EVALUATION OF A SYSTEM FOR ELECTRONIC EXCHANGE OF LABORATORY INFORMATION: A PRE-IMPLEMENTATION STUDY

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EVALUATION OF A SYSTEM FOR ELECTRONIC EXCHANGE OF LABORATORY INFORMATION: A PRE-IMPLEMENTATION STUDY

by

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DEDICATION

To my parents

Don and Doreen

who have taught me the importance of

education, perseverance

and the value of family;

and to my boyfriend Dion

who has believed in my abilities

and encouraged me

every step of the way.

ABSTRACT

MEDINET is an interface that will allow electronic exchange of laboratory orders and results between heterogeneous laboratory information systems, in real-time. This study was designed to examine the expected impact of Medinet, prior to implementation. It was the pre-implementation component of a two phase evaluation study.

Study sites included two of the Province's Institutional Health Boards and two Provincial reference laboratories. Study instruments included: a) key informant interviews; b) a survey of laboratory personnel; c) a survey of physicians; d) laboratory turnaround time (TAT); and e) a measure of the accuracy with which orders are transmitted to the laboratory.

As a result of improved timeliness of results delivery and more accurate transmission of laboratory orders and results, it is expected that the implementation of Medinet will improve information management, reduce unnecessary utilization of laboratory services and enhance the quality of patient care. Several concerns with the implementation of Medinet were identified and discussed.

Baseline measurements of turnaround time (TAT) and order accuracy were established. The post-implementation study, planned for 6 and 12 months after implementation, will assess the impact of Medinet on each.

Ultimately, study participants would like to see province-wide integration of laboratory information that supports electronic exchange of orders and results between geographically dispersed sites, direct physician order entry (POE) and immediate access to a patient's longitudinal history of laboratory services.

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INTRODUCTION

Background

The use of laboratory services to investigate patients and the subsequent checking of test results are vital aspects of health care delivery. Physicians order laboratory tests to aid in diagnosis, to assist with monitoring, screening and prognosis and, in some cases, because prior test results are not available (Wertman, Sostrin, Paviova and Lundberg, 1980; Lundberg, 1983). The laboratory is one of the greatest repositories of objective information on patient health status and in some departments, up to 40% of all decisions are based on laboratory results (Bradshaw, Gardner and Pryor, 1989; Shabot, LoBue, Leyerle, Dubin 1990).

Physicians rely on laboratories to provide test results in a manner that is medically useful. Errors in laboratory services may extend from the quality and accuracy of data, through the adequacy of data storage and processing, to ensuring the availability of reports to those who need them (Block, Laloum, Rajs, Stalnikowicz and Shapiro, 1996). To ensure the best possible service, many laboratories have invested significantly in analytical procedures, automated instrumentation, laboratory computer systems and trained professional staff (Connelly, Willard, Hallgren and Sielaff, 1996). More recently, the parts of the laboratory testing process that lie outside the laboratory walls has been increasingly recognized as an opportunity to improve laboratory service and value. One strategy that is increasingly being perused is improving the manner in which laboratory information is exchanged between clinician and laboratory.

Laboratory information in its present form is extremely dispersed. Laboratory test results are often fragmented across multiple institutions and are therefore difficult to obtain when required. Studies have shown that physicians desire convenient, integrated and quick access to clinical data (Kaplan and Lundsgaarde, 1996). Lack of integration of laboratory information across multiple sites has been identified as a major barrier to improving efficiency, reducing unnecessary duplicate testing and ensuring continuity of care between primary and tertiary care (More, Sengupta and Manley, 2000). Thus, a continuous challenge in the health care system has been to ensure that laboratory results are available to health care providers in a timely and reliable manner.

With the enhanced capabilities of modern technology, the potential exists for a major impact on the manner in which laboratory information is exchanged. For many Canadian jurisdictions, the ultimate goal is to have a health information system that would allow access to all test results generated on a patient and be able to relate laboratory results to other clinical and pharmaceutical information. It would accumulate new information for each health care encounter and would allow any physician treating a patient to have immediate access to an accurate and complete medical history at any location (Neville, Keough, Barron, MacDonald, Gates, Tucker, Cotton, Farrell, Hoekman, Bornstein and O'Reilly, 2004; NLCHI, 1998). In addition to enabling better medical decisions, a fully integrated health information system may lower the cost associated with multiple, fragmented, paper-based systems being used today (Aller, 1999; NLCHI, 1998).

Rationale

A reference laboratory is an outside facility that will receive a specimen and perform specialized or routine services that the hospital laboratory does not perform. With a paper-based system for exchanging orders and results between an ordering site and a reference laboratory, a paper order will be transported to the reference laboratory where, often, it will be transcribed to a computerized information system. When testing is complete, a paper report will be transported from the reference laboratory back to the ordering site. Once received, the report will often be transcribed to a computerized information system at the ordering site. In addition to the time required for the transportation process, additional paper creates more work and more opportunity for error in transcription or for bundling orders with the wrong samples. Thus, improving the interface between the ordering site and reference laboratory is a potential means of improving accuracy, reliability and efficiency with which laboratory information is exchanged.

The electronic exchange of laboratory orders and results between geographically dispersed locations is an important step towards province-wide integration of laboratory and other diagnostic information. A project between the provinces two largest reference laboratories, the laboratory program at the Health Care Corporation of St. John's (HCCSJ) and the Newfoundland Public Health Laboratory (PHL), and two of the Province's regional Health Boards, the Central East Health Care Institutions Board and the Avalon Health Care Institutions Board, presents an opportunity to evaluate MEDINET – an interface that will allow real-time exchange (i.e. a seamless flow) of

laboratory test orders and results between all hospitals within each region and the Provincial reference laboratories. Evaluation of the Medinet system in its initial implementation stage is important so that findings and outcomes of early implementations can be used as an experience base for further implementation. Successful implementation of the Medinet system may be used as a basis for the province wide exchange of laboratory information.

While there is a general belief in the benefits of information technologies in health care, the number of well-designed studies proving these benefits is limited (van der Loo, van Gennip, Bakker, Hasman, Rutten, 1995). The present study is the pre-implementation component of a two phase evaluation study. The pre-implementation component will examine the expected impact of implementing Medinet for real-time electronic exchange of laboratory information, prior to implementation. The evaluation approach developed for this study may be used as a framework for evaluating similar information systems projects.

Objectives

The objectives of the present study are as follows:

1. To identify the goals and expected benefits of introducing Medinet for real-time exchange of laboratory information.
2. To identify potential issues and concerns with the implementation of Medinet.
3. To establish the expected impact of Medinet implementation on management, processing and exchange of laboratory information.

4. To establish the expected impact of Medinet implementation on utilization of laboratory services.
5. To establish the perceived value of real-time exchange of laboratory information with respect to quality of care.
6. To establish baseline measurements of laboratory test turnaround time (TAT) and order accuracy.
7. To identify future directions and priorities for province-wide exchange of laboratory information.

CHAPTER II

SYSTEM OVERVIEW, RELATED INITIATIVES AND LITERATURE REVIEW

System Overview

Current System for Exchanging Laboratory Information

The laboratory information system (LIS) that is currently used by all clinical laboratories within Newfoundland and Labrador is the MEDITECH laboratory information system. The Meditech LIS is a computerized information system that manages laboratory test data throughout the testing process and generates laboratory reports. All test results that are entered into the system can be viewed along with appropriate patient identification information, relevant reference range(s) for the diagnostic test and a flag for an abnormal test result. The system will also provide a longitudinal history of laboratory test information that is available for an individual. Within health care institutions in Newfoundland and Labrador, the Meditech LIS is interfaced with the Meditech Hospital Information System (HIS). Using the Meditech HIS, a clinician can inquire regarding the status of laboratory results.

Meditech laboratory information systems are built specific to the nomenclature (i.e. the coding system used to describe laboratory orders, results and observations) used by the laboratory in which it is installed. Each of the Province's Institutional and Integrated Health Boards share a common laboratory coding system and LIS network. For example, all clinical laboratories within the Central East Health Care Institutions Board share a common Meditech LIS and are linked to form a network. Therefore, a test

order that is entered at any site within the Central East region can be viewed from any other site within that network. In addition, any clinic that has established a connection to the Meditech system within the region can access the laboratory information.

Once laboratory information is entered into the Meditech LIS, it is readily accessible across the network. However, there is also an exchange of information that occurs between health care institutions across the Province and the provincial reference laboratories in St. John's. With the current paper-based system, laboratory information is exchanged between ordering site and reference laboratory by fax, telephone, postal service, and courier.

Proposed System for Exchanging Laboratory Information

With the introduction of Medinet comes the potential for a major impact on the way laboratory data is exchanged, particularly between distant sites. Medinet is an interface that enables communication between two heterogeneous laboratory information systems (LIS), in real-time. That is, upon data entry, Medinet enables a seamless flow of laboratory orders and results between the LIS at an ordering site and a reference laboratory, without human intervention.

Medinet enables the seamless flow of orders and results between ordering site and reference laboratory through the mapping of parallel codes. With the initial set up of the Medinet interface, all codes (or names) used by the ordering site will be entered into a dictionary and cross-referenced to parallel codes used by the reference laboratory. When an order is entered that is intended for a reference laboratory, Medinet will recognize this

and will electronically transmit the order to the reference laboratory. The order code used by the ordering site will be mapped to the parallel code used by the reference laboratory and the order will file directly into the reference laboratory's LIS. Similarly, upon completion of the test at the reference laboratory, Medinet will transmit the test results to the ordering site, where it will file into the ordering sites' LIS. Since each Meditech LIS is built according to the specific nomenclature of the laboratory in which it is used, a separate dictionary of parallel codes must be set up for each reference laboratory to which an ordering site wishes to communicate via Medinet.

The Medinet interface is written by MEDITECH and is commercially available. It is designed to enable communication between a Meditech laboratory information system and an outside laboratory information system. The outside laboratory information system can be another Meditech LIS or another vendor LIS. In order to meet the specific requirements of the current initiative, however, extensive customization was necessary and was carried by MEDITECH.

While it was recognized that other interfaces exist with similar functions, other vendor products were not considered for this initiative. It was deemed favorable to maintain a 'sole source solution', as all regional laboratories and reference laboratories within Newfoundland and Labrador currently have Meditech laboratory information systems in place (Personal Communication, Manager of Application Development, Health Care Corporation of St. John's, May 2004). In addition, Meditech is a major product vendor for the provincial Health Information Network (HIN) currently underway in Newfoundland and Labrador. Through its research and development process, it was

determined that Meditech products were often more stable and reliable than other vendor products, with the flexibility to communicate with other Meditech products (Personal Communication, Technical Lead, Health Information Network (HIN), Newfoundland and Labrador Centre for Health Information, May 2004).

Within Newfoundland and Labrador, significant progress is being made towards the development of a province-wide Electronic Health Record (EHR), which is a major component of the provincial Health Information Network (HIN). The fully implemented HIN will enable authorized personnel to immediately access health information for any patient including pharmacy, laboratory and other diagnostic services, and other clinical information, with all information linked through the patients' Unique Personal Identifier (UPI). With full implementation, the diagnostic services component will allow physicians to electronically order diagnostic services on-line, offer online decision support at the time of request, and enable immediate access to a longitudinal history of diagnostic service orders and results (NLCHI, 1998).

As a first step towards the province wide integration of laboratory information, the initial implementation of Medinet will enable real-time electronic exchange of laboratory test orders and results between all institutions within the Central East and Avalon regions and the provinces' two largest reference laboratories in St. John's. Successful implementation of Medinet in its infancy may lead to province-wide adoption of Medinet and enable real-time exchange of laboratory test orders and results between reference laboratories and health care institutions throughout the Province.

Other Canadian Initiatives Related to Electronic Exchange of Laboratory Information

Similar to Newfoundland and Labrador, other Canadian jurisdictions have identified electronic sharing of laboratory information as high priority. Across Canada, there are a number of initiatives currently underway with respect to the electronic sharing of laboratory information, and are usually linked to provincial health infostructure initiatives. The ultimate goal is to have complete integration of laboratory information within, and eventually between, all provinces and territories as a component of a pan-Canadian electronic health record (EHR). It has been suggested that core systems such as laboratory and pharmacy information systems should be developed as a route to the EHR rather than pursuing the premature establishment of a full-scale electronic health record (ACHI, 2002). Using laboratory information systems as a starting point for implementing electronic health records has been documented since the 1960s (Collen, 1995 pg 167, as cited in Silverstein and Rothschild, 1999).

Since the majority of the jurisdictions are in their planning and pilot implementation stages, detailed documentation of major initiatives is often unavailable. However, an overview of what is known about electronic exchange of laboratory information in Canada is provided below.

British Columbia. In 1998, the HealthNet/BC Project formed the Lab Test Standard Task Group (LTSTG) with representatives from HealthNet/BC working groups, the BC Health Information Standards Council and private sector and provincial labs. In 1999, the BC Lab Test Standard (LTS) was developed to enhance the quality of patient care through the timely exchange of consistent lab data, and to reduce the cost of

managing the exchange of laboratory information. In January 2000, the BC Lab Test Standard version 1.1 was approved by the BC Health Information Standards Council as a set of provincial standards for electronic transmission of laboratory data.

Version 1.3 of the Lab Test Standard (LTS) is now available. The standard defines the business and technical requirements for the electronic exchange of lab test data and accounts for all information exchanges that occur from the time an order is issued until the time a final result is received. The Lab Test Standard is based on a set of standard identifiers including the Personal Health Number (PHN), which is the provincial standard for personal identification; the Provider Data Standard (including Provider ID), BC Test Order Codes (BCTOC), the standard for test orders; and LOINC, the standard for reporting of test results. The LTS also provides a comprehensive set of rules regarding ordering lab tests, referring/redirecting orders, requesting order status, reporting results, accessing a patients' lab test history and privacy and confidentiality issues.

The Lab Test Standard has identified a number of benefits to be realized as a result of electronic interchange of lab test data. Among these are reduced delay in results delivery; immediate access to test status without staff intervention; reduced effort to correct errors in capturing and transcribing data; reduced effort to refer orders to other labs; enhanced interpretation of results due to availability of previous test results; increased practitioner use of information technology; and the facilitation of other information exchange development (HealthNet/BC, 2002).

A number of BC laboratory systems are currently using the Lab Test Standard. Among these is a private sector province-wide initiative called PathNet. PathNet is a web-based electronic laboratory reporting system that integrates patient laboratory information from multiple participating laboratories, within and across regional boundaries. It allows physicians to access up-to-date laboratory test results, in real-time, for any patient that has had a test completed at any participating laboratory. In addition, PathNet will flag any abnormal test result(s) and allow access to a patient's laboratory test history. Other laboratory systems using the Lab Test Standard include BC Communicable Disease Control (BCCDC) in providing lab test results to the Population Health Information System (PHIS), the federal Canadian Integrated Public Health Surveillance initiative and the BC Cancer Agency (WHIC, 2002).

Alberta. The primary focus for laboratory information exchange in Alberta has been on results reporting and providing a longitudinal history of lab test results. A joint initiative between the Capital Health Authority (CHA), the Physician Office System Program (POSP), Dynacare Kasper Medical Laboratories (DKML) and Alberta Wellnet has created a laboratory test results repository that will allow physicians to electronically receive and file lab results directly into a patient's record. Presently, the system is for reporting test results only and still requires paper forms to be used for lab requisitions. While physician order entry has been identified as a component of the provincial electronic health record initiative, there is still significant work remaining. The Capital Health Authority Electronic Lab Results Reporting Project was launched in Northern Alberta in June, 2002 and is anticipated to expand to include other health authorities.

Currently, physician office systems can electronically receive requested lab test results and a pilot implementation of the lab results history system is being prepared. With full implementation, it is proposed that access to a patient's lab test history will be available along with the Alberta Wellnet Pharmaceutical Information Network (PIN).

A major barrier to the electronic exchange of laboratory information in Alberta is a difference in interest between physicians and labs. While the majority of Alberta physicians consider direct access to laboratory information as high priority, many labs have no financial or conceptual interest in lab data exchange between various stakeholders (WHIC, 2002).

The Western Health Information Collaborative (WHIC) is a process initiated by the Western Premiers and Deputy Ministers of Health to explore collaborative opportunities with respect to health infostructure initiatives and includes British Columbia, Alberta, Saskatchewan, Manitoba, Northwest Territories, Nunavut and Yukon. In addition to the Electronic Lab Results Reporting Project, Alberta has taken the lead role on behalf of the Western Health Information Collaborative (WHIC) in developing a common view of laboratory business approaches, strategies and options. A vision and common business model for laboratory information exchange has been developed and work is underway on a pan-Canadian standard for laboratory information exchange, in conjunction with the Canadian Institute for Health Information (CIHI) (WHIC, Project Profiles, May 2004).

Manitoba. Manitoba is currently developing an integrated multi-site organization known as Diagnostic Services of Manitoba (DSM), which will undertake all provincial

laboratory services. The goal of DSM is to avoid future costs through economies of scale in material costs and test utilization.

An integrated province-wide Laboratory and Rural and Northern Imaging Information System (LIS/RIS) is the key infrastructure component required for full functioning of the DSM. The system of interlocking laboratories will use a common set of standards for all associated laboratory procedures. With full implementation, specimens can be collected and prepared in one location, transported to another site for testing, and results will automatically be returned to the originating site in real-time. Only laboratory personnel will have authorized access to the LIS/RIS. All hospital and physician access will be through a data repository or a hospital results reporting capability (WHIC, 2002).

The initial implementation phase of the DSM will not include automated computer order entry. As order entry capabilities become more available in the province, the LIS/RIS will be expanded to facilitate automated physician order entry. Laboratory and imaging results will be the initial building block for Manitoba's electronic health record. The initial phase of the DSM is expected to be complete by 2004 (WHIC, 2002).

Saskatchewan. As a component of the Saskatchewan Health Information Network (SHIN), Saskatchewan is planning a province wide web-based capability for laboratory test orders and results reporting, based on the storage and extraction of laboratory data from a central repository. Since the fall of 2000, work has been underway on a multi-regional integrated clinical system project that will integrate applications from several areas including registration, lab, pharmacy and operating room

scheduling. All regions involved in the project are implementing a common Laboratory Information System that will help automate the process of ordering, performing and reporting laboratory tests. Systems are being configured to generate HL7 messages to enable information flow between applications into a common view once it has been installed (WHICH, 2002).

Canada Health Infoway

Canada Health Infoway (*Infoway*) is a non-for-profit corporation that was established to help facilitate the development and implementation of electronic health record (EHR) systems in Canada (see *Infoway* Vision and Mission, Appendix D). *Infoway* defines an EHR as a secure and private lifetime record of an individual's key health history and care. The record would be available electronically to authorized health care providers and the individual anywhere and anytime in support of care. *Infoway* makes strategic investments, leveraging existing initiatives to develop reusable, interoperable solutions that can be replicated in other jurisdictions. They have identified 6 investment areas, including laboratory information systems, and have been allocated $1.1 billion by the Government of Canada to invest in such initiatives. To date, *Infoway* has committed $158 million to 17 project investments Canada-wide (Canada Health Infoway, 2003). Presently, *Infoway* is exploring project investments related to electronic sharing of laboratory information (Personal Communication, CEO, Newfoundland and Labrador Centre for Health Information, May 2004).

Related Research

Approaches to Evaluating Information Technologies in Healthcare

New perspectives on evaluation are emerging in the area of information technologies in health care. While the randomized control trial (RCT) is considered the "gold standard" for studying many health care interventions, the application of the randomized control trial to large-scale information technology projects is recognized as inappropriate for a number of reasons. In particular, there is difficulty in introducing randomization into the study design, as was shown in the evaluation of the integrated Hospital Information System (HIS) in the Northern Province of South Africa (Health Systems Trust, 2002), and all issues of evaluation can not be addressed in a randomized control trial (Heathfield, Pitty and Hanka, 1998; Burkle, Ammenwerth, Prokosch, and Dudeck, 2001). A review of the literature has revealed that a pre-/post- implementation (or before- and-after) design is the most widely agreed upon approach to evaluating new information technologies in healthcare (Neville, Gates, Tucker, Keough, MacDonald, Barron, Cotton, Farrell, Hoekman, Bornstein and O'Reilly, 2004).

Bonnie Kaplan has carried out extensive research in the area of health information systems evaluation and proposes a multi-method approach to evaluation which assesses both technical and social factors. She suggests five methodological guidelines that can be useful when developing a comprehensive evaluation plan. These include: 1) focus on a variety of technical, economic and organizational concerns; 2) use multiple methods including measurement, experimental techniques and observational approaches; 3) be

modifiable and adapt to changing circumstances; 4) be longitudinal, and 5) be formative as well as summative, providing regular feedback to relevant individuals (Kaplan, 1995).

DeLone and McLean (1992) advocate that information system success is a multidimensional construct and should be measured as such. They provide a framework for characterizing and measuring the success of information systems, which includes six major dimensions: 1) system quality, 2) information quality, 3) usage, 4) user satisfaction, 5) individual impact, and 6) organizational impact. DeLone and McLean later updated their model to include 'service quality' as an important dimension of information system success and collapse 'individual impact' and 'organizational impact' into 'net benefits' (DeLone and McLean, 2003).

Heathfield, Hudson, Kay, Mackay, Marley, Nicholson, Peel, Roberts and Williams (1999), who examined the issues in the multi-disciplinary assessment of healthcare information systems, concluded that large-scale IT projects can not be evaluated against theoretical or academic standards or by using *pure* methods. Instead, "*we have to adapt as best as possible*".

Evaluation Studies

A comprehensive search of the literature did not detect a single evaluation study that focuses on a system for electronically exchanging laboratory orders and results between heterogeneous laboratory information systems at geographically dispersed sites. Most evaluation studies in the domain of health information systems have focused on user satisfaction with an electronic patient record system. With respect to laboratory

information exchange, most evaluation studies focus on laboratory information within a single inpatient setting. A review of relevant research follows.

Wolfe (1986) describes a cost-benefit analysis in which manual laboratory operations were compared to laboratory operations after implementation of an electronic laboratory computer system, using a combination of quantitative and qualitative methods. The laboratory information system supports the transmission of test results to, and inquiries of test status from, wards and clinics throughout a military hospital and satellite facilities. Among the indicators used in the evaluation were number of tests repeated due to reporting delays, number of tests repeated due to lost test results, number of telephone calls to the laboratory, number of transcription errors, turnaround time, impact on staff morale, impact on retrieval of information and clinician satisfaction with services. Overall, implementation of the laboratory information system resulted in increased satisfaction with services by medical and administrative staff and a decrease in problem areas such as duplicate testing due to delayed and lost results and telephone calls to the laboratory regarding test status. While details pertaining to the cost-benefit analysis were limited, before-and-after comparison indicated that the laboratory information system was cost-effective with life-cycle benefits exceeding life-cycle costs by $750,000. Wolfe notes that there were a number of benefits with respect to quality of care and overall effectiveness of laboratory operations that could not be quantified. Among these were improved turnaround time, improved and easier access to test results, improved and more useful report formats and increased laboratory management capability.

An evaluation by Branger (Branger, van der Wouden, Schudel, Verboog, Duisterhout, van der Lei and van Bammel, 1992; Branger and Duisterhout, 1991), carried out in the Netherlands, focused on electronic data interchange (EDI) for exchanging laboratory results and admission/discharge reports between geographically dispersed sites. Analysis of the procedure for handling laboratory test reports before and after the introduction of the electronic communication system indicated that the percentage of transcription errors decreased from 0.5% to 0% and suggested that the delay in results reporting had decreased considerably. Overall, general practitioners were satisfied with the electronic communication system, with 39% rating the increased speed of laboratory reporting, and 100% rating the integration of laboratory reports into electronic patient records, as either very useful or useful. Physicians that used an electronic medical record system valued the increased speed of delivery somewhat higher than physicians not using an electronic medical record system, thus denoting the value of electronically integrating all available patient information. While the project enabled electronic communication between GP offices, hospitals and pharmacies, the study sample was limited in scope to EDI messaging among GPs and between GPs and hospitals. Further, tools and measures used in the assessment of the paper-based system and electronic system were not always comparable, thus diminishing the value of the findings.

In an early study, Kaplan (1987a) examined the impact of a clinical laboratory computer system in a large university medical center, focusing on expectations as expressed by laboratory directors and chief supervisory personnel prior to implementation and impacts reported by laboratory technologists after system

implementation. Among the expected changes were a decrease in the number of telephone calls to the laboratory for test results, fewer transcription errors, more accurate results reporting, more timely results delivery and a reduction in unnecessary testing. Many of the themes that emerged from the laboratory technologists' survey regarding impacts of the system were similar to the expectations expressed by laboratory directors and chief supervisors prior to implementation. There was general agreement that the new computer system enabled faster results reporting and greater accuracy and completeness of reports. Some managers and directors felt pushed into the system without adequate consultation with individuals in their laboratory and some technologists felt that they had been misled by the system vendor. Kaplan concludes that more study is needed related to the way in which a computer system affects workflow and how any changes in their work influence users' reactions to the system. She also suggests that more research is needed to better understand the relationship between managers' and staffs' expectations of computerized laboratory information systems.

In an evaluation of an order entry and results reporting system connecting a typical ward and the laboratory department in a Norwegian hospital (Ostbye, Moen, Erikssen and Hurlen, 1997), a multi-method approach was used to identify and quantify important effects of system implementation. Evaluation was considered particularly important in determining implementation strategies for other departments and hospitals. Among the activity indicators assessed were the number and types of tests ordered, time of day the order was entered, time used for ordering, waiting time before results were available and the number and duration of telephone calls between wards and the

laboratory. Results indicated that the system was well received by all users and shows clear improvements in many functions. Important strengths of the study include: 1) the prospective design using a number of different data sources including data from the hospital information system, telephone records, surveys and interviews; 2) the inclusion of a non-intervention ward for comparison; 3) the inclusion of background indicators or variables that were unlikely to be affected by system implementation but might affect the results of the evaluation such as length of stay, number of admissions, number of staff in different categories and overtime work; and 4) joint evaluation by an internal and external evaluator. Notable study limitations included low survey response rate, unsuspected problems following initial implementation, simultaneous use of the old system and new system for the laboratory and many wards, and failure to include a cost-benefit analysis.

More recently, Effler, Ching-Lee, Bogard, Ieong, Nekomoto and Jernigan (1999) conducted a study in which an electronic reporting system was compared to a conventional paper-based system for reporting notifiable diseases from clinical laboratories to a state Department of Health. With the paper-based system, test results were transcribed at laboratories throughout the state of Hawaii and sent to the Hawaii Department of Health (HDOH) by mail or fax. By contrast, the electronic system used automated data extraction and electronic intercomputer communication to report notifiable diseases to the HDOH. Outcome measures were assessed during the same six month period for each system since both systems were operating concurrently upon initial implementation of the electronic reporting system. Analysis indicated that with the

electronic reporting system, the total number of reports received had more than doubled, electronic reports arrived an average of 3.8 days earlier and many data fields were significantly more likely to be complete than with the paper-based reporting system. Among the challenges encountered related to electronic transmission of laboratory information between heterogeneous systems were difficulties with the data extraction program due to a lack of standard nomenclature across laboratories, lapses in data transmission due to ongoing system adjustments and failure of the host computer to reset after suboptimal connections, and difficulty with automated reporting since some laboratory reports are interim and might be released prematurely.

A review of relevant literature has revealed that most evaluations of health information systems projects involve a comparison of some type. In some evaluation studies, the comparison is between a paper-based system and an electronic system. In the evaluation of other systems, the comparison is a pre- and post-implementation (or before-and-after) comparison. Consistent with this, Burkle et al. (2001) notes that evaluation is based on comparison. When evaluating a clinical information system, they suggest comparing the status after the system is introduced to the status before (or the previous system), or establishing the expected effects of the system prior to implementation and assessing whether those effects have been established. While none of the preceding studies are directly comparable to the present study with respect to evaluation approach or type of system assessed, they were helpful in identifying indicators to use in the evaluation.

CHAPTER III

METHODS AND PROCEDURES

Evaluation Approach

This study was the pre-implementation component of a two phase evaluation study. This component examines the expected impact of implementing Medinet for real-time electronic exchange of laboratory information, prior to implementation. The post-implementation component is to be conducted at 6 and 12 months after Medinet implementation. The two phase design of the evaluation will enable the expected value/impact of implementing Medinet for real-time exchange of laboratory information to be compared to the value/impact realized after the system is implemented and fully operating.

Sample and Setting

The target population for this study included laboratory staff, physicians and information systems specialists from four sites: 1) the Health Care Corporation of St. John's, 2) the Newfoundland Public Health Laboratory, 3) the Central East Health Care Institutions Board and 4) the Avalon Health Care Institutions Board. The Central East Health Care Institutions Board and the Avalon Health Care Institutions Board were determined to be the first regions to link to the provincial reference laboratories via Medinet upon mutual agreement between the Boards and the reference laboratories. This decision was influenced by high costs associated with the large volume of laboratory reports currently being sent to these sites by postal service, as well as by lengthily turnaround times associated with the distance between ordering and reference sites.

Description of the Sites

Health Care Corporation of St. John's. The Health Care Corporation of St. John's has a very large laboratory department that provides both routine and highly specialized services to hospitals and clinics throughout the province. Among some of the services offered are chemistry, hematology, biochemistry, cytopathology and genetics. During 2000/2001, approximately 6.2 million lab tests were performed by the Health Care Corporation of St. John's.

Newfoundland Public Health Laboratory. The Newfoundland Public Health Laboratory (or Public Health Laboratory) is the provincial reference laboratory for clinical and public health microbiology and for infectious disease epidemiology. The Public Health Laboratory provides routine, reference and specialized laboratory services to all physicians, hospitals, clinics and health-related agencies in the province, in a cost-effective manner. Laboratory services include serology, virology, bacteriology, mycobacteriology, parasitology, mycology and sanitary/environmental microbiology.

Central East Health Care Institutions Board. The Central East Health Care Institutions Board offers services to a population of approximately 45,000 individuals and is presently serviced by 62 physicians. James Payton Memorial Hospital in Gander is the regional referral centre with primary acute care services provided from Brookfield Bonnews Health Care Centre in Brookfield, Fogo Island Hospital and the Notre Dame Bay Memorial Health Centre in Twillingate. In addition, the Board operates long-term care facilities and a number of District Health Centres within the region. In 2001, seven thousand seven hundred and eighty seven (7, 787) specimens were referred out from the

Central East region for testing. It is estimated that less than twenty specimens were referred out of province with the remaining orders referred to either the Public Health Laboratory or the Health Care Corporation of St. John's.

Avalon Health Care Institutions Board. The Avalon Health Care Institutions Board serves a population of approximately 54,100 individuals and is serviced by 58 physicians. Carbonear General Hospital is the main referral centre for the region with three health centres located in Old Perlican (Dr. A. A. Wilkinson Memorial Health Centre), Whitbourne (Dr. W. H. Newhook Community Health Centre) and Placentia (Placentia Health Centre). In addition, the Board operates two long-term care facilities - the Harbour Lodge Nursing Home and the Interfaith Citizen's Home. More than 30,000 specimens are referred from the Avalon region to the Health Care Corporation of St. John's and the Public Health Laboratory for testing each year. With an average of two tests per specimen, specimens referred from the Avalon region contribute to approximately 60,000 completed tests each year.

Instruments

The evaluation approach employed both quantitative and qualitative methods, including: a) key informant interviews; b) a survey of laboratory personnel; c) a survey of physicians; d) laboratory turnaround time (TAT); and e) a measure of the accuracy with which orders are transmitted from the ordering site to the reference laboratory. Presented in Table 1 is a summary of how each study instrument contributed to the study objectives.

Table 1

Relationship between Study Objectives and Study Instruments

Objective	Instrument(s)
1) identify goals and expected benefits of introducing Medinet	Key Informant Interviews Laboratory Personnel Survey Physician Survey
2) identify potential issues/concerns with Medinet	Key Informant Interviews Laboratory Personnel Survey Physician Survey
3) establish the expected impact of Medinet on management, processing and exchange of laboratory information	Key Informant Interviews Laboratory Personnel Survey
4) establish the expected impact of Medinet implementation on utilization of laboratory services	Physician Survey Laboratory Personnel Survey
5) establish the perceived value of real-time exchange of lab information with respect to quality of care	Key Informant Interviews Physician Survey
6) establish baseline measurements of laboratory test turnaround time and order accuracy	Turnaround Times (TAT) Order Accuracy Measurement
7) identify future directions and priorities for province wide exchange of lab information	Key Informant Interviews Laboratory Personnel Survey Physician Survey

Key Informant Interviews

The purpose of the key informant interviews was to establish the expected impact of Medinet as perceived by key individuals that are to be directly involved with the implementation of the system. Interview questions were developed based on informal discussions with senior laboratory personnel and information systems specialists. In developing the questions, it was recognized that key informants would have prior knowledge of the system and its functions. The interview included a total of nine open-ended questions and focused on goals for the implementation of Medinet, confidentiality concerns, specific functions of Medinet and future goals for electronic exchange of laboratory information (see interview questions, Appendix F).

Laboratory Personnel Survey

A questionnaire was developed for the study based on informal discussions with senior laboratory personnel from each of the laboratory sites. Other questions were arrived at after a review of the literature related to the laboratory testing process and the evaluation of laboratory information systems. During questionnaire development, laboratory managers indicated that staff had been introduced to Medinet through informal discussions and circulated materials. The questionnaire examined the expected impact of Medinet prior to its implementation, as perceived by laboratory staff that are regularly involved in the information handling and exchange process. Survey items included demographics, workflow within the laboratory, common problems associated with laboratory information exchange, utilization of laboratory services and the expected

impact of Medinet on each. A five-point Likert scale was used for the majority of the questions. A final item provided a space for additional comments (see questionnaire, Appendix H).

A pretest was conducted with three senior laboratory personnel, representing three of the four laboratory sites. Each individual completed the questionnaire and reviewed it for clarity and relevance of content. A few necessary changes were made prior to the distribution of the questionnaire. Responses from the three completed questionnaires were included in the data analysis.

Physician Survey

The investigator developed the survey for the study. Questions were based on informal discussions with information systems specialists at each of the sites, the Medical Director of one of the Institutional Boards participating in the study, and literature related to the role of laboratory testing in patient management. The Medical Director and information systems specialists suggested that most physicians would not have prior knowledge of Medinet and thus an explanation of its function should be provided. The main purpose of the physician survey was to establish the perceived value of real-time electronic exchange of laboratory information with respect to quality of care, prior to the implementation of Medinet. Survey items included demographics, the utilization of laboratory services, the role of laboratory services in patient management, and the expected impact of Medinet on each. A five-point Likert scale, with options ranging from (1) strongly agree to (5) strongly disagree, was used for a majority of the questions.

Among the other items were three open-ended questions, including an opportunity to provide additional comments (see questionnaire, Appendix K).

A draft questionnaire was given to three individuals (a physician, a laboratory supervisor and an information systems specialist) to review for content and clarity. Each of the three individuals suggested that the questionnaire was appropriate for this group.

Turnaround Times (TAT)

For the purpose of this study, turnaround time (TAT) was defined as the elapsed time between specimen collection and entry of test results in the laboratory information system at the ordering laboratory. Measures included mean turnaround time and the cumulative percentage of reports received in 24 hour increments.

Order Accuracy

As an indicator of the accuracy with which laboratory orders are transferred from the LIS at the ordering laboratory to the LIS at the reference laboratory, paper copies of original laboratory orders were compared to their respective orders after being transcribed at the reference laboratory. Discrepancies between the original and transcribed order were counted and classified as minor or major. Due to inconsistencies in naming conventions and the information that is captured at each laboratory site, only fields that were consistently captured using the same naming system were included in the analysis. These fields included age, sex, hospital number, collection date and physician's name (see order accuracy record, Appendix L). A detailed explanation of the discrepancy classification scheme is provided in Appendix M.

Data Collection

Key Informant Interviews

The investigator conducted semi-structured telephone interviews with eight individuals that were identified by Medinet project leaders as expected to be directly involved in the implementation of Medinet. Key informants included 3 laboratory managers, 2 laboratory technical supervisors and 3 information systems specialists.

Key informants were contacted by telephone, read an introductory script that explained the purpose of the study and ensured confidentiality of all information and were asked to participate in the study (see telephone script, Appendix E). If the individual agreed to participate, he or she was given the option to complete the interview at that time or reschedule the interview for a later date. All interviews were conducted between June 3 and July 4, 2003.

Notes were taken during the telephone interview and re-written directly following completion of the interview to increase legibility of the responses. Interviews lasted between fifteen and twenty-five minutes in duration.

Laboratory Personnel Survey

At each site, the laboratory director/manager was asked to tally the number of staff involved in the information handling and exchange process. These included office staff, some technical staff and some supervisory staff. On March 18, 2003, survey packages were sent by mail to the laboratory director/manager at each site, who distributed the packages to those staff that they had previously identified as being

involved in the information handling and exchange process. A total of 35 survey packages were distributed to laboratory staff at the four participating sites. Survey packages contained a questionnaire, a cover letter explaining the purpose of the study and a pre-addressed stamped return envelope. On April 8, 2003, three weeks after the initial distribution of survey packages, a second set of survey packages were distributed to laboratory staff in a similar manner, as an effort to maximize response rate. All completed questionnaires that were returned as of July 10, 2003 were included in the data analysis.

Physician Survey

A mailing list of physicians practicing within the areas covered by the Central East Health Care Institutions Board (N = 62) and the Avalon Health Care Institutions Board (N = 58) as of March 31, 2003 was provided by the Newfoundland and Labrador Medical Association (NLMA). On April 3, 2003, survey packages were distributed by mail to all 120 physicians practicing within these regions. Each survey package contained a questionnaire, a covering letter that explained the purpose of the study and provided a brief description the Medinet system, and a pre-addressed stamped return envelope. On April 24, 2003, three weeks after the initial mail out of survey packages, a second set of survey packages were mailed to all physicians in an effort to maximize the response rate. A note was included to thank those who had already completed and returned the questionnaire (Appendix J). All completed questionnaires that were returned as of July 14, 2003 were included in the data analysis.

Turnaround Times (TAT)

Laboratory directors/managers identified two tests that are commonly referred to the Health Care Corporation of St. John's and two tests that are commonly referred to the Public Health Laboratory and provided turnaround times for a specified time frame. Turnaround time, without personal identifiers attached, was obtained from the Meditech Laboratory Information System (LIS) at the ordering site. The laboratory director/manager read and signed a data release form (Appendix N) prior to releasing the printed TAT reports to the investigator.

Order Accuracy

The laboratory director/manager at the reference laboratories retained all original orders received from the Central East and Avalon regions during a specified seven day period. Once all orders had been transcribed to the LIS at the reference laboratory, corresponding transcribed orders were printed. Data entry operators were not aware of the specific time period to be included in the analysis prior to data entry. All laboratory orders were obtained from the reference laboratories in paper format. For laboratory orders obtained from the Public Health Laboratory, patient names were removed before being released to the investigator. For laboratory orders obtained from the Health Care Corporation of St. John's, the Newfoundland and Labrador Centre for Health Information (a trusted third party) provided a Health Information Consultant to remove all patient names prior to analysis by the investigator. Before releasing the data to the investigator, each laboratory director/manager read and signed a data release form (Appendix O).

Data Analysis and Presentation

All numerical survey data was analyzed using the SPSS Statistical Package. Study findings are presented using descriptive statistics including frequencies, means and percentages. No statistical comparisons were carried out due to the non-experimental design of the study and because it was deemed unnecessary for achieving the study objectives. Open-ended survey and interview items were analyzed using a method similar to content analysis as described by Neuendorf (2001). After reading all responses several times, the text was manually coded by the investigator and categorized according to emerging themes. Findings from open-ended items are presented in summary form. Turnaround times are presented as mean turnaround time and the percentage of reports received in twenty-four hour (1 day) increments. The findings from the order accuracy analysis are presented as discrepancy counts and error rates for each data field.

Ethical Considerations

This study was carried out upon approval of the Human Investigations Committee (HIC) of Memorial University of Newfoundland and the Research Proposal Approval Committee (RPAC) of the Health Care Corporation of St. John's. Forms used to obtain consent for data release are presented as Appendices. Interviewees implied consent by verbally agreeing to participate in a telephone interview. Survey respondents implied consent by returning a completed questionnaire. All electronic data records were stored on password protected computer files, and all paper data records in a locked filling cabinet, at the Newfoundland and Labrador Centre for Health Information (NLCHI).

CHAPTER IV
RESULTS

Findings are presented according to study instrument. Study instruments include a) key informant interviews; b) laboratory personnel survey; c) physician survey; d) laboratory turnaround time (TAT); and e) a measure of order accuracy.

Key Informant Interviews

Characteristics of the Sample

Semi-structured interviews were conducted with a total of eight individuals. The sample consisted of a Regional Laboratory Manager, two Laboratory Division Managers, two Laboratory Technical Supervisors, a Director of Information Systems, a Manager of Application Development and a Systems Analyst. Years working in their current position ranged from 0.5 to 25 years for those working in a laboratory related area and from 5 to 12 years for those working in the area of information systems. Age ranged from 20-29 years to 50-59 years; five of the eight interviewees were male (Table 2).

Findings

Interview responses were coded by the investigator and grouped into three broad themes. Themes include: 1) goals for the implementation of Medinet, 2) concerns and anticipated challenges with the implementation of Medinet and 3) future directions and priorities for laboratory information exchange.

Table 2

Sample Demographics, Key Informants Interviews

Variable	*n*
Current Position	
Laboratory related	5
Information Systems related	3
Years in current position	
Laboratory	
Range	0.5 - 25
Mean	10.7
Information Systems	
Range	5 - 12
Mean	8.3
Site	
HCCSJ	3
PHL	2
Central East	2
Avalon	1
Gender	
Male	5
Female	3
Age range (years)	
20 – 29	1
30 – 39	1
40-49	3
50-59	1
Not stated	2

Goals for the Implementation of Medinet

Three major goals for the implementation of Medinet were identified including improved quality of patient care, more efficient information handling and exchange and cost savings.

One of the most important goals for the implementation of Medinet, as identified by key individuals from the laboratory department and information systems department, is improved quality of care. Informants suggested that Medinet will improve the quality of data being exchanged and the timeliness of results delivery, thereby improving the quality of patient care.

By reducing manual data entry by at least two transcriptions, interviewees anticipate that Medinet implementation will significantly reduce transcription errors. Laboratory supervisory personnel described two types of errors that occur during the transcription process. One is a reflection of the different nomenclature within each laboratory site. Data entry often requires interpretation of orders by data entry or clerical staff and was cited as a common source of error.

> *"All hospitals don't use the same terminology so sometimes labs have to try and interpret orders and results when entering data. This leaves room for error."*

> *"[Medinet] will reduce problems with mis-identified samples and incorrect orders entered due to different mnemonics because the information will be received electronically."*

The other type of error was described as *keying errors* and includes typos and missed information. Laboratory informants note that keying errors can result in the wrong test being completed, incorrect results given to the patient or the report being sent to the wrong physician or site.

> *"The computer will verify the results and file the results directly into the system for us. This will eliminate human error, thereby decreasing the risk to patients."*

Almost all of the interviewees indicated that they expect more timely delivery of laboratory results following the implementation of Medinet. It is anticipated that the implementation of Medinet will improve the timeliness of results delivery in two ways. First, in current practice, a report will sometimes be sent to the wrong physician or site because of an error that occurred during transcription, leading to a time delay in receipt of results by the ordering physician. It is expected that Medinet will,

> *"....improve patient care and ensure that the ordering doctors are actually getting results and not having lost hard copy reports."*

Secondly, current practice involves sending reports by mail to the ordering site, resulting in a delay between the time results are ready at the reference laboratory and the time the patient receives the results. Interviewees suggest that the implementation of Medinet will:

> *"...improve timeliness of reporting since reports will be available immediately."*

> *"...reduce turnaround time for lab reports by allowing for real-time resulting and reporting of lab results."*

Another major goal for the implementation of Medinet is to provide more efficient information handling and exchange. Both laboratory supervisory personnel and information systems specialists suggest that the current system for exchanging laboratory information between ordering site and reference laboratory is inefficient and resource intensive. As one individual put it, the main goal for the implementation of Medinet is *"to establish a seamless flow of laboratory orders and results."*

Another added:

> *"Once all the bugs are worked out and the rest of the regions are connected, I think we will see a greater level of efficiency than has ever been seen before."*

With the implementation of Medinet, it is anticipated that information handling and exchange will be less resource intensive and time will be saved to work on other important tasks. Seven out of eight interviewees referred to potential time savings through a reduction in manual data entry and/or the preparation of paper reports.

> *"There is a lot of time spent entering data and preparing paper reports which is very resource intensive."*

> *"...hoping it will cut down on the work involved in entering results. We enter all our results when they come in from the reference labs."*

It was also mentioned that information is sometimes missing from the order, particularly when the order is hand written. This information is often necessary to complete the test and release the results. It is anticipated that Medinet will enable more efficient patient and specimen identification. Thus,

> "*...time will be saved by not having to track the MCP number or other information.*"

Further, several informants note that the current paper-based system for exchanging laboratory orders and results between ordering and reference site is not efficient since laboratory reports are returned to the ordering site by mail, thus delaying results delivery. The implementation of Medinet is expected to lead to a more efficient information exchange process since it will enable real-time or immediate availability of results.

Only a few of the interviewees referred to cost savings as a goal for the implementation of Medinet. One individual suggested that the cost of implementing Medinet would be recovered after one year by eliminating the postage bill for results

delivery. Another suggested that the cost of implementing the system would be recovered after two years by eliminating overtime payment to clerical staff. Those who implicated cost savings as a goal for the implementation of Medinet, however, referred to it as more of an added benefit rather than a true goal.

> *"Risk management is the main issue. Other than that, saving money is an added benefit."*

Concerns and Anticipated Challenges with the Implementation of Medinet

It is recognized by both laboratory informants and information systems informants that there will be a significant amount of work involved in the implementation of Medinet. Concerns and anticipated challenges that were identified relate to: (a) the differing nomenclature among laboratories; (b) the connection of multiple sites to the reference laboratories; (c) a shift in responsibility for printing reports, and (d) security and confidentiality.

Although Medinet is designed to allow communication between laboratory information systems with differing nomenclature, almost all of the interviewees expect that there will be challenges regarding the cross-referencing of Meditech dictionaries. Some of the individuals that were interviewed have been involved in the testing phase of the system and suggested that there has already been problems with the cross-referencing of Meditech dictionaries.

> *"Sometimes Medinet can cross-reference but sometimes nomenclature has to be identical in both systems."*

> *"Some [Meditech] modules are more confusing than others. Some are as simple as 'yes' or 'no' or 'positive' or 'negative'. Some will have a range of possibilities. These will be more difficult to set up."*

It is expected that cross-referencing will become an even greater challenge as more sites implement the system. A few individuals suggested that ordering laboratories may have to change their nomenclature to match that of the reference laboratory, which could require staff retraining, both inside and outside the laboratory.

In addition to the challenge of cross-referencing dictionaries, there is a concern with the ability of Medinet to recognize the nomenclature used by each ordering site to which the reference laboratory is connected.

> *"If Western and Central are linked to [the reference lab], we don't know how Medinet will handle having orders from two different systems. This may be a challenge."*

> *"There is a potential problem with naming conventions. When all sites are connected to the Health Care Corporation and the Public Health Lab, Medinet will have to recognize the naming system for each different lab."*

There is also a concern that all orders sent to the reference laboratory via Medinet will file into the system in no particular order, causing a difficulty with sorting and labeling.

> *"The lag between receipt of the electronic order and receipt of the sample could cause a problem if the order can not be printed by ordering site."*

> *"Some issues are expected regarding the labeling of samples since we will have to reprint labels and affix them to samples. This could lead to labeling errors."*

Shifting the responsibility of printing laboratory reports from the reference laboratory to the ordering site was also raised as a concern by several of the laboratory informants. It was suggested that physicians who require a paper report could print the report from their office, thus saving time within the laboratory. It is recognized,

however, that not all physicians are connected to the regional Meditech system. One interviewee noted,

> *"It's hard to convince them it is worthwhile and of course cost is another issue."*

Several interviewees suggested that physicians will be concerned that security and confidentiality will be compromised with the implementation of Medinet. As one of the interviewees suggested, *"People just don't have faith in computers"*. It is perceived that the reason for the concern will be largely related to the exchange of information that is considered more sensitive than other information. It was described how, currently, some physicians request that the results of certain tests, such as a HIV test, be sent directly to them as a paper report and not made available through the regional Meditech system. With the implementation of Medinet, there will be no separation of results within the LIS. Thus, all orders that are received via Medinet will have the results returned electronically.

Notably, however, neither laboratory supervisory personnel nor information systems specialists have any confidentiality or security concerns with the implementation of Medinet. It was noted that access to laboratory data is now restricted to appropriate staff and that there will be no additional access to laboratory data following the implementation of Medinet. Some interviewees suggested that the implementation of Medinet would even enhance the security of laboratory data.

> *"There will be far less chance of an electronic report being read by someone who shouldn't be reading it then a hard copy of the report which can be left on a fax machine or printer for anyone to read it."*

> *"It is better than paper since paper can be opened by anyone from the time it leaves the office in an envelope."*

Laboratory supervisory personnel were also concerned that Medinet implementation would make the modification of information more difficult. Three situations were described in which it may be necessary to modify laboratory information: a positive test result may require that further testing be carried out, a 'mistake' on the original order is recognized at the reference laboratory, or a reference range has changed due to changing methodology. It is understood that Medinet will only transmit the results if the order is modified in the LIS at both the reference laboratory and the ordering site and thus, is perceived as a potential problem. One individual suggested that a communication protocol specifically intended for handling these situations may be necessary.

Future Directions and Priorities for Laboratory Information Exchange

It was suggested that the extent to which laboratory information should be electronically exchanged is dependent upon the purpose of the information and the nature of the system being used for information exchange. All laboratory and information systems informants agreed that laboratory orders and results should be electronically exchanged between all hospitals and the Province's two main reference laboratories via Medinet. Further, they suggested that all physicians, both inside and outside the hospital, should have access to their regional Meditech system and that eventually, physician order entry (POE) will follow. *"That way, they would get the greatest benefit from Medinet."*

Medinet is perceived as a positive step towards an Electronic Health Record (EHR) and the elimination of paper. Several individuals suggested that complete access

to a person's laboratory information from any site in the province is considered ideal for continuity of care.

> *"Physicians should be able to follow their patients regardless of the site at which the testing is performed. The information should appear seamless to the user of the information."*

Two of the interviewees, a laboratory informant and an information systems informant, added that the fully implemented Provincial Health Information Network (HIN) would enable complete integration of laboratory information at a provincial level.

> *"There is another potential for all hospitals and laboratories to speak to each other via the HIN."*

> *"Medinet itself is not an inquiry system. So while it is a step towards province-wide information exchange, it may not really be necessary to implement between each region. The full HIN architecture will fit better for this."*

It was also acknowledged that the implementation of Medinet, as well as other projects relating to electronic exchange of laboratory information, would be less difficult if all laboratories within the Province shared a common nomenclature. As previously noted, some of the interviewees expect challenges with the cross referencing of Meditech dictionaries and that ultimately, coding systems at the regional laboratories may have to be changed to match that of the reference laboratories.

Laboratory Personnel Survey

Characteristics of the Sample

Of the 35 questionnaires that were distributed, 23 completed questionnaires were returned for a response rate of 65.7%. Respondent's age ranged from 31 to 61 years with mean age being 46.4 years.

Among the laboratory personnel that responded, 11 (47.8%) indicated that they are in a technical position, 6 (26.1%) in a data entry/clerical position and 5 (21.7%) in a supervisory position. Years working in their current position ranged from 3 to 33 years with the mean number of years being 15.37 (Table 3).

Table 3

Sample Demographics, Laboratory Personnel Survey

Variable	*Response (n)*	*Value*
Age	21	
Range (years)		31-61
Mean (years)		46.4
Current position	23	
Technical		11 (47.8%)
Data Entry/Clerical		6 (26.1%)
Supervisory		5 (21.7%)
Other		1 (4.3%)
Years in lab related area		
Current position	19	
Range		3-33
Mean		15.37
Other position	12	
Range		0-20
Mean		2.4

Findings

Expected Impact of Medinet

Laboratory personnel were asked a series of questions regarding their expectations for the impact of Medinet on laboratory workflow, problem areas associated with laboratory information exchange and the overall impact of Medinet on laboratory services.

Expected Impact on Laboratory Workflow. As shown in Table 4, more than half of all respondents expect that Medinet will decrease the effort required to send an order to a reference laboratory (56.5%) and verify the order upon receipt (52.1%). A considerable proportion of respondents expect no change (34.8% and 47.8%, respectively). Only eleven respondents (47.8%) expect time between specimen collection and testing to decrease following the implementation of Medinet. A larger proportion of the respondents expect the elapsed time between testing and results dissemination to decrease (73.7%). More than half of all respondents (52.2%) indicated that they expect Medinet to have no impact on the effort involved in verifying laboratory results prior to release from the reference laboratory, while almost all respondents (94.7%) expect a decrease in the effort required to verify results upon receipt at the ordering site. Moreover, 52.6% anticipate the decrease in effort to verify results at the ordering site to be significant. A large majority are expecting a decrease in effort to distribute results to both the ordering site (89.5%) and the ordering physician (86.9%).

Table 4

Expected Impact of Medinet on Laboratory Workflow

Indicator	Level of Impact				
	Significant Decrease	Slight Decrease	No Change	Slight Increase	Significant Increase
Effort to send order to reference laboratory n = 23	9 (39.1%)	4 (17.4%)	8 (34.8%)	2 (8.7%)	0 (0.0%)
Effort to verify order at reference lab n = 23	5 (21.7%)	7 (30.4%)	11 (47.8%)	0 (0.0%)	0 (0.0%)
Time between specimen collection and testing n = 23	3 (13.0%)	8 (34.8%)	12 (52.2%)	0 (0.0%)	0 (0.0%)
Effort to verify results at reference lab n = 23	1 (4.3%)	10 (43.5%)	12 (52.2%)	0 (0.0%)	0 (0.0%)
Effort to distribute results to ordering site n = 19	13 (68.4%)	4 (21.1%)	2 (10.5%)	0 (0.0%)	0 (0.0%)
Time between testing and results dissemination n = 19	5 (26.3%)	9 (47.4%)	5 (26.3%)	0 (0.0%)	0 (0.0%)
Effort to verify results at ordering lab n = 19	10 (52.6%)	8 (42.1%)	1 (5.3%)	0 (0.0%)	0 (0.0%)
Effort to distribute results to ordering physician n = 23	13 (56.5%)	7 (30.4%)	3 (13.0%)	0 (0.0%)	0 (0.0%)

Note: For some items, not all individuals responded.

Expected Impact on Common Problem Areas. Laboratory personnel were asked to respond to a series of items concerning their expectations for the impact of Medinet on selected problem areas associated with the information exchange process. As Table 5 illustrates, respondents expect that Medinet will have a positive impact on a range of areas related to information exchange.

Following Medinet implementation, a large majority expect a decrease in the number of test orders and results sent to the wrong site (73.7% and 82.6%, respectively), the number of 'lost' test orders and results (73.9% and 95.7%, respectively) and the number of tests carried out that were not intended on the original order (73.9%). A majority of the respondents expect a decrease in the amount of paper generated (73.9%) while a small number of respondents expect an increase (21.7%).

For only two of the problem areas did a majority of the respondents expect Medinet to have no change or increase the problem. These are the effort involved in redirecting an order from one reference laboratory to another reference laboratory and the number of STAT or urgent tests ordered in non-emergency situations.

Table 5

Expected Impact of Medinet on Selected Laboratory Problem Areas

Indicator	Level of Impact				
	Significant Decrease	Slight Decrease	No Change	Slight Increase	Significant Increase
Telephone inquires to clarify order information n = 23	4 (17.4%)	9 (39.1%)	7 (30.4%)	3 (13.0%)	0 (0.0%)
Inquires regarding test status n = 23	9 (39.1%)	5 (21.7%)	6 (26.1%)	3 (13.0%)	0 (0.0%)
Effort to trace a tests status n = 23	8 (34.8%)	7 (30.4%)	8 (34.8%)	0 (0.0%)	0 (0.0%)
Effort to redirect order to other reference site n = 23	2 (8.7%)	5 (21.7%)	16 (69.6%)	0 (0.0%)	0 (0.0%)
Test results sent to wrong site n = 23	11 (47.8%)	8 (34.8%)	4 (17.4%)	0 (0.0%)	0 (0.0%)
Test orders sent to wrong site n = 19	9 (47.4%)	5 (26.3%)	5 (26.3%)	0 (0.0%)	0 (0.0%)
Lost test results n = 23	12 (52.2%)	10 (43.5%)	1 (4.3%)	0 (0.0%)	0 (0.0%)
Lost test orders n = 23	11 (47.8%)	6 (26.1%)	6 (26.1%)	0 (0.0%)	0 (0.0%)
Test's performed but not intended n = 23	6 (26.1%)	11 (47.8%)	5 (21.7%)	1 (4.3%)	0 (0.0%)
Duplicate test orders n = 22	9 (40.9%)	3 (13.6%)	9 (40.9%)	1 (4.5%)	0 (0.0%)
STAT test order in non-emergency situation n = 19	3 (15.8%)	5 (26.3%)	9 (47.4%)	1 (5.3%)	1 (5.3%)
Amount of paper generated n = 23	11 (47.8%)	6 (26.1%)	1 (4.3%)	1 (4.3%)	4 (17.4%)

Note: For some items, not all individuals responded.

Overall Impact of Medinet on Laboratory Services. Results of the laboratory personnel survey indicate that, overall, laboratory personnel expect the implementation of Medinet to have a positive impact on laboratory services. As shown in Table 6, more than eighty percent of respondents (82.6%) agree that Medinet will improve the efficiency by which laboratory information will be handled and exchanged. Nearly all respondents (95.6%) expect that Medinet will improve the timeliness of normal test results delivery. While still a majority, only 69.6% expect that Medinet will improve the timeliness of abnormal results delivery. A total of 14 respondents (60.8%) either strongly or somewhat agree that Medinet will improve the reliability of results reporting. Nearly seventy percent of those surveyed agree that Medinet will result in a change in responsibilities within the laboratory (69.5%) and a decrease in workload (69.5%). A majority (82.6%) agree that both physician and patient satisfaction with laboratory services will improve.

Additional Comments

Laboratory personnel were provided with an opportunity to make additional comments regarding their expectations for real-time electronic exchange of laboratory information. A total of 5 (21.7%) individuals provided a response to this item.

While all respondents indicated that they expect the implementation of Medinet to result in more timely results delivery and a decrease in transcription errors, concerns with Medinet implementation were also expressed. One concern is regarding the shift in responsibility for printing paper reports. Following the implementation of Medinet, the printing of paper reports will be the responsibility of the ordering site and no longer the

responsibility of the reference laboratory. One individual suggested that if all physician clinics would connect to the regional Meditech system, the laboratory would *"avoid the paper chase"* that they are faced with.

Table 6

Overall Impact of Medinet on Laboratory Services (n = 23)

Indicator	Level of Impact				
	Strongly Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Strongly Disagree
Improve timeliness of normal test results	15 (65.2%)	7 (30.4%)	1 (4.3%)	0 (0.0%)	0 (0.0%)
Improve timeliness of abnormal test results	10 (43.5%)	6 (26.1%)	5 (21.7%)	2 (8.7%)	0 (0.0%)
Improve reliability of test results	5 (21.7%)	9 (39.1%)	6 (26.1%)	0 (0.0%)	3 (13.0%)
Improve efficiency of information handling	15 (65.2%)	4 (17.4%)	3 (13.0%)	0 (0.0%)	1 (4.3%)
Improve physician satisfaction with services	11 (47.8%)	8 (34.8%)	4 (17.4%)	0 (0.0%)	0 (0.0%)
Improve patient satisfaction with services	13 (56.5%)	6 (26.1%)	4 (17.4%)	0 (0.0%)	0 (0.0%)
Change responsibilities within lab	5 (21.7%)	11 (47.8%)	6 (26.1%)	1 (4.3%)	0 (0.0%)
Decrease workload	7 (30.4%)	9 (39.1%)	4 (17.4%)	2 (8.7%)	1 (4.3%)
Require comprehensive training session	9 (39.1%)	5 (21.7%)	3 (13.0%)	5 (21.7%)	1 (4.3%)

Also indicated as a concern, was the connection of more than one site to the reference laboratory via Medinet. It was noted that all orders sent through the Medinet connection may file directly into the Meditech LIS at the reference laboratory and not sorted according to ordering site. It was suggested that if orders have to be sorted and specimens relabeled, time may not be saved and errors can still be made.

Physician Survey

Characteristics of the Sample

Of the 120 questionnaires that were distributed, a total of 59 completed questionnaires were returned and included in the analysis. Two questionnaires were returned from the Central East region indicating that they were undeliverable and excluded from calculation of the response rate. The overall adjusted response rate was 50.0%. Among the 59 physicians that responded, 36 (61.0%) practice within the Central East Health Care Institutions Board and 23 (39.0%) practice within the Avalon Health Care Institutions Board. The adjusted response rate for the Central East region and the Avalon region was 60.0% and 39.7%, respectively.

Those who responded ranged in age from 30 to 68 years with a mean age of 45.3 years; 79.7% of respondents were male. The mean age of male respondents was somewhat higher than the mean age of female respondents at 47.3 and 37.7 years, respectively. A majority of the respondents were general practitioners (61.0%) and work in a hospital setting (59.3%). Years of practice ranged from 1 to 44 years with the mean years of practice being 18.6 years. Presented in Table 7 is demographic information for

the sample of respondents. Presented in Table 8 is demographic information for the physician population surveyed.

Table 7

Sample Demographics, Physician Survey

Variable	*Response (n)*	*Value*
Board	59	
Central East		36 (61.0%)
Avalon		23 (39.0%)
Gender	59	
Male		47 (79.7%)
Female		12 (20.3%)
Age		
Total	56	
Range (years)		30-68
Mean (years)		45.3
Male	44	
Range (years)		31-68
Mean (years)		47.3
Female	12	
Range (years)		30-47
Mean (years)		37.7
Field of Practice	59	
General Practitioner		36 (61.0%)
Specialist		22 (37.3%)
Other		1 (1.7%)
Work Setting	59	
Hospital		35 (59.3%)
Private Practice		12 (20.3%)
Group Practice		10 (16.9%)
Other		2 (3.4%)
Years of Practice	57	
Range (years)		1-44
Mean (years)		18.6

Table 8

Population Demographics, Physician Survey

Variable	*N*
Board	
Central East	62
Avalon	58
Gender	
Male	95
Female	25
Age Range	
25-29	2
30-34	21
35-39	16
40-44	24
45-49	23
50-54	9
55-59	16
60-64	4
65-69	4
70-74	1
Field of Practice	
General Practitioner	72
Specialist	47
Other	1
Work Setting	
Hospital	80
Clinic	29
Other	1
Unknown	10

Source: Newfoundland and Labrador Medical Association (NLMA)

Findings

Physician's use of Laboratory Tests and Results

Physicians were asked to indicate the percentage of clinical visits in which they order laboratory testing and the percentage of all clinical decisions they base on laboratory results. As shown in Table 9, a majority of physicians indicated that they will order laboratory testing during 1% to 25% of all visits and base between 1% and 25% of all clinical decisions on laboratory results. Approximately half indicated that they order laboratory testing during more than 25% of all visits (52.6%) and base more than 25% of all clinical decisions on laboratory results (48.3%).

Physicians were also asked to indicate all forms or methods by which they receive laboratory reports. Among the most common forms are paper - computer generated reports (79.3%) and electronic reports (58.6%). A considerable proportion of physicians also indicated that they receive laboratory reports as paper, hand written, reports (10.3%) and verbal reports (41.4%). Nearly eighty percent (79.7%) of physicians have access to Meditech for obtaining laboratory results. Of those who indicated that they have access to Meditech, a total of 87.2% indicated that they use Meditech for obtaining laboratory results 'often' or 'always'.

Table 9

Physician's use of Laboratory Tests and Results

Variable	*Response (n)*	*Frequency*
% of visits order lab testing	57	
0		3 (5.3%)
1-25		24 (42.1%)
26-50		19 (33.3%)
51-75		9 (15.8%)
76-100		2 (3.5%)
% of decisions based on lab results	56	
0		2 (3.6%)
1-25		27 (48.2%)
26-50		15 (26.8%)
51-75		10 (17.9%)
76-100		2 (3.6%)
Receive Lab Reports*	58	
Verbally		24 (41.4%)
Paper - Hand Written		6 (10.3%)
Paper - Computer Generated		46 (79.3%)
Paper - By Fax		16 (27.6%)
Electronically		34 (58.6%)
Other		0 (0.0%)
Access to Meditech	59	
Yes		47 (79.7%)
No		12 (20.3%)
Use Meditech	47	
Always		19 (40.4%)
Often		22 (46.8%)
Sometimes		3 (6.4%)
Rarely		2 (4.3%)
Never		1 (2.1%)

* Sum of percentages not equal to 100% since physicians were asked to indicate all that apply.

Physician's Perceptions Regarding the Availability of Laboratory Results

Physicians were asked a series of questions regarding the availability of laboratory results. As Table 10 illustrates, a majority of physicians agree that both normal and abnormal laboratory results are available in a timely manner (80.7% and 84.2%, respectively). Nearly half of all respondents agree that diagnosis is delayed until laboratory results are available (47.3%) and that treatment is deferred until laboratory results are received (43.8%).

Table 10

Physicians Perceptions Regarding the Availability of Laboratory Results

Indicator	Level of Agreement				
	Strongly Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Strongly Disagree
Normal results available in timely manner n = 57	29 (50.9%)	17 (29.8%)	5 (8.8%)	4 (7.0%)	2 (3.5%)
Abnormal results available in timely manner n = 57	30 (52.6%)	18 (31.6%)	3 (5.3%)	4 (7.0%)	2 (3.5%)
Diagnosis delayed until results received n = 57	6 (10.5%)	21 (36.8%)	14 (24.6%)	8 (14.0%)	8 (14.0%)
Treatment deferred until results received n = 57	4 (7.0%)	21 (36.8%)	18 (31.6%)	9 (15.8%)	5 (8.8%)
Patients inquire before results available n = 56	9 (16.1%)	18 (32.1%)	12 (21.4%)	12 (21.4%)	5 (8.9%)
STAT test ordered to speed up process n = 56	11 (19.3%)	7 (12.3%)	5 (8.8%)	15 (26.3%)	19 (33.3%)
Duplicate test ordered when report 'lost' n= 55	9 (16.4%)	21(38.2%)	11 (20.0%)	7 (12.7%)	7 (12.7%)

Note: For some items, not all individuals responded.

A total of 48.2% of physicians strongly or somewhat agree that a patient will inquire about laboratory tests result prior to the availability of the report. More than half (54.6%) agree that they will order a duplicate laboratory test when the report is considered 'lost', while only 31.6% agree that they will request STAT (or urgent) testing in a non-emergency situation in order to speed up the testing process (Table 10).

Expected Impact of Medinet

Physicians were asked a series of questions regarding their expectations for the impact of Medinet on the utilization of laboratory services and the quality of patient care. Presented in Table 11 is physicians' expectations for the impact of Medinet on the utilization of laboratory services. Presented in Table 12 is physicians' expectations for the impact of Medinet on the quality of patient care.

Expected Impact on Laboratory Service Utilization. Approximately two thirds of those who responded agree that the implementation of Medinet will decrease unnecessary utilization of laboratory services. A combined total of 65.6% and 63.8%, respectively, either strongly or somewhat agree that the implementation of Medinet will decrease unnecessary laboratory testing due to lost orders/results and order inaccuracies (Table 11).

Table 11

Expected Impact of Medinet on Laboratory Service Utilization (n = 58)

Indicator	Level of Agreement				
	Strongly Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Strongly Disagree
Decrease STAT test requests for non-emergency	17 (29.3%)	19 (32.8%)	11 (19.0%)	7 (12.1%)	4 (6.9%)
Decrease duplicate testing due to lost orders/results	23 (39.7%)	15 (25.9%)	11 (19.0%)	5 (8.6%)	4 (6.9%)
Decrease unnecessary testing due to order inaccuracies	20 (34.5%)	17 (29.3%)	9 (15.5%)	7 (12.1%)	5 (8.6%)

Expected Impact on Quality of Care. As illustrated in Table 12, more than eighty percent of physicians agree that Medinet implementation will result in more timely diagnosis (82.7%) and more timely patient treatment (86.2%). While still a majority, a smaller percentage of physicians agree that Medinet will decrease length of hospital stay due to delays in results reporting (67.8%) and safeguard patients from unnecessary testing due to 'lost' test orders and results (75.9%). More than half (57.9%) of physicians agree that Medinet implementation will improve the reliability of laboratory results (i.e. the reliability of results reporting) and a majority agree that Medinet will enhance patient and physician satisfaction with the quality of laboratory services (70.7% and 82.8%, respectively).

Table 12

Expected Impact of Medinet on Quality of Patient Care

Indicator	Level of Agreement				
	Strongly Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Strongly Disagree
More timely diagnosis n = 58	22 (37.9%)	26 (44.8%)	6 (10.3%)	3 (5.2%)	1 (1.7%)
More timely patient treatment n = 58	24 (41.4%)	26 (44.8%)	4 (6.9%)	3 (5.2%)	1 (1.7%)
Decrease length of stay n = 56	19 (33.9%)	19 (33.9%)	10 (17.9%)	6 (10.7%)	2 (3.6%)
Safeguard patients from unnecessary testing n = 58	23 (39.7%)	21 (36.2%)	11 (19.0%)	3 (5.2%)	0 (0.0%)
Improve reliability of laboratory results n = 57	15 (26.3%)	18 (31.6%)	15 (26.3%)	5 (8.8%)	4 (7.0%)
Enhance patient satisfaction with services n = 58	18 (31.0%)	23 (39.7%)	11 (19.0%)	3 (5.2%)	3 (5.2%)
Enhance physician satisfaction with services n = 58	25 (43.1%)	23 (39.7%)	6 (10.3%)	1 (1.7%)	3 (5.2%)

Note: For some items, not all individuals responded.

Response to Open-ended Items

In addition to the items already discussed, the survey included three open-ended questions. These items covered: 1) issues and concerns with electronic exchange of laboratory information; 2) benefits of sharing laboratory information on a province-wide basis; and 3) additional comments regarding expectations for real-time electronic exchange of laboratory information. A summary of the results follow.

Issues and Concerns with Electronic Exchange of Laboratory Information. A total of 38 physicians (64.4%) provided a response to this question. The main concern raised by those who responded was pertaining to confidentiality. Concerns regarding confidentiality ranged from the potential for hackers to access personal information to staff viewing results of family and friends. However, some physicians suggested that confidentiality is always an issue where sensitive information is concerned and that no matter how the information is exchanged, the issue will always exist. One physician suggested that electronic exchange of laboratory information will actually improve confidentiality since it will eliminate several intermediate steps involved in the mail-out of paper reports.

A few respondents suggested that not all physicians are computer literate and that the lack of a paper report may cause a problem in that regard. Only one physician expressed concern regarding system breakdown and the possibility of losing information. A majority of the physicians stated that they have no major concerns regarding electronic exchange of laboratory information.

Benefits of Sharing Laboratory Information. A considerable proportion of physicians (76.2%) responded to this item. The question read, *"To what extent do you feel that it would be beneficial to exchange laboratory information among laboratories, hospitals and physicians within the province?"* The question referred to the exchange of laboratory information in general and was not specific to the exchange of laboratory information via Medinet.

With the exception of two respondents, all physicians suggested that electronic exchange of laboratory information would be very beneficial and has significant potential for improved quality of patient care. Respondents feel that it would be very useful to be able to access a patient's laboratory information from any site within the province. It was suggested that patients often undergo unnecessary testing following referral to other centers and that "*more data leads to better decisions*". For many physicians, viewing laboratory data via Meditech is an integral part of practice and "*the main gap is in accessing data from other sites*".

In addition to improved quality of care, several of the respondents added that electronic exchange of laboratory information would result in cost savings through a decrease in mailing costs, a decrease in duplicate testing and a decrease in need for secretarial support.

Additional Comments. Additional comments were provided by 23 of the respondents (39.0%). In general, the physicians that responded feel that real-time electronic exchange of laboratory information will greatly improve patient care with the major benefit being more timely decision making. In addition, greater efficiency of time

utilization is expected since many physicians spend a considerable amount of time tracking laboratory results by telephone.

Responses indicate that, overall, physicians support the implementation of Medinet and are further interested in having a system that will enable access to a patient's laboratory information from any site within the province. Several physicians noted that they have positive feedback for the implementation of Meditech at the regional level and they expect similar benefits from Medinet at the provincial level. As one physician suggested, "*it is the next step in a Province where care is fragmented by geography*". Only a small number of respondents indicated that they were skeptical that adequate funding would be available for province-wide implementation and retention of Medinet.

Turnaround Time (TAT)

Turnaround times were obtained from the Central East Health Care Institutions Board and the Avalon Health Care Institutions Board for tests that are commonly referred to the Health Care Corporation of St. John's and the Public Health Laboratory. Presented in Table 13 are mean turnaround times and the cumulative percentage of reports received in 24 hour (1 day) increments, for selected tests referred from the Central East region. All turnaround times are for specimens collected between March 16, 2003 and April 12, 2003, inclusive (28 day time interval). The mean turnaround time for orders referred from the Central East region to the Health Care Corporation, IGE/RAST (a type of allergy test) and ANA (a test for rheumatologic diseases), was just over 15 days (370 hours 24 minutes and 381 hours 29 minutes, respectively). For orders referred to the

Public Health Laboratory, HBsAg (a test for hepatitis B) and Chlamydia, the mean turnaround time was 12.9 days (308 hours 37 minutes) and 14.9 days (357 hours 8 minutes), respectively.

Table 13

Turnaround Time (TAT) for Selected Tests Referred from the Central East Health Care Institutions Board to the Provincial Reference Laboratories

	HCCSJ		*PHL*	
TAT Range	*IGE/RAST*	*ANA*	*HBsAg*	*Chlamydia*
23H 59M (1 day)	0.0 %	0.0 %	0.0 %	0.0 %
47H 59M (2 days)	0.0 %	0.0%	0.0 %	2.5 %
71H 59M (3 days)	0.0 %	0.0%	0.0 %	2.5 %
95H 59M (4 days)	0.0 %	0.0%	0.0 %	2.5 %
119H 59M (5 days)	0.0 %	0.0%	0.0 %	2.5 %
143H 59M (6 days)	0.0 %	0.0%	1.6 %	2.5 %
167H 59M (7 days)	0.0 %	0.0%	4.9 %	2.5 %
191H 59M (8 days)	0.0 %	3.4%	6.5 %	2.5 %
215H 59M (9 days)	0.0 %	3.4%	9.8 %	2.5 %
239H 59M (10 days)	0.0 %	3.4%	16.5 %	2.5 %
263H 59M (11 days)	12.5 %	6.8%	30.0 %	2.5 %
287H 59M (12 days)	20.8 %	6.8%	41.8 %	5.0 %
311H 59M (13 days)	29.1 %	17.1%	48.5 %	12.5 %
335H 59M (14 days)	37.4 %	17.1%	60.3 %	35.0 %
359H 59M (15 days)	49.9 %	44.6%	68.7 %	52.5 %
>359H 59M (16 + days)	50.0 %	55.1%	30.5 %	47.5 %
Mean TAT	370 H 24 M (15.4 days)	381 H 29 M (15.9 days)	308H 37 M (12.9 days)	357 H 8M (14.9 days)
Total Tests	24	29	59	40

Presented in Table 14 are mean turnaround times and the cumulative percentage of reports received in 24 hour (1 day) increments, for tests referred from the Avalon region. Turnaround times for tests referred to the Health Care Corporation of St. John's are for specimens collected between April 16, 2003 and June 12, 2003, inclusive (58 day time interval). Turnaround times for tests referred to the Public Health Laboratory are for specimens collected between April 16, 2003 and May 12, 2003, inclusive (27 day time interval).

Table 14

Turnaround Time for Selected Tests Referred from the Avalon Health Care Institutions Board to the Provincial Reference Laboratories

	HCCSJ		*PHL*	
TAT Range	*VB12*	*T4*	*HBsAg*	*H. Pylori IgG*
23H 59M (1 day)	0.0 %	0.0%	0.0%	0.0 %
47H 59M (2 days)	0.0 %	0.0%	0.0%	0.0 %
71H 59M (3 days)	0.0 %	0.0%	0.0%	0.0 %
95H 59M (4 days)	0.0 %	0.0%	0.0%	0.0 %
119H 59M (5 days)	1.6 %	1.2%	0.0%	0.0 %
143H 59M (6 days)	1.6 %	1.2%	0.0%	0.0 %
167H 59M (7 days)	2.5 %	2.4%	10.0%	0.0 %
191H 59M (8 days)	11.1 %	15.7%	25.0%	0.0 %
215H 59M (9 days)	31.2 %	37.6%	40.0%	0.0 %
239H 59M (10 days)	42.7 %	56.6%	55.0%	12.1 %
263H 59M (11 days)	49.9 %	65.5%	65.0%	15.1 %
287H 59M (12 days)	60.1 %	76.2%	65.0%	18.1 %
311H 59M (13 days)	77.6 %	90.8%	75.0%	21.1 %
335H 59M (14 days)	88.1 %	96.4%	80.0%	30.1 %
359H 59M (15 days)	92.7 %	97.6%	90.0%	30.1 %
>359H 59M (16 + days)	6.6 %	1.7%	10.0%	69.6 %
Mean TAT	263 H 20 M (11 days)	235 H 24 M (9.8 days)	252 H 34 M (10.5 days)	377 H 6M (15.7 days)
Total Tests	302	232	20	33

The mean turnaround time for orders referred from the Avalon region to the Health Care Corporation, VB12 (a test for vitamin B12 deficiency) and T4 (a test of thyroid function), was 11 days (263 hours 20 minutes) and 9.8 days (235 hours 24 minutes), respectively. For orders referred to the Public Health Laboratory, HBsAg (used in hepatitis B testing) and H. Pylori IgG (a test for gastrointestinal bacteria), the mean turnaround time was just over 10.5 days (252 hours 34minutes) and 15.7 days (377 hours 6 minutes), respectively.

Order Accuracy

Original laboratory orders were compared to their respective transcribed orders to determine the accuracy with which the information was transferred. For laboratory orders referred to the Health Care Corporation of St. John's, all orders received between June 22, 2003 and June 28, 2003 were included in the analysis. For laboratory orders referred to the Public Health Laboratory, all orders received between June 8, 2003 and June 14, 2003 were included in the analysis.

A discrepancy was classified as minor or major according to a pre-defined classification scheme. In general, a discrepancy was classified as major if there was blatant error in the required information or if the information was missing. Other discrepancies (e.g. missing time from collection date) were classified as minor. Only major discrepancies were included in the calculation of error rate. A detailed explanation of the discrepancy classification scheme is given in Appendix M.

As Table 15 illustrates, 117 laboratory requisitions were referred from the Central East region to the Health Care Corporation of St. John's during the specified one week

period. A total of eight major discrepancies were detected for an error rate of 6.8%. During the same one week period, 442 laboratory requisitions were referred from the Avalon region. Ninety-eight major discrepancies were detected for an error rate of 22.2%. For orders referred from both sites, a majority of the major discrepancies were related to physician's name. The overall rate of major discrepancy (or error) for orders referred to the Health Care Corporation of St. John's was 19.0%.

Table 15

Number of Discrepancies and Error Rate for Laboratory Orders Referred to the Health Care Corporation of St. John's

Field	Central East (n = 117)		Avalon (n = 442)		Overall Error Rate (n = 559)
	minor	major	minor	major	
Age	0	0 (0%)	0	11 (2.5%)	2.0%
Sex	N/A	0 (0%)	N/A	0 (0%)	0%
Hospital Number	N/A	1 (0.9%)	N/A	2 (0.5%)	0.5%
Collection Date	103	0 (0%)	2	18 (4.1%)	3.2%
Physicians Name	11	7 (6%)	14	67 (15.2%)	13.2%
Total	114	8 (6.8%)	16	98 (22.2%)	19.0%

As shown in Table 16, 52 laboratory requisitions were referred from the Central East region to the Health Care Corporation of St. John's between June 8 and 14, 2003. A total of 10 discrepancies were detected; eight were classified as major (error rate 15.4%) and two were classified as minor. During the same one week period, 50 laboratory requisitions were referred from the Avalon region and a total of 18 discrepancies were

detected; 6 major (error rate 12.0%) and 12 minor. Major discrepancies were related to collection date and physician's name only. For orders referred to the Public Health Laboratory, the overall rate of major discrepancy (or error rate) was 13.7%.

Table 16

Number of Discrepancies and Error Rate for Laboratory Orders Referred to the Public Health Laboratory

Field	Central East (n = 52)		Avalon (n = 50)		Major Error Rate (n = 102)
	minor	major	minor	major	
Age	0	0 (0%)	9	0 (0%)	0 (0%)
Sex	N/A	0 (0%)	N/A	0 (0%)	0 (0%)
Hospital Number	N/A	0 (0%)	N/A	0 (0%)	0 (0%)
Collection Date	0	2 (3.8%)	0	1 (2.0%)	3 (2.9%)
Physicians Name	2	6 (11.5%)	3	5 (10.0%)	11 (10.8%)
Total	2	8 (15.4%)	12	6 (12.0%)	14 (13.7%)

CHAPTER V
DISCUSSION

Following a discussion of response rate and sample characteristics for interviews and surveys, findings will be discussed according to study objectives. Where possible, the discussion will include comparisons and references to other similar studies.

Response Rate and Sample Characteristics

Key Informant Interviews

Interviews were conducted with a total of eight individuals who are expected to be directly involved with the implementation of Medinet. With the exception of the Avalon Health Care Institutions Board, interviews were conducted with at least one individual from the laboratory department and one individual from the information systems department at each of the four study sites. It was indicated to the investigator that the information systems department within the Avalon region was not familiar with Medinet at the time the interviews took place and thus not able to contribute to the study. In one case, the person who was initially identified as a key informant suggested that another individual be interviewed since that individual would be more involved with the implementation of Medinet. Most individuals were experienced in their position, with mean years in their current position being 10.7 years for laboratory key informants and 8.3 years for information systems key informants.

Laboratory Personnel Survey

The response rate for the survey of laboratory personnel was reasonable with completed questionnaires returned by approximately 60% of the study population. A review study which characterized response rates of 321 mail surveys published in medical journals in 1991 found an overall mean response rate of 60%, and for surveys of non-physicians, a mean response rate of 68% (Asch, Jedrziewski and Christakis, 1997). In spite of the reasonable response rate, the method of distribution may have had a negative impact on responses. Survey packages were distributed by the laboratory manager at each site and not personalized. This may have resulted in a lower response rate than if they had received personalized survey packages. Personalization of survey contacts and materials has obtained consistently higher response rates, particularly when the contact is from the principle investigator (Field, Cadoret, Brown, Ford, Greene, Hill, Hornbrook, Meenan, White and Zepka, 2002).

A majority of respondents were laboratory technologists or technicians. Since the principle function of computerized information systems in the laboratory is data management, wherein they relieve the clerical burden of data acquisition and transcription (Kaplan, 1987a), it might be expected that the end users of the system (i.e. data entry/clerical staff) would be more likely to respond to the survey. However, the manner in which the surveys were distributed created difficulty in determining response rate across job category. Laboratory managers were asked to identify and distribute surveys to those staff that are involved in the information handling and exchange process or are expected to be significantly affected by the implementation of Medinet. Thus, the

population surveyed did not include all laboratory staff and with the exception of the total number of surveys distributed, there is no documentation of demographic variables for the specific population surveyed. Overall, laboratory staff were experienced in the current position with the average respondent having more than 15 years experience.

Physician Survey

The response rate for the physician survey was consistent with the average response rate found in a review of response rates of physician surveys (Asch, Jedrziewski and Christakis, 1997). However, it was somewhat lower than that reported in previous studies of physician attitudes towards electronic communication technologies (Gadd and Penrod, 2001; Marshall and Chin, 1998; Sittig, Kuperman and Fiskio, 1999; Pringle, 1989), where response rate was as high as 94% (Pringle, 1989). Response rate was highest for physicians practicing within the Central East region. The Central East Health Care Institutions Board is more technologically advanced than the Avalon Health Care Institutions Board and is well on its way towards a regional electronic patient record. Since physicians are more likely to respond to a survey if they are interested in the research topic or they perceive the topic to be relevant to their practice (Kaner, Haighton, McAvoy, 1998), greater familiarity and experience with computerized systems among physicians practicing within the Central East region may have contributed to the higher response rate for that region.

The demographic composition of the sample of respondents in this study was similar to that of other studies of physician attitudes towards electronic communication

technologies; a majority of the respondents were over the age of 40 and there was a higher percentage of males than females (Gadd and Penrod, 2001; Marshall and Chin, 1998). In many respects, the sample of respondents reflected that of the total physician population surveyed.

Discussion of Findings

Goals and Expected Benefits for the Implementation of Medinet

It has been suggested that the most important benefit from the implementation of electronic information systems in healthcare is likely to be improved quality of care (Wyatt, 1994). In the present study, all three groups of informants (laboratory staff, physicians and key informants from both laboratory and information systems departments) identified improved quality of care, through a reduction in transcription errors and improved timeliness of results, as a major goal for the implementation of Medinet. Although a reduction in errors and improved timeliness of results delivery may be recognized as contributors to improved quality of care, good measurement of such quality improvements remains a challenge (van Gennip and Talmon, as cited in Ostbye, Moen, Erikssen and Hurlen, 1997; Wolfe, 1986).

Another major goal that was identified by key individuals from both the laboratory and information systems departments was more efficient information management. Currently, a lot of time is spent transcribing orders and results and preparing paper reports. Following the implementation of Medinet, it is expected that the processing of laboratory orders and results within the laboratory will be less resource intensive, requiring less time and personnel. Laboratory informants suggest that this will

allow staff to dedicate more time to other important tasks. In addition, the current system for exchanging laboratory orders and results between sites is dependant on the postal service and, for this reason alone, has been described as inefficient. Informants recognize that Medinet will enable real-time exchange of orders and results between sites and, thus, leading to improved timeliness of results delivery and ultimately, improved quality of care. In a review of health information system implementation projects in Canada between 1991 and 1997, most articles identified improved service, efficiency, utilization and productivity as an important objective or expectation for system implementation. Follow-up interviews with article authors found that expectations for system implementation had been met or partly met for 22 out of 24 projects (Lau and Hebert, 2001).

A third goal for the implementation of Medinet is cost savings. Cost savings, through the elimination of the postage bill and unnecessary payment for clerical support, was identified in both the open-ended section of the physician survey as well as in the key informant interviews as a goal for the implementation of Medinet. However, cost savings was mentioned by only few individuals and was referred to as more of an added benefit rather than a major goal. Consistent with the findings of this study, Wyatt (1994) maintains that the most important benefit of such systems is likely to be improved quality of care rather than cost savings.

Burkle and colleagues (2001) note the identification of expected effects or goals against which the impact of the system can be assessed as an important aspect in the evaluation of health information systems. Chin and McClure (1995), who carried out a

post-implementation evaluation of the pilot site implementation of the outpatient Clinical Information System (CIS) in the Northern region of Kaiser Permenente, U.S.A., first identified five high-level end goals for the CIS implementation including: 1) improved health outcomes, 2) lower operating costs, 3) improved revenue capture, 4) improved member/group satisfaction, and 5) support for management and analytical systems. Chin and McClure felt that it would be too difficult to quantify these high-level goals and refined them into a set of criteria for a successful system. The evaluation of the CIS was carried out based on the refined criteria for a successful system. Similarly, the high level goals that have been identified for the implementation of Medinet can be developed into more specific indicators to assess the extent to which the goals have been met after the system has been implemented and functioning for a period of time.

In their evaluation of a clinical imaging system in a Veterans Affairs Medical Center in Washington, D.C, Kaplan and Lundsgaarde (1996) advocate the power of qualitative methods for identifying potential benefits and key processes to use in future investigation. Other multi-method evaluations of health information systems projects, such as the before and after study of the integrated Hospital Information System in the Northern Province of South Africa (Health Systems Trust, 2002), have recognized the qualitative component as a valuable data source for interpreting findings and assessing the impact of the system.

The qualitative approach used in the present study to identify end goals for Medinet implementation enabled the identification of goals that otherwise may not have been recognized by the investigator and outlined how respondents expect to meet the

goals that have been identified. Unlike previous studies of information systems in healthcare that have developed evaluation plans based on the expected benefits assumed by the investigator (Doran and DePalma, 1996; Chin and McClure, 1995), this study will enable the development of evaluation indicators for a post-implementation study which are based on more than the investigators pre-defined categories of interest.

Potential Issues and Concerns with the Implementation of Medinet

With the implementation of any new information technology there is potential for problems and challenges. One of the reasons that new computerized health information systems fail is because those involved in system development and implementation do not recognize potential problems and lessons learned from past projects (Littlejohns, Wyatt and Garvican, 2003). In this study, participants identified three areas of concern for the implementation of Medinet including system capabilities, the elimination of paper reports and confidentiality and security. Recognizing these issues prior to implementation is important so that all parties can work together to develop solutions to the problems before it is too late.

Medinet is designed to allow communication between heterogeneous laboratory information systems. However, key individuals from the laboratory department and the information systems department anticipate challenges in doing so, especially when multiple sites are connected to the reference laboratory. Laboratory staff did not recognize the potential problems associated with the cross-referencing of dictionaries, which is likely due to the fact that the laboratory staff will not be directly involved with

the implementation of Medinet and may not consider potential problems at the implementation level. However, laboratory staff still recognize the connection of multiple sites to the reference laboratory as an area for concern. Provided with an opportunity to make additional comments regarding the implementation of Medinet at the end of the survey, several of the laboratory staff indicated a concern with the way in which orders will file into the LIS at the reference laboratory. With the connection of multiple sites, there is apprehension that all orders will fill into the LIS with no way to sort the orders by ordering site, thereby increasing the amount of work associated with sorting and re-labeling specimens.

In their evaluation of a system for electronically submitting laboratory reports for notifiable diseases to a state Department of Health, Effler and colleagues (1999) found that one of the major challenges with the system was that the extraction process was complicated by the diversity of coding schemes in use among the laboratories. Since the test coding schemes used at each facility are individualized, the data extraction program and data dictionary used in the information system at the Department of Health had to be tailored to each facility. Similarly, with the implementation of Medinet for the communication of orders and results between ordering and reference site, naming and coding systems used at the reference laboratory will have to be cross-referenced with that of each ordering site. This has been recognized as a potential challenge for the implementation of Medinet.

With the implementation of Medinet, there will no longer be paper reports sent from the reference laboratory to the ordering site. Instead, results will be sent

electronically and filed into the LIS at the ordering site, in real time. The elimination of paper reports sent from the reference laboratory has been identified by key laboratory informants, laboratory staff and physicians as a reason for concern. For physicians who still require paper reports after Medinet is implemented, either the ordering site will have to print and send the report to the physician or the physician will have to print the report directly from the regional Meditech Hospital Information System (HIS). Although the later has been identified as the preferred option by laboratory supervisors, it is recognized that not all physicians have access to Meditech. Physicians expressed a similar concern and added that not all physicians are computer literate. According to the results of the physician survey, however, nearly 80% of physicians have access to their regional Meditech system and 87.2% indicated that they use Meditech to view laboratory results often or always. Since a majority of physicians practicing within a hospital setting have access to and use Meditech for obtaining laboratory results, the biggest challenge would likely be for physicians who practice outside the hospital setting, and are less likely to have access to Meditech.

There has been a long history of "physician resistance" to computers in health care (Kaplan, 1987b). Among one of the theories of resistance to information systems is a lack of knowledge or a reluctance to change (Markus, 1983, as cited in Kaplan, 1998). In their assessment of the impact of an electronic medical record system (EMR) on community based primary care practices, Wager and colleagues (Wager, Lee, White, Ward and Ornstein, 2000) found that physicians and staff are not comfortable letting go of paper records. While some practitioners indicated that they would be willing to "let go

of paper" when they felt the system was without error, others indicated that they were not comfortable letting go of paper records at all. In an earlier study, Wager, Ornstein and Jenkins (1997) found that one of the major issues with using a computerized system to access a patients' medical record was the high cost associated with implementing and maintaining the system. Similarly, in this study, it was recognized that it is difficult to convince physicians that subscribing to Meditech is worthwhile, especially for physicians who practice outside the hospital setting where cost may be an issue.

Also identified by key informants and physicians as an area for concern was confidentiality and security. While, for the most part, key informants indicated that they had no apprehension about confidentiality and security themselves, they suggested that physicians would be concerned that security and confidentiality will be compromised following the implementation of Medinet. When asked, physician indicated that issues with confidentiality and security ranged from the potential for hackers to access personal information to having staff view laboratory results of family and friends. It was recognized by both key informants and physicians, however, that confidentiality and security are always an issue where personal information is involved and that the implementation of Medinet may actually enhance the security of laboratory data since several steps involved in the processing of paper orders/reports will be eliminated.

It is not unexpected that physicians are concerned with confidentiality and security of patient information that is being electronically transmitted between geographically dispersed sites. Similar to the findings of the present study, a pre-implementation assessment of physicians' attitudes prior to the implementation of an

outpatient electronic medical record in a large academic health system in the United States found one of their chief concerns to be related to issues of patient privacy (Gadd and Penrod, 2001). In spite of physicians' perceptions that electronically exchanging information can compromise confidentiality and security, data security technology is actually quite advanced and is continuously improving. Elements of security can include authentication, access control, creating an audit trail and physical security of the system (Connelly, 1999). Each of these security elements are currently in place with the regional Meditech systems and would continue to be used following the implementation of Medinet.

Perceived Impact on Information Management, Processing and Exchange

Information management and communication technologies in the laboratory often have been justified in terms of outcomes such as costs, timeliness and accuracy of results (Kaplan 1987a). Few evaluations of information management and communication technologies have focused on the impact of the new technology on work processes or tasks within the laboratory. In an assessment of electronic data interchange (EDI) for the delivery of laboratory results from hospital laboratories to GP offices, for example, Branger measured time intervals between the generation and arrival of laboratory reports and assessed the impact of EDI on physician workload, while failing to consider the impact of the electronic communication technology on the processing of orders within the lab (Branger, van der Wouden, Schudel, Verboog, Duisterhout, van der Lei and van Bemmel, 1992; Branger and Duisterhout, 1992). While the approach is somewhat

different than that of the present study, a cost-benefit analysis was found in which time spent by laboratory personnel in information-handling activities was measured using an extensive work sampling program. Time and estimated hours of work per week were captured before and after system implementation. Information-handling activities included transcription and recording of test results, compilation of workload statistics and quality control logging. Results showed that time devoted to information-handling activities decreased significantly following the implementation of the computerized medical laboratory system (Wolfe, 1986).

In the present study, laboratory staff, many of whom interact with the laboratory information system on a daily basis, were asked to indicate how they expect Medinet to impact specific tasks associated with the laboratory testing process. In addition to agreeing with the statement "Medinet will improve the efficiency of information handling and exchange", many indicated that that they are expecting the implementation of Medinet to result in a decrease in time and effort associated with various aspects of laboratory workflow as well as a reduction in problems that are commonly associated with a paper-based system for exchanging laboratory orders and results.

At the ordering site, the greatest expected impact of Medinet implementation involves the verification of laboratory results at the ordering site and the dissemination of results to ordering physicians. Upon receipt of test results by the ordering site, the current system forces manual verification and entry of results into the LIS. That is, an appropriate staff member in a supervisory position will assess each report to ensure that the results 'make sense'. When the results have been verified, a data entry operator will

transcribe the results to the LIS before sending the paper report to the ordering physician. Since laboratory orders and results will be electronically exchanged between ordering and reference site and manual verification and entry of results will no longer be necessary following Medinet implementation, it is not surprising that a majority of laboratory staff expect the effort involved in the verification of results to decrease. However, the high percentage (86.9%) of laboratory staff expecting a decrease in effort to distribute results to the ordering physician suggests that laboratory staff may not be considering the shift in responsibility that will occur if physicians still require paper reports. Supporting this hypothesis, nearly 80% of laboratory staff are expecting a decrease in the volume of paper generated following the implementation of Medinet. As previously discussed, the shift in responsibility for printing reports has been identified as an area for concern.

Medinet implementation is also expected to have an overall positive impact on the timeliness of results delivery. A majority of laboratory staff strongly or somewhat agree that the implementation of Medinet will improve the timeliness of both normal and abnormal results delivery. Further, most laboratory staff (73.7%) are expecting the interval between testing and results dissemination to decrease and nearly all (94.7%) are expecting a decrease in effort to send results to the ordering site. Some of the laboratory staff that were surveyed are involved with the preparation and distribution of reports and are aware of the resources involved. At one of the reference laboratories, for example, there are two full time staff dedicated to the preparation and distribution of laboratory reports. Survey results suggest that laboratory staff recognize the potential to decrease

time and effort involved in the testing process and, thus, are expecting more timely results delivery.

Although laboratory staff clearly expect a decrease in the time interval between testing and results dissemination as a result of Medinet implementation, the expected impact on the interval between specimen collection at the ordering site and testing at the reference site is not as apparent. Approximately half of all respondents expect a decrease in time between collection and testing, while the other half expect no change. There are two factors that, together, may contribute to this finding: 1) the delivery of a specimen from the ordering site to the reference laboratory will still depend on the courier service, and 2) manual data entry at the reference laboratory will be eliminated. It follows that some laboratory staff recognize the potential to save time through the elimination of manual data entry while others perceive the potential time savings to be small or negligible.

Other aspects of the testing process in which laboratory staff expect little or no impact are the verification of orders when received by the reference laboratory and the verification of results before releasing them to the ordering site. This suggests that most laboratory staff perceive much of the work involved in verifying orders and results at the reference laboratory to be independent of the type of system (i.e. paper-based or electronic) used to exchange orders and results between sites.

In an assessment of a Picture Archiving and Communications System (PACS) on radiology turnaround time, PACS implementation was found to significantly reduce the imaging-to-dictation time and, therefore, the time required to make the report available to

the physician. Consistent with laboratory staff expectations for the implementation of Medinet, the improved timeliness was attributed to the fact that PACS eliminates all the workload associated with hard copy films, thus improving efficiency as well as the number of lost films (Twair, Torreggiani, Mahmud, Ramesh and Hogan, 2000).

In addition to specific tasks associated with the processing of a laboratory order, laboratory staff expect that Medinet will have a positive impact on several problem areas that are commonly associated with a paper-based system for exchanging laboratory information. Among the problems that Medinet is expected to affect are missing or lost orders, missing or lost reports, telephone calls to the ordering site to clarify order information and telephone calls to the laboratory regarding a test status.

Where paper orders and results are being exchanged, especially between multiple sites, there is the potential to bundle orders with the wrong specimens or send reports to the wrong site. Following the implementation of Medinet, a majority of the laboratory staff expect a decrease in the number of lost test orders and results, and many expect the decrease to be significant. If an order *is* sent to the wrong site, however, most laboratory staff are expecting no change in the effort required to redirect the order to the intended site. This suggests that laboratory staff understand that the Medinet connection will be between ordering site and reference site only. That is, if an order that is sent to the wrong reference site, it will still have to be printed and delivered to the intended reference lab.

Another problem area for the laboratory is telephone calls. In some clinical laboratories, telephone calls to and from the laboratory is recognized as one of the biggest problems associated with a paper-based system for exchanging orders and results

(Kaplan, 1987a) and has been associated with increased levels of stress (Ostbye, Moen, Erikssen and Hurlen, 1997) among laboratorians and clinicians.

In an evaluation of a system that enabled electronic communication between hospital wards and the clinical laboratory in an inpatient setting, the volume of telephone calls to the laboratory regarding test results was reduced to half following the implementation of laboratory information system (Wolfe, 1986). In a more recent study by Ostbye and colleagues (1997), the number of telephone calls from the laboratory to the ward decreased following implementation of a similar system, while the affect on telephone calls from the ward to the laboratory was unclear. It was noted that the number of telephone calls from the ward to the laboratory is generally quite modest, and thus, the impact of a new information management and communication technology on inquires to the laboratory regarding a tests status may be small.

In the present study, many laboratory staff indicated that they expect a decrease in telephone calls from the reference laboratory to the ordering site as well as from the ordering site to the laboratory. Some laboratory staff (43.4%), however, expect no change or a slight increase in both. This finding may be partially explained by a comment made in the key informant interviews by one of the laboratory informants. Following Medinet implementation, the informant suggested that it will not be possible to modify an order received by the reference laboratory without making the same modification in the LIS from which the order was sent. Thus, when responding to this item, some laboratory staff may have considered that a means of constant communication, such as telephone, will be necessary between ordering and reference site.

Further, and as noted by Ostbye et al. (1997), the number of telephone calls between the ordering site and reference laboratory may be perceived as small and thus, the perception that any impact on telephone calls will be small.

In this study, a similarity was found between the findings from the laboratory survey and interviews with key individuals from the laboratory department and information systems department, with respect to the expected impact of Medinet on information management. Key informants described the current system for exchanging laboratory information between ordering and reference site as "inefficient" and "resource intensive". Similar to the laboratory staff, both laboratory and information systems informants anticipate greater efficiency of information handling and exchange through a reduction in manual data entry and preparing reports and more timely results delivery.

In addition to their expectations regarding specific tasks and problem areas associated with the testing process, laboratory staff are expecting a decrease in workload following Medinet implementation. While this may or may not be the case, it is important that those responsible for system implementation recognize all user expectations so that any false expectations or potential concerns can be appropriately addressed prior to implementation. In an early study, Kaplan (1987a) advocates the importance of understanding the relationship between anticipated and actual impacts of computer technologies since one of the reasons that new computer technologies are resisted is unrealistic expectations about the impact that the system might have. As was the case with the implementation of an integrated Hospital Information System (HIS) in the Northern Province of South Africa (Health Systems Trust, 2002), for example, the

difference in expectations between those responsible for system implementation, the system vendor and system users was one of the factors that contributed to the ultimate failure of the system.

Perceived Impact on Utilization of Laboratory Services

Unnecessary utilization of laboratory services has been estimated to range from ten to fifty percent of the total volume of tests ordered (Lewandrowski, 2003). Among the factors that contribute to unnecessary testing are the timeliness of results delivery (Barnett, Bimmell, Peracca and Rosemann, 1975; Valenstein, Leiken and Lechmann, 1988; Howanitz and Steindel, 1991) and the accuracy with which the original laboratory order is executed in the laboratory (Fin, Valenstein and Burke, 1988; Valenstein and Howanitz, 1995). Findings from this study indicate that both physicians and laboratory staff are expecting a decrease in unnecessary laboratory testing following the implementation of Medinet.

Research has shown that there may be a threshold of tolerance for perceived delays in laboratory services (Novis, Zarbo and Saladino, 1998) and that lengthy turnaround time can lead to duplicate test requests (Barnett, Bimmell, Peracca and Rosemann, 1975; Valenstein, Leiken and Lechmann, 1988; Howanitz and Steindel, 1991). Supporting this, nearly 55% of physicians in the present study agree that they will re-order a test if it is not available in the timely manner or considered lost. More than 65% of physicians agree that Medinet will decrease unnecessary testing due to lost test orders or results.

It has also been suggested that long delays in routine turnaround time can result in STAT abuse (Barnett et al., 1975). That is, a physician will make a STAT or urgent test request in a non-emergency situation rather than wait for the result of a test ordered with routine priority. In this study, a difference in opinion was found between physicians and laboratory staff with respect to the expected impact of Medinet on STAT test requests. More then 60% of physicians agreed that Medinet implementation would decrease STAT test requests in non-emergency situations, while a majority of laboratory staff expect no change. A possible explanation for this difference in expectation is that laboratory staff perceive the problem of STAT abuse to be small, thus expecting little change following Medinet implementation. Supporting this, only 31.6% of physicians indicated that they will order a test with a STAT or urgent priority in order to speed up the testing process.

In addition to increasing unnecessary testing, slow turnaround time can lead to physician dissatisfaction with services (Steindel, Jones and Howanitz, 1996; Howanitz and Steindel, 1991). Studies that have examined the needs and expectations of clinicians regarding the timeliness of laboratory services have found that laboratories often do not meet physicians' expectations (Steindel, 1995). Contributing to this is the differences in turnaround time definitions and expectations among laboratorians and clinicians, where clinicians expect much more rapid response (Steindel, 1995; Howanitz, Cembrowski, Steindel and Long, 1993). Further, Howanitz et al. (1993) found a difference in turnaround time expectations and definitions between physician specialties and departments. Despite the general difference in turnaround time expectations among

clinicians and laboratorians, both physicians and laboratory staff are expecting the implementation of Medinet to enhance physician satisfaction with laboratory services.

As implied by the high percentage (73.9%) of respondents who expect a decrease in tests performed that were not intended on the original order, laboratory staff also anticipate a reduction in unnecessary testing through more accurate transmission of orders from the ordering site to the reference site. Similarly, a College of American Pathologists Q-Probe study of 577 institutions (Valenstein and Howanitz, 1995) found that the most commonly cited reason for completing tests with no documented orders, and for not completing ordered tests, was failure to enter orders correctly into the computer system. In an examination of the accuracy with which test orders were transmitted, the median institution reported that 0.7% of tests completed had no written order and 1.9% of test orders were not completed. For some institutions, the percentage of completed tests that were not ordered was more than 6%. They conclude that accurate transmission of test orders to the laboratory is a problem for many institutions that should not be ignored as order inaccuracies can lead to increased costs due to unnecessary testing as well as unsatisfied clients and increased morbidity.

While electronic exchange of orders and results is expected to have a positive impact on unnecessary laboratory testing, Bates and colleagues (1999) maintain that information-related reasons for inappropriate resource utilization should be addressed by combining a computerized order entry system with a computerized review and reminder system that provides information at the time the order is made (Bates, Pappius, Kuperman, Sittig, Burstin, Fairchild, Brennan and Teich, 1999). Bates has carried out

extensive work around the reduction of errors using computerized information systems at Brigham and Women's Hospital in Boston, Massachusetts, U.S.A.

Perceived Value with respect to Quality of Care

Physicians use various information sources during the healthcare process and make many clinical judgments based on available data (Silverstein and Rothschild, 1999). Past research has found that up to 40% of all clinical decisions are based on laboratory results in some areas such as the intensive care unit (Bradshaw et al., 1989; Shabot et al., 1990). In the present study, a majority of physicians indicated that they will order laboratory testing during 1-25% of all patient visits and base 1-25% of all clinical decisions on laboratory results. However, approximately twenty percent of physicians indicated that they order laboratory tests during more than 50% of all visits and base more than 50% of clinical decisions on laboratory results. Since laboratory results provide essential information for clinical decision making in patient care, it follows that improvements to laboratory results can improve the quality of patient care.

With respect to the perceived value of real-time exchange of laboratory information as it relates to the quality of patient care, there is a clear relationship between the findings among all three groups of informants. One of the major goals for the implementation of Medinet as identified by key individuals from the laboratory department and information systems department is improved quality of care. Both laboratory and information systems informants are expecting that Medinet will improve the quality of patient care by improving the accuracy with which laboratory orders and

results are transmitted and improving the timeliness of results delivery. Similarly, a majority of laboratory staff expect that Medinet will improve the reliability and timeliness of results delivery. Findings from the physician survey suggest that physicians recognize the potential of Medinet to improve the reliability and timeliness of results delivery and expect this improved timeliness and reliability to translate to improved quality of care. Specifically, a majority of physicians are expecting that Medinet implementation will lead to more timely diagnosis and treatment and shorter hospital stays, safeguard patients from unnecessary testing and enhance patient satisfaction with services.

Timeliness of patient care is an important quality attribute and has been linked in many cases to patient outcomes (Steindel, Jones and Howanitz, 1996). It has been suggested that the contribution of clinical laboratory results to patient care depends on the time interval between the decision to order the test and receipt of the test results by the physician (Barnett, McIver and Gorton, 1978). While computerized systems for communicating laboratory orders and results within a hospital setting are common in many institutions, the paper-based system often used to exchange laboratory information outside the hospital setting has limited the ability to improve the timeliness of results delivery from a distant laboratory. However, new technologies are emerging that enable electronic exchange of information between distant sites. Thus, more timely exchange of laboratory orders and results between distant sites is now becoming a reality. In the present study, more than 80% of physicians strongly or somewhat agreed that real-time

exchange of laboratory information between ordering and reference site will lead to more timely diagnosis (82.7%) and more timely patient treatment (86.2%).

Marshall and Chin (1998) carried out an evaluation of clinician attitudes towards two components of an outpatient electronic medical record system (an online charting and ordering system and a Results Reporting System) in Kaiser Permanente Northwest, a large HMO in the United States. Overall, most clinicians felt that the electronic medical record system improved quality of patient care, with 72% of physicians reporting that the Results Reporting System (RRS) improved the quality of patient care and 60% reporting an improvement with the use of the online charting and ordering system. Further, 74% of respondents felt that the RRS had improved their ability to act on laboratory results in a timely fashion. Marshall and Chin conclude that the most important capability of an electronic record system is its ability to retrieve critical information such as lab test results.

Research has also suggested a relationship between laboratory delays and increased length of hospital stay. Delays in hospital discharge can extend patients' disabilities, increase hospital costs and place patients at risk for developing iatrogenic diseases (Steindel, Jones and Howanitz, 1996). In a discussion document of five Q-Probe studies related to timeliness of laboratory tests, however, Steindel (1995) suggests that the relationship between laboratory delays and increased length of hospital stay is weak. Despite this, 67.8% of physicians in this study agree that the implementation of Medinet will decrease length of hospital stay. Notably, the percentage of physicians who agree that Medinet will decrease length of hospital stay is somewhat lower than for the other

indicators (i.e. timeliness of diagnosis, timeliness of treatment, unnecessary testing, and satisfaction with services). This implies that physicians perceive timeliness of laboratory results to be least associated with length of hospital stay among the indicators assessed.

Whether or not more timely results will make any medical difference, physicians and patients want test results as rapidly as possible (Valenstein, 1996). Supporting this, nearly 50% of physicians in the present study agreed that a patient will inquire about test results before the results are available. As previously discussed, clients become dissatisfied with services if laboratory turnaround time does not meet their expectations (Steindel, Jones, and Howanitz, 1996; Howanitz and Steindel, 1991). Howanitz and Howanitz (2001) suggest that to improve patient and clinician satisfaction with services, it is important to report all results as rapidly as possible, especially when it comes to outpatient results. Given the general consensus that Medinet will improve the timeliness of results delivery, it is not unexpected that a majority of physicians are expecting enhanced patient satisfaction following Medinet implementation. Patient satisfaction is regarded as an important component of the quality of medical care (Narayan, Gregg, Fagot-Campagna, Gary, Saddine, Parker, Imperatore, Valdez, Beckles and Engelgau, 2003).

In addition to the direct effect of timeliness, it is expected that the quality of patient care will be enhanced by improving the accuracy with which laboratory orders and results are transmitted. Ordering accuracy assumes an important relation to the quality of laboratory testing, and hence, the quality of care. If a laboratory fails to complete an ordered test, diagnostic evaluation is delayed which could lead to increased

hospital stays and a delay in beginning therapy. If a laboratory completes the wrong test, the test may have to be re-ordered and the patient may be subject to unnecessary testing. As noted in the interviews with key laboratory and information systems informants, inaccurate transmission of a laboratory order can also lead to results being sent to the wrong site, further delaying results delivery and associated care. Already discussed, the most commonly cited reason for not completing ordered tests and for completing tests with no documented orders in a College of American Pathologisits Q-Probe Study was failure to enter orders correctly into the computer system (Valenstein and Howanitz, 1995). Since such inaccuracies may lead to increased morbidity and cause patients to become dissatisfied with services, authors Valenstein and Howanitz conclude that laboratories should not ignore ordering inaccuracies and that improving test ordering accuracy can improve patient care.

Establishment of Baseline Measurements

Turnaround Time (TAT). The timeliness of results reporting is measured by laboratory test turnaround time (TAT). While other definitions of TAT have been used in previous studies of laboratory timeliness, for the purpose of this study, TAT is defined as the elapsed time between specimen collection and the entry of test results into the laboratory information system (LIS) at the ordering site. Upon entry of the results into the Meditech LIS at the ordering site, the results are available for viewing by the ordering physician. A similar definition of turnaround time has been used by the College of American Pathologists (Steindel, Jones and Howanitz, 1996). Collecting baseline data on

timeliness of results delivery is necessary in order to establish a standard against which to measure any changes, after the implementation of Medinet.

Routinely used measures of turnaround time include mean, median, 90^{th} percentiles and the proportion of tests processed within pre-defined time limits (Valenstein, 1996). In this study, turnaround time measures included mean TAT and the percentage of tests processed in twenty-four hour time increments. Two factors were considered in choosing the specific measures of turnaround time for this study. Firstly, it has been suggested that the inclusion of 90^{th} percentiles or the proportion of tests processed within pre-defined time limits, in addition to mean or median TAT, is favorable for tracking improvements in TAT since the mean can be significantly influenced by outliers (Valenstein, 1996). Secondly, mean TAT and the percentage of tests processed in twenty-four hour time increments could be obtained from the Meditech laboratory information system with relatively little difficulty as compared to median TAT and 90^{th} percentiles. Thus, mean TAT and the percentage of tests processed in twenty-four hour (1 day) time increments were deemed the most appropriate indicators of laboratory timeliness for this study.

Turnaround times were obtained from the regional laboratories for two tests that are routinely sent to the Health Care Corporation of St. John's (HCCSJ) and two tests that are routinely sent to the Public Health Laboratory (PHL). Results indicate that that the mean TAT for tests referred to the provincial reference laboratories from the Central East region ranged from 12.9 days (HbsAg) to 15.9 days (IGE/RAST and ANA). For tests referred from the Avalon region, mean TAT ranged from 9.8 days (T4) to 15.7 days (H.

Pylori IgG). The cumulative percentage of reports received in twenty four hour increments, presented in Tables 13 and 14, will be particularly important for assessing the impact of Medinet on the frequency of outliers.

The specific tests and time frame for which turnaround times were obtained from the two Institutions Boards participating in the study are not the same in all cases since each site has a different volume and set of tests that they send to the provincial reference laboratories. This does not interfere with the objectives of the study since turnaround time was obtained for the purpose of establishing baseline measurements only and not for comparison between ordering sites.

Based on the investigators knowledge of the process involved in sending an order to the reference laboratory, and consistent with several College of American Pathologists Q-Probes studies (Steindel, 1995), the major factor contributing to turnaround time for tests referred from the regional laboratories throughout the Province to the provincial reference laboratories is transportation time. Currently, the transportation of specimens/orders and results to and from the reference laboratories is dependant on courier and postal services. Thus, it is reasonable that the larger the transportation time, the larger the turnaround time. Since the Central East Health Care Institutions Board is located at a further distance from the provincial reference laboratories than the Avalon Health Care Institutions Board, it follows that the TAT for the same test referred from each region would be greater for tests referred from the Central East region. For example, turnaround time for the HbsAg test was obtained from both the Central East region and the Avalon region. For tests referred from the Central East region, the mean

TAT was 12.9 days and at the end of 15 days 68.7% of tests had been processed. For tests referred from the Avalon region, the mean TAT was 10.5 days with 90.0% of tests processed within 15 days.

Results reporting can be further delayed when unfavorable weather conditions limit the transportation of laboratory specimens/orders and results to and from the reference laboratory. Other situations can also arise that may delay the entry of test results into the LIS. This can happen when test results are received at the ordering site prior to a weekend or holiday or when the laboratory is operating with reduced staff due to illness.

Order Accuracy. Errors that occur during the laboratory testing process can adversely affect patient management and lessen the quality of care and services. At worst, a physician may act on incorrect laboratory results and the patient may be treated inappropriately. Research has shown that most laboratory errors occur during the pre-analytical phase of the testing process (Bonini, Plebani, Ceriotti and Rubboli, 2002).

The accuracy with which laboratory orders are executed has been found to vary widely across institutions (Valenstein and Howanitz, 1995). Unless a system for electronic physician order entry (POE) is in place, there is usually at least one transcription in the test ordering process after a physician orders a test for a patient. The more transcriptions involved in the testing process, the greater the potential for inaccurate transmission of order and results.

In this study, errors during the transcription of the original order to the LIS at the reference laboratory were recorded to establish a benchmark for comparison after

Medinet is implemented. Because there were differences detected in the information being captured within and between ordering sites, as well as within and between reference laboratories, the analysis was limited to data fields in which information was captured in a consistent manner. The differences observed may be partially accredited to a lack of common standards or guidelines across the Province for capturing information on laboratory orders.

A discrepancy between the information on the original order and the transcribed order was classified as minor or major depending on the nature and potential consequence of the discrepancy. In general, a discrepancy was classified as major if it was a blatant error or the information was missing. Other discrepancies, such as a difference of one letter in the middle of a physician's name, were classified as minor. Only the major discrepancies were considered in calculating the error rate. A similar classification approach was used by Weir, Hurdle, Felgar, Hoffman, Roth and Nebeker (2003) in an evaluation of input errors associated with direct text entry of progress notes.

One study of error rate in a pathology laboratory reported transcription errors associated with up to 39% of laboratory orders (Khoury, Burnett and Mackay, 1996). Findings from this study indicate a much lower error rate, with major discrepancies associated with 19% of orders referred to the Health Care Corporation of St. John's and 13.7% of orders referred to the Public Health Laboratory. Consistent with the findings of Valenstein and Meier (1999), the data field having the highest rate of error was physicians' name (13.2% and 10.8% for the Health Care Corporation of St. John's and

Public Health Laboratory, respectively). The data field with the lowest rate of major error was sex, with a 0% error rate for each reference laboratory.

Future Directions and Priorities

Electronic sharing of laboratory information has been identified as high priority both within Canada and internationally. When asked the extent to which they feel that laboratory information should be electronically exchanged within Newfoundland and Labrador, key informants and physicians suggested that, at the very least, laboratory orders and results should be electronically exchanged between all ordering sites and the two provincial reference laboratories. That is, Medinet should be implemented within each Institutional Board to link the regional Meditech LIS to the LIS at the Health Care Corporation of St. John's and the Public Health Laboratory. As one physician noted, "*it is the next step in a province where care is fragmented by geography*". Both laboratory and information systems informants recognize that it would not be necessary or beneficial to electronically exchange orders and results between each region of the Province since the low volume of tests orders being sent between the other regions would not justify the cost of implementation.

Key individuals from the laboratory department and information systems department suggest that all physicians should have access to their regional Meditech system. That way, direct physician order entry (POE) could follow. With direct physician order entry, the physician would enter the laboratory order directly into the Meditech system and the order would be electronically transmitted to the reference

laboratory. When testing was complete, the results would be electronically transmitted to the ordering site where the physician could immediately view the results using the Meditech Hospital Information System (HIS). As already discussed, a majority of physicians who responded to the survey indicated that they have access to Meditech and regularly use Meditech for viewing laboratory results. Again, the biggest challenge would likely be for physicians that practice outside the hospital setting where they have to independently subscribe to Meditech to gain access.

Coupled with computerized decision support, direct POE has even greater potential for improving the quality and efficiency of patient care. David Bates has conducted extensive research on the impact of physician order entry on medication error prevention at Brigham and Women's Hospital, an academic tertiary-care hospital in the United States. In a study where physician order entry was coupled with successive levels of decision support, Bates and colleagues found that direct POE alone substantially decreased the rate of medication errors. Further reductions in errors were achieved with the addition of decision support features such as drug allergy and drug-drug interaction warnings (Bates, Teich, Lee, Seger, Kuperman, Ma'Luf, Boyle and Leape, 1999). Other evaluation studies have demonstrated further benefits of direct physician order entry systems. Tierney, for example, demonstrated that POE can reduce utilization and costs by informing physicians of the cost of testing (Tierney, Miller and McDonald, 1990) and the probability of obtaining an abnormal test result for the particular test ordered (Tierney, McDonald, Hui and Martin, 1988).

Information integration is the bringing together of relevant data and information from multiple sources and observation periods and making it readily available to physicians (Connelly, 1999) and other authorized users. The bringing together of information from various encounters that occur throughout a patients' lifetime is known as vertical integration (Connelly, 1999) and has been identified by physicians and informants in this study as an important direction for optimum patient care. As indicated in the open-ended questions of the physician survey, using the Meditech system to view laboratory results is an integral part of practice for many physicians. "*The main gap is in accessing data from other sites*". One laboratory informant and one information systems informant recognized province-wide integration of laboratory information as a later phase of the provincial Health Information Network (HIN) for Newfoundland and Labrador.

The absence of universal standardized nomenclature and coding schemes for managing and exchanging laboratory and other health information is widely recognized as a barrier to electronically sharing health information between heterogeneous systems (Bates and Gawande, 2003; Alvarez and Zelmer, 1998; Effler et al, 1999; CDC, 1997). Given this lack of standardization, one approach to enabling electronic exchange of orders and results is to remove all laboratory information systems that were previously installed in each ordering and reference site and replace them with a single multi-site LIS. This would result in a system that is easy to synchronize as the integration of laboratory information moves into new phases or levels, but would be very costly and time consuming to implement (Aller, 1999). An alternative approach, and the approach taken in this province, is to leave the existing legacy systems in place and link them to the

reference laboratory using interfaces, such as Medinet. This approach requires conversion and translation tables that must be manually built and maintained. The development of such conversion and translation tables becomes more of a challenge as more and more systems are linked (Aller, 1999). As previously discussed, the cross-referencing of Meditech dictionaries has been identified as an area for concern with the implementation of Medinet. It was suggested that coding systems at the regional laboratories may have to be changed to match that of the reference laboratories.

Similar to other Canadian jurisdictions, the ultimate goal for Newfoundland and Labrador is province-wide integration of laboratory information that supports electronic exchange of orders and results between geographically dispersed sites, direct physician order entry (POE) and immediate access to a patient's longitudinal history of laboratory and other diagnostic services from any site in the province (Neville, Keough, Barron, MacDonald, Gates, Tucker, Cotton, Farrell, Hoekman, Bornstein and O'Reilly, 2004).

Study Strengths and Limitations

The present study has several important strengths:

1.) While only the pre-implementation component is reported here, the study is designed as a pre- and post-implementation study. It is expected that the post-implementation phase will be carried out at approximately six months and one year after implementation. The pre- and post- implementation design enables comparison which is important in evaluation studies.

2.) A multi-method approach was taken using a combination of qualitative (key informant interviews) and quantitative (surveys and measurements of turnaround time and order accuracy) methods.

3.) Multiple data sources were used which enable triangulation of findings.

4.) The evaluation was carried out by an external investigator with no vested interest in the system or institutions studied.

5.) Two Institutional Health Boards that were identified as the potential initial implementation sites for Medinet were included in the study. Implementation sites will often change due to unforeseen problems.

Several limitations of the study were also identified:

1.) Small sample size for the ordering sites prevented any comparisons between ordering site and reference site with respect to findings of the laboratory survey.

2.) Study instruments were developed for the study and not validated.

3.) Neither laboratory staff nor physicians had received formal education with respect to Medinet and thus may not have fully understood its functions and/or limitations. Surveys did not assess level of IT or, more specifically, Medinet knowledge.

4.) A cost-benefit analysis was excluded from the study due to anticipated difficulties in obtaining costing information and quantifying many expected benefits (e.g. timeliness of results delivery, patient satisfaction).

5.) While also identified as study strength, the inclusion of a number of data sources limited any in depth analysis without going beyond the study scope. A more in-depth analysis is planned and will be released as a series of reports.

CHAPTER VI

SUMMARY, RECOMENDATIONS AND CONCLUSIONS

Summary

With the enhanced capabilities of modern technology, the potential exists for a major impact on the manner in which laboratory information is exchanged between geographically dispersed locations. Following the implementation of Medinet, an interface that will enable electronic exchange of information between heterogeneous laboratory information systems, laboratory orders and results will be electronically exchanged between ordering site and reference laboratory, in real-time.

The design of the study is a pre- and post- implementation evaluation, using a multi-method approach. While the present study reports on the pre-implementation component only, a post-implementation study is planned for approximately six months and one year after Medinet implementation.

With seven distinct objectives, the study was carried out to: 1) identify goals and expected benefits for the implementation of Medinet; 2) establish concerns and potential challenges with the implementation of Medinet; 3) establish the expected impact of Medinet on the management, processing and exchange of laboratory information; 4) establish the expected impact of Medinet on utilization of laboratory services; 5) establish the perceived value of real-time exchange of laboratory information with respect to quality of patient care; 6) establish baseline measurements of turnaround time and order

accuracy; and 7) identify future directions and priorities for laboratory information exchange.

The target population for the study included laboratory staff, physicians and information systems specialists from four sites: 1) the Health Care Corporation of St. John's, 2) the Public Health Laboratory, 3) the Central East Health Care Institutions Board and 4) the Avalon Health Care Institutions Board. The Central East Health Care Institutions Board and the Avalon Health Care Institutions Board were identified as the regions that were most likely to be the first to link to the provincial reference laboratories (the laboratory program at the Health Care Corporation of St. John's and the Public Health Laboratory) via Medinet.

Study instruments included: a) key informant interviews; b) a survey of laboratory personnel; c) a survey of physicians; d) laboratory turnaround time (TAT); and e) a measure of the accuracy with which orders are transmitted to the reference laboratory. All study instruments were developed for the study by the investigator.

The study findings indicate that there are three major goals for the implementation of Medinet: 1) to improve quality of care, through more timely results delivery and fewer transcription errors; 2) to improve information handling and exchange, by reducing much of the work involved in transcribing and preparing reports; and 3) to reduce costs associated with the laboratory testing process, by eliminating the postage bill for results delivery and overtime payment to data entry staff.

Concerns and potential challenges with the implementation of Medinet are related to system capabilities, the elimination of paper reports and security and

confidentiality. While Medinet is designed to allow exchange of laboratory information between heterogeneous systems, there are challenges anticipated related to the cross-referencing of Meditech dictionaries and the establishment of a connection between multiple sites. The responsibility of printing paper reports will shift from the reference laboratory to the ordering site, following Medient implementation. It was suggested that physicians print their own reports from the regional Meditech system and this change in work patterns was recognized as a challenge. While some physicians are concerned that confidentiality and security will be comprised following Medinet implementation, others recognize that confidentiality and security are always a concern where patient information is involved.

Overall, it is expected that Medinet implementation will improve management, processing and exchange of laboratory information. Laboratory staff expect a decrease in time and effort associated with various aspects of the testing process, the most notable of which are the verification of laboratory results at the ordering site and the distribution of results to ordering site and ordering physician. Laboratory staff also expect that Medinet implementation will have a positive impact on selected problems commonly associated with a paper-based system for exchanging laboratory information including lost orders and results and telephone calls between the laboratory and ordering site.

As a result of improved timeliness of results delivery and more accurate transmission of laboratory orders and results, physicians and laboratory staff expect a decrease in unnecessary laboratory testing due to lost tests orders and results, STAT test requests in non-emergency situations and tests performed that were not intended on the

original order. In addition, both laboratory staff and physicians expect enhanced physician satisfaction with laboratory services.

With respect to quality of care, it is perceived that Medinet will lead to improved timeliness of result delivery and improved accuracy with which orders and results are transmitted. More timely diagnosis and treatment, shorter hospital stays, reduced patient exposure to unnecessary testing and enhanced patient satisfaction with services are all anticipated consequences of Medinet implementation.

Baseline measurements of turnaround time (TAT), mean TAT and the cumulative percentage of reports received in 24 hour increments, were established for orders commonly referred from the Central East region and the Avalon region. Baseline measurements of the accuracy with which orders are transmitted to the laboratory were established using a system for categorizing discrepancies as minor or major. Only major errors were included in the calculation of error rates. Baseline measurements will be important during the post-implementation study to assess the impact of Medinet implementation on turnaround time and order accuracy.

Although electronic exchange of orders and results between ordering site and reference site is considered essential and a positive step toward the elimination of paper, study participants would like to see province-wide integration of laboratory information that supports electronic exchange of orders and results between geographically dispersed sites, direct physician order entry (POE) and immediate access to a patient's longitudinal history of laboratory and other diagnostic services from any site in the province.

Implications for Future Research

Important implications for future research have emerged from this study:

1) When assessing expectations of new information technologies prior to implementation, inclusion of questions that can help establish the respondents' level of knowledge of the system would be helpful in understanding the reasons for certain responses.
2) A broad approach was considered appropriate for achieving the objectives of this study. However, more in-depth analysis is needed to understand why certain groups have different perceptions or expectations of the same system.
3) In the evaluation of new computer technologies, the goals of key stakeholders should be identified prior to system implementation instead of basing the evaluation on assumed benefits by the investigator.
4) The use of qualitative methods to establish the goals for new information technologies can help the investigator gain a better understanding as to how key stakeholders expect the identified goals to be met.

Conclusion

Findings of this pre-implementation study indicate that the implementation of Medinet is expected to have an overall positive impact on information management, utilization of laboratory services and quality of patient care. In addition to the pre-defined categories defined by the investigator, further indicators for a post-

implementation study can be developed based on interview findings and responses to open-ended questions. Baseline measurements of turnaround time and order accuracy have been established, against which the effects of Medinet implementation can be assessed. Concerns and potential challenges have been identified and can now be appropriately addressed. The multi-method, pre- and post- implementation approach developed for this study can be adapted for the evaluation of similar information technologies in healthcare.

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Appendix D

Canada Health Infoway Vision and Mission

Vision

A high-quality, sustainable and effective Canadian health care system supported by an infostructure that provides Canadians and their health care providers timely, appropriate and secure access to the right information when and where they enter into the health care system. Respect for privacy is fundamental to this vision.

Mission

Fostering and accelerating the development and adoption of electronic health information systems with compatible standards and communications technologies on a pan-Canadian basis with tangible benefits to Canadians. *Infoway* will build on existing initiatives and pursue collaborative relationships in pursuit of its mission.

2003 Canada Health Infoway
http://www.infoway-inforoute.ca/preview/aboutinfoway/vision.php?lang=en, (accessed 05/04/2004)

Appendix E

Key Informant Interview Telephone Script

Hello Mr. /Ms. _____

My name is Kayla Gates. I am a graduate student with the Faculty of Medicine, Division of Community Health, at Memorial University. As you know, I am conducting an evaluation study of the Medinet system as my Master's thesis.

I am calling to ask for your participation in the study by answering a few questions regarding your expectations for the introduction of the Medinet system. As you are already aware, it is expected that Medinet will be introduced in the _____ *(Central East/Avalon)* Health Care Institutions Board in the very near future, which will enable real-time exchange of laboratory information between all hospital laboratories in the _____ *(Central East/Avalon)* region and the provincial reference laboratories in St. John's.

You are not obligated to participate in the study and confidentiality of all information is ensured. If you choose to participate in the study but are not available for an interview at this time, we can schedule the interview to take place at a more convenient time. If you are willing to volunteer your time to participate in the study, it will be very much appreciated.

(If the individual agrees to participate) Will we go ahead with the interview now or should we schedule for another time?

Scheduled interview date: _____

Thank You.

After the interview is complete:

Thank you so much for your time. Would it be okay to contact you and ask some similar questions after Medinet has been implemented and fully operating for approximately six months?_____

Again, thank you. I appreciate your participation in the study very much.

Appendix F

Key Informant Interview Questions

1. What do you feel are the main goals for the implementation of Medinet?

2. a) What are some of the problems that are currently encountered with respect to the handling and exchange laboratory information?

   b) How do you anticipate that the introduction of the Medinet system will impact these problem areas?

3. Do you anticipate any problems or issues with the process by which Medinet allows the exchange of laboratory data?

4. How do you anticipate that Medinet's autoverification feature will impact the information exchange process?

5. How do you feel that real-time electronic exchange of laboratory information will impact issues of confidentiality (e.g. release of HIV results)?

6. Are there any issues or problems that you anticipate being raised as result of real-time electronic exchange of laboratory data, that doesn't already exist with the conventional system for laboratory information exchange?

7. To what extent do you feel that laboratory information should be interchanged among regions within the province?

8. Are there any other comments that you would like to make regarding your expectations for real-time electronic exchange of laboratory information?

Appendix G

Laboratory Personnel Survey Cover Letter

March 18, 2003

Dear Sir or Madam:

My name is Kayla Gates. I am a graduate student with the Faculty of Medicine, Division of Community Health, at Memorial University of Newfoundland. I have developed an evaluation study of the Medinet system. The full evaluation will consist of a pre- and a post-implementation component so that the perceived value/impact of the system prior to its implementation can be compared to the value/impact realized after the system has been introduced and fully operating for a period of six months. I have received approval from the Human Investigations Committee and Research Proposal Approval Committee to conduct the pre-implementation component as my Master's thesis.

Medinet is a system that will enable electronic exchange of laboratory test orders and results between distant laboratory sites, in real-time. It is expected that Medinet will be introduced in one or more of the Institutional Health Boards (i.e. the Avalon Board and/or the Central East Board) in the near future. This will enable real-time exchange of laboratory test orders and results between all hospitals in those regions and the provincial reference laboratories in St. John's (the Public Health laboratory and the Health Care Corporation of St. John's). Further implementation of Medinet on a province-wide basis will enable real-time exchange of laboratory test orders and results between all reference laboratories and hospital laboratories within the province.

Enclosed you will find a short questionnaire and a stamped return envelope. I am asking for your participation in the study by completing the questionnaire and returning it using the stamped return envelope provided. Participation in the study is voluntary and complete anonymity is ensured.

I would like to thank you in advance for participating in this study.

Sincerely,

Kayla D. Gates

Appendix H

Laboratory Personnel Survey

Perceived Impact of the MEDINET System for Real-Time Exchange of Laboratory Information

MEDINET is a system that will enable electronic exchange of laboratory test orders and results between distant laboratory sites, in real-time. Implementation of Medinet on a province-wide basis will enable real-time exchange of laboratory test orders and results between all reference laboratories and hospital laboratories within the province.

Please complete the following demographic information.

1. Which of the following best describes your current position? (n=23)
   a.) Technical (11)
   b.) Clerical (2)
   c.) Data entry (4)
   d.) Supervisory (5)
   e.) Other (please specify) _____ (1)

2. Please indicate the number of years that you have been working in a clinical laboratory related area: * For responses to question 2, see Table 3 page 42

   a.) Present position _____ Years c.) At present site _____ Years
   b.) At other site(s): _____ Years d.) Other position(s) _____ Years

3. In what year were you born? 19____ * For responses to question 3, see Table 3 page 42

Please respond to items 4 and 5 by circling one of the following responses:

*1 **Significant Decrease***
*2 **Slight Decrease***
*3 **No Change***
*4 **Slight Increase***
*5 **Significant Increase***

The processing of a test order often involves several intermediate steps between specimen collection and receipt of test results at the originating laboratory.

4. How do you anticipate that real-time electronic exchange of laboratory test orders and results will impact each of the following:

	(D)				*(I)*
a.) effort required to send a test order to a reference laboratory (n=23)	1(9)	2(4)	3(8)	4(2)	5(0)

b.) effort (time) required to verify orders at the reference laboratory (n=23)	1(5)	2(7)	3(11)	4(0)	5(0)
c.) time elapsed between specimen collection and testing (n=23)	1(3)	2(8)	3(12)	4(0)	5(0)
d.) effort (time) required to verify results before release from reference laboratory (n=23)	1(1)	2(10)	3(12)	4(0)	5(0)
e.) effort (time) required to distribute results to originating laboratory (n=19)	1(13)	2(4)	3(2)	4(0)	5(0)
f.) elapsed time between testing and dissemination of results from reference laboratory (n=19)	1(5)	2(9)	3(5)	4(0)	5(0)
g.) effort (time) required to verify results upon receipt at the originating laboratory (n=19)	1(10)	2(8)	3(1)	4(0)	5(0)
h.) effort (time) required to distribute results to ordering physician (n=23)	1(13)	2(7)	3(3)	4(0)	5(0)

A review of the laboratory testing process has identified several problem areas that may exist with the exchange of laboratory information.

5. How do you feel that real-time electronic exchange of laboratory information between an ordering laboratory and a reference laboratory will impact each of the following:

	(D)				*(I)*
a.) number of telephone inquires to clarify inaccurate/incomplete order information (n=23)	1(4)	2(9)	3(7)	4(3)	5(0)
b.) number of inquires regarding test status (n=23)	1(9)	2(5)	3(6)	4(3)	5(0)
c.) effort required to trace a test's status (n=23)	1(8)	2(7)	3(8)	4(0)	5(0)
d.) effort involved in the referral of a test order that was intended for another reference laboratory (n=23)	1(2)	2(5)	3(16)	4(0)	5(0)
e.) number of test results sent to incorrect location from reference laboratory (n=23)	1(11)	2(8)	3(4)	4(0)	5(0)
f.) number of orders received at the reference laboratory that were meant for another location (n=19)	1(9)	2(5)	3(5)	4(0)	5(0)
g.) number of 'lost' test results (n=23)	1(12)	2(10)	3(1)	4(0)	5(0)
h.) number of 'lost' test orders (n=23)	1(11)	2(6)	3(6)	4(0)	5(0)

	(D)				(I)
i.) number of tests performed that was not intended on the original test requisition (n=23)	1(6)	2(11)	3(5)	4(1)	5(0)
j.) number of duplicate test orders (n=22)	1(9)	2(3)	3(9)	4(1)	5(0)
k.) number of STAT/urgent test orders in non-emergency situations (n=19)	1(3)	2(5)	3(9)	4(1)	5(1)
l.) amount of paper generated (n=23)	1(11)	2(6)	3(1)	4(1)	5(4)

Please respond to items 4 and 5 by circling one of the following responses:

1 Significant Decrease
2 Slight Decrease
3 No Change
4 Slight Increase
5 Significant Increase

6. Overall, do you feel that real-time exchange of laboratory information will:

	(A)				(D)
a.) improve timeliness of 'normal' test result to ordering physician (n=23)	1(14)	2(7)	3(1)	4(0)	5(0)
b.) improve timeliness of 'abnormal' test result to ordering physician (n=23)	1(10)	2(6)	3(5)	4(2)	5(0)
c.) improve reliability of test results (n=23)	1(5)	2(9)	3(6)	4(3)	5(0)
d.) improve overall efficiency of information handling (n=23)	1(15)	2(4)	3(3)	4(0)	5(1)
e.) improve physician satisfaction with laboratory services (n=23)	1(11)	2(8)	3(4)	4(0)	5(0)
f.) improve patient satisfaction with laboratory services (n=23)	1(13)	2(6)	3(4)	4(0)	5(0)
g.) result in a change of work responsibilities within the laboratory (n=23)	1(5)	2(11)	3(6)	4(4)	5(0)
h.) result in a decreased workload (n=23)	1(7)	2(9)	3(4)	4(2)	5(1)
i.) require a comprehensive training session prior to introduction (n=23)	1(9)	2(5)	3(3)	4(5)	5(1)

Appendix I

Physician Survey Cover Letter

April 3, 2003

Dear Sir or Madam:

My name is Kayla Gates. I am a graduate student with the Faculty of Medicine, Division of Community Health, at Memorial University of Newfoundland. I have developed an evaluation study of the Medinet system. The full evaluation will consist of a pre- and a post-implementation component so that the perceived value/impact of the system prior to its implementation can be compared to the value/impact realized after the system has been introduced and fully operating for a six month period. I have received approval from the Human Investigations Committee and Research Proposal Approval Committee to conduct the pre-implementation component as my Master's thesis.

Medinet is a system that will enable electronic exchange of laboratory test orders and results between distant laboratory sites, in real-time. It is anticipated that Medinet will be introduced in the _____ *(Central East/Avalon)* Health Care Institutions Board in the near future. This will enable real-time exchange of laboratory test orders and results between all hospitals in the _____ *(Central East/Avalon)* region and the provincial reference laboratories in St. John's (the Public Health laboratory and the Health Care Corporation of St. John's). Further implementation of Medinet on a province-wide basis will enable real-time exchange of laboratory test orders and results between all reference laboratories and hospital laboratories within the province.

Enclosed you will find a short questionnaire and a stamped return envelope. I am asking for your participation in the study by completing the questionnaire and returning it using the stamped return envelope provided. Participation in the study is voluntary and complete anonymity is ensured.

I would like to thank you in advance for participating in this study.

Sincerely,

Kayla D. Gates

Appendix J

Physician Survey Second Mail-out Note

Approximately three weeks ago, you received a survey package consisting of a cover letter that explained the purpose of the study, a questionnaire and a stamped return envelope.

If you have had the opportunity to complete and return your questionnaire, I thank you so much for volunteering your time. I am asking you nothing further at this time.

If you have not had an opportunity to complete and return the questionnaire, please find enclosed a second survey package that is identical to that originally received. This will provide you with a second opportunity to participate in the study, if you still intend to do so. I would like to thank you in advance for volunteering your time to the study.

Appendix K

Physician Survey

Perceived Value of the MEDINET System for Real-time Exchange of Laboratory Information

MEDINET is a system that will enable electronic exchange of laboratory test orders and results between distant laboratory sites, in real-time. Implementation of Medinet in the Central East Health Care Institutions Board will enable real-time exchange of laboratory test orders and results between all hospitals in the Central East region and the provincial reference laboratories in St. John's (the Public Health laboratory and the Health Care Corporation of St. John's). Further implementation of Medinet on a province-wide basis will enable real-time exchange of laboratory test orders and results between all reference laboratories and hospital laboratories within the province.

Please complete the following demographic information.

1. Which of the following best describes the setting at which you currently work? (n=59)

a.) Hospital (35)
b.) private practice (12)
c.) group practice (10)
d.) other (please specify) _____ (2)

2. Which of the following best describes your current field of practice? (n=59)

a.) General Practitioner (36)
b.) Specialist (22)
c.) Other (please specify) _____ (1)

3. In what year were you born? 19_____ * For responses to question 3, see Table 7 page 50

4. Please indicate if you are: (n=59)

a.) Male (47)

b.) Female (12)

5. Please indicate the number of years that you have been practicing medicine in each of the following settings: * For responses to question 3, see Table 7 page 50

a.) Total years of practice _____
b.) Years of Practice in Newfoundland & Labrador _____
c.) Years at your current site _____
d.) Total years in hospital setting _____

e.) Total years in non-hospital setting _____
f.) Other (please specify) _____

Items 6 and 7 refere to your use of laboratory services.

* For responses to questions 6 and 7, see Table 9 page 53

6. For approximately what percentage of all clinical visits do you order laboratory tests for the patient? _____

7. Approximately what percentage of all clinical decisions or diagnosis do you base on laboratory test results? _____

Items 8 through 10 refer to the manner in which you obtain laboratory test results. Please read each question carefully.

8. In which of the following forms do you currently obtain laboratory test results? (circle all that apply) (n=58)

a.) Verbal/phone report (24)
b.) Hand written report (6)
c.) Printed computer generated report (46)
d.) Fax (16)
e.) Electronic report (34)
f.) Other (please specify) _____ (0)

9. Do you currently have access to the MEDITECH system for obtaining laboratory test results?

_____ Yes (47)

_____ No (12) **IF NO, please skip to question 11**

10. Using the following scale, please indicate the extent to which you use the MEDITECH system for obtaining laboratory test results? (n=47)

a.) Always (19)
b.) Often (22)
c.) Sometimes (3)
d.) Rarely (2)
e.) Never (1)

For items 11 through 13, please indicate the extent to which you agree/disagree with each statement using the following scale:

1 Strongly Agree (A)
2 Somewhat Agree
3 Neither Agree nor Disagree
4 Somewhat Disagree
5 Strongly Disagree (D)

11. In general:

	(A)				*(D)*
a.) 'Normal' laboratory test results are available in a timely manner (n=57)	1(29)	2(17)	3(5)	4(4)	5(2)
b.) 'Abnormal' laboratory test results are available in a timely manner (n=57)	1(30)	2(18)	3(3)	4(4)	5(2)
c.) Diagnosis is delayed until laboratory test results are received (n=57)	1(6)	2(21)	3(14)	4(8)	5(8)
d.) Treatment is deferred until laboratory test results are received (n=57)	1(4)	2(21)	3(18)	4(9)	5(5)
e.) A patient will inquire about a test result before it is available (n=56)	1(9)	2(18)	3(12)	4(12)	5(5)
f.) In non-emergency situations, a STAT test is ordered to speed up the testing process (n=57)	1(11)	2(7)	3(5)	4(15)	5(19)
g.) A duplicate test is ordered when a test order/result is considered 'lost' (n=55)	1(9)	2(21)	3(11)	4(7)	5(7)

Studies have shown that unnecessary utilization of laboratory services can contributed, in part, to the way in which laboratory information is exchanged between physician and laboratory.

12. Do you feel that real-time electronic exchange of laboratory test orders and results will decrease unnecessary utilization of laboratory services by:

a.) Decreasing STAT/urgent test requests in non-emergency situations (n=58)	1(17)	2(19)	3(11)	4(7)	5(4)
b.) Decreasing duplicate testing due to 'lost' test orders/results (n=58)	1(23)	2(15)	3(11)	4(5)	5(4)
b.) Decreasing unnecessary testing due to order inaccuracies (n=58)	1(20)	2(17)	3(9)	4(7)	5(5)

To contribute to patient management, laboratory results must be available in a manner than is medically useful.

13. Do you feel that real-time electronic exchange of laboratory test orders and results will enhance quality of care by:

	(A)				*(D)*
a.) enabling more timely decision making regarding diagnosis (n=58)	1(22)	2(26)	3(6)	4(3)	5(1)
b.) enabling more timely patient treatment (n=58)	1(24)	2(26)	3(4)	4(3)	5(1)
c.) decreasing length of hospital stay due to delays in laboratory results delivery (n=56)	1(19)	2(19)	3(10)	4(6)	5(2)
d.) safeguarding patients from unnecessary testing due to 'lost' test orders/results (n=58)	1(23)	2(21)	3(11)	4(3)	5(0)
e.) improving reliability of laboratory test results (n=57)	1(15)	2(18)	3(15)	4(5)	5(4)
f.) enhancing patient satisfaction with quality of services (n=58)	1(18)	2(23)	3(11)	4(3)	5(3)
g.) enhancing physician satisfaction with laboratory services (n=58)	1(25)	2(23)	3(6)	4(1)	5(3)

For the final three questions, please feel free to use the back cover in addition to the space provided, if necessary.

14. Do you feel that the real-time electronic exchange of laboratory data will raise any new issues or intensify any existing problems with laboratory services (for example, with confidentiality)? If YES, how?

Appendix L

Order Accuracy Record

Reference Site: HCCSJ_____ PHL_____

Institutional Health Board: Central East_____ Avalon_____

Total Orders: _____

Total Fields: _____

Date Received: _____

Field	**Discrepancy Type**		
	Minor	Major	**Total**
Age			
Sex			
Collection date			
MCP Number			
Physician's Name			
Total			

Appendix M

Order Accuracy Classification Scheme

Field	Minor	Major
Age	Difference of 1 year due to miscalculation from MCP#	Missing Difference > 1year (not due to miscalculation from MCP#)
Sex	N/A	Missing Different
Hospital Number	N/A	Missing Different
Collection Date	Missing time Different time	Missing month/day/year Different month/day/year
Physician's Name	Difference of 1 letter Added/missing initial	Missing Different first name/last name

Appendix N

Data Release Form for obtaining Turnaround Time

Permission to Access Data

TITLE:	Development of an Evaluation Framework for a System that Enables Real-Time Exchange of Laboratory Information: The Medinet System.
INVESTIGATOR(S):	Miss Kayla D. Gates Telephone number: (709) 757-2445

I have been asked by Kayla Gates, a graduate student with the Faculty of Medicine, Division of Community Health at Memorial University of Newfoundland to provide to take part in an evaluation study of the Medinet system.

It has been explained to me that my participation in the study will include providing Miss Gates with turnaround times for laboratory tests sent to Health care Corporation of St. John's and the Public Health Laboratory between *Date 1* and *Date 2*. It has been explained that all data in paper format will be stored in a locked filing cabinet and all data in electronic format as password protected computer files. Upon completion of the study, the data will be stored at NLCHI; the guardian of the data will be Don MacDonald, Director of Research and Development.

I give permission for Miss Gates to have access to the above information.

Signature of Laboratory Manager/Director	Date
Signature of Principal Investigator	Date

Appendix O

Data Release Form for obtaining Laboratory Orders

Permission to Access Data

TITLE: Development of an Evaluation Framework for a System that Enables Real-Time Exchange of Laboratory Information: The Medinet System.

INVESTIGATOR(S): Miss Kayla D. Gates
Telephone number: (709) 757-2445

I have been asked by Kayla Gates, a graduate student with the Faculty of Medicine, Division of Community Health at Memorial University of Newfoundland to provide her with all laboratory orders received from the Central East and Avalon Health Care Institutions Board during a specified one week period, to be analyzed for errors and inaccuracies.

I am agreeable to the following process: I will retain each laboratory order list received from the Central East and Avalon Health Care Institutions Board between *Date 1* and *Date 2,* and print the corresponding list from our laboratory information system after all orders have been transcribed. As a trusted third party, the Newfoundland and Labrador Centre for Health Information (NLCHI) will receive the requested information and remove all personal identifiers from the orders prior to its analysis by Miss Gates. Both Miss Gates and NLCHI will store all data in paper format in a locked filing cabinet and all data in electronic format as password protected computer files. Upon completion of the study, the de-identified data will be stored at NLCHI; the guardian of the data will be Don MacDonald, Director of Research and Development.

I give permission for Miss Gates to have access to the above information after removal of personal identifiers by NLCHI acting as a trusted third party.

_____ _____

Signature of Laboratory Manager/Director Date

_____ _____

Signature of Principal Investigator Date