Workflow Associated With the Collection of Clinical Lab Data at the Point of Care

Brian Jeffrey Pearson

Submitted to the faculty of the School of Informatics
in partial fulfillment of the requirements
for the degree of
Master of Science in Health Informatics,
Indiana University

August 2007

Accepted by the Health Informatics Graduate Program Faculty, Indiana University,
in partial fulfillment of the requirements of the degree of
Master of Science in Health Informatics.

Thesis Committee

_____
Anna M. McDaniel, DNS, RN, FAAN

_____
Josette Jones, PhD, RN

_____
Mahesh Merchant, PhD

Date of Oral Examination July 27, 2007

Dedicated to my family

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGEMENTS

Sincere gratitude to Dr. Anna McDaniel, Dr. Josette Jones, and Dr. Mahesh Merchant for their guidance throughout this process. Each was very important at various stages of this work.

ABSTRACT

Brian Jeffrey Pearson

Workflow Associated With the Collection of Clinical Lab Data at the Point of Care

It is important for health clinics to capture clinical laboratory results such as point-of-care testing (POCT) data in order to meet personal health information needs while increasing patient throughput and improving clinical and economical outcomes. Personal health information needs should be exchanged at three levels: among patients and providers, across a community, and across the country. Health information technology is an important tool in addressing such a need while providing efficiency, safety, and quality. Electronically stored clinical data are necessary to attain the benefit of health information technology, so that the provider can achieve greater patient safety and efficiency through provider order entry, disease management, and clinical decision support. In any field of health care and medicine it is important to carefully document all forms of data.

The purpose of this study was to examine the workflow associated with the collection of clinical lab data at the point of care. Staff members at an ambulatory, multi-specialty primary care clinic in Indianapolis, Indiana, were observed via a continuous time-motion study. Flowcharts were created for the step-by-step workflow process of a general POCT, lab, and for each role observed. Analysis of the subjects' interview responses revealed the content of the pros and cons of possible data transfer modes from an electronic medical record (EMR) to a health information exchange (HIE). The tables derived from the time-motion study table were then analyzed, resulting in the creation of

tables summarizing the approximate total time and percentage involved for each category of tasks observed. It was found that the majority of the time spent throughout the workflow process is on behalf of the nurse vs. the medical records clerk, who is involved, the least amount of time. The nurse plays the role of directing the entire workflow process of point of care testing and clinical laboratory tests. It was observed that the POCT results are recorded directly into a patient's chart, resulting in no electronic documentation, while clinical laboratory test results are stored electronically in an EMR and printed out for chart storage. The processing task category takes the most amount of time throughout the duration of workflow process for POCT, clinical laboratory test, and the observed subject. Changes in the workflow process would most likely affect the phlebotomist; least likely affect the primary care provider, while the nurse, check-out clerk, and medical records clerk would be minimally affected. Overall, a change in the workflow process for a provider such as the medical facility observed in the study would create a higher patient intake and faster result turnaround, resulting in quality patient care. The use of data transfer of POCT and the clinical laboratory from an EMR to a HIE would create a broader depth of content that would be available for healthcare providers locally, regionally, nationally, and ultimately internationally.

CHAPTER ONE: INTRODUCTION & BACKGROUND

Introduction to Subject

In any field of health care and medicine it is important to carefully document all forms of data (Haux, Knaup, & Leiner, 2007). Information technology such as the Electronic Health Record (EHR) allows extensive documentation of patient data to be stored and exchanged electronically. The EHR facilitates the use of patient data to support patient care, fulfill external obligations, support administration, support quality management, support scientific research, and support clinical education (Haux et al., 2007).

Currently, the US health care system is moving to wide scale implementation of electronic health records. The Healthcare Information and Management Systems Society (HIMSS) is working to achieve the national goal of EHR use in 80% of healthcare organizations and 50% of physician practices by 2010 (The Healthcare Information and Management Systems Society (HIMSS) Electronic Health Record). Electronic medical records (EMRs) are clinician-focused records that enhance the workflow and care delivery in a particular setting or institution. The electronic health record (EHR), on the other hand, allows for cross-institutional data sharing while storing the EMR content for multiple providers within an institution. The EHR usually stores patient personal health information from multiple encounters of care vs. single encounters (AHRQ).

One benefit of the EHR is the potential for rapid exchange of personal health information. Personal health information needs to be exchanged at three levels: among patients and providers, across a community, and across the country (Halamka et al.,

2005). Communities such as Indianapolis and Santa Barbara, California have already begun to organize regional health information exchanges (HIE) that will allow for multiple organizations to share patient information. With the use of health information technology such as EMRs and EHRs healthcare providers will be able to provide a health information infrastructure system that will allow for the access of clinical data such as point-of-care tests and laboratory tests.

Health information technology is an important tool in addressing efficiency, safety, and quality that are major challenges facing healthcare (J. Marc Overhage, Evans, & Marchibroda, 2005). Electronically stored clinical data are necessary to achieve the benefits of health information technology, so that the provider can achieve greater patient safety and efficiency through provider order entry, disease management, and clinical decision support. Instead of generating clinical information accessible only at the point of care, each laboratory, radiology center, or provider should be directly interconnected to a health information infrastructure to allow other practitioners to obtain needed "outside" organization clinical data, because much of the clinical data needed is from "outside" the organization (J. Marc Overhage et al., 2005).

Laboratory data are used to support disease management (DM) in ways such as: identification of disease risks, diagnosis, confirmation, and surveillance to name a few. The lab can be used to identify the disease levels while setting a laboratory range for future test comparison, treatment, and monitoring (Haux et al., 2007). Point-of-care testing (POCT) is used when clinical laboratory results are needed rapidly. The definition of POCT is generally any testing that is performed near the patient. Settings that use POCT include doctor's offices, emergency departments, Intensive Care Units,

and patient transport settings (Lode, 2005). Clinical decision-making in POCT settings may be delayed due to pre- and post-analytical steps of testing. Testing at the site of the encounter can eliminate the need for return visits and/or phone consultations. In result, testing at the point of care may lead to an increase in patient throughput and improving clinical and economical outcomes (Lode, 2005).

The results of POCT are important components of personal health information that may not be automatically captured in an EHR. Understanding workflow components may help to optimize a clinical information system for capturing the full range of clinical information, including POCT results. Specifically, understanding the workflow process could help pinpoint how POCT data may be transmitted to a health information exchange for storage in a data repository/warehouse.

Workflow studies that address information systems implementation are an appropriate methodology to understand how workflow is related to clinical information collection, storage, and retrieval. For example, a time-motion study may be structured so that continuous observation or work sampling is used. Continuous observation allows the observer to shadow a health professional while recording each performed task for analysis. The data from time-motion studies have been shown to be valuable in the evaluation of an information system's impact on workflow (Pizziferri et al., 2005).

With the use of health information technology, EMR and a connection to an HIE, POCT and clinical laboratory tests can be shared amongst healthcare practitioners. Understanding the workflow associated with POCT and clinical laboratory test collection will help determine how the results can be shared amongst healthcare institutions via health information exchanges.

Understanding the workflow associated with electronically capturing health information such as POCT and clinical laboratory tests should help healthcare providers across the nation, country, and even the world determine: What mode of health information technology should be used for data capture and (or) storage? For example, an EMR and EHR. What health information should be stored? For example, POCT and clinical laboratory tests. Once the aforementioned questions are understood healthcare practitioners can use HIE to regionally, nationally, and worldwide store and share important health information necessary for providing healthcare to those in need.

Importance of Subject

The purpose of this study is to evaluate the workflow process of clinical laboratory data in an ambulatory multi-specialty primary care setting. The intended outcome of the project is to better understand how point-of-care clinical laboratory test results can be captured into an electronic medical record and then sent to be stored in a health information exchange for multi-institutional usage.

CHAPTER TWO: LITERATURE REVIEW

Electronically Stored Health Data

In an effort to improve the quality, safety, efficacy, and cost of health care in the United States the electronic collection, aggregation, and reporting of health information has become relevant. The EMR consists of a set of databases (or repositories) that contain the health information for a patient at a particular health organization or institution. The Agency for Healthcare Quality and Research (AHRQ) states that EMRs are clinician-focused and enhance or augment the workflow of clinicians. The EHR (electronic health record) expands the functional ability of the EMR by cross-institutional data sharing. The EHR stores data from a subset of each institution's EMR. The EHR generally stores data about a patient and spans multiple episodes of care vs. single encounters (AHRQ). In order to accomplish the goal of "anytime, anywhere medical care information and decision support," (Yasnoff et al., 2004, p. 2) a minimum of five requirements must be present at any point of care EMR: (1) immediate availability of the complete medical record (compiled from all sources of healthcare); (2) up-to-date decision support; (3) selective reporting; (4) use of tools to facilitate care delivery (e.g., e-prescribing); and (5) patient consent for access to information (Yasnoff et al., 2004).

With the use of a health information exchange (HIE) a network of medical institutions will be able to share collected electronic health data at necessary destination(s).

Collection of electronic health data across multiple systems and institutions will allow a broad array of purposes. Collection of health data from multiple sources will

facilitate point of care medical care. Health IT enables the possibility of improving the quality and safety of care delivery, while adding to the development and dissemination of evidence-bases protocols, and providing the allocation of health care resources in a more effective manner (AHRQ, Health Information Exchange Policy). Information technology is currently being developed with more focus on clinical information.

In order to benefit from exchanging data it is not possible to just invest in health information technology. The investment must be made in health information exchange (HIE) as well (AHRQ). Ultimately, such systems will make interoperability possible by not only viewing or reading incoming data from another entity; the system can use, incorporate, and send health data to necessary destinations. The vast amount of connectivity over numerous networks/systems will increase the value of the health IT investment by the ability to manipulate or analyze data (AHRQ, Health Information Exchange Policy).

HIE and health IT advocates need to establish how data exchanges can maximize the value of HIE communities clinically and economically while establishing population health (AHRQ). The new health IT systems need to be secure, private, and established by the developers and implementers of such systems. When new possibilities of exchanging data are being considered, existing data protections need to be extended or adapted throughout the new connections and relationships. These new exchanges and relationships need a new form of privacy and security practices so in the future any new vulnerabilities will not undermine the system's source of protections (AHRQ).

Major decisions, issues, and factors to consider that are associated with the use of health information technology to store health information in order to send such

information to health information exchanges include:

- How do healthcare practitioners align POCT processes to facilitate a smoother, faster transition to electronic medical records?
- How do healthcare practitioners improve document processes to manage changing compliance requirements?
- What critical steps can healthcare practitioners use to minimize errors and enhance patient safety?
- How can healthcare practitioners speed up the flow of paper-based data into health information management with minimal effort?

Health Information Exchange

The capability to exchange personal health information is needed at three levels: among patients and providers within an enterprise, across a community, and across the country (Halamka et al., 2005). Communities such as Indianapolis, Santa Barbara, California, and Boston, Massachusetts have begun to organize regional health information exchanges (RHIOs) that allow multiple organizations to share patient information. Furthermore, the need for an established way for health information exchange to expand beyond the aforementioned cities is great. For example, when a patient relocates to another city, state, community, his or her entire medical history is normally lost. Aggregation of public health, quality measurement, or research data is prevented due to fragmentation and lack of uniformity across the country in an efficient or standardized manner (Halamka et al., 2005). Health information exchange is comprised of many networks that are capable to exchange and communicate information

amongst each other to form a regional health information organization, or RHIO. The networks within the RHIO can use a variation of data management, financing, privacy policies, data standards, and governance, however, in order to attain national interoperability, each geographically or affinity-based network needs to adopt the same policies and standards.

In November 2001, the National Committee on Vital and Health Statistics (NCVHS) stated the need for a National Health Information Infrastructure (NHII). In July 2004, the Department of Health and Human Services released a Strategic Framework report entitled *The Decade of Health Information Technology: Delivering Consumer-centric and Information-Rich Health Care* which states the need for the establishment of a "national health information network" to enable nationwide interoperability as well as RHIOs, that will provide local leadership, oversight, fiduciary responsibility, and governance for the development, implementation, and application of secure health information exchange across care settings (J. Marc Overhage et al., 2005). These organizations have been referred to as regional or local health information infrastructures that will act as the foundation of an interconnected infrastructure of systems, clinical data standards, networks, procedures, and laws that will allow for an electronic-based record of medical care as opposed to the primarily used paper records.

Clinical documentation

It is important in each field of health care and medicine to carefully document all forms of events, regardless of the manner of patient treatment. Clinical documentation can be of little use if data are not collected and stored in a systematic way in order to be

readily retrieved for clinical decision making, regulatory compliance and quality improvement (Haux et al., 2007). Medical documentation is referred to as medical data management, and for decades has established a methodology of "systematic recording/coding, storing/representing and using/analyzing patient data that can result in considerable time and money" (Haux et al., 2007, p. 74). Related or synonymous terms include: health information management, health data management and health record administration (Haux et al., 2007). Computers allow extensive documentation and various analyses, which in result allow patient data to be stored in an electronic health record. Allowing "the right medical information about a patient at the right time, at the right place, to the right persons, in the right form" (Haux et al., 2007, p. 75) is difficult and challenging. There exists multiple uses of patient data, but data should be recorded only once and used for several of the following purposes: "to support patient care (to remind staff of and communicate information, to help in organizing the care process); to fulfill external obligations (legal requirements, accreditation, and reimbursement regulations); to support administration (in planning, controlling, and refunding the health care institution's services); to support quality management (by enabling critical reflection and systematic monitoring of processes); to support scientific research (by enabling patient selection and statistical analysis); to support clinical education (by providing information for clinical review and case examples)"(Haux et al., 2007, p. 75).

Laboratory Data

Laboratory data can be used to support disease management (DM) in numerous ways such as: identification of disease via disease screening; identifying risks of a disease

by using predictive measures; diagnosis and confirmation of a disease; results of a lab test can identify treatments that need to be changed or identified; and identification of appropriate level(s) of medication being prescribed for a patient via compliance/surveillance. The laboratory can provide the beneficial tests needed to assist in the identification process, treatment and monitoring of problematic areas, while establishing normal laboratory ranges for future comparison and benchmarking (Haux et al., 2007). The laboratory supports DM in the following ways: screening, prediction, identification, treatment, and monitoring/compliance.

Missing clinical information during primary care creates a problem resulting in professional communication breakdown that could possibly create an adverse affect of patient care. According to Smith et al. (2005), in 1 of 7 patient visits important clinical information from laboratory reports, letters/dictations, radiology results, history and physical examination, and medications may be missing. One study found that 59.5% of visits with missing clinical information, clinicians thought that the missing data would result in a delay of care or at the least a duplicate medical service. In 44.0% of visits with missing clinical information clinicians believed the patients would be adversely affected (Smith et al., 2005). Most medical errors in family physician practices result from administrative error such as problems with the filing system and chart completeness (record(s) unavailable, care given but not documented, and record not up to date or complete) (Dovey et al., 2002). Communication with a patient is hampered when time is spent trying to find missing clinical information instead of talking to the patient about their care, resulting in a delay of providing quality care (Dovey et al., 2002; Elder & Hickner, 2005). Physicians unsuccessfully spend about five to ten minutes in 25.6% of

visits looking for missing information (Smith et al., 2005).

EHR usage may potentially decrease the amount of missing clinical information (Elder & Hickner, 2005). Physicians who have implemented a full EMR report fewer visits with missing clinical information (Smith et al., 2005). Therefore, the use of EHRs should help facilities like the observed primary care clinic keep the percentage of missing clinical information to a minimum resulting in more time with the patient for treatment assessment.

Point-of-care testing

The world's biggest market for diagnostic testing is the United States. POCT or point-of-care testing is one of the most active segments in diagnostic testing. POCT test devices are becoming more compact, easier to use, more accurate, and tests can be more frequently performed at the point of care, no matter where the setting may be (Scalise, 2006). There exist two different trends in clinical diagnostics: (1) extensive automation and consolidation of testing within central laboratories, and (2) decentralizing the tests to near patient sites. POCT is recommended when test results are needed faster rather than using conventional testing procedures. The definition of POCT is generally any testing that is performed near the patient. Settings that use POCT include: doctor's offices (e.g. outpatient clinics and primary care facilities), emergency departments, intensive care units and other hospital units, operating rooms, patient transport settings, and even patient homes (Lode, 2005).

Speed is the key characteristic of POCT. Point of care testing during the patient encounter may eliminate the need for any return visit and/or phone consultation.

Therefore, the time spent testing in the doctor's office may lead to increasing patient throughput, while improving clinical and economic outcomes (Lode, 2005). POCT objective is to provide quicker results and permit faster clinical decision-making while improving patient outcomes. POCT pertains to tests conducted outside the traditional core or central laboratory. These clinical laboratory test are conducted close to the site of patient care and are usually done by clinical staff whose primary training is not in the clinical laboratory sciences, and sometimes by patients themselves (Pearson, 2006).

A POCT program is generally managed by the laboratory POCT coordinator, whose job entails managing the database of testing personnel, coordinating training of new personnel, choosing test methods, and monitoring quality control and proficiency programs. The nurse manager enforces policies, schedules new employee training and annual certification of testing personnel, and schedules annual point-of-care competency evaluation of staff. The education department trains new employees and certificates testing personnel. The laboratory staff trains new employees, reviews quality control data, and verifies of equipment function and maintenance (Scalise, 2006).

Clinical decision-making in POCT settings may be delayed due to pre- and post-analytical steps of testing. To ensure that the POCT program will work it is important that every employee understands that workflow components to prevent unnecessary delays in care delivery. Furthermore, results of POCT generally are not automatically captured in an EMR, increasing the likelihood of missing clinical data. To insure that a complete record of clinical information is available to all care providers, clinical workflow processes must be developed to capture POCT result for storage in a health information exchange data repository. Understanding the existing workflow process can

be useful to optimize clinical information systems for how the data can be sent to a RHIO in order for the clinical data to be stored in the data repository/warehouse.

Workflow studies that address information systems implementation

A workflow study such as a time-motion study can be structured so that continuous observation or work sampling is performed. Continuous observation consists of the observer shadowing the needed health professional while recording each time spent to perform each task performed by the professional. The data collected from such a study is valuable in evaluation of information system's impact on workflow (Pizziferri et al., 2005).

Overhage et al. (2001) conducted an example of a time motion study in a test of how physician order entry (POE) can be beneficial. The Medical Gopher order entry system was found to improve patient care. The time-motion study was conducted in a manner that provided detailed time use data of the physicians use of the POE while surveying their opinions about the POE system (J. M. Overhage, Perkins, Tierney, & McDonald, 2001). This example shows how a time motion study can gather beneficial data in evaluating a health information technology system.

Pizziferri et al. (2005) conducted a time-motion study in five primary care clinics to determine if EHR documentation may take longer than paper-based systems. Physicians were observed and specific activities were timed during a clinic session before and after EHR implementation. The study survey revealed a respondent belief that the EHR resulted in quality improvement (Pizziferri et al., 2005). This study is relevant in providing a time motion study that is helpful in determining the affect of EHR.

Endress et al. (2006) conducted a study to show how system integration in clinical workflow was used to evaluate demands on future system developments in the integration of an OR-image documentation system. The study examined how the critical path method (CPM) (which is part of the workflow) revealed how the workflow can maximize the system operation. The test was conducted in order to show integration possibilities and to define workflow-based requirements for the development process of new systems (Endress, Aydeniz, Wallwiener, & Kurek, 2006). This is relevant to how workflow can be used in the evaluation of health information systems, in this example an OR-image documentation system.

Study Purpose

The purpose of this study is to conduct an observational study of workflow associated with the collection of clinical lab data at the point of care in an ambulatory multi-specialty clinic. The collected data will help in creating a better understanding of how clinical laboratory data can be captured and transmitted to an electronic data repository/warehouse for health information exchange.

CHAPTER THREE: METHODOLOGY

Design

To characterize clinical workflow around POCT and data management, a continuous time-motion study was conducted. A case study approach was used.

Participants and Setting

The setting for this study was an ambulatory Midwestern urban multi-specialty primary care clinic. The sample consisted of one nurse, one doctor, one checkout clerk, and two phlebotomists.

Procedures

The study was conducted in three phases. Phase I was a continuous time-motion study that involved observing the workflow process for point-of-care testing (POCT) and clinical laboratory tests. A spreadsheet/table to record the step-by-step workflow process was created for data collection. For each observation, the job title of the subject (i.e. nurse), description of the task, and time spent to complete the task were recorded. Refer to the model (figure 1) for the recording tool used to capture the workflow process.

(Job title)	Description of the task.	Duration of task Start | End	Notes

Figure 1. Model of spreadsheet used to record step-by-step workflow process

Phase II consisted of analyzing the workflow process by creating step-by-step flowcharts of the workflow process. A flowchart for each role within the clinic was created. In addition, a cumulative flowchart of the entire clinical information workflow process for POCT was created. Note; the flowcharts were created right after Phase I was completed.

In Phase III follow-up telephone interviews with the subjects were conducted after the completion of Phase II to verify that each task was recorded correctly, determine how to store the clinical data, and elicit feedback on how they perceive their everyday workflow process would be affected by participation in a RHIO. Refer to the figure 2 for the interview schedule.

The following questions were asked during the interview:

1) What methods could be used in this practice to collect laboratory data for storage in an EMR (electronic medical record) in order to submit to an external data "warehouse" for health information exchange? *Use the following prompts if participant does not volunteer answers:*

Fax?

Email?

Input into computer record?

Web interface?

2) How would these different processes change the way you work (i.e. how will it affect time and how will affect your comfort with the process)?

Figure 2. Outline of Interview questions

Data Analysis

The Phase I data collected in the time-motion study were transcribed and entered into a spreadsheet for analysis. The task categories in the observation were coded into 6 categories and derived from personal job experience and general pilot observations used to validate the categories. The categories include: Processing, Communicating, Recording, Processing/Recording, Specimen collection, and Interpretation. Processing occurred when the subject performed a task that required a (series of) step(s) and/or action(s). Communicating occurred when the subject verbally communicated with the patient. Recording occurs when the subject documented any form of data/information/result. Processing/Recording occurred when the subject performed a task that required a (series of) step(s) and/or action(s) and documentation of the data/information/result. Specimen Collection occurred when the subject performed a task related to collection of the lab specimen. Interpretation occurs when the subject reviews a result and/or specimen. Each (ID) corresponds to the observed POCT or clinical laboratory test being tracked from the time-motion study. Each observed subject (Role) from the time-motion study was coded into 5 categories for the modified data collection spreadsheet: 1 = Primary Care Physician (PCP), 2 = Nurse, 3 = Check-out Clerk, 4 = Phlebotomist, and 5 = Medical Records Clerk. Each subject was coded so less room would be taken up during data entry. Modification of figure 1 into figure 3 is depicted below.

ID	Role	Task Category	Task	Time

Figure 3. Model of spreadsheet used to record data of Time-Motion Study

Phase II involved an analysis of the transcribed data from Phase I. Flowcharts of

the workflow process were created for the general POCT, general laboratory result, and for each subject observed. A color code system was used in order to visually associate corresponding task and roles throughout the flowchart: Pale blue = to be determined, Green = Nurse, Blue = PCP, Aqua = Check-out Clerk, Red = Phlebotomist, and Yellow = Medical Records Clerk. The corresponding task categories total approximate time for each flowchart was then added up and summarized into a percentage of time for each observed subject and test.

Phase III involved an analysis of the interview content. From each subject's response a table of pros and cons for possible modes of data transfer was developed.

In order to protect each human subject an overview of the study process was submitted to Institutional Review Boards of entities involved. This is done in order to make sure the studies means of activity falls into an established set of regulations. These regulations included research involving the use of interview procedures or observation of public behavior in addition to the information obtained was recorded in such a manner that the human subjects could be identified, directly or through identifiers linked to the subjects and any disclosure of the subjects' responses outside the research will not place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability or reputation.

A consent form was created, reviewed and signed by the subject and person obtaining the consent clearly stating the study purpose, procedures, risks, benefits, alternatives, confidentiality, costs, payment, contact information for questions and problems, and the voluntary nature of the study.

CHAPTER FOUR: RESULTS

Overview of Phases

Phase I

Continuous Time-Motion Study:

Phase I consisted of a continuous time-motion study that involved observing the workflow process for point-of-care testing (POCT) and clinical laboratory tests. I used a spreadsheet/table to record the step-by-step workflow process. I then recorded my findings in a step-by-step manner to capture the workflow process using the developed model (figure 1). It should be noted that at the observed primary care clinic there exist two destinations for lab specimen analysis: one for specialty tests and one for general tests. The specimen collection is done at the in house laboratory and then picked up by a courier to go to the corresponding laboratory. The specialty clinical laboratory tests include: PT/INR (Prothrombin Time/ International Normalized Ratio), Testosterone, and Parathyroid hormone (PTH). The general clinical laboratory tests include: CBC (Complete Blood Count), CMP (Comprehensive Metabolic Panel), ALT (Alanine aminotransferase), AST (Aspartate aminotransferase), and Lipid Profile (Cholesterol, HDL (High-density lipoprotein) Cholesterol, LDL (Low-density lipoprotein) Cholesterol, Triglycerides) tests.

The majority of the time spent throughout the workflow process is on behalf of the nurse. The nurse plays the role of directing the entire workflow process of POCT and clinical laboratory tests. The nurse is directly involved with processing, communicating

(which includes follow-up of the results), recording, processing/recording, specimen collection, and interpretation of POCT. The nurse is directly involved with processing, communicating, recording, and processing/recording while being indirectly involved with specimen collection and interpretation of clinical laboratory tests.

The other observed positions play a role in the completion of the workflow process of POCT and clinical laboratory tests, but not as in depth as a nurse. The phlebotomist is most involved in the specimen collection of clinical laboratory tests while the primary care provider (PCP), check-out clerk, and medical records clerk are involved at various points of POCT and clinical laboratory tests workflow process.

In general: the workflow of a POCT involves the nurse and PCP while a clinical laboratory test involves each of the five subject roles (PCP, nurse, check-out clerk, phlebotomist, and medical records clerk).

It was observed that the POCT results are recorded directly into a patient's chart; resulting in no electronic documentation vs. clinical laboratory test results, which are stored electronically in an EMR and printed out for chart storage.

Results: See appendix A

Phase II

Flowchart of Workflow Process:

Analysis of the data recorded in Phase I helped in development of a step-by-step flowchart of the workflow process for the general POCT, general laboratory result, and for each subject observed. The flowcharts should help in determining what mode of data

transfer (Table 8.0) can be used to complete the workflow process for each observed test and subject role that requires the need of storing the results in an EMR and HIE.

Note: the process of a POCT and Clinical Laboratory Test begins after checking into the primary care clinic.

Workflow process for a POCT

The workflow for a general POCT involves the encounter form being sent via the Check-in computer to a pod (work area) printer. Next, a nurse/check-out clerk for the PCP takes the encounter form to an examination room with the patient chart. Then the PCP informs the nurse the needed type of POCT so that the desired test can be performed. Depending on either a positive test, where the PCP/nurse writes a prescription; or a negative test, where the patient is sent home. Finally, the nurse documents the results in the patient's chart.

Workflow process for a Clinical Laboratory Test

The workflow for a general clinical laboratory test involves the encounter form being sent via the check-in computer to a pod printer. A nurse/check-out clerk then takes the encounter form for the PCP to an examination room with the patient chart. The PCP then fills out the needed lab test on the encounter form and hands to the check-out clerk in order to enter the needed labs into the EMR. Once the phlebotomist receives the lab order the lab requisition can be printed out, the patient's blood can be drawn. The phlebotomist then writes out the lab requisition for the specialized tests or prints out the hard copy lab requisition for the general tests so the courier can pick up the specimen with the corresponding lab requisition. The results are obtained in two formats. The

specialized lab report is printed out on formatted paper or the general lab report is sent via email, which is then printed out. After the reports are received, one copy is filed in the laboratories filing and one copy is delivered to medical records from the corresponding laboratory. The medical records clerk then pulls the patients chart and delivers the lab report to the ordering PCP. After PCP review the patient is informed (by the nurse) of the lab report results and filed (by the nurse) in the patient chart, which is then returned to Medical Records.

Workflow process for subject roles

The workflow process for a PCP involves the PCP determining the needed lab or POCT. After the PCP informs the check-out clerk of the desired test an EMR is used to order the needed lab via the encounter form. After a break in the process for further processing the PCP obtains the lab report on their desk or verbally from the medical records clerk. After PCP interpretation of the lab report and a decision is made, the chart with the lab report is sent to medical records to be filed or given to the nurse in order to notify the patient of the result and further directions.

The workflow process for a nurse involves receiving the encounter form from the printer. That is followed by filling out the white sheet with previous vitals/medication/etc. After the patient is brought back from the waiting room the patient is then weighted and brought to the exam room. After checking patient vitals (blood pressure), blood sugar, and updates/performs medication review the patient is then requested to give a urine sample. Note, a urine sample is requested from each patient check-up. After the urine sample is analyzed for abnormal levels and the resulting levels

are positive, a blood sugar check is performed to determine if the patient is diabetic (if not already), or it the levels are negative, the nurse has the patient wait for the PCP. After the urine level results are recorded in the patient chart a break in the process for further processing occurs. Once the results return and the patient is informed of the lab report (Cholesterol, Triglycerides, HDL, LDL, etc.) Note: if the report is abnormal the patient is informed how to improve the levels or if the report is normal the patient is told the results are sufficient. The results of Cholesterol, A1C, PSA, and Triglycerides levels are recorded in the patient's chart.

The workflow process for the check-out clerk involves receiving the encounter form from the PCP and filling out the EMR with needed lab parameters so that the requested lab can be sent to the laboratory via the EMR.

The workflow process for the phlebotomist involves receiving the lab order and printing out the lab requisition. After the phlebotomist draws the patient's blood a hand written lab requisition for specialized test or the hard copy lab requisition for general test are picked up with the specimen by the corresponding lab. A specialized lab report is then printed out on formatted paper or a general lab report is sent via email (and printed out). One copy is filed in the laboratories filing and one copy is delivered to Medical Records from the corresponding laboratory.

The workflow process for the medical records clerk involves receiving the lab report from the laboratory, pulling the patients chart, and delivering the lab report to the ordering PCP.

Results: See appendix B

Phase III

Follow-up Interview:

The follow-up interview with each subject determined that each task was recorded correctly while providing each subject's view of what mode can be used to transfer the POCT and clinical laboratory test to a data warehouse, and how they feel their everyday workflow process will be affected from such a change in the workflow process. In general, each subject needed a prompt in order to answer question one. I had to suggest possible modes of data transfer to each subject other than the medical records clerk (they did pause for a second, however I only had to remind the subject of one possible mode).

For question one, the responses varied, but each mode was mentioned and agreed upon at least once. Each subject but the PCP mentioned email as a mode of data transfer. For question two, the check-out clerk, nurse, and medical records clerk believed the workflow process would enhance/speed-up production and work completion. The nurse mentioned that the job process and turnaround time of labs would become faster. The phlebotomist thought it would be difficult to complete day-to-day tasks and the PCP was concerned about data security. The check-out clerk believed her comfort level would improve because the ordered labs would be stored in the computer's memory. The nurse, PCP, and medical records clerk said that their comfort level would not change with a change in the workflow process. The PCP even mentioned that his day-to-day task/routine would not be affected because instead of using an encounter form to order a clinical laboratory test it could be sent from the exam room via a personal digital assistant

(PDA), computer, etc. The phlebotomist said that at minimum one more task added to drawing blood for nine doctors would make the workflow process more difficult.

Results: See appendix C

Data Analysis Results

Phase I:

After analyzing each table throughout the continuous time-motion study a corresponding table, which provides the total approximate time and percentage for each observed subject Task Category within the clinic, was created. Note the following tables for the results:

PCP:		
Task Category	Approx. time	approx. %
Processing	5 minutes	35.71%
Interpretation	8m40s	61.90%
Recording	20 seconds	2.38%

Table 1.0 PCP

Nurse:		
Task Category	approx. time	approx. %
Processing	20m10s	15.38%
Communicating	19m15s	14.69%
Processing/Recording	42 minutes	32.04%
Specimen Collection	33 minutes	25.17%
Recording	16m40s	12.71%

Table 2.0 Nurse

Phlebotomist:		
Task Category	approx. time	approx. %
Processing	36m21s	38.80%
Processing/Recording	45s	0.78%
Recording	2m45s	2.86%
Communicating	1m50s	1.90%
Specimen Collection	53m35s	55.66%

Table 3.0 Phlebotomist

Check-out Clerk:		
Task Category	approx. time	approx. %
Processing	15m5s	60.12%
Processing/Recording	11 minutes	39.88%

Table 4.0 Check-out Clerk

Medical Records Clerk:		
Task Category	approx. Time	approx. %
Processing	45 minutes	100%

Table 5.0 Medical Records Clerk

General Lab:		
Task Category	approx. time	approx. %
Processing	47m57s	92.75%
Recording	1m15s	2.42%
Communicating	30 seconds	0.97%
Specimen Collection	1 minute	1.93%
Interpretation	1 minute	1.93%

Table 6.0 General Lab

PT/INR:		
Task Category	approx. time	approx. %
Processing	7m53s	61.19%
Recording	15 seconds	1.94%
Communicating	1m10s	9.06%
Specimen Collection	2m35s	20.05%
Interpretation	1 minute	7.76%

Table 6.1 PT/INR

Testosterone:		
Task Category	approx. time	approx. %
Processing	49m46s	89.11%
Recording	1m30s	2.68%
Communicating	1m10s	2.09%
Specimen Collection	2m25s	4.33%
Interpretation	1 minute	1.79%

Table 6.2 Testosterone

Strep Screen:		
Task Category	approx. time	approx. %
Processing	11m21s	39.12%

Recording	6m10s	21.25%
Communicating	9m5s	31.30%
Specimen Collection	1m55s	6.61%
Recording/Communicating	30 seconds	1.72%

Table 7.0 Strep Screen

Micro Albumin:		
Task Category	approx. time	approx. %
Communicating	35 seconds	15.56%
Specimen Collection	45 seconds	20%
Processing	2 minutes	53.33%
Recording	25 seconds	11.11%

Table 7.1 Micro Albumin

Pregnancy Test:		
Task Category	approx. time	approx. %
Processing	50 seconds	40%
Specimen Collection	45 seconds	36%
Recording	10 seconds	8%
Communicating	20 seconds	16%

Table 7.2 Pregnancy Test

Phase II:

Each subject (PCP, nurse, phlebotomist, check-out clerk, and medical records clerk) analyzed their corresponding flow-chart and found that each step was represented accurately. No further analysis or changes were needed.

Phase III:

After analyzing each interview I was able to create a corresponding table that provides the pros and cons of the possible mode of data transportation from an electronic medical record (for example) to a health information exchange. The table provides a

useful tool explaining the numerous modes of data transportation. Each possible mode has various pros and cons that should help healthcare providers such as the observed primary care clinic to better access which mode of transfer is right for the corresponding healthcare facility. The table can be found in the discussion section.

Chapter Five: DISCUSSION

This section discusses the results that were reported in the previous section. The section begins with an explanation of the outcome from the three phases (continous time-motion study, flowchart of workflow process, and follow-up interview). This section is concluded by a discussion of the implications from the results found during the data analysis of phase III and I (follow-up interview and continuous time-motion study).

Explanation of Outcomes

Phase I: continuous time-motion study

The continuous time-motion study provided sufficient data that was vital in the completion of phase II (flowchart of workflow process). The tool used captured the step-by-step workflow process of each POCT and laboratory test in addition to each subject involved throughout the process of the particular clinical test. The approximate duration time for each task category was then summarized that provided the approximate percentage respectively. The calculations provide a useful table that breaks down the time spent for each specific task category.

Phase II: flowchart of workflow process

The flowchart of workflow process was derived form the analysis of phase I. Each table was analyzed and in result a flowchart for the general workflow process of a POCT and clinical laboratory test in addition to a flowchart for each subject observed was created. These flowcharts provide a useful figure that outlines in detail each step in the process of the respected clinical test.

Phase III: follow-up interview

The follow-up interview provided useful insight that not only verified that the flowcharts from phase II are accurate, but each subject's opinion provided the content needed for the creation of the pros and cons table of data transfer modes. The following tables cover the pros and cons of possible modes of data transfer from an electronic medical record (for example) to a health information exchange. This table provides a valuable tool in determining what mode of data transfer can and/or should be used for transferring the data of clinical tests from a EMR to a HIE.

Mode	Pros:	Cons:
Fax	1. Fast 2. Medical records clerk can send. 3. Familiar process	1. Can be misdirected 2. Need fax access. 3. Requires additional process by RHIO
Email	1. Fast 2. PCP/nurse can send from exam room/office area.	1. May not be secure 2. Need computer access 3. New process (change in current workflow processes)
Input into EMR	1. Medical records clerk can input data. 2. Reduces missing data 3. Can be automatically captured into data	1. Requires time for login, authentication 2. Need computer access 3. New process (change in current workflow

	repository if networked	processes)
Web interface	1. Secure 2. PCP/nurse can send from exam room/office area. 3. Can be automatically captured into data repository	1. Requires time for login, authentication 2. Need computer and server access. 3. New process (change in current workflow processes)

Table 8.0 Pros and Cons of Data Transfer Modalities

Conclusions that can be derived from the three phases are: the Processing task category takes up the most amount of time throughout the duration of workflow process for POCT, clinical laboratory test, and the observed subject roles. Of the observed roles, the nurse is involved within the most amount of time vs. the medical records clerk is involved in the least amount of time, throughout the workflow process. Changes in the workflow process would most likely affect the phlebotomist, least likely affect the PCP, while the nurse, check-out clerk, and medical records clerk would be minimally affected (if at all

Overall, a change in the workflow process for a provider such as the observed primary care clinic would create a higher patient intake and faster result turnaround, resulting in quality patient care. The use of data transfer of POCT and clinical laboratory test results from an EMR to a HIE would create a broader depth of content that will be available (for healthcare providers staring at the point-of-care, that leads to a regional

HIE, that leads to a national HIE, that leads to a worldwide HIE) in order to access patient health data such as POCT and clinical laboratory test results.

Implications of Results of Outcomes

The content described above provides numerous tools (tables and flowcharts) that are helpful to the industry of healthcare in understanding how the workflow process provides the content needed in the present and future so that the transfer of POCT and clinical laboratory data at the point of care to a health information exchange is possible. Transferring of such data is vital to the future plan for a regional, national, and even a worldwide health information exchange data repository. Once this occurs the possibilities of health information access is limitless and critical to providing proper and accurate healthcare. In my opinion when access to such critical health information is available any where health information technology is available, the quality of patient will be greatly improved. I suggest that this transition occurs sooner than later in order to provide the sought after high quality patient care.

CHAPTER SIX: CONCLUSION

Limitations

One limitation of this study was that only one work setting was observed. Although in depth analysis of the workflow processes were uncovered, these may not be generalizable to other settings.

The day of the week that a clinical laboratory test is performed can affect the accuracy of the time duration to perform a test during the observation and every day testing. Monday tends to have a higher quantity of performed tests due to the lack of PCPs present to read a result on Friday. The time of the day can also affect the time duration to perform a clinical laboratory test. Early morning tends to have more tests performed vs. the amount performed in the afternoon, due to patient avoidance of fasting for required labs.

The accuracy of the time-motion study was challenging when calculating the approximate time for each Task Category. Knowing exact time for each step was not possible in the way I recorded the content. In the future if I were to repeat the process I would make sure I write down in precise detail the time for each task and not via task grouping as I did in this study.

Another limitation I encountered was during the creation of the Task Categories. I thought that each task would be separate, however this did not occur. The Processing/Recording task was used because each task happened to occur simultaneously. It would not be possible for each task to be separated due to the simultaneous occurrence. To pinpoint overlapping of tasks, through visual

representation, a timeline can be used to record each category as it occurs across time in order to show overlapping/simultaneous occurrence. This should provide accurate time assessment of the workflow process for each Task Category.

Future Research

Future research may include a more detailed time-motion study (as described in the above section), which should provide a more precise, and accurate assessment of the data obtained for such a study. This in result should help create a better understanding of time spent for each outlined Task Category. This will then help to truly access how the pros and cons of data transfer table will help a healthcare organization to determine which mode of data transfer is best suited for a transfer of health information such as POCT and clinical laboratory test results to a health information exchange. In the future, actual field-tests to pilot different methods for data transfer of POCT results should be conducted using time-motion methods to optimize data exchange within workflow constraints.

Summary

Through the three phases (continous time-motion study, flowchart of workflow process, and follow-up interview) the study provided a basis of how analyzing the workflow process of clinical test such as POCT and clinical laboratory test can provide the needed data to create a tool such as the pros and cons of data transfer. The results should help healthcare settings to determine the appropriate mode of data transfer of clinical data to a health information exchange.

REFERENCES

Agency for Healthcare Quality and Research. *Electronic medical/health records*. Retrieved May 30, 2007, from http://healthit.ahrq.gov/portal/server.pt?open=514&objID=5554&mode=2&holderDisplayURL=http://prodportallb.ahrq.gov:7087/publishedcontent/publish/communities/k_o/knowledge_library/key_topics/health_briefing_01232006114616/electronic_medical_health_records.html

Agency for Healthcare Quality and Research. *Health Information Exchange Policy Issues*. Retrieved May 30, 2007, from http://healthit.ahrq.gov/portal/server.pt?open=514&objID=5554&mode=2&holderDisplayURL=http://prodportallb.ahrq.gov:7087/publishedcontent/publish/communities/k_o/knowledge_library/key_topics/health_briefing_04052006112504/health_information_exchange_policy_issues.html

Dovey, S. M., Meyers, D. S., Phillips, R. L., Jr., Green, L. A., Fryer, G. E., Galliher, J. M., et al. (2002). A preliminary taxonomy of medical errors in family practice. *Quality & Safety in Health Care, 11*(3), 233-238.

Elder, N. C., & Hickner, J. (2005). Missing clinical information: the system is down.[comment]. *JAMA, 293*(5), 617-619.

Endress, A., Aydeniz, B., Wallwiener, D., & Kurek, R. (2006). The critical path method to analyze and modify OR-workflow: integration of an image documentation system. *Minimally Invasive Therapy & Allied Technologies: Mitat, 15*(3), 177-186.

Halamka, J., Overhage, J. M., Ricciardi, L., Rishel, W., Shirky, C., & Diamond, C. (2005). Exchanging health information: local distribution, national coordination. As more communities develop information-sharing networks, a coordinated approach is essential for linking these networks. *Health Affairs, 24*(5), 1170-1179.

Haux, R., Knaup, P., & Leiner, F. (2007). On educating about medical data management - the other side of the electronic health record. *Methods of Information in Medicine, 46*(1), 74-79.

Healthcare Information and Management Systems Society.. *Electronic Health Record.* Retrieved May 30, 2007, from http://www.himss.org/ASP/topics_ehr.asp

Lode, P. V. (2005). Point-of-care immunotesting: Approaching the analytical performance of central labratory methods. *Clinical Biochemistry, 38*, p591-p606.

Overhage, J. M., Evans, L., & Marchibroda, J. (2005). Communities' readiness for health information exchange: the National Landscape in 2004. *Journal of the American Medical Informatics Association, 12*(2), 107-112.

Overhage, J. M., Perkins, S., Tierney, W. M., & McDonald, C. J. (2001). Controlled trial of direct physician order entry: effects on physicians' time utilization in ambulatory primary care internal medicine practices. *Journal of the American Medical Informatics Association, 8*(4), 361-371.

Pearson, J. (2006). Point-of-care-testing and Clinical Governance. *Clin Chem Lab Med, 44*(6), p765-p767.

Pizziferri, L., Kittler, A. F., Volk, L. A., Honour, M. M., Gupta, S., Wang, S., et al. (2005). Primary care physician time utilization before and after implementation of

an electronic health record: a time-motion study. *Journal of Biomedical Informatics, 38*(3), 176-188.

Scalise, D. (2006). POINT-OF-CARE TESTING. *Hospitals & Health Networks, Vol. 80*(Issue 9), p75-83.

Smith, P. C., Araya-Guerra, R., Bublitz, C., Parnes, B., Dickinson, L. M., Van Vorst, R., et al. (2005). Missing clinical information during primary care visits.[see comment]. *JAMA, 293*(5), 565-571.

Yasnoff, W. A., Humphreys, B. L., Overhage, J. M., Detmer, D. E., Brennan, P. F., Morris, R. W., et al. (2004). A consensus action agenda for achieving the national health information infrastructure. *Journal of the American Medical Informatics Association, 11*(4), 332-338.

APPENDIX A: Step-by-step Workflow Process

Continuous time-motion study of a primary care clinic – PCP

ID	Role	Task Category	Task	Time
1	1	Interpretation	looks over result	11:44 - 11:45
1	1	Interpretation	signs off on result	11:44 - 11:45
1	1	Processing	places record in pile for medical records	11:44 - 11:45
2	1	Interpretation	looks over result	11:45 - 11:45
2	1	Interpretation	signs off on result	11:45 - 11:45
2	1	Processing	places record in pile for medical records	11:45 - 11:45
3	1	Interpretation	looks over hospital result	11:46 - 11:46
3	1	Interpretation	signs off on result	11:46 - 11:46
3	1	Processing	places record in pile for medical records	11:46 - 11:46
4	1	Interpretation	looks over result	11:46 - 11:46
4	1	Interpretation	write re-check in 6 months	11:46 - 11:46
4	1	Interpretation	places record in pile for nurse	11:46 - 11:46
5	1	Interpretation	looks over result	11:47 - 11:47
5	1	Interpretation	signs off on result	11:47 - 11:47
5	1	Processing	places record in pile for medical records	11:47 - 11:47
6	1	Interpretation	looks over result	11:48 - 11:48
6	1	Interpretation	signs off on result	11:48 - 11:48
6	1	Processing	places record in pile for nurse	11:48 - 11:48
7	1	Interpretation	looks over result	11:48 - 11:48
7	1	Interpretation	signs off on result	11:48 - 11:48
7	1	Processing	places record in pile for medical records	11:48 - 11:48
8	1	Interpretation	looks over result	11:48 - 11:48
8	1	Interpretation	signs off on result	11:48 - 11:48
8	1	Processing	places record in pile for medical records	11:48 - 11:48
9	1	Interpretation	looks over result	11:49 - 11:49
9	1	Interpretation	signs off on result	11:49 - 11:49
9	1	Processing	places record in pile for nurse	11:49 - 11:49
10	1	Interpretation	looks over result	11:49 - 11:49
10	1	Interpretation	signs off on result	11:49 - 11:49
10	1	Processing	places record in pile for nurse	11:49 - 11:49

11	1	Interpretation	looks over result	11:50 - 11:50
11	1	Interpretation	signs off on result	11:50 - 11:50
11	1	Processing	places record in pile for nurse	11:50 - 11:50
12	1	Interpretation	looks over result	11:50 - 11:50
12	1	Interpretation	signs off on result	11:50 - 11:50
12	1	Processing	places record in pile for nurse	11:50 - 11:50
13	1	Interpretation	looks over result	11:50 - 11:50
13	1	Interpretation	signs off on result	11:50 - 11:50
13	1	Processing	places record in pile for nurse	11:50 - 11:50
General PCP observation:				
ID	Role	Task Category	Task	Time
1	1	Interpretation	looks over result	7:41 - 7:42
1	1	Interpretation	signs off on result	7:41 - 7:42
1	1	Interpretation	places record in pile for nurse or places record in pile for medical records	7:41 - 7:42
			repeat steps above	
General PCP observation:				
ID	Role	Task Category	Task	Time
1	1	Processing	Leaves room with patient chart	8:50 A.M. (6/13/07)
1	1	Recording	fills out encounter form with needed lab details	
1	1	Processing	Hands chart with encounter form to check-out clerk	8:51 A.M. (6/13/07)
			repeat steps above	

Continuous time-motion study of a primary care clinic – nurse

ID	Role	Task Category	Task	Time
1	2	Processing	grab chart	9:24 - 9:25
1	2	Communicating	call back patient	9:24 - 9:25
1	2	Processing/Recording	weigh patient	9:24 - 9:25
1	2	Processing	bring patient to room	9:24 - 9:25
1	2	Communicating	determine need for exam	9:25 - 9:35
1	2	Communicating	patient has back problem	9:25 - 9:35
1	2	Specimen Collection	wait for urine sample	9:25 - 9:35
2	2	Processing	grab chart	9:35 - 9:39
2	2	Recording	prepare PCP white sheet	9:35 - 9:39
2	2	Communicating	call back patient	9:35 - 9:39
2	2	Processing/Recording	weigh patient	9:35 - 9:39
2	2	Processing	bring patient to room	9:35 - 9:39
2	2	Processing/Recording	check/record vitals	9:35 - 9:39
1	2	Processing	leave room to □urine sample	9:39
1	2	Processing	grab urine sample	9:40 - 9:41
1	2	Processing	perform urine test	9:40 - 9:41
1	2	Recording	record non-abnormal result	9:40 - 9:41
2	2	Processing/Recording	check/record vitals	9:41 - 9:45
2	2	Specimen Collection	wait for urine sample	9:41 - 9:45
3	2	Processing	grab chart	9:46 - 9:50
3	2	Recording	prepare PCP white sheet	9:46 - 9:50

3	2	Communicating	call back patient	9:46 - 9:50
3	2	Processing/Recording	weigh patient	9:46 - 9:50
3	2	Processing	bring patient to room	9:46 - 9:50
3	2	Processing/Recording	check/record vitals	9:46 - 9:50
2	2	Processing	grab urine sample	9:49 - 9:50
2	2	Processing	perform urine test	9:49 - 9:50
2	2	Recording	record non-abnormal result	9:49 - 9:50
3	2	Specimen Collection	wait for urine sample	9:57
3	2	Processing	grab urine sample	9:58 - 10:00
3	2	Processing	perform urine test	9:58 - 10:00
3	2	Recording	record non-abnormal result	9:58 - 10:00
4	2	Processing	grab chart	9:58 - 10:08
4	2	Recording	prepare PCP white sheet	9:58 - 10:08
4	2	Communicating	call back patient	9:58 - 10:08
4	2	Processing/Recording	weigh patient	9:58 - 10:08
4	2	Processing	bring patient to room	9:58 - 10:08
4	2	Processing/Recording	check/record vitals	9:58 - 10:08
4	2	Specimen Collection	wait for urine sample	10:08
5	2	Processing	grab chart	10:09 - 10:17
5	2	Recording	prepare PCP white sheet	10:09 - 10:17
5	2	Communicating	call back patient	10:09 - 10:17
5	2	Processing/Recording	weigh patient	10:09 - 10:17
5	2	Processing	bring patient to room	10:09 - 10:17

5	2	Processing/Recording	check/record vitals	10:09 - 10:17
5	2	Specimen Collection	wait for urine sample	10:17
4	2	Processing	grab urine sample	10:17 - 10:19
4	2	Processing	perform urine test	10:17 - 10:19
4	2	Recording	record non-abnormal result	10:17 - 10:19
5	2	Processing	grab urine sample	10:22
5	2	Processing	perform urine test	10:22
5	2	Recording	record non-abnormal result	10:22
6	2	Processing	grab chart	10:24 - 10:42
6	2	Recording	prepare PCP white sheet	10:24 - 10:42
6	2	Communicating	call back patient	10:24 - 10:42
6	2	Processing/Recording	weigh patient	10:24 - 10:42
6	2	Processing	bring patient to room	10:24 - 10:42
6	2	Processing/Recording	check/record vitals	10:24 - 10:42
6	2	Processing/Recording	blood sugar (pt. is diabetic)	10:24 - 10:42
6	2	Specimen Collection	wait for urine sample	10:42
6	2	Processing	grab urine sample	10:44
6	2	Processing	perform urine test	10:44
6	2	Recording	record abnormal result	10:44
7	2	Processing	grab chart	10:44 - 10:51
7	2	Recording	prepare PCP white sheet	10:44 - 10:51
7	2	Communicating	call back patient	10:44 - 10:51
7	2	Processing/Recording	weigh patient	10:44 - 10:51
7	2	Processing	bring patient to room	10:44 - 10:51
7	2	Processing/Recording	check/record vitals	10:44 - 10:51
7	2	Specimen Collection	wait for urine sample	10:51
8	2	Processing	grab chart	10:52 -

				10:54
8	2	Recording	prepare PCP white sheet	10:52 - 10:54
7	2	Processing	grab urine sample	10:54 - 10:55
7	2	Processing	perform urine test	10:54 - 10:55
7	2	Recording	record non-abnormal result	10:54 - 10:55
call pt.	2	Communicating	inform patient of test result	10:55 - 10:56
8	2	Communicating	call back patient	10:57 - 11:02
8	2	Processing/Recording	weigh patient	10:57 - 11:02
8	2	Processing	bring patient to room	10:57 - 11:02
8	2	Processing/Recording	check/record vitals	10:57 - 11:02
8	2	Specimen Collection	wait for urine sample	11:02
8	2	Processing	prepare room for pap smear	11:02 - 11:04
8	2	Recording	sign medical waiver	11:02 - 11:04
8	2	Recording	label specimen container	11:02 - 11:04
8	2	Processing	grab urine sample	11:06 - 11:07
8	2	Processing	perform urine test	11:06 - 11:07
8	2	Recording	record non-abnormal result	11:06 - 11:07
Informing patients of laboratory results:				
ID	Role	Task Category	Task	Time
1	2	Communicating	call patient	4:30 - 4:31
1	2	Communicating	leave message on patient answering machine	4:30 - 4:31
1	2	Recording	record chol./trig./PSA/A1C levels in front of chart	4:32
2	2	Communicating	call patient	4:32 -

				4:35
2	2	Communicating	inform test result (X-ray)	4:32 - 4:35
2	2	Administrative	file result in correct area of chart	4:32 - 4:35
3	2	Communicating	call patient	4:37 - 4:39
3	2	Communicating	inform patient of lab result	4:37 - 4:39
3	2	Communicating	inform patient to watch fat, carb., etc. intake	4:37 - 4:39
3	2	Communicating	inform patient to stay on current mediation	4:37 - 4:39
3	2	Recording	record informed patient on lab result	4:37 - 4:39
3	2	Recording	Record chol./trig levels in front of chart	4:39 - 4:40
4	2	Communicating	call patient	4:41 - 4:42
4	2	Communicating	leave message on patient answering machine	4:41 - 4:42
4	2	Recording	record chol./trig./PSA levels in front of chart	4:42
5	2	Communicating	call patient	4:43 - 4:44
5	2	Communicating	leave message on patient answering machine	4:43 - 4:44
6	2	Communicating	call patient	4:45
6	2	Communicating	inform patient A1C level is high	4:45
6	2	Communicating	inform patient to watch sugar intake	4:45
6	2	Recording	record A1C level in front of chart	4:45
7	2	Communicating	call patient	4:47 - 4:48
7	2	Communicating	leave message on patient answering machine	4:47 - 4:48
8	2	Communicating	call patient	4:48 - 4:49
8	2	Communicating	inform patient of kidney function/creatine level	4:48 - 4:49
9	2	Communicating	call patient	4:50 - 4:51
9	2	Recording	write N/A (no answer) on test (with time)	4:50 - 4:51

10	2	Communicating	call patient	4:51 - 4:52
10	2	Communicating	leave message on patient answering machine	4:51 - 4:52
11	2	Communicating	call patient	4:53 - 4:57
11	2	Communicating	inform patient of (chol./A1C/PSA/trig./HDL/LDL) levels	4:53 - 4:57
11	2	Communicating	inform patient to watch sugar/pasta/potato intake	4:53 - 4:57
11	2	Communicating	inform patient AHN will send patient dietary information	4:53 - 4:57
11	2	Recording	record (chol./A1C/PSA/trig.) levels in front of chart	4:57

Continuous time-motion study of a primary care clinic – phlebotomist

ID	Role	Task Category	Task	Time
1	3	Processing	receive lab order	1:48 - 1:49
1	3	Recording	record in patient log	1:48 - 1:49
1	3	Processing	print-out requisition form	1:48 - 1:49
1	3	Communicating	call patient to laboratory	1:48 - 1:49
1	3	Specimen Collection	grab collection supplies	1:50 - 1:53
1	3	Specimen Collection	Draw specimen	1:50 - 1:53
1	3	Specimen Collection	dispose of waste	1:50 - 1:53
1	3	Communicating	send patient away	1:50 - 1:53
1	3	Processing	let specimen clot for 30 minutes	1:50 - 1:53
X	3	Processing	spin already clotted specimens for 15 minutes	1:54 - 2:09
2	3	Processing	receive lab order	1:54 - 1:58
2	3	Recording	record in patient log	1:54 - 1:58
2	3	Processing	print-out requisition form	1:54 - 1:58
2	3	Communicating	call patient to laboratory	1:54 - 1:58
2	3	Specimen Collection	grab collection supplies	1:54 - 1:58
2	3	Specimen Collection	Draw specimen	1:54 - 1:58
2	3	Specimen Collection	dispose of waste	1:54 - 1:58
2	3	Communicating	send patient away	1:54 - 1:58
2	3	Processing	let specimen clot for 30 minutes	1:54 - 1:58
3	3	Processing	receive lab order	2:10 - 2:13
3	3	Recording	record in patient log	2:10-

				2:13
3	3	Processing	print-out requisition form	2:10 - 2:13
3	3	Communicating	call patient to laboratory	2:10 - 2:13
3	3	Specimen Collection	grab collection supplies	2:10 - 2:13
3	3	Specimen Collection	Draw specimen	2:10 - 2:13
3	3	Specimen Collection	dispose of waste	2:10 - 2:13
3	3	Communicating	send patient away	2:10 - 2:13
3	3	Processing	let specimen clot for 30 minutes	2:10 - 2:13
4	3	Processing	receive lab order	2:11 - 2:18
4	3	Recording	record in patient log	2:11 - 2:18
4	3	Processing	print-out requisition form	2:11 - 2:18
4	3	Communicating	call patient to laboratory	2:11 - 2:18
4	3	Specimen Collection	grab collection supplies	2:11 - 2:18
4	3	Specimen Collection	Draw specimen	2:11 - 2:18
4	3	Specimen Collection	dispose of waste	2:11 - 2:18
4	3	Communicating	send patient away	2:11 - 2:18
4	3	Processing	let specimen clot for 30 minutes	2:11 - 2:18
X	3	Processing	bag specimens w/ lab requisitions to be sent to general Lab	2:11 - 2:12
5	3	Processing/Recording	fill out specialty lab requisition form for C. Diff lab	2:23 - 2:28
5	3	Processing	bag specimen to be picked by courier	2:23 - 2:28
5	3	Processing	copy of requisition form put in tray for future comparison	2:23 - 2:28
6	3	Processing	receive lab order	2:27 - 2:31
6	3	Recording	record in patient log	2:27 -

				2:31
6	3	Processing	print-out requisition form	2:27 - 2:31
6	3	Communicating	call patient to laboratory	2:27 - 2:31
6	3	Specimen Collection	grab collection supplies	2:27 - 2:31
6	3	Specimen Collection	draw specimen	2:27 - 2:31
6	3	Specimen Collection	dispose of waste	2:27 - 2:31
6	3	Communicating	send patient away	2:27 - 2:31
6	3	Processing	let specimen clot for 30 minutes	2:27 - 2:31
7	3	Processing	receive lab order	2:40 - 2:46
7	3	Recording	record in patient log	2:40 - 2:46
7	3	Processing	print-out requisition form	2:40 - 2:46
7	3	Communicating	call patient to laboratory	2:40 - 2:46
7	3	Specimen Collection	grab collection supplies	2:40 - 2:46
7	3	Specimen Collection	draw specimen	2:40 - 2:46
7	3	Specimen Collection	dispose of waste	2:40 - 2:46
7	3	Communicating	send patient away	2:40 - 2:46
7	3	Processing	let specimen clot for 30 minutes	2:40 - 2:46
8	3	Processing	receive lab order	2:41 - 2:48
8	3	Recording	record in patient log	2:41 - 2:48
8	3	Processing	print-out requisition form	2:41 - 2:48
8	3	Communicating	call patient to laboratory	2:41 - 2:48
8	3	Specimen Collection	grab collection supplies	2:41 - 2:48
8	3	Specimen Collection	draw specimen	2:41 - 2:48

8	3	Specimen Collection	dispose of waste	2:41 - 2:48
8	3	Communicating	send patient away	2:41 - 2:48
8	3	Processing	let specimen clot for 30 minutes	2:41 - 2:48
9	3	Processing	receive lab order	2:47 - 2:52
9	3	Recording	record in patient log	2:47 - 2:52
9	3	Processing	print-out requisition form	2:47 - 2:52
9	3	Communicating	call patient to laboratory	2:47 - 2:52
9	3	Specimen Collection	grab collection supplies	2:47 - 2:52
9	3	Specimen Collection	draw specimen	2:47 - 2:52
9	3	Specimen Collection	dispose of waste	2:47 - 2:52
9	3	Communicating	send patient away	2:47 - 2:52
9	3	Processing	let specimen clot for 30 minutes	2:47 - 2:52
10	3	Processing	receive lab order	2:51 - 2:55
10	3	Recording	receive lab order	2:51 - 2:55
10	3	Processing	print-out requisition form	2:51 - 2:55
10	3	Communicating	call patient to laboratory	2:51 - 2:55
10	3	Specimen Collection	grab collection supplies	2:51 - 2:55
10	3	Specimen Collection	draw specimen	2:51 - 2:55
10	3	Specimen Collection	dispose of waste	2:51 - 2:55
10	3	Communicating	send patient away	2:51 - 2:55
10	3	Processing	let specimen clot for 30 minutes	2:51 - 2:55
11	3	Processing	receive lab order	2:59 - 3:05
11	3	Recording	record in patient log	2:59 -

				3:05
11	3	Processing	print-out requisition form	2:59 - 3:05
11	3	Communicating	call patient to laboratory	2:59 - 3:05
11	3	Specimen Collection	grab collection supplies	2:59 - 3:05
11	3	Specimen Collection	draw specimen	2:59 - 3:05
11	3	Specimen Collection	dispose of waste	2:59 - 3:05
11	3	Communicating	send patient away	2:59 - 3:05
11	3	Processing	let specimen clot for 30 minutes	2:59 - 3:05
12	3	Processing	receive lab order	3:00 - 3:12
12	3	Recording	record in patient log	3:00 - 3:12
12	3	Processing	print-out requisition form	3:00 - 3:12
12	3	Communicating	call patient to laboratory	3:00 - 3:12
12	3	Specimen Collection	grab collection supplies	3:00 - 3:12
12	3	Specimen Collection	draw specimen	3:00 - 3:12
12	3	Specimen Collection	dispose of waste	3:00 - 3:12
12	3	Communicating	send patient away	3:00 - 3:12
12	3	Processing	let specimen clot for 30 minutes	3:00 - 3:12
1 to 6	3	Processing	spin specimens (1-6) in centrifuge for 15 minutes	3:07 - 3:22
1 to 6	3	Processing	bag specimens w/ lab requisitions to be picked by courier	3:22 - 3:23

ID	Role	Task Category	Task	Time
1	3	Processing	receive lab order	1:48 - 1:49
1	3	Recording	record in patient log	1:48 -

				1:49
1	3	Processing	print-out requisition form	1:48 - 1:49
1	3	Communicating	call patient to laboratory	1:48 - 1:49
1	3	Specimen Collection	grab collection supplies	1:50 - 1:53
1	3	Specimen Collection	draw specimen	1:50 - 1:53
1	3	Specimen Collection	dispose of waste	1:50 - 1:53
1	3	Communicating	send patient away	1:50 - 1:53
1	3	Processing	let specimen clot for 30 minutes	1:50 - 1:53
X	3	Processing	spin already clotted specimens for 15 minutes	1:54 - 2:09
2	3	Processing	receive lab order	1:54 - 1:58
2	3	Recording	record in patient log	1:54 - 1:58
2	3	Processing	print-out requisition form	1:54 - 1:58
2	3	Communicating	call patient to laboratory	1:54 - 1:58
2	3	Specimen Collection	grab collection supplies	1:54 - 1:58
2	3	Specimen Collection	draw specimen	1:54 - 1:58
2	3	Specimen Collection	dispose of waste	1:54 - 1:58
2	3	Communicating	send patient away	1:54 - 1:58
2	3	Processing	let specimen clot for 30 minutes	1:54 - 1:58
3	3	Processing	receive lab order	2:10 - 2:13
3	3	Recording	record in patient log	2:10- 2:13
3	3	Processing	print-out requisition form	2:10 - 2:13
3	3	Communicating	call patient to laboratory	2:10 - 2:13
3	3	Specimen Collection	grab collection supplies	2:10 -

				2:13
3	3	Specimen Collection	draw specimen	2:10 - 2:13
3	3	Specimen Collection	dispose of waste	2:10 - 2:13
3	3	Communicating	send patient away	2:10 - 2:13
3	3	Processing	let specimen clot for 30 minutes	2:10 - 2:13
4	3	Processing	receive lab order	2:11 - 2:18
4	3	Recording	record in patient log	2:11 - 2:18
4	3	Processing	print-out requisition form	2:11 - 2:18
4	3	Communicating	call patient to laboratory	2:11 - 2:18
4	3	Specimen Collection	grab collection supplies	2:11 - 2:18
4	3	Specimen Collection	draw specimen	2:11 - 2:18
4	3	Specimen Collection	dispose of waste	2:11 - 2:18
4	3	Communicating	send patient away	2:11 - 2:18
4	3	Processing	let specimen clot for 30 minutes	2:11 - 2:18
X	3	Processing	bag specimens w/ lab requisitions to be sent to general lab	2:11 - 2:12
5	3	Processing/Recording	fill out specialty lab requisition form for C. Diff lab	2:23 - 2:28
5	3	Processing	bag specimen to be picked by courier	2:23 - 2:28
5	3	Processing	copy of requisition form put in tray for future comparison	2:23 - 2:28
6	3	Processing	receive lab order	2:27 - 2:31
6	3	Recording	record in patient log	2:27 - 2:31
6	3	Processing	print-out requisition form	2:27 - 2:31
6	3	Communicating	call patient to laboratory	2:27 - 2:31
6	3	Specimen Collection	grab collection supplies	2:27 -

				2:31
6	3	Specimen Collection	draw specimen	2:27 - 2:31
6	3	Specimen Collection	dispose of waste	2:27 - 2:31
6	3	Communicating	send patient away	2:27 - 2:31
6	3	Processing	let specimen clot for 30 minutes	2:27 - 2:31
7	3	Processing	receive lab order	2:40 - 2:46
7	3	Recording	record in patient log	2:40 - 2:46
7	3	Processing	print-out requisition form	2:40 - 2:46
7	3	Communicating	call patient to laboratory	2:40 - 2:46
7	3	Specimen Collection	grab collection supplies	2:40 - 2:46
7	3	Specimen Collection	draw specimen	2:40 - 2:46
7	3	Specimen Collection	dispose of waste	2:40 - 2:46
7	3	Communicating	send patient away	2:40 - 2:46
7	3	Processing	let specimen clot for 30 minutes	2:40 - 2:46
8	3	Processing	receive lab order	2:41 - 2:48
8	3	Recording	record in patient log	2:41 - 2:48
8	3	Processing	print-out requisition form	2:41 - 2:48
8	3	Communicating	call patient to laboratory	2:41 - 2:48
8	3	Specimen Collection	grab collection supplies	2:41 - 2:48
8	3	Specimen Collection	draw specimen	2:41 - 2:48
8	3	Specimen Collection	dispose of waste	2:41 - 2:48
8	3	Communicating	send patient away	2:41 - 2:48
8	3	Processing	let specimen clot for 30 minutes	2:41 -

				2:48
9	3	Processing	receive lab order	2:47 - 2:52
9	3	Recording	record in patient log	2:47 - 2:52
9	3	Processing	print-out requisition form	2:47 - 2:52
9	3	Communicating	call patient to laboratory	2:47 - 2:52
9	3	Specimen Collection	grab collection supplies	2:47 - 2:52
9	3	Specimen Collection	draw specimen	2:47 - 2:52
9	3	Specimen Collection	dispose of waste	2:47 - 2:52
9	3	Communicating	send patient away	2:47 - 2:52
9	3	Processing	let specimen clot for 30 minutes	2:47 - 2:52
10	3	Processing	receive lab order	2:51 - 2:55
10	3	Recording	receive lab order	2:51 - 2:55
10	3	Processing	print-out requisition form	2:51 - 2:55
10	3	Communicating	call patient to laboratory	2:51 - 2:55
10	3	Specimen Collection	grab collection supplies	2:51 - 2:55
10	3	Specimen Collection	draw specimen	2:51 - 2:55
10	3	Specimen Collection	dispose of waste	2:51 - 2:55
10	3	Communicating	send patient away	2:51 - 2:55
10	3	Processing	let specimen clot for 30 minutes	2:51 - 2:55
11	3	Processing	receive lab order	2:59 - 3:05
11	3	Recording	record in patient log	2:59 - 3:05
11	3	Processing	print-out requisition form	2:59 - 3:05
11	3	Communicating	call patient to laboratory	2:59 -

				3:05
11	3	Specimen Collection	grab collection supplies	2:59 - 3:05
11	3	Specimen Collection	draw specimen	2:59 - 3:05
11	3	Specimen Collection	dispose of waste	2:59 - 3:05
11	3	Communicating	send patient away	2:59 - 3:05
11	3	Processing	let specimen clot for 30 minutes	2:59 - 3:05
12	3	Processing	receive lab order	3:00 - 3:12
12	3	Recording	record in patient log	3:00 - 3:12
12	3	Processing	print-out requisition form	3:00 - 3:12
12	3	Communicating	call patient to laboratory	3:00 - 3:12
12	3	Specimen Collection	grab collection supplies	3:00 - 3:12
12	3	Specimen Collection	draw specimen	3:00 - 3:12
12	3	Specimen Collection	dispose of waste	3:00 - 3:12
12	3	Communicating	send patient away	3:00 - 3:12
12	3	Processing	let specimen clot for 30 minutes	3:00 - 3:12
1 to 6	3	Processing	spin specimens (1-6) in centrifuge for 15 minutes	3:07 - 3:22
1 to 6	3	Processing	bag specimens w/ lab requisitions to be picked by courier	3:22 - 3:23

Continuous time-motion study of a primary care clinic – check-out clerk

ID	Role	Task Category	Task	Time
1	4	Processing	order lab via EMR	10:51
walk-in	4	Processing	order lab via EMR	10:51
2	4	Processing	pickup encounter form	10:51 - 10:52
walk-in	4	processing/recording	fill out encounter form with lab details	10:53
2	4	Processing	patient comes to checkout desk	11:21 - 11:25
2	4	Processing	collect $ from previous balance/print receipt	11:21 - 11:25
2	4	Processing	send patient to laboratory	11:21 - 11:25
2	4	Processing	order lab via EMR	11:21 - 11:25
3	4	Processing	receive pt. chart w/ encounter form from PCP	12:12 - 12:20
3	4	Processing	to schedule follow-up on 2D echo call is made	12:12 - 12:20
3	4	Processing	patient is scheduled for follow-up visit	12:12 - 12:20
3	4	Processing	order lab via EMR	12:12 - 12:20
3	4	Processing	send patient to laboratory	12:12 - 12:20
4	4	Processing	receive pt. chart w/ encounter form from PCP	12:20 - 12:21
4	4	Processing	order lab via EMR	12:20 - 12:21
5	4	Processing	receive pt. chart w/ encounter form from PCP	12:35 - 12:46
5	4	processing/recording	fill out ultrasound form (give pt. directions)	12:35 - 12:46
5	4	Processing	send patient to laboratory	12:35 - 12:46
5	4	processing/recording	fill out encounter form with lab details	12:35 - 12:46

Continuous time-motion study of a primary care clinic – medical records clerk

ID	Role	Task Category	Task	Time
1	5	Processing	Receive lab results in inbox	3:25
1	5	Processing	alphabetize lab results	4:00
1	5	Processing	find patient chart	4:05
1	5	Processing	bring chart with lab result to PCP	4:10

Continuous time-motion study of a primary care clinic – workflow of lab test

General Lab:				
ID	Role	Task Category	Task	Time
1	1	Processing	hands chart w/ encounter form to checkout clerk w/ correct lab details	10:27 - 10:28 A.M. (6/11/07)
1	4	Recording	fill out EMR w/ lab details	10:29 - 10:30 A.M. (6/11/07)
1	4	Processing	submit lab order to laboratory	10:29 - 10:30 A.M. (6/11/07)
1	3	Processing	receive lab order via EMR	10:31 - 10:34 A.M. (6/11/07)
1	3	Recording	record lab details in patient log	10:31 - 10:34 A.M. (6/11/07)
1	3	Processing	print-out lab requisition	10:31 - 10:34 A.M. (6/11/07)
1	3	Communicating	call patient to laboratory	10:42 - 10:43 A.M. (6/11/07)

1	3	Communicating	ask patient if they have fasted	10:42 - 10:43 A.M. (6/11/07)
1	3	Specimen Collection	grab collection supplies	10:42 - 10:43 A.M. (6/11/07)
1	3	Specimen Collection	draw specimen	10:42 - 10:43 A.M. (6/11/07)
1	3	Specimen Collection	dispose of waste	10:42 - 10:43 A.M. (6/11/07)
1	3	Communicating	send patient away	10:42 - 10:43 A.M. (6/11/07)
1	3	Processing	let specimen clot for 30 minutes	10:43 - 11:17 A.M. (6/11/07)
1	3	Processing	place specimen in centrifuge for 15 minutes	11:17 - 11:33 A.M. (6/11/07)
1	3	Processing	bag specimen w/ lab requisition to be picked up by courier	11:33 - 11:34 A.M. (6/11/07)
1	3	Processing	courier picks up specimen	12:04 P.M. (6/11/07)
1	3	Processing	receive lab result via Outlook	1:17 P.M. (6/11/07)
1	3	Processing	print-out 1 copy for Medical Records and print-out 1 copy for laboratory file cabinet	1:19 P.M. (6/11/07)
1	3	Processing	place 1 copy for Medical Records in Medical Records and place 1 copy in laboratory file cabinet	1:19 P.M. (6/11/07)

1	5	Processing	bring chart with lab result to PCP	2:00 P.M. (6/12/07)
1	1	Interpretation	reviews lab result	7:53 A.M. (6/14/07)
1	2	Communicating	informs patient of lab results	3:16 P.M. (6/14/07)
PT/INR:				
ID	Role	Task Category	Task	Time
1	4	Processing	pickup encounter form	9:48 - 9:51 A.M. (6/11/07)
1	4	Processing	grab chart	9:48 - 9:51 A.M. (6/11/07)
1	4	Processing	fill out EMR w/ lab details	9:48 - 9:51 A.M. (6/11/07)
1	4	Processing	submit lab order to laboratory	9:48 - 9:51 A.M. (6/11/07)
1	3	Processing	receive lab order via EMR	9:55 - 9:59 A.M. (6/11/07)
1	3	Recording	record lab details in patient log	9:55 - 9:59 A.M. (6/11/07)
1	3	Processing	print-out lab requisition	9:55 - 9:59 A.M. (6/11/07)
1	3	Communicating	call patient to laboratory	9:59 - 10:02 A.M. (6/11/07)
1	3	Specimen Collection	grab collection supplies	9:59 - 10:02 A.M. (6/11/07)
1	3	Specimen Collection	draw specimen	9:59 - 10:02 A.M.

				(6/11/07)
1	3	Specimen Collection	dispose of waste	9:59 - 10:02 A.M. (6/11/07)
1	3	Communicating	send patient away	9:59 - 10:02 A.M. (6/11/07)
1	3	Processing	bag specimen w/ lab requisition to be picked up by courier	10:02 - 10:03 A.M. (6/11/07)
1	3	Processing	courier picks up specimen	12:04 P.M. (6/11/07)
1	3	Processing	receive lab result via Outlook	3:21 P.M. (6/11/07)
1	3	Processing	print-out 1 copy for Medical Records and print-out 1 copy for laboratory file cabinet	3:21 P.M. (6/11/07)
1	3	Processing	place 1 copy for Medical Records in Medical Records and place 1 copy in laboratory file cabinet	3:23 P.M. (6/11/07)
1	5	Processing	look for chart to give result to PCP	3:29 - 3:31 P.M. (6/11/07)
1	5	Processing	bring chart with lab result to PCP	3:29 - 3:31 P.M. (6/11/07)
1	1	Interpretation	reviews lab result	3:31 - 3:32 P.M. (6/11/07)
1	1	Processing	places chart with result and further instruction on nurses desk	3:31 - 3:32 P.M. (6/11/07)
1	2	Communicating	informs patient of lab results and further instruction	3:51 - 3:52 P.M. (6/11/07)

Testosterone:				
ID	Role	Task Category	Task	Time
1	4	Recording	fill out lab request from out of office PCP in EMR	3:05 P.M. (6/11/07)
1	4	Processing	submit lab order to laboratory	3:08 P.M. (6/11/07)
1	4	Processing	resend lab order due to wrong lab specifications	3:15 P.M. (6/11/07)
1	3	Processing	receive lab order via EMR	3:16 P.M. (6/11/07)
1	3	Recording	record lab details in patient log	3:16 P.M. (6/11/07)
1	3	Processing	print-out lab requisition	3:16 P.M. (6/11/07)
1	3	Recording	fill out specialty lab requisition	3:16 P.M. (6/11/07)
1	3	Communicating	call patient to laboratory	3:17 - 3:19 P.M. (6/11/07)
1	3	Specimen Collection	grab collection supplies	3:17 - 3:19 P.M. (6/11/07)
1	3	Specimen Collection	draw specimen	3:17 - 3:19 P.M. (6/11/07)
1	3	Specimen Collection	dispose of waste	3:17 - 3:19 P.M. (6/11/07)
1	3	Communicating	send patient away	3:17 - 3:19 P.M. (6/11/07)

1	3	Processing	let specimen clot for 30 minutes	3:19 - 4:10 P.M. (6/11/07)
1	3	Processing	place specimen in centrifuge for 15 minutes	4:10 - 4:25 P.M. (6/11/07)
1	3	Processing	bag specimen w/ lab requisition to be picked up by courier	4:25 P.M. (6/11/07)
1	3	Processing	place copy of specialty lab requisition in laboratory tray to match with returned result	4:25 P.M. (6/11/07)
1	3	Processing	bring specimen to lockbox for courier retrieval	5:00 P.M. (6/11/07)
1	3	Processing	courier picks up specimen	around 5:50 - 6:00 P.M. (6/11/07)
1	3	Processing	receive lab result via specialty lab printer	8:83 A.M. (6/12/07)
1	3	Processing	place 1 copy for Medical Records in Medical Records and place 1 copy in laboratory file cabinet	9:32 A.M. (6/12/07)
1	5	Processing	places lab result with patient chart	9:48 A.M. (6/12/07)
1	5	Processing	bring chart with lab result to PCP	10:29 A.M. (6/12/07)
1	1	Interpretation	reviews lab result	7:52 A.M. (6/14/07)
1	2	Communicating	informs patient of lab results	10:30 A.M. (6/14/07)

Continuous time-motion study of a primary care clinic – workflow of POCT

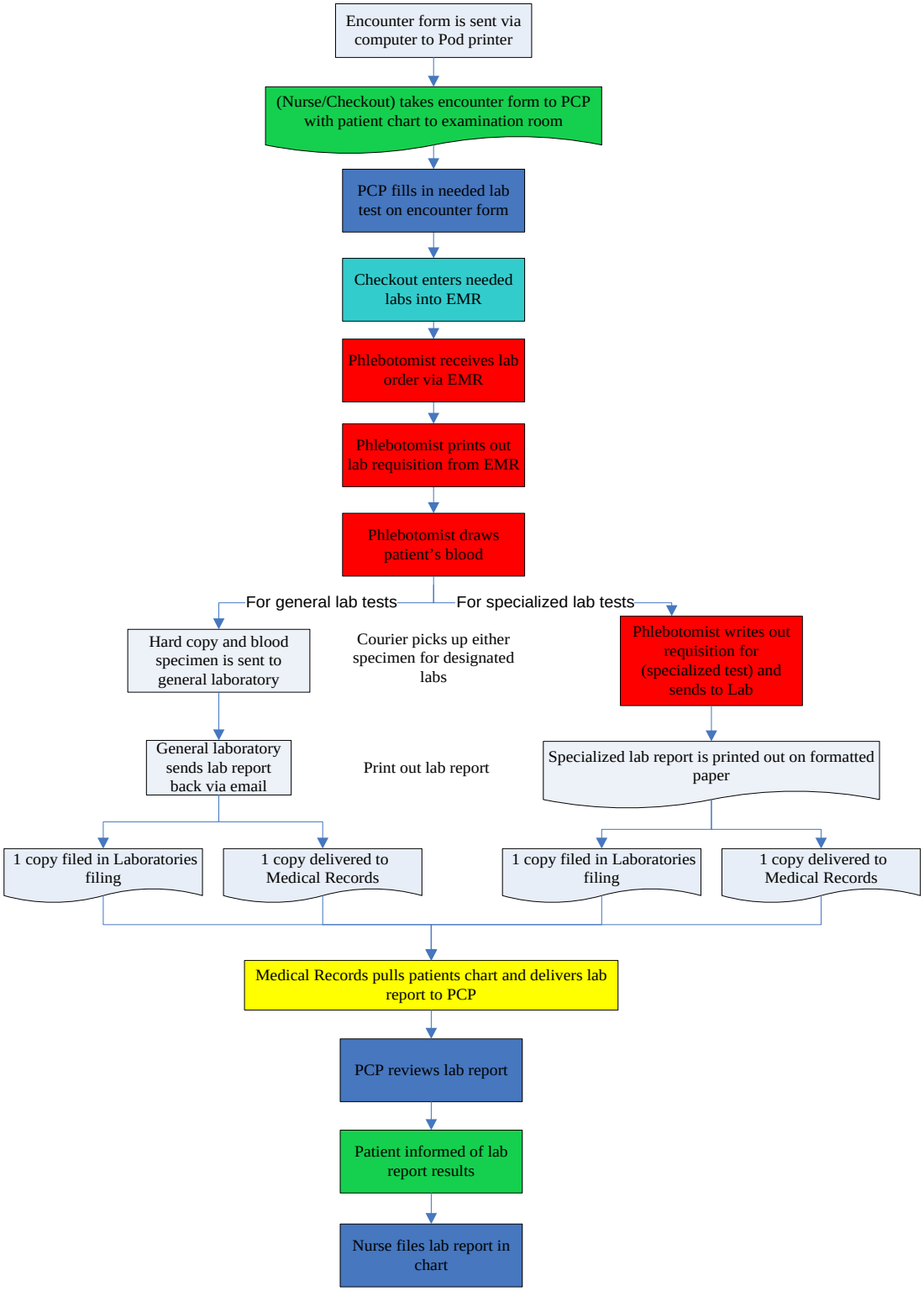
Strep Screen:				
ID	Role	Task Category	Task	Time
1	5	Processing	pickup encounter form	4:15 P.M. (6/11/07)
1	5	Processing	grab chart	4:15 P.M. (6/11/07)
1	5	Processing	give chart to nurse	4:15 P.M. (6/11/07)
1	2	Recording	prepare PCP white sheet	4:27 - 4:30 P.M. (6/11/07)
1	2	Recording	date patient chart	4:27 - 4:30 P.M. (6/11/07)
1	2	Communicating	call back patient	4:30 - 4:32 P.M. (6/11/07)
1	2	Specimen Collection	swap throat	4:30 - 4:32 P.M. (6/11/07)
1	2	Processing	run strep screen in applicator & wait for 10 minutes	4:40 P.M. (6/11/07)
1	2	Recording	record negative result on white sheet	4:40 P.M. (6/11/07)
1	1	Communicating	inform patient of negative result	4:52 - 5:01 P.M. (6/11/07)
1	1	Recording / Communicating	write prescription	4:52 - 5:01 P.M. (6/11/07)

1	1	Recording	dictate visit	evening of 6/11/07
1	4	Processing	check-out clerk sends dictation to transcription service via computer	8:45 A.M. (6/12/07)
1	5	Processing	receive dictation	2:23 P.M. (6/14/07)
1	5	Processing	place dictation in patient chart	4:20 P.M. (6/14/07)
Micro Albumin:				
ID	Role	Task Category	Task	Time
1	1	Communicating	leaves exam room to inform nurse to perform test	5:01 P.M. (6/11/07)
1	2	Specimen Collection	wait for urine sample	5:07 - 5:10 P.M. (6/11/07)
1	2	Processing	process test in urine reader (Clinitek 50)	5:07 - 5:10 P.M. (6/11/07)
1	2	Recording	print off results	5:07 - 5:10 P.M. (6/11/07)
1	2	Recording	record non-abnormal result	5:11 P.M. (6/11/07)
1	2	Communicating	inform patient of normal result	5:12 P.M. (6/11/07)

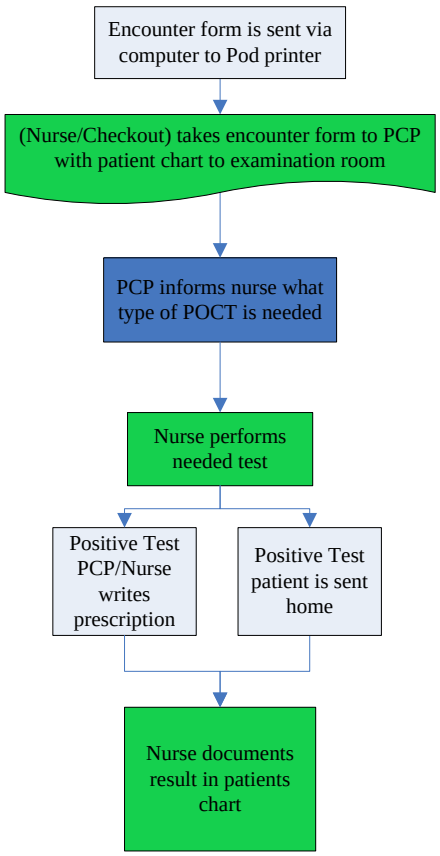
Pregnancy test:				
ID	Role	Task Category	Task	Time
1	2	Processing	grab chart with encounter form	11:55 A.M. (6/13/07)
1	2	Specimen Collection	wait for urine sample	11:56 A.M. (6/13/07)
1	2	Processing	perform test	11:57 A.M. (6/13/07)
1	2	Recording	record result in patient chart	11:58 A.M. (6/13/07)
1	2	Communicating	inform patient	11:58 A.M. (6/13/07)

Appendix B: Flowchart of Workflow Process

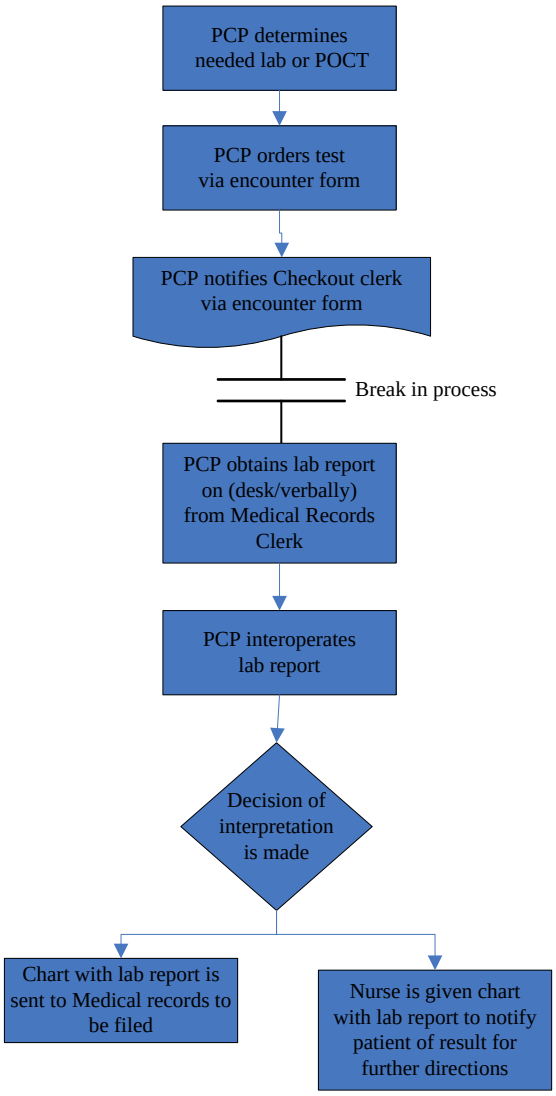
Workflow for Laboratory Test



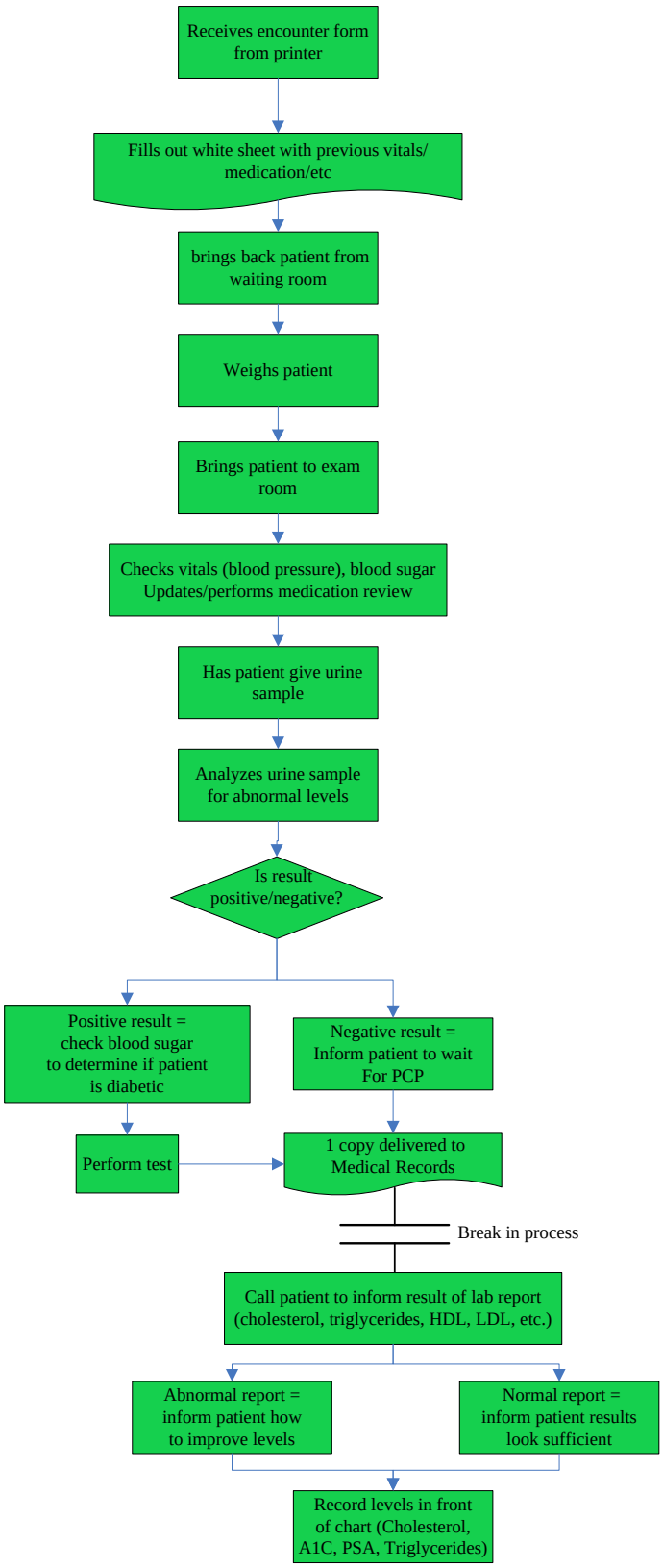
Workflow for Point-of-Care Test



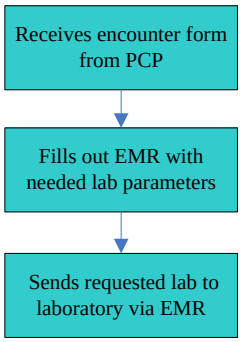
Workflow for PCP's



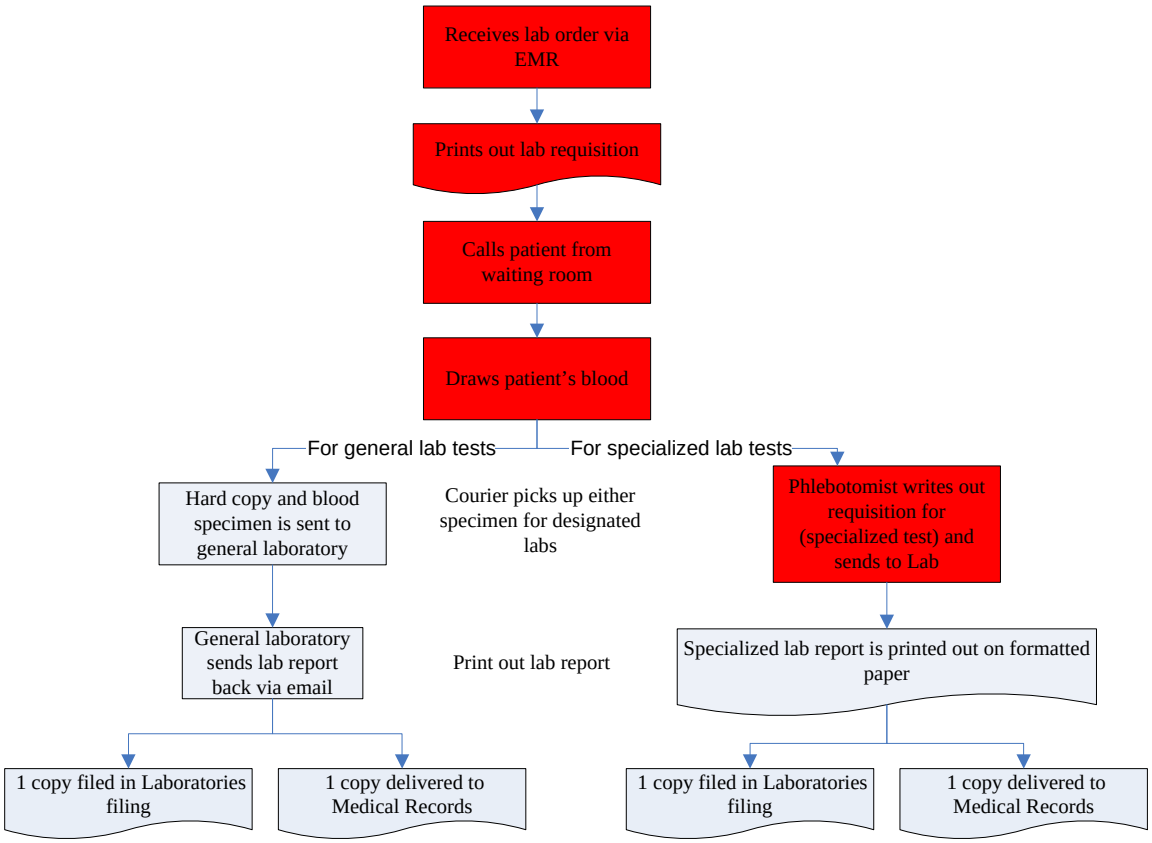
Workflow for Nurses



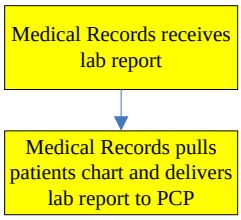
Workflow for Checkout Clerk



Workflow for Phlebotomist's



Workflow for Medical Records Clerk



Appendix C: Follow-up Interview

Phase III:

Checkout clerk:

1) What methods could be used in this practice to collect laboratory data for storage in an EMR (electronic medical record) in order to submit to an external data "warehouse" for health information exchange? *Use the following prompts if participant does not volunteer answers:*

   Fax?

   Email?

   Input into computer record?

   Web interface?

She believes that all four mentioned above can be used to submit the laboratory data. She mentions that she believes this will help make the information more secure.

2) How would these different processes change the way you work (i.e. how will it affect time and how will affect you comfort with the process)?

She believes that it will speed up the process and allow the computer to display what patient labs are needed.

She believes that her comfort level will improve. She will not have to worry about what labs are being ordered because the computer will have the labs stored in its memory.

Nurse:

1) What methods could be used in this practice to collect laboratory data for storage in an EMR (electronic medical record) in order to submit to an external data "warehouse" for health information exchange? *Use the following prompts if participant does not volunteer answers:*

Fax?

Email?

Input into computer record?

Web interface?

She believes that the fax and email would be the best options.

2) How would these different processes change the way you work (i.e. how will it affect time and how will affect you comfort with the process)?

She believes that it will make her job process and turnaround time of the labs faster.

She believes that this will make her more comfortable knowing that she can better track the lab results (time from AHN to core lab and back to AHN, etc.).

Phlebotomist:

1) What methods could be used in this practice to collect laboratory data for storage in an EMR (electronic medical record) in order to submit to an external data "warehouse" for health information exchange? *Use the following prompts if participant does not volunteer answers:*

Fax?

Email?

Input into computer record?

Web interface?

She believes that all four mentioned above can be used to submit the laboratory data to an external data "warehouse" for health information exchange.

2) How would these different processes change the way you work (i.e. how will it affect time and how will affect you comfort with the process)?

She believes that it will crunch it. It will be difficult to keep up with and complete day-to-day tasks. One more tasks added to drawing blood for nine doctors will make the process more difficult.

PCP:

1) What methods could be used in this practice to collect laboratory data for storage in an EMR (electronic medical record) in order to submit to an external data "warehouse" for health information exchange? *Use the following prompts if participant does not volunteer answers:*

Fax?

Email?

Input into computer record?

Web interface?

He believes that the use of a web interface such a web portal will suffice.

2) How would these different processes change the way you work (i.e. how will it affect time and how will affect you comfort with the process)?

Overall, he is worried if the site is really secure.

He feels that his day-to-day task/routine will not be affected because instead of handing the encounter form to checkout clerk to send to laboratory he will send it from the room via PDR, computer, etc.

Medical Records clerk:

1) What methods could be used in this practice to collect laboratory data for storage in an EMR (electronic medical record) in order to submit to an external data "warehouse" for health information exchange? *Use the following prompts if participant does not volunteer answers:*

Fax?

Email?

Input into computer record?

Web interface?

She believes that email, print off and mail results, and fax. I had to mention web interface/portal to her.

2) How would these different processes change the way you work (i.e. how will it affect time and how will affect you comfort with the process)?

She believes that it will speed up the process and allow for more work to be completed or be more productive.

She believes that her comfort level will be same; it will not bother her at all if her everyday job process is changed.

VITA

Brian J. Pearson

brian.j.pearson@vanderbilt.edu
(317) 341-2410
2108 Hayes Street Apt. 23
Nashville, TN 37203 USA

Education

Master of Science in Health Informatics, Expected August 2007
School of Informatics, Indiana University Purdue University at Indianapolis (IUPUI)
Thesis: Workflow Associated With the Collection of Clinical Lab Data at the Point of Care
Advisor: Anna McDaniel

- Workflow Associated With the Collection of Clinical Lab Data at the Point of Care.

Bachelor of Science in Informatics, May 2005
School of Informatics, Indiana University at Bloomington
Project: IU Menu

Research Interests

-

Experiences

Health Information Services Consultant, Vanderbilt Medical Center, Nashville, TN
June 2007 – Present

- Aids and supplements work of internal consultants to customers of the Medical Center, applying and optimizing the application of information technology to business objectives.
- Acts as internal consultant on straight forward projects.
- Researches issues of institutional or strategic importance.

Medical Records Clerk/Office Float, American Health Network, Indianapolis, IN
August 2005 – June 2007

- Started the job floating around the office checking in and checking out patients while covering employees who are absent from day to day.
- Then moved to medical records for Dr. Harvey N. Himelstein.
    - File charts, pull charts, file dictation, and pull test results.

- Use NextGen EPM to keep track of patient files.

Computer Technician, American Health Network, Indianapolis, IN
May 2005 – August 2005

- Re-configure and replace computers/servers (configure to needs of company).
- Networking (patch network connections/ upkeep server room, etc).
- Go on site to company sites and install computers/servers, and fix problems that occur on day-to-day basis.

Internship, Indiana Hemophilia and Thrombosis Center, Indianapolis, IN
June 2004 – August 2004

- Database Work (Excel).
- Customizing Lab Tracker (A hemophilia patient information database).
- Every day IT/Network tasks.