X	Close referral	A client decides she does not want to participate in a program. Marcella logs into the information system, finds the client record and changes her referral status to "closed".
56	Management of Referrals	X	X	Find contact information for a referral	Marcella needs to call a client who has been referred for participation in a program. She logs into the information system, finds the client record and goes to the contact information feature. Marcella calls the client.
57	Management of Referrals	X	X	Create new referral	Marcella has receives a secure e-mail about a referral for one of the local health jurisdiction's programs. She logs into the information system and navigates to the referral feature. Marcella creates a client record for the referral and enters the client's contact information.

Table VIII. Information needs and scenarios of use grouped by activity type and persona (continued)

No.	Activity Type	Marcella Persona	Victoria Persona	Information Need	Activity Scenario
58	Management of Referrals	X	X	Document a referral to another organization or provider	Marcella has evaluated a client and referred her to another provider. She logs into the information system, finds the client record and changes the referral status. She documents the reason for the status change and the provider to which the client has been referred.
59	Management of Referrals	X	X	Document a referral to another division at the local health jurisdiction	Marcella refers a client to another division at the local health jurisdiction so the client may access additional services. Marcella logs into the information system, finds the client record and documents the details of the referral.
60	General Communication	X	X	Communicate remotely via secure messenger	Marcella is about to go visit a client but has some questions about a problem the client has. She wants feedback from her supervisor before the visit so she logs into the information system and goes to the secure messenger feature. She sees that her supervisor is online and they have a brief text conversation about the client's problem.
61	General Communication	X	X	Send a fax	Marcella needs to send a fax to a provider at a hospital that does not have IT systems that exchange data with the information system. After she has scanned a signed paper form to digital format, she logs into the information system and goes to the fax feature. She selects the provider's number from a contact list, selects the scanned paper form and sends the fax from within the information system. The fax transmission is logged and the fax is archived.
62	General Communication	X	X	Receive a fax	Marcella logs into the information system and sees that she has a fax notification. She navigates to the fax feature. She sees that a provider from a local hospital has faxed several sheets of notes about one of her clients. Marcella chooses the "link" feature, finds the client record in the information system and attaches the faxed documents to the client record.

Table VIII. Information needs and scenarios of use grouped by activity type and persona (continued)

No.	Activity Type	Marcella Persona	Victoria Persona	Information Need	Activity Scenario
63	General Communication		X	View staff contact information in order of preference for contact type (example: home phone, mobile, text)	Victoria needs to contact one of her nurses because she hasn't responded to a staff alert notice. She logs into the information system and finds the nurse's contact information and calls the nurse via home phone.
64	Administrative - Workforce		X	View a mapped visualization of staff location	Victoria wants to see where all of her nurses are located according to her schedule at a given time. She logs into the information system and goes to the mapping feature. She selects a day and time and all the nurses on her team to see a map with pins with each nurse's name and location according to the current schedule.
65	Administrative - Workforce		X	View a map of all client appointments as scheduled for all staff members	Victoria wants to see where all of her nurses are working on a given day. She logs into the information system and goes to the mapping feature. She selects the current day and all the nurses on her team to see a map with pins labeled with client locations and scheduled visit times, the nurse assigned to each client and routes drawn between locations.
66	Administrative - Workforce		X	Assign a client to a staff member	Victoria is assigning clients to her staff members. She logs into the information system and assigns clients to individual staff members based on the difficulty of each case.
67	Administrative - Workforce		X	Automate quarterly requests that staff members update their personal profile information	Victoria logs into the information system and sets up a recurring, quarterly reminder to update personal profile information. The reminder will appear when each staff member logs in to the information system until the profile is updated.
68	Administrative - Workforce		X	Change status for staff member	One of Victoria's staff members has gone on vacation but forgotten to update her status. Victoria logs into the information status, finds that staff members profile and updates the status to "on vacation".

Table VIII. Information needs and scenarios of use grouped by activity type and persona (continued)

No.	Activity Type	Marcella Persona	Victoria Persona	Information Need	Activity Scenario
69	Administrative - Workforce		X	Check attendance trends for staff	Victoria wants to see how her staff are doing with regard to attendance and make sure none of her staff are in danger of running out of leave balance. She logs into the information system and runs a report that shows attendance for each staff member over a selected time period.
70	Administrative - Workforce		X	Contact nurse who hasn't sent a message at the end of the day	Victoria receives an alert (by e-mail, text message or phone call from service) that one of her nurses hasn't sent a message at the end of the day that indicates that she is safe at home. Victoria logs into the system remotely from home, finds the nurse's profile and gets her contact information. Victoria calls the nurse at home to confirm that she is OK.
71	Administrative - Workforce		X	Document reflective management with nurses regarding clients	Victoria is doing her regular reflective management meetings with her nurses regarding their work with clients. During and after these sessions, she logs into the information system, goes to the staff evaluation feature and documents feedback with regard to each nurse and her clients.
72	Administrative - Workforce		X	Document hiring interviews	Victoria has just conducted a hiring interview. She logs into the information system and goes to the HR feature. She documents details of the hiring interview, noting interviewee strengths and weaknesses and writes recommendations about whether or not to hire.
73	Administrative - Workforce		X	Request a meeting based on schedule availability	Victoria wants to schedule an ad hoc meeting. She logs into the information system and goes to the staff scheduler which shows the times and availability of her staff. She selects the best time/date and sends a meeting request for that time/date.
74	Administrative - Workforce		X	Find out who is scheduled for a meeting	Victoria wants to know who is attending a scheduled meeting. She logs into the information system and goes to the staff scheduler. She navigates to the date/time of the meeting and sees who is confirmed to attend.

Table VIII. Information needs and scenarios of use grouped by activity type and persona (continued)

No.	Activity Type	Marcella Persona	Victoria Persona	Information Need	Activity Scenario
75	Administrative - Workforce		X	Manage attendance roster	Victoria has taken attendance and needs to update the attendance roster. She logs into the information system and goes to the attendance feature. By default, staff members are shown as "present" according to their schedules but are not counted as such until confirmed. Victoria marks those who are out for the day and confirms the rest who are present.
76	Administrative - Workforce		X	Schedule an interpreter	Victoria needs to schedule an interpreter to help one of her nurses with a client visit. She logs into the information system and goes to the interpreter scheduling feature. She makes a request for the date of the client visit based on the interpreter's availability.
77	Administrative - Workforce		X	See schedule for all staff for all programs for all clients	Victoria wants to see the schedule for everybody on her team. She logs into the information system and goes to the staff scheduling feature. From here, she selects the option for "seeing all" and is shown a calendar that includes all staff under her supervision.
78	Administrative - Workforce		X	See staff competencies	Victoria wants to view the competencies of a staff member to assign her emergency responsibilities. She logs into the information system, goes to the HR feature and finds the profile of the nurse in question. She sees that the nurse in question has the competencies to fill a position that is open as per the continuity of operations plan.
79	Administrative - Workforce		X	See staff informal skills and experience	Victoria wants to view the informal skills and experience of a staff member to assign her emergency responsibilities. She logs into the information system, goes to the HR feature and finds the profile of the nurse in question. She sees that the nurse in question has the skills to fill a position that is open as per the continuity of operations plan.

Table VIII. Information needs and scenarios of use grouped by activity type and persona (continued)

No.	Activity Type	Marcella Persona	Victoria Persona	Information Need	Activity Scenario
80	Administrative - Workforce		X	See staff licensure (from HR)	Victoria wants to view the licensure of one of her nurses to make sure that she is current with her requirements. She logs into the information system, goes to the HR feature and finds the profile of the nurse in question. She sees that the nurse in question is current in her training and certifications.
81	Administrative - Workforce		X	Send reminder about a work item (and automatically log it)	Victoria is reviewing workload for her staff in the information system and sees that an upcoming due date for a work item is approaching for one of her nurses. She sends a friendly internal reminder to the nurse to put the item on her "to do" list. The alert will appear to the nurse each time she logs until it is addressed.
82	Administrative - Workforce		X	View staff documentation practices	Victoria logs into the information system and goes to the staff management feature. She selects a nurse's profile. Once in the profile for the nurse, she can see the clients assigned to the nurse and do a general review of her documentation practices for evaluation and feedback purposes.
83	Emergency Communication	X	X	Receive staff alert notification	The county is experiencing inclement weather in the form of a snow storm. Marcella receives a staff alert notification during an emergency via her preferred method of contact (phone, text message, e-mail, alert with information system)
84	Emergency Communication	X	X	Respond to an alert notification	The county is experiencing inclement weather in the form of a snow storm and Marcella has received an alert notification to contact the local health jurisdiction and indicate her availability. Marcella logs into the information system and goes to the alert feature. She flags her status as unavailable because she has to pick up her children from school and it will be a long drive through snow.
85	Emergency Communication		X	Send staff alert notification	The county is experiencing inclement weather in the form of a snow storm. Victoria sends an alert to staff through the information system that the local health jurisdiction will be open.

Table VIII. Information needs and scenarios of use grouped by activity type and persona (continued)

No.	Activity Type	Marcella Persona	Victoria Persona	Information Need	Activity Scenario
86	Continuity of Operations Planning		X	View continuity of operations plan to determine what services to deliver during an emergency	The county is experiencing inclement weather in the form of a snow storm. As a supervisor, Victoria must advise her available staff as to what services to suspend and/or provide. Victoria logs into the information system and accesses the continuity of operations plan. She confirms that home visitation services can be temporarily suspended without serious impact to those clients. She directs those staff at the central office to help out with clinic operations.
87	Continuity of Operations Planning		X	Reorganize workload during mass vaccination efforts	A new strain of flu is requiring mass vaccinations. Victoria works with executive administration to modify the response plan to include vaccinations during home visits in order to maintain normal operations. After meeting with her nurses, each logs into the information system to adjust their client schedules for longer visits for those clients who want their families vaccinated. Victoria reviews the work reorganization through the information system.
88	Continuity of Operations Planning		X	See which employees are willing to make calls during an emergency	The county is experiencing inclement weather in the form of a snow storm. Victoria logs into the information system to see which of her nurses have indicated that they will make calls to clients for notification about closure of the local health jurisdiction and appointment cancellation and rescheduling. She views the list of available nurses and sends them an e-mail requesting their services. For those that reply, she creates a "to do" list of clients to call within the information system.
89	Continuity of Operations Planning		X	Set up operating plan during an emergency based on available staff members and their skill sets	During a new flu threat, Victoria must see if all of her nurses have current injection skills for vaccination efforts during home visits. As all of her nurses are available, she logs into the information system and verifies that all of her nurses have recent experience with injections.

Reports Identified from Interviews

Table IX shows a list of reports as identified from interviews that the information system design will generate for either Marcella or Victoria.

Table IX. List of Reports Identified from Interviews

	Reports identified from interviews
1	Create custom report
2	View a client data report for use during court proceedings
3	View a report by problem (not visit date)
4	View a report of clients by residence, intervention and other history
5	View a report of health indicators
6	View absenteeism reports from schools
7	View case load report
8	View client by program type and risk criteria
9	View client consent form
10	View client data by problem type
11	View client data with community health assessment data
12	View client report with enrollment date and first visit
13	View clients by selected zip codes with visit information
14	View clients that were scheduled and clients that were seen by staff member
15	View community population demographic report
16	View community population vs. case load report
17	View depression screen report with totals and scores
18	View effectiveness of an intervention
19	View H1N1 infection rates in the community
20	View how many clients have visited the local health jurisdiction in one day
21	View how many staff have the education for and what resources are available for a new program
22	View immunization rates in the community
23	View low birth weight infants or preterm by intervention
24	View maternal child health data merged with other data sources (example: epi data sources)
25	View mortality/morbidity for a particular disease
26	View NFP CIS reports
27	View number of visits by type of visit by client profile with interventions and effectiveness of interventions
28	View program by billable unit
29	View referrals with date assigned and outcome
30	View school lunch program comparison report
31	View selected clients by program type and dosage intensity, number of visits, how intensive the visit was, personnel requirements
32	View staff by program, custom group and client information
33	View WIC history report
34	View women by prevented complications

3.3 Validation of the System Design

3.3.1 Results of Focus Groups

Table X shows the composition of each focus group with participant job titles and the

populations of the counties served by each local health jurisdiction.

Table X. Focus Group Composition with Participant Job Titles

	Spokane Regional Health District (county pop. 464,000)	Public Health - Seattle & King County (county pop. 1,931,000)	Total
Public Health Nurse (Home Visitation)	2	2	4
Public Health Nurse (Obstetrics)		1	1
Pubic Health Nurse Supervisor	1		1
Nursing Student		1	1
Medical Nutritionist		1	1
Senior Health Administrator	1		1
	4	5	9

Persona Feedback

Focus group participants from both local health jurisdictions agreed with the descriptions of the

two personas with some recommendations for edits and changes. Participants suggested changes

so the personas would more accurately reflect descriptions of typical practitioners who hold that

job role in the real-world. Participant recommendations for edits and changes are indicated

below.

Marcella - public health nurse persona

Description changes suggested by participants:

• Add documentation of client encounters to responsibilities (using Omaha)

• Add code time by activity codes to responsibilities

• Add view and manage personal case load to responsibilities

• Add health education and teaching to responsibilities

Victoria - public health nurse manager persona

Description changes suggested by participants:

- Change Masters of Public Health Administration to Masters of Nursing for background description

- Add view and manage case load of all nurses to responsibilities

- Provide data about case loads for program oversight and evaluation

Design Feedback

Content analysis revealed agreement between participants from both local health jurisdictions in the following thematic areas where characteristics, information needs and activity scenarios of the conceptual information system design were useful to support their work in the following thematic areas:

- The need for a dynamic, flexible system

- Support for client service and documentation activities

- Support for workload tracking activities

- Support for staff management activities

- One-time data entry

- Real-time documentation

- Communication and integrated data between divisions

- Support for integrated scheduling

- Communication to external providers

Some of the following descriptions below contain direct quotes from study participants. Participant names and information system names have been redacted.

Support for common work activities and changes in work

Participants from both local health jurisdictions emphasized the need for a dynamic flexible system, leading one participant to state: *"Our workload keeps changing and the definition of the job we do keeps changing. So it has to be a dynamic system that allows for some change."* (Focus Group Participant 6) The client service/documentation scenarios were positively validated by participants from both LHJs (see information needs and activity scenarios numbers 16-52 in Table VIII). Participants also agreed that administrative information needs and activity scenarios for tracking workload were useful and accurate (both self and workforce – see Table VIII). From a management standpoint, participants in both focus groups recognized the need for supervisors to access overall case load to allocate work and remain within staffing budget constraints.

One-time data entry

The support for one-time data entry of client data in the information system design was very important to participants in both local health jurisdictions. Current documentation and data management processes in both LHJs require duplicate entry of the same data into multiple electronic and paper-based systems. Selected comments from focus group participants about the usefulness of one-time data entry are shown below:

> *"It would be nice to receive the referral, and put it once and then have them in the system."* (Focus Group Participant 3)

"So once they put that in, will the system automatically populate other fields that require the same data. That would be huge." (Focus Group Participant 1)

"Usually I have to run down there and run around and find it or I have to go find the chart somewhere to be able to find out what kind of additional assessments they've done." (Focus Group Participant 6)

Real-time documentation

The conceptual information system design supports real-time documentation of client services. This real-time documentation feature was highly valued by participants from both local health jurisdictions. Participants stated:

"If <the obstetrics nurse> *were to see an OB client and make a note about it, there's no way when you're out in the field that you have any way to see what that would be."* (Focus Group Participant 5)

"Futuristically, we want this to be done in real time." (Focus Group Participant 1)

"A really big one is the pediatric nurse practitioners, physicians, that are following up on a child, maybe the PHN sent the child to them because of an issue - growth related - or whatever, they have no access to the notes that were generated in <the current information system> *and typically they're not filed in the chart in a timely manner. It could be months later by the time they make it into the chart."* (Focus Group Participant 8)

Communication and integrated data between divisions

The ability to view integrated data from other divisions within the local health jurisdiction was a feature that participants from both focus groups validated as useful. Integrated data from other divisions and providers were stated to be useful from the standpoints of communication and a

holistic view of patient history. The ability to toggle between mother and child records was also validated as useful. Comments regarding integrated data views are shown below:

> *"I'm amazed that she can check the pharmacy. She can check the lab results. That would be good. Well to be able to check what medications she's on, to be able to check lab results from a previous visit you know. We can't do any of that. It would work. It would be good customer service."* (Focus Group Participant 8)

> *"They say they have their immunizations but for us to be able to confirm that would be nice."* (Focus Group Participant 3)

> *"Say <another public health nurse> has a client that I'm covering for, I can go in and pull up the chart."* (Focus Group Participant 4)

> *"So if you're trying to follow up on a patient who has a failure to thrive issue and saw the doctor in the medical clinic, trying to track down that chart might be a challenge. And you don't really know how that visit went whereas if both the nurse and the provider, in this case the doctor, charted electronically, it would make access and communication easier for work."* (Focus Group Participant 7)

Support for integrated scheduling

In conjunction with real-time documentation and integrated views of data from other divisions, support for integrated scheduling was a highly valued feature of the conceptual information system design in both local health jurisdictions. Statements by participants about the value of integrated scheduling are shown below:

> *"If you're scheduling an appointment to be able to schedule it and the system would also have it pop into the nurses' calendar. That would be really nice. Otherwise you do your paper calendar and then come back here and enter all the data on the computer and their e-mail."* (Focus Group Participant 3)

"Making an appointment from a client during a visit would be one of the top ones." (Focus Group Participant 8)

Communication to external providers

Another feature of the information system design that ties in with integrated views of data from other divisions is the ability to communicate with and see data from providers external to the local health jurisdiction. Comments about external communication follow:

"I call First Steps and say OK ... here's a client, she doesn't want NFP, can you take her over there... It would be cool to be able to click "Client Not Interested" that generates a form and gets electronically sent to the person who gave me the referral. All I got to do is put in Dr. Sisteros, referred to, here's the response." (Focus Group Participant 4)

"Let's say that I wanted to send a letter to a doctor you know to say that "I'm concerned about how this baby's growing", I would have to go into, now there's not template in <the current information system> to do that, I would have to go out and go into Word and create that document myself. And then maybe print it out and then it goes into the hard chart. Whereas it would be nice if it still stayed within the body of the charting." (Focus Group Participant 7)

Reports Feedback

Participants from both local health jurisdictions validated the reports function and the reports to be included as part of the information system design. The importance of basic demographic reporting and customized reporting to determine how populations were being served was emphasized in both local health jurisdictions. One report (about school absenteeism) was seen as unnecessary in Spokane. Participants had this to say of the proposed reporting features:

"Supervisors are required to provide data on case loads...I want to be able to say why this funding is essential... that report is so essential to validating what we do.

It justifies where the money goes and it is time-consuming... that kind of easy to access data would be really helpful. " (Focus Group Participant 4)

"We do have grant specific information about money that needs to be tracked and some of those are coming from an outside non-profit. Some of it's specific like in the department of health...some of them are ongoing annual things like breastfeeding funds and...there are capacity building grants. A variety of things that we need, that the supervisor needs to track... that might be a very useful tool to know how we're doing because different staff have different responsibilities. " (Focus Group Participant 6)

One participant requested a report that allowed her to print the number of hours she had spent with a client for client use to get high school credit. This participant also emphasized the importance of being able to generate reports for use in court testimony.

That would be awesome because then you could also pull out your KBS scores where you could see OK she started to improve but then for some reason she didn't. Dad came back in the picture she got into drugs and sanitation went down the pipes... When you get up on the stand the PD... he wants you to be able to spit it back to him. (Focus Group Participant 4)

Device Preferences

Consensus in both local health jurisdictions was that the conceptualized information system should run on a laptop computer. To a lesser extent, some participants also expressed a desire to have system features available on a smart phone such as a blackberry or an iPhone. In contrast to this preference, some participants indicated that they currently do not take a laptop into clients' homes because of the feeling that it is obtrusive and disruptive to the home visit. Participants also discussed the potential effect of the technical expertise of public health nurses based on age and generational familiarity with technology that might inform different device preferences.

Participatory Design

Participants in both local health jurisdictions expressed strong support for engagement in the participatory design of technology that supports their work. In addition, participants from both LHJs expressed frustration that they were often not consulted with regard to technology they would be required to use or, when their opinions were solicited, their suggestions were not implemented in the delivered system. We note that as this was a longitudinal, participatory study, participants gained some knowledge of the design process and the results of prior information system design work.

> *"That seems like an ongoing rumbling of anything that comes. Did they ask us? Would it work? Would it help?"* (Focus Group Participant 6)

> *"The systems that have failed are the ones that haven't gotten input by the people that have to use the systems."* (Focus Group Participant 3)

> *"We had this little pack of nurses all talking about it. And looking at it on the wall. And we made a list of all the things we wanted it to do. Which is a lot like what that is. And then none of it was implemented. So it would be nice if somebody actually not only heard us but did it."* (Focus Group Participant 4)

New Feature Suggestions

Add a specific feature for workload/productivity management (with acuity levels)

In both Seattle and Spokane, participants described a specific feature for workload and productivity management for supervisors. In Spokane, the feature was described with regard to acuity levels and would present itself as checked items in the client record. In Seattle, the request was for a tool that would accurately reflect and clearly present the work of public health nurses through data aggregation.

Add a management feature for personal licensure and certifications

In Seattle, one participant suggested a management feature for personal requirements and certifications similar to the one that supervisors have would be useful. Currently, they have a separate application with a unique user id and password.

Add work flow reminders

In Spokane, one participant suggested a work flow reminder system that would prompt the nurse to finish the steps of a protocol such as print, file or send documentation to another provider. She suggested that this might be useful when juggling several priorities.

Automatically code time by activity codes to document travel time and miles traveled

Nurses are required to code their time in billable units for services provided to clients during encounters. In Spokane, this is currently done on a clipboard. Participants requested an activity coding feature in the information system and agreed that a drop-down list of common codes might be useful.

Add a feature for permanent alerts for client information

One participant in Spokane suggested permanent alerts for things like penicillin allergies. When opening the client record, the alert would present itself.

Add a feature for permanent alerts for client information

One participant in Spokane suggested temporary alerts for things like transient conditions. When opening the client record, the alert would present itself in the same way as permanent alerts.

Add a feature to track client conditions over time

One participant in Spokane suggested a feature to set parameters for client conditions for things such as depression scores would helpful. Flagged conditions could be tracked over time as concerns arose. When parameters met certain conditions, the nurse would be alerted.

Add a feature for graphic visualization of client data

Participants in Spokane suggested a feature to visualize body mass index with regard to growth curves in order to visualize data to physicians. They suggested that other creative ways to visualize data might be useful.

Design Corrections, Perceived Challenges and Concerns

Participants in Spokane emphasized the need to correctly model work flow with regard to referrals and client record creation. In general, the client record creation process must include clerical staff and reflect the current referral and record creation process. In many cases, nurses do not create the record but review it and edit after it already exists. Participants felt that this part of document work flow and management was not accurately or well represented in the conceptual information system design. Participants expressed a need to be respectful of organizational boundaries prompting one participant to state, *"I don't want to mess with clerical"* (Focus Group Participant 4). One supervisor felt the same way about documentation of recruiting interviews, that it was a function of HR, and should be struck from the system design.

With regard to interpretation services, there was general agreement that this would be a valuable feature but does not fit the current interpretation process or resources of the LHJ in Spokane. In addition, there was some disagreement about whether or not to support printing of standardized forms; the concern was that the continued support of printed forms might be a barrier to the realization of a paperless system.

In Seattle, participants strongly emphasized the need for an information system that could support the different organizational implementations of programs for maternity support services and WIC. Participants from both local health jurisdictions voiced strong concerns about the technical challenges of integrating data sources from different programs based on federal and state regulations and policies. There was a strong recommendation from participants in Seattle that any information system design must emphasize the remote support of face-to-face encounters for home visitation versus an emphasis on the support of remote nursing via electronic means.

> *"That's always been a fear that they replace home visits with remote nursing. Yeah, don't even think about it... There's a lot you can learn about somebody by washing your hands in their bathroom."* (Focus Group Participant 5)
>
> *"Or seeing where they sleep or where their kids sleep."* (Focus Group Participant 8)
>
> *"Or what their kitchen looks like."* (Focus Group Participant 5)

Technology Changes at One Site During the Study

In between the data collection interviews and the focus group to validate the conceptual information system design, one local health jurisdiction implemented features for remote

documentation based on the needs of public health nurses and supervisors. Participants were

satisfied with these technology changes as a step in the right direction. Participant statements

about support for remote documentation follow:

> *"I was getting to the point where I was going to say that we're not going to upload download anymore. It's going to have to be direct entry and amazingly enough we walked into the meeting and they said 'guess what, we're now doing direct entry from the field'... As long as they can get a signal they can record anywhere now." (Focus Group Participant 1)*

> *"Well we were living with that piece but... we were actually near a revolt...That's what it took. Because I was going in there with the idea that I'm done. I'm done. I'm going back to paper. I can't deal with this anymore and the nurses shouldn't have to do this...I think that we feel like that we can move ahead at least for a little longer."* (Focus Group Participant 3)

> *"This gives me the ability to go home and plug in and enter my data and come into work and print it out and put in the chart and I'm done. And then I just hand my forms to* <the clerical staff person> *and I'm off to the next one. I mean I don't have to come in... before I can do anymore data entry. That drives me nuts. It makes me crazy."* (Focus Group Participant 4)

Validation of the Approach for Operations Support

Our approach to supporting emergency operations through appropriate support of routine

operations was further validated with a real-world example during one of the focus groups when

one of the participants related the story of the public health center's telephone system.

> *"That's how we got our current telephone system. They realized that the telephone system doesn't even handle the day-to-day functions so how can you expect to create a process to use the communication system if that's not functional on a day-to-day basis... A lot of providers like public health nurses, we didn't have our own telephone, so we had to rely on somebody in environmental health, picking up, recognizing our name and transferring the call. It was like only one central phone number to everybody in the entire building... And it was an issue*

every year, and it went into surveys and we were always told it was way too expensive, there's no way there's money in the budget to support it, can't do it, we know it's a big problem so let's move on ... So our current district manager identified that as an issue and he used the funding for how to apply emergency services to get a new phone system. " (Focus Group Participant 5)

3.4 Summary of Results

In summary, we conducted a systematic review of scientific literature to determine the current status of technology support for continuity of operations planning in public health with the aim of informing future system design in the public health domain. In addition, we conducted nineteen semi-structured interviews with public health practitioners in two local health jurisdictions to assess the information needs of public health practitioners in the real world. From the information needs, design recommendations and barriers derived from content analysis of twelve selected interviews, we developed a conceptual information system design by implementing practices from scenario-based design. This information system design aims to support continuity of operations by supporting routine daily operations. We then validated that design in focus group sessions in the same local health jurisdictions where we had conducted our interviews. Chapter 4 includes a discussion of our results.

Chapter 4: Discussion

Discussion of Results

In the following section we discuss implications of our findings, limitations of our research study and future opportunities for research with regard to the three specific aims of our study.

4.1 Assessing Information Needs

4.1.1 Discussion of Systematic Literature Review

The information systems and technology projects included in this review span levels that range from implementation to conceptual or proposed frameworks to fully operational systems. All systems and technologies are described with some measure of detail that can inform the design of future information systems that support public health continuity of operations planning. Of the twenty included studies, sixteen give sponsoring agencies and/or project resource contributors (see Table I).

Patterns of Information Need Support

All systems that met the inclusion criteria satisfied the need for synthesized information. Information systems in general are often designed to integrate data from multiple sources while improved decision-making is often dependent on synthesized data that promotes better situational awareness. Those systems that satisfied the need for coordination/incident command support also supported the collaboration information need. This is not surprising because communication and information flow are requirements of coordination and collaboration activities. However, formal coordination activities often apply a more directed hierarchical approach. Those systems that supported the need for centralized data access also supported the

need for remote work capability and/or portable data for a variety of roles and contexts. This may be due to the advent of web technologies that allow access to networked stores of digital data. Remote data access and centralized data storage are defining features of these recently and widely adopted technologies. Most systems satisfied the need for planning, plan testing and exercise support. The two exceptions are the North Carolina Center for Public Health Preparedness NCCPHP Training Web site[99] and the AID-N framework[106]. The widespread technology support of planning and training exercises may result from a push for emergency preparedness after the attacks of September 11, 2001. All systems, with the exception of the NCCPHP Training Web site[99], also supported resource tracking and capacity management. The support of this need can be attributed to the potential for improved decision-making during emergencies when resource tracking and capacity management information is available.

Of the twenty studies selected for inclusion, only two were published before September 11, 2001. Studies of these systems, the Emergency Computer Communications Network[95] and EPEDAT[96], were published in 1995 and 1997, respectively. After that, the remaining studies selected for inclusion begin again in 2003. The appearance of studies of technologies that support emergency management during this period coincides with substantial funding opportunities for research and design made available by the United States Federal Government following the attacks of September 11, 2001. We note the lack of studies in this topic area during the period between 2001 and 2003 is likely due to the time it takes to implement a study and disseminate the results in peer-reviewed outlets.

Only HERDS[107], a fully operational system, and SAFE[108], a proposed framework, supported all information needs from the list of search terms. As an operational system, HERDS represents an archetype that stands as an example of successful information system design. The recent appearance of studies of systems like HERDS and SAFE in the published literature may indicate a new level of maturity in public health emergency management technology efforts and knowledge. One point of interest is the Emergency Computer Communications Network[95], the earliest system study included in our review. Deployed in 1993 and published about in 1995, this early system supported many of the information needs that are supported by HERDS and SAFE during a time when Web technology was largely unavailable. As such, the Emergency Computer Communications Network can be judged an innovative front-runner of modern information systems.

Follow-up Search

In the follow-up to our initial search, thirty-nine publications were returned in the search results set. One article[117] was a follow-up to an included video-conferencing study[104]. Three other studies[118-120] combined GIS technology and public health data methods but did not meet our inclusion criteria. These studies were published in the International Journal of Health Geographics (IJHG). The IJHG is a newer journal dedicated to GIS to health-related data. IJHG and the articles returned from the follow-up search may indicate that GIS technology has a growing role to play in the design of public health information systems. A review of current use of GIS technologies may be indicated.

Limitations

One limitation of this review is that it relies on a list of search terms and information needs compiled from author familiarity with a corpus of literature gained through searches over time and research experience with public health continuity of operations planners. In addition, this review does not make a formal analysis of the differential or conflicting use of similar terms across disciplines. We believe this last limitation is addressed by the divergent approach used for search term selection and the broad inclusion criteria applied to the set of documents returned as a result of the search process.

Opportunities for Research

As the concept of continuity of operations planning has a low profile in public health, it is not surprising that only one study (Access Grid[104]) makes explicit mention of COOP in the context of the public health domain (using the alternate reference of "business continuity"). This apparent gap in studies of information systems that have a continuity of operations focus in public health presents opportunities for applied informatics research. Opportunities include the design of technology interventions in the form of information systems that integrate disparate data sources and support remote work for real-world impact on public health operational support. Such an approach can reduce the need for raised awareness of continuity of operations planning as COOP would then be intrinsically supported by everyday systems.

Significance and Implications

The implications of the findings of this systematic review of the literature may raise awareness of the importance of continuity of operations planning in the public health domain and the need for technology support of it through integrated information systems. In addition, these findings

may help public health informaticians in the design, development and deployment of information systems that will support public health continuity of operations.

4.1.2 Discussion of Information Needs from Interviews

The information needs identified from interviews represent those of a subset of individuals who work in public health practice. This is by no means a comprehensive list: a larger study that might include participant observation, a greater number of study sites and a comprehensive analysis of policies, licensure and accreditation requirements at local, state and national levels would be required to create a complete model of public health practice information needs and activities.

Percentage Agreement and Kappa Coefficients

The values of percentage agreements and kappa coefficients rose successively after each code reconciliation session in the cases of all three transcripts independently coded by both reviewers to develop the codebook. In none of the cases did percentage agreement reach 100% in the NVivo software reports as would be expected when both reviewers are in complete agreement. The reason for this discrepancy is the way NVivo generates estimates combined with the way codes were reconciled. NVivo calculates percentage agreement and kappa coefficients at the character level that sometimes generate lower estimates of agreement[121]. Codes that were agreed up on by both reviewers for general blocks of text or utterances were not recoded to the character level to create exact matches in the NVivo software but left "as is" when both coders marked essentially the same text passages because recoding to the character is tedious and provides little in return. Thus, there was 100% agreement between reviewers in practice but this

is not reflected in the NVivo estimates of percentage agreement. The overall average percentage agreement for all three transcripts as reported by the NVivo 8 software is 98.76%.

Final reconciled kappa coefficients for the three transcripts were 0.66, 0.77 and 0.91 with an overall average kappa of 0.78. The increase in kappa values on each successive transcript could be interpreted as an indication of greater inter-rater reliability as the codebook and the rules of its application matured. According to Viera, these reconciled kappa scores fall along a continuum of agreement that ranges from Moderate (.60) to Substantial(.80) to Almost Perfect (1.0)[122]. As stated earlier, NVivo calculates kappa coefficients at the character level and this may contribute to lower kappa coefficient estimates[121].

Limitations of Kappa Coefficient for Inter-Rater Agreement

The kappa coefficient is a statistical measure of agreement level between two coders that accounts for random chance agreement[121-124]. A weighted kappa estimates less agreement between coders when categories within particular codes have meanings that are further apart[122, 123]. In our case, however, we were not using codes that have different meanings within categories and a weighted kappa is not necessarily an appropriate measure of inter-rater reliability[122]. We present the kappa coefficients calculated by NVivo 8 with these caveats in mind.

Significance and Implications

The findings represented by these information needs indicate that public health practitioners in different local health jurisdictions share commonalities in their daily work practice. These

findings enhance earlier work to identify and support standards for public health business processes[1], public health work tasks[7] and public health accreditation efforts[125]. The importance of identifying existing standards of practice has implications for training initiatives, better quality service delivery and greater efficiencies that may result in greater value for each tax dollar spent on pubic health services.

4.2 Conceptualizing an Information System Design

4.2.1 Discussion of Design Work

Summary of the Design Process

Our approach to the design process was participatory as afforded by circumstances. Our interviews attempted to solicit current work practices, desired changes, barriers to work goals and the perceived information needs of participants. In addition, we explicitly solicited the design recommendations of all participants about their "perfect system". Design work by the principal investigator for personas and activity scenarios was followed by focus groups to validate design and solicit further design recommendations from participants as discussed in the next section.

Limitations

A project in which an actual information system was to be developed and deployed would require a greater degree of participation on the part of those who would use the information system. Nurses and nurse supervisors would have to be included as team members and consulted in an iterative fashion with greater frequency about features of the information system design. In addition, the design process of this study was constrained by financial resources, abbreviated

timelines for deliverables and limited access as afforded by the schedules of busy participants who graciously volunteered their time.

Significance and Implications

Our findings indicate that public health nurses, nurse supervisors and other public health practitioners are interested in participating as stakeholders and designers of the technology that supports their work. This is significant because many past development efforts have excluded from the design process the very public health practitioners who will use information systems developed for public health practice. One implication of the findings is that with willing public health practitioner involvement in design, designers may build better public health information systems.

4.3 Reviewing and Refining System Design

4.3.1 Discussion of Focus Group Results

Common Work Flow Characteristics and Problems

Many common work processes and workflow problems related to technology were identified in both local health jurisdictions. These findings are not unexpected because potential common causes were indicated at the onset of the study. As discussed in Chapter 1, some indications that different local health jurisdictions have common work flow characteristics and problems are the existence of common business processes[1], work tasks[7], non-integrated technologies developed through categorical funding for individual specific program aims[8] and issues related to funding shortages[8, 38, 39]. In both local health jurisdictions, the findings of our study confirm the need for technology that supports the following thematic areas of information needs and activities that we

identified from interviews: the need for dynamic, flexible and integrated information systems, support for client service and documentation activities, support for workload tracking activities, staff management activities, one-time data entry, real-time documentation, communication and integrated data exchange between divisions, integrated scheduling and communication to external providers.

Refining the Design

Participants in focus groups at both local health jurisdictions suggested additional details for persona descriptions and features for the information system design that were not available through content analysis of our original interviews. These feature suggestions include greater support for personal licensure management, a host of workflow reminders, the ability to code time by the chosen units of measure at each LHJ, the ability to track client conditions over time and ways to visualize client data for communication with over providers. Findings from both local health jurisdictions show that public health nurses and other public health practitioners want to participate in the design of technology that supports their work. The addition of new features as the project progressed confirms the need to include practitioners in design work and successive iterations during participatory design activities.

Confirmed Need for Flexibility

One requested feature of information systems from participants in both local health jurisdictions is the need for flexibility in technology support. Indeed, the need for flexibility in technology support was confirmed when the client documentation process was changed at one of the study sites during the course of the study due to overwhelming demand on the part of nurses and nurse

supervisors. The new changes in the way the information system supported documentation work satisfied some participant concerns about the need for remote access. This feature change to support remote access in client documentation at one of the study sites illustrates the importance of configurability and flexibility in implemented information systems in public health.

Our findings indicate that many public health nurses and other staff who provide demand services to clients are not satisfied with the way their work is supported by technology. In many instances, participants stated they had "given up" and resolved to work within the constraints presented by currently installed information systems. In one extreme case, nursing staff threatened to stop using the information system for documentation and return to paper charting because the system was stopping them from doing their work.

Validation of Emergency Support through Daily Operations

In chapter 1, we advanced the idea that in order to support operational continuity during emergencies, local health jurisdictions must first support routine operations with technology. This idea was inferred from experiences gained from field work at one local health jurisdiction and from published literature[17, 18, 20, 22, 28, 29] pertaining to continuity of operations planning and emergency management. During the course of our study, one focus group participant validated the approach by recounting the story of a telephone system upgrade due to communications problems during routine operations that became much greater barriers during emergencies. This unsolicited real-world example is important because it triangulates the idea of support of continuity of operations during emergencies through technology support of routine operations and suggests that our inference is correct.

Limitations

Participant composition of both focus groups was based on access, availability and willingness to participate. For this reason, the first focus group involved both nurses and supervisors who had been involved in the initial interviews. One limitation of this focus group is that some of the participants may have been reluctant to express candid opinions about their work and the proposed information design that was the subject of the session in the presence of their supervisors. In contrast, the second focus group did not involve any supervisors but none of the participants had been involved in the initial interviews that were analyzed to create the information system design. As a result, the second focus group was initially characterized by a degree of reservation on the part of the participants. It may be that participants in this focus group continued to hold reservations about candid opinions related to their work and the design. Another limitation of the second focus group is that participants had less familiarity with the aims of the study and the design it produced. However, this could also be seen as a strength in that participants of the second focus group validated a design based on the recommendations of other public health practitioners.

Significance and Implications

The findings of our focus groups with regard to the conceptual information design are important because they validate public health nurses', nurse supervisors' and other public health staff belief that they would be better served by integrated information systems in the course of their daily work. If these practitioners are well-supported by technology, they will have a greater ability to serve their clients and this may lead to better population health outcomes. In addition, our findings indicate that appropriate technology support during normal operations will likely lead to

increased resilience during emergency operations. This is direct support of continuity of operations planning and the idea of managing resources to maintain organizational up time rather than directing efforts to recover from organizational down time during emergencies.

4.4 Conclusion

One goal of this practitioner-centered study of information needs and activities was to explore and describe public health service delivery work and the context in which it occurs during routine and emergency operations. The decision to conduct research in this topic area is motivated by the timeliness of the need for integrated, remote support for public health work activities due to the recent threat of a global H1N1 influenza outbreak and the increased frequency of disasters worldwide. A second goal of this study was the creation and validation of a conceptual information system design to support public health field nursing for client documentation, workload and workforce management. One benefit of such an information system design is the description and analysis of ways to reduce disruptions in the delivery of public health services in order to maintain continuity of operations during critical incidents like infectious disease outbreaks, earthquakes, floods, etc. Another benefit of this type of conceptual information system design is the identification of potential ways to improve the efficiency of public health nurses' and nurse supervisors' work through better support of their work activities during day-to-day operations. Through these design efforts, we aimed to facilitate the reuse of design knowledge in the public health domain.

The target group in this study was current public health operations practitioners who work in the two local health jurisdictions that comprise the study site. The conceptual information system design was created using interviews and scenario-based design methods[45-57] and then validated

for usefulness and support of work processes through focus groups with members of each local health jurisdiction. The conceptual design developed in this study is a first attempt to model the integrated support of information needs and work activities for public health nurses and nurse supervisors through a single information system design. A goal of the design is to guide informaticians and system designers in the development of future public health information systems that support common work processes across the close to 3,000 local health jurisdictions in the United States. In addition, the documented information needs and activities from this study contribute to the general knowledge and theory of the actual work performed by public health practitioners as they engage in the day-to-day delivery of demand services.

Comparing the Conceptual Design to Systematic Review Results

Our conceptual information system design meets the inclusion criteria as outlined for the systematic review in Specific Aim 1. In addition, the system design also satisfies all broad categories of information needs that comprised our search terms. Summarized again, these categories are the need for support of synthesized information, centralized data access, coordination & collaboration activities, staff training & education, planning, internal and external communication, alerting, staff attendance & contact list management, resource tracking & capacity management, remote work and geographic data access and visualization. As a proposed system that supports these broad categories, our information system design compares well with HERDS[107] and SAFE[108], the two most modern and comprehensive systems identified from our review. As such, our conceptual design can be placed in the category of *networked and communications-enabled decision support tools* from the systematic review.

Potential for Design Reuse

Whittaker et al. proposed the idea that designers should seek to "jointly identify reference tasks,

collect data, analyze the tasks, and disseminate and make use of the results"[68] for domains with

common characteristics. Our focus group findings suggest that the idea of developing reusable

design knowledge to support public health work across local health jurisdictions is a feasible

undertaking. Although this study was a comparison of only two local health jurisdictions, we

seek not to make statements about all local health jurisdictions in the United States. Instead, the

results of our thematic analysis [42, 84] can be generalized through induction to inform the

beginnings of a theory of reusable design knowledge for public health practice. As defined by

Thomas, "*inductive analysis* refers to approaches that primarily use detailed readings of raw data

to derive concepts, themes, or a model through interpretations made from the raw data by an

evaluator or researcher."[126] Fielding and Fielding state that inductive analysis is the procedure

by which theory is tested in qualitative studies and one significant way that qualitative studies

differ from quantitative studies is "that testing theoretical ideas is not the end of scientific

enquiry but a step leading to the refinement of theory."[127] In his discussion of case study

research , Yin explains that it is important to understand that cases are not statistical sampling

units and that a preferred method for achieving analytic generalization is to focus on the

theoretical propositions that motivate a study[128]. We note that this study is not formally

designed as a multi-case study nor did we specifically set out to build or test an explicit theory

but rather to explore the idea of reusable design in two local health jurisdictions. However, the

local health jurisdictions that comprise our study setting represent comparable units of analysis

in which common themes of information needs and work activities were validated. These

findings allow us to make supportive claims about the *logic* of design reuse in local health

jurisdictions with similar characteristics that can inform a theory of reusable design knowledge for public health practice.

Design Definitions for Informatics Research

In Chapter 1, we introduced a definition of an information need for informatics design work that drew on the works of Friedman[58], Davis[59], Case[60] and Carroll[46]. That definition is:

Definition of an Information Need for Informatics Design Work

A person's recognition that an information resource should help him or her know something, learn something or do something better than without that information resource.

This definition worked well when used in different ways during the course of this study as applied to a literature review and to perform content analysis of information needs and activities from interview transcripts. Whether this definition can be used broadly across information design work for biomedical and health informatics research will require further testing in other design studies.

Friedman defines a Fundamental Theorem of Biomedical Informatics as: "A person working in partnership with an information resource is 'better' than that same person unassisted."[58] Based on the findings of this study that information systems sometimes impeded the work of public health practitioners in two local health jurisdictions, we propose a design corollary that follows from Friedman's Fundamental Theorem.

The Bad Design Corollary to Friedman's Fundamental Theorem of Biomedical

Informatics

A person working in partnership with a poorly designed *information resource is*

'worse' *than that same person unassisted.*

Considerations for Public Health Information Design Research

The results of this study and the process by which they were obtained indicate several

considerations for on-site information design research at local health jurisdictions. Foremost on

this list is the need for trust on the part of nurses and other public health practitioners for

researchers to gain access to their specialized knowledge and experiences. Public health

practitioners work in a domain that has seen considerable change in the last several decades. It is

important for researchers and information designers to understand that public health practitioners

will not automatically assume the best intentions for work process reengineering in a domain that

has seen considerable cuts for efficiency and budget control. During the course of this study, we

sometimes encountered hesitancy to participate at the outset of interactions with new participants

or study groups. In addition, public health practitioners are very busy as a result of the resource-

constrained environment in which they work. Sensitivity to trust issues, flexibility in scheduling

data collection and patience on the part of researchers are required to conduct information design

research in public health field settings while maintaining proper respect for the practice and

practitioners of public health work. In addition, researcher awareness of organizational dynamics

is also important. Researchers in public health field settings must remain attentive and sensitive

to work "territories" when conducting research in local health jurisdictions. For example, public

health nurses were respectful of other work territories like those of clerical and human resources staff. Designers must be aware of these work territories when designing systems that will interact with different groups of practitioners who work in local health jurisdictions. Related to the territory concept, information design researchers must be sure to accurately model current and desired work flows that support the humanity of the work that nurses do when they provide care to clients from vulnerable populations.

One of two key themes identified among seventy-four recommendations in the national agenda for public health informatics established at the AMIA 2001 Spring Congress is "that all stakeholders need to be engaged in coordinated activities related to public health information architecture, standards, confidentiality, best practices, and research" [129]. The methods and findings of our research support this key theme. In addition, these types of study results support the funding and governance recommendations of the national public health informatics agenda by allowing public health policies to be informed by validated public health information design knowledge. Hills et al. discuss the possibility of enhancement to the delivery of public health essential services through greater information availability in health information exchanges (HIEs); the findings of this study can inform the development and evaluation of current HIE efforts[130]. As one means to this end, an integrated information design of the type produced by this study can implement existing interoperability standards for electronic data exchange such as the HL7 standard[131]. In similar fashion, the design and design methods from this study could be used to support the requirements for submission of electronic data for reportable lab results and electronic syndromic surveillance data from clinical providers to public health agencies as required by Federal mandates for meaningful use[132].

Future work

In this study, we created and validated a conceptual information system design to support the work of public health nurses and nurse supervisors in two local health jurisdictions. Our findings suggest that reusable design knowledge is a possibility in the public health domain and that public nurses, supervisors and other public health staff are willing to participate in the design of technology that supports their work. Future work to build on the findings of this study include the further development and validation of information needs and activity scenarios as design knowledge through research with public health practitioners in the field, use of this design knowledge to advocate for integrated solutions on a national level, the creation and testing of prototypes that illustrate the ability to move from design concepts to working technology artifacts and the development of case studies to test the proposed definition of an informatics information need and the bad design corollary described earlier.

A final observation of this study is that a solution to meet the needs of public health work for the delivery of demand services may take the form of a standardized information system that comes with a few out-of-the box configurations tailored to local health jurisdictions of different sizes and organizational structures. Such an information system would likely include an application programming interface that allows access to data in the system for heavy customization and integration with other technologies. At present, however, one of the major barriers to integrated information systems in public health is the current way that public health is funded. Part of any real change in technology

support for public health practice must include a shift in public health policy and the

funding mechanism for public health programs. Such a policy shift should include

coordinated, top-down support of the work of local public health practice through

iterative and continued participation of the people who deliver public health services.

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Vita

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Appendix A – Interview Guide

Interview Questions

1. Can you talk little bit about your background and education and how it led you to your current position in public health?

2. Can you talk a little bit about your current responsibilities?

3. What are some of the routine tasks and activities you perform on a daily basis?

4. Do you interact with clients and staff in the (Women, Infants and Children/Maternity Support Services/Maternal Child Health/Immunization) program as part of your responsibilities?

5. What information or communication systems are involved with your work and how do you use those systems?

6. What are some of the barriers to your work efficiency with regard to information or communication systems?

7. Based on past experience, can you think of ways your work changes during emergencies?

8. Can you think of ways that remote work support could help you during routine operations or emergencies?

9. Do you think it would help to have remote work support for your coworkers/supervisors/direct reports, and if so, how would it help?

10. How do you know who is scheduled on any given day?

11. How do you know who is present at work on any given day?

12. How do you know who has called in sick?

13. How do you know where folks are if they work off-site?

14. How do you contact your coworkers/supervisors/direct reports?

15. How is staff contact information updated?

16. Would it help to know if someone lived close to work?

17. Can you currently find out someone's availability and whether they can make it to work?

18. Do you maintain personalized information for coworkers/supervisors/direct reports and, if so, how do you do that?

19. How do you know what skills your coworkers/supervisors/direct reports have and how do you find that information?

20. How do you know the responsibilities of your coworkers/supervisors/direct reports and how do you find that information?

21. What are some things that you would like to be able to do with your information or communication systems that would improve how you work during routine operations?

22. Do you think these information systems improvements for routine operations would help during emergencies? If so, how?

Appendix B – Code Book

The following is a code book for the thematic and descriptive coding of qualitative interviews to identify the work tasks of public health practitioners, the barriers they encounter in accomplishing their work goals, the information systems they use in the course of their work and the design recommendations they make to improve the support of their work through better information systems. It includes the primary and secondary coding questions that the codes in this book attempt to answer, a short description of how the codes should be applied and a description of the codes.

The purpose of this code book is to facilitate design activities for the improvement of public health information systems. The codes in this code book are non-exclusive. That is, more than one code can be applied to a single utterance. This code book is intended to allow researchers to code for specific tasks and extract and abstract the information needs (goals) of those tasks. Non-exclusive coding allows reporting of work tasks and information needs in more than one pattern area, thus allow more than one view for potential design foci. These codes were developed by Blaine Reeder and Rebecca Hills in the first half of 2010.

Primary coding question

What are the typical tasks that public health workers perform to accomplish their work?

Secondary coding question

What are the barriers associated with the work of public health practitioners, the information technology systems they use and the design recommendations they make with regard to those information systems?

How to apply coding

- Start at the beginning of a sentence if possible.

- Code full sentences whenever possible.

- Go to the end of a "paragraph" (when the person stops talking) if possible

- Code a reference to more than one code if necessary. Example: talking about referrals and KIPHS would go under "Manage Referrals" and "IT Systems - KIPHS"

List of Codes

1. Label: Attend a Meeting

Definition: When an individual attends any sort of pre-scheduled geographically co-located or virtual meeting mediated by technology

Cues: When a participant talks about going to or planning to go to such an event or references what happened there

Example: "On a weekly basis we meet with the liaison from Child Protective Services."

Do not code as: Conference attendance as meeting attendance

2. Label: *Author a Document*

Definition: When a practitioner participates in the writing of a document, communication or record in hard copy or digital format

Cues: When a participant talks about writing

Example: "At one point we had a tool that was designed for us and then you know you could go in and pick out what your title was and what you did and it would track when the entry was made and then everybody could go in and add and see what entries were in there."

Do not code as: *no "do not code as" description*

3. Label: *Communicate - Face to Face*

Definition: When a practitioner has an in-person conversation with anyone else

Cues: When a participant talks about conversations with supervisors, peers or direct reports or things that were said in conversations

Example: "Another big part of my job is basically counseling with my nurses because of secondary trauma that they experience with the clients that they see. So I do that everyday that the come in and they work with me."

Do not code as: Phone conversations, e-mail or other remote types of communications as face-to-face communications

4. Label: Communicate – General Communication

Definition: When a practitioner engages in any communication, internal or external, by any means (face-to-face, e-mail, phone) with anyone (peer, supervisor, direct report, external partner)

Cues: When a participant talks about or exchanging information with any other person

Example: "Both. Internally and externally. Internally they were able to get a hold of us. They had call down numbers so the EOC was able to get a hold of somebody. And then we got to where we're supposed to go. It was all an internal communication. There wasn't any computer or any switching between systems or trying to make a system work because nothing worked."

Do not code as: *no "do not code as" description*

5. *Label: Communicate - via E-mail*

Definition: When a practitioner exchanges information with another person via e-mail

Cues: When a participant talks about writing/sending/receiving e-mail or the information received as part of an e-mail exchange

Example: "I check e-mails and respond back and forth within the organization and without."

Do not code as: The act of getting information from a Web site or the Internet

6. *Label: Communicate - via Facebook*

Definition: When a practitioner has any communication that takes place via Twitter

Cues: When a participant uses the word "Facebook" or talks about information received in those communications.

Example: "We're starting to use Facebook and Twitter for some of the things like the STD programs."

Do not code as: *no "do not code as" description*

7. *Label: Communicate - via Fax*

Definition: When a practitioner exchanges information with another person via fax

Cues: When a participant talks about writing/sending/receiving fax or the information received as part of an fax exchange

Example: "So now how I stopped that from being a frustration is I just fax with a confirmed fax over to them saying this is what's up with this patient, and with a little nurse note"

Do not code as: The act of getting information from a Web site or the Internet

8. *Label: Communicate - via Phone (Land line or unspecified type)*

Definition: When a practitioner has any conversation that takes place via any phone (land line, mobile phone or unspecified)

Cues: When a participant talks about phone conversations or information received in those conversations.

Example: "I kinda have to go through a few different places to find out who's absent or not

coming in then I can go into the various office schedules, but there's really usually at least 3 different offices open so I have to maybe check in with another office, with the phone system, and then I have what's happening with sharing the caseload."

Do not code as: The act of receiving text messages via cell phone or conversations that take place via handheld radio

9. Label: Communicate - via Mobile Phone

Definition: When a practitioner has any conversation that takes place via a mobile phone

Cues: When a participant uses the words "cell phone" or "mobile phone" or talks about mobile phone conversations or information received in those conversations.

Example: "They do call clients and the clients can call them but you know the nurses are funny because when they're on a home visit, they turn off their cell phone. "

Do not code as: The act of receiving text messages via cell phone or conversations that take place via handheld radio

10. Label: Communicate - via Text Message

Definition: When a practitioner has any communication that takes place via text messaging

Cues: When a participant uses the words "texting" or talks about text communications or information received in those communications.

Example: "We are finding with some of our younger staff texting works well."

Do not code as: *no "do not code as" description*

11. Label: Communicate - via Twitter

Definition: When a practitioner has any communication that takes place via Twitter

Cues: When a participant uses the words "twitter" or "tweet" or talks about information received in those communications.

Example: "We're starting to use Facebook and Twitter for some of the things like the STD programs."

Do not code as: *no "do not code as" description*

12. Label: Communicate - with Client

Definition: When a practitioner exchanges information with a client via face-to-face conversation, e-mail, phone or other means

Cues: When a participant talks about conversations with clients via both technical and non-technical means

Example: "You know hey Suzie, you have to act right. You can't treat my staff that way. I want to keep seeing you."

Do not code as: *no "do not code as" description*

13. Label: Communicate - with Staff

Definition: When a practitioner exchanges information with a direct reports

Cues: When a participant talks about conversations with staff via both technical and non-technical means

Example: "Yeah. I do. And so one of the things that I do, you know you asked about quarterly, I don't believe that happens across the board but I do ask the nurses when they tell me oh I'm

moving or I'm getting married or I'm doing this, it's like OK do we have your new current information. Oh no! Can we have it? It's a conversation that we have, individually. It just happens if I hear this information."

Do not code as: *no "do not code as" description*

14. Label: Evaluate Data

Definition: How individuals take one or more data source to determine if criteria are being met, to make a decision or to communicate a situation status to a peer, direct report or supervisor.

Cues: When a participant is talking about looking at reports or multiple sources of information to increase situational awareness. Data evaluation could involve conversations, database queries or official reports.

Example: "One of the things that I do is I have a lot of data that comes in based upon all of the information that we're entering into that national NFP database. So they send me stuff on a quarterly basis and I have to evaluate whether or not I'm in compliance and if there's any indicators that we're starting to look like falling down on then I have to address correction plans and those kinds of things to get us back to where we need to be."

Do not code as: The products of data evaluation, for example a report (a "data evaluation") as data evaluation. Data evaluation is the act not the product

15. Label: Generate Depression Score

Definition: When a practitioner engages in the act of generating a standardized score that measures depression for a client

Cues: When a participant talks about score generation or the information related to score generation

Example: "So it's like a score. They actually have a tool that they use and then the client score comes to like twenty four or whatever. The number of clients that had a score over fifteen means that they had significant concerns with depression. You know those types of things or you know even to get a client demographics - I can't even get client demographics report."

Do not code as: *no "do not code as" description*

16. Label: Generate Reports

Definition: When a practitioner engages in the act of generating any type of synthesized information for purposes of decision-making or communication.

Cues: When a participant talks about collecting, indexing, tabulating, formatting or any other transformation of data by either machine or manual means

Example: "And then the CIS I'm usually in there running reports looking at things probably at least two to three times a week. I actually spend quite a bit of time looking at that kind of stuff."

Do not code as: *no "do not code as" description*

17. Label: Geographically Visualize Data

Definition: When a practitioner chooses to display a data source or sources on a map

Cues: When a participant mentions mapping , the desire to see data visualized on a map or makes a reference to "GIS" or "Geographic Information Systems".

Example: "You know I think that would be great for like a new nurse. Starting out to try to organize themselves. Yeah. This is how you can organize your day and think it might actually help my administration too because that's a visualization that they have a hard time with because my nurses because one of my groups is a specialized sub-group I guess of maternity support services because we see substance using women."

Do not code as: *no "do not code as" description*

18. Label: Interview for Hiring

Definition: When a practitioner engages in the interview and recruiting process to fill open positions in the local health jurisdiction

Cues: When a participant mentions interviews or being part of the recruiting process

Example: "I interview, make recommendations for hire."

Do not code as: *no "do not code as" description*

19. Label: Manage Billing Information

Definition: When a practitioner works with or prepares information for billing

Cues: When a practitioner mentions billing information, billing information systems or methods of reimbursement for services

Example: "When the clerks approve the note, that triggers a billing and then the billing goes off to the state. It goes into computerland and goes to the state for billing so that we can get paid for the visit that we did."

Do not code as: *no "do not code as" description*

20. Label: Manage Client Information

Definition: When a practitioner manages any data related to a client including health information, scheduling, billing and referrals

Cues: When a participant mentions client documentation, referrals, eligibility, billing, contacts or any other information related to a client that must be managed by information system or on paper

Example: "And so what happens is that you get a new referral, the administrative assistants will input that information in as a referral and then they update to make it into an open case and then as the nurses see the client, they have to, basically, schedule an appointment. It's a clinic based system that they're trying to use for home visiting and nursing documentation and it doesn't meet the needs."

Do not code as: *no "do not code as" description*

21. Label: Manage Data using Paper

Definition: When a practitioner manages data using paper or forms

Cues: When a practitioner mentions "writing" or "paper" or any activity related to hard copy forms. These activities will sometimes be intermingled with information system data management

Example: "OK. The nurses have specific screens that they have to complete. There's a form that's completed on every visit and then there's assessments that are done on an interval basis. And so those are completed in paper format, they're turned into my administrative assistant who then inputs them into the CIS data system."

Do not code as: *no "do not code as" description*

22. Label: Manage Data with Information Systems

Definition: When a practitioner manages data using information systems

Cues: When a practitioner mentions "typing" or "data entry" or any activity related to using information systems to input, extract, transform or use data. These activities will sometimes be intermingled with paper forms data management

Example: "One of the things that I do is I have a lot of data that comes in based upon all of the information that we're entering into that national NFP database. So they send me stuff on a

quarterly basis and I have to evaluate whether or not I'm in compliance and if there's any indicators that we're starting to look like falling down on then I have to address correction plans and those kinds of things to get us back to where we need to be."

Do not code as: *no "do not code as" description*

23. Label: Manage Overall Workflow

Definition: When a practitioner coordinates different activities as part of what takes place for work in the organization

Cues: When a participant talks about scheduling or coordinating work with peers (that they do not supervise) to get things done. This may happen by exception or as part of normal duties.

Example: "I'll let my supervisor know, "Well, you weren't here yesterday, so went and blocked this provider's schedule because she wasn't coming in.""

Do not code as: *no "do not code as" description*

24. Label: Manage Personal Workload

Definition: When a practitioner coordinates his or her own work activities

Cues: When a participant talks about scheduling or coordinating tasks that are part of his or her own work duties.

Example: "And so at that point it usually gets two weeks out. So, ideally, we would put all of the people that live in the Valley in one day."

Do not code as: *no "do not code as" description*

25. Label: Manage Phone Contact List

Definition: When a practitioner manages or uses phone contact information

Cues: When a participant talks about getting someone's phone number or calling them

Example: "We have an emergency contact form that's filled out and the RAS2 manages that. So if I need to get a hold of somebody, I go to her. And hopefully it's been updated. And it still has current information."

Do not code as: *no "do not code as" description*

26. Label: Manage Referrals

Definition: When a practitioner engages in the activity of managing a new client from the time that client was referred until the client is enrolled or declined based on eligibility

Cues: When a participant mentions the words "referral" or references enrolling, contacting or scheduling with a new client.

Example: "I received referrals for both programs actually and evaluate whether or not they meet the appropriate criteria and then I assign those referrals to appropriate staff and then just kind of try to keep track of workloads and whether or not they are doing what they need to do."

Do not code as: *no "do not code as" description*

27. Label: Operate during Emergency

Definition: When a practitioner engages in any activity on the part of the local health jurisdiction during times of emergency operations

Cues: When a participant mentions what he or she was doing during a storm, flood, mass vaccination or other non-normal operations situation

Example: "Yeah you know it was really funny it seemed because as far as with the wind storm when there was no power anywhere, things ran rather smoothly."

Do not code as: *no "do not code as" description*

28. Label: Schedule a Client Visit

Definition: When a practitioner engages in any activity related to scheduling a client visit

Cues: When a participant mentions scheduling or home visitation

Example: "Yeah what they do though is they cluster their visits. I try to keep their referrals within the same area so that they're not driving all over the place. So I try to keep them in an area so they cluster their visits all together."

Do not code as: *no "do not code as" description*

29. Label: Schedule Staff

Definition: When a supervisor manages the schedule of direct reports

Cues: When a participant mentions the word "schedule" or "scheduling" or managing or changing the schedule of direct report

Example: "One of the things that I did with my PHNs which I was not a popular supervisor is last year, I took them off their alternative work schedules for that very reason. I couldn't keep track of where they were and I'm responsible for signing their time sheets and responsible for saying yes these are the hours that they worked."

Do not code as: *no "do not code as" description*

30. Label: See Staff Competencies

Definition: When a supervisor engages in activities to find or see staff abilities and experience

Cues: When a participant mentions what he or she needs to see or would like to see regarding staff skills or licensure

Example: "Yeah in that context, it would be really nice to know what someone's skill set was. Because even on a day to day basis, if you're able to pull that out and say, wow, here's a nurse that's got all this stuff, let's have her be the lead and then these match up that way with skill sets."

Do not code as: *no "do not code as" description*

31. Label: See Staff Location

Definition: When a supervisor engages in activities to find out where a direct report's whereabouts

Cues: When a participant mentions needs regarding knowledge of staff location or his or her efforts to find the location of a given staff member

Example: "No. It would be cool if I could but our systems aren't sophisticated enough. I could run zip code reports but zip code reports aren't necessarily going to say that we had five visits on this day in this zip code but they could be in three different zip codes in the same area."

Do not code as: *no "do not code as" description*

32. Label: Supervise Staff

Definition: Any activity engaged in by a supervisor to manage staff activities

Cues: When a supervisor mentions anything related to changing, assessing or communicating with direct reports

Example: "We have what's called reflective supervision so I'm required to meet with each staff member for an hour once a week to just really look at their practice, review and discuss their visits, try to identify areas of concern or things that are going well and really try to get them to be really reflective in their own practice and focus on the needs of the clients. So that's really fun."

Do not code as: *no "do not code as" description*

33. Label: Track Staff Workload

Definition: Any activity engaged in by a supervisor to manage staff workload in order to meet service demand

Cues: When a supervisor mentions the word "workload" or anything related to staff ability to handle workload or directing staff with regard to referrals or clients

Example: "I received referrals for both programs actually and evaluate whether or not they meet the appropriate criteria and then I assign those referrals to appropriate staff and then just kind of try to keep track of workloads and whether or not they are doing what they need to do."

Do not code as: *no "do not code as" description*

34. Label: Work Remotely

Definition: When a practitioner works off-site or in the field. This activity may include technology support.

Cues: When a participant talks about being away from the office or using technology to access information on a network or from a central computer.

Example: "Yes, you can do the remote on KIPHS, but you still gotta come back here and back it up. You gotta do your upload before you can do anything else."

Do not code as: *no "do not code as" description*

35. Label: Work with WIC program

Definition: When a practitioner talks about working for or collaborating with the WIC program

Cues: When a participant mentions WIC or the CIMS information system

Example: "They come internally through our WIC program and then we also get them from outside sources, the department of social and health services, physician's offices, schools, you know those kinds of things."

Do not code as: *no "do not code as" description*

36. Label: Work with COOP plan

Definition: When a practitioner works with COOP at the organization

Cues: Any mention of the COOP plan

Example: "Right. We've been working on a disaster preparedness plan for years but the plan is a closed plan so it's all about what to do within the facility which is fine. We know what to do within the facility but what about the nurses who are out in the community?"

Do not code as: *no "do not code as" description*

37. Label: Work with Internal Partners

Definition: When a practitioner collaborates with individuals who are employed by the local health jurisdiction but work in another program or operating unit

Cues: Any mention of other programs or operating units within the LHJ

Example: "They have their own separate things that they schedule with, and the nutritionist is with the maternity support services. And then there's the dental, which they have their own thing. And then there's the family health here."

Do not code as: no "do not code as" description

38. Label: Work with External Partners

Definition: When a practitioner collaborates with individuals who are not employed by the local health jurisdiction as part of his or her efforts to accomplish work goals

Cues: Any mention non-LHJ collaborators or the names of external organizations

Example: "The Washington State University is basically our partner from the research perspective but we're also working with an organization called SCAN and Catholic Charities."

Do not code as: *no "do not code as" description*

39. Label: Write Incident Report

Definition: When a practitioner documents a dangerous situation involving a client or other person as part of work safety regulations or policies

Cues: When a participant relates event about a client and/or discusses writing or documentation about such an event

Example: "I think it's a fine line that you walk when you write something like that in the chart then there's also the incident report that needs to be written if the patient's really acting badly."

Do not code as: *no "do not code as" description*

40. Label: Deal with Barriers and Obstacles

Definition: When a practitioner must deal with any situation or artifact that prevents him or her from accomplishing stated work goals

Cues: When the participant utters words such as "can't", "won't", "couldn't, "shouldn't", "didn't" and other negators with regard to work, often in relationship to information systems or organizational structure.

Example: "I have never ever worked with a system that is so cumbersome as a system is. It is not user friendly by any means. The nursing staff absolutely hate it. As a manager, I think that it is, if I had the ability, I would pull the plug on it but I don't have the ability to do that."

Do not code as: *no "do not code as" description*

41. Label: Design Recommendations

Definition: When a practitioner talks about what he or she would like to see in an information system to better support his or her work. This code could often be considered the mirror image of barriers and obstacles.

Cues: When a participant utters phrases like "it would be nice to have" or "the system should display it all together".

Example: "You should be able to connect families you know move between problems."

Do not code as: *no "do not code as" description*

42. Label: Information Technology (IT) System

Definition: Any technology artifact that manages data or supports work processes

Cues: When a participant references or mentions working with a "computer" or "system" or "technology" or the general name used to reference any of these. Code the specific type of system by product name by adding a new code.

Example: "We use Microsoft Outlook. So a lot of e-mail, calendar, appointment requests and things like that."

Do not code as: Do not code hardware. For example, a "server" in reference to the actual computer hardware but not a server program that performs some function is not appropriate to code as an IT System.

Appendix C – Focus Group Guide

Personas

1. Do the descriptions of the personas for Marcella and Victoria accurately reflect the description of someone who would perform the job of public health nurse and public health nurse supervisor?

2. How do the persona descriptions differ from a description of someone who might perform a job similar to yours?

3. How might these persona descriptions be improved to more accurately reflect someone who might perform a job similar to yours?

Scenarios

1. In general, do the descriptions of the activities in these scenarios accurately reflect the type of work that you do?

2. Are there missing activities that are not described for the type of work that you do?

3. Are any activities listed here that are unnecessary and that should be removed?

4. Are the descriptions of these activities accurately matched to the responsibilities of Marcella and Victoria?

5. How would you improve the scenario descriptions, if at all?

6. Do these activities represent descriptions of how you would like to have your work supported by an information system?

7. Which are the most important scenarios?

8. Which are the least important scenarios?

9. What types of hardware or devices would you like to see available to support these activities?

   a. That is, do you think devices like phones, PDAs, tablet PCs, laptops or other technology are better suited to support some of these activities over others?

Reports

1. Do the listed reports represent reports that you need and would use?

2. Are there reports that should be added?

3. Are there reports that should be removed?

Design

1. How do you feel about participating in the design of technology that will support your work?

    a. Do you feel it is useful or not useful?

    b. Do you feel it will help result in better technology that supports your work?

    c. Would you be willing to participate in a development project from start to finish?