Review of Laboratories of Eastern Health

by

University Health Network
Laboratory Medicine Program

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A. Background

The leadership of Eastern Health in St. John's Newfoundland requested an external review of its laboratory medicine operations by the University Health Network (UHN) Laboratory Medicine Program (LMP). The review will support the ongoing system-wide quality improvement activities in preparation for the upcoming hospital-wide Accreditation Canada survey scheduled in September, 2010.

In addition, UHN-LMP was requested to immediately conduct an investigation of erroneous reporting of low blood levels for the widely used immunosuppressant drug, cyclosporine A, in transplant patients.

Eastern Health is the largest integrated health authority in Newfoundland and Labrador, with 12,000 dedicated employees serving a regional population of more than 293,790. They offer the full continuum of health and community services, including public health, long-term care, community services, hospital care and unique provincial programs and services.

The geographic catchment area for Eastern Health is that part of the province of Newfoundland and Labrador east of (and including) Port Blandford. This area includes the Avalon, Burin and Bonavista Peninsulas as well as Bell Island. The geographic territory covered by Eastern Health is approximately 21,000 km^2. Settlement patterns, due in large part to the region's historic ties to the cod fishery, have resulted in many small communities, scattered predominately along the coastline of the peninsulas. The area also takes in the capital of the province and the largest metropolitan area, the St. John's CMA (census metropolitan area). The boundaries of Eastern Health include 111 incorporated municipalities, 69 local service districts and 66 unincorporated municipal units.

Scope of the Review

The review of the Eastern Health Authority Quality Management System (QMS) was conducted within a framework of standards and regulatory requirement references for laboratory medicine programs in Canada. These include, College of American Pathologist, Ontario Laboratory Accreditation, AABB (formerly the American Association of Blood Banks) and American Society of Histocompatibility and Immunogenetics.

The scope of review work was encompassed by the following key activities at the Eastern Health sites in the areas listed below:

1. On site visits by several discipline-specific teams to:

   General Hospital (Health Sciences Centre)
   Areas visited and reviewed:
   - Biochemistry
   - Haematology
   - Transfusion Medicine
   - Microbiology
   - Pathology
   - Cytogenetics
   - Molecular Diagnostics
   - Histocompatibility
   - Specimen Management
   - Point of Care Testing

   St. Clare's Mercy Hospital
   Areas visited and reviewed:
   - Biochemistry
   - Haematology
   - Transfusion Medicine
   - Pathology
   - Specimen Management

2. Review of global operations, safety, Quality System development and Laboratory Information Systems at both sites

3. Review of documentation (policies, processes, procedures, and records)

4. Interviews with laboratory medical and scientific leadership and staff

Although an accreditation readiness review was not conducted during this visit, the UHN team has several years of experience working with the accrediting agencies identified above, and used this to give context to this review of Eastern Health.

B. Executive Summary

The leadership team at the Eastern Health Authority Laboratories is committed to building a better Quality Management System than the one that currently exists. Many initiatives are underway as they prepare for assessment by Accreditation Canada, to be followed by Ontario Laboratory Accreditation (OLA). The timelines for both accreditations are extremely short and will require the focused dedication of the quality resource team, laboratory physicians and scientists, administration and technical staff. Furthermore, it is essential that the Laboratory receive the complete support of the Eastern Health Authority senior management team in order to achieve these goals. A critical element for successful achievement of these goals is the implementation of a dynamic and integrated Quality Management System. The detailed observations and recommendations made by the University Health Network Laboratory Medicine Program reviewers are provided in the following report. The common themes are:

Leadership and Resources:

Laboratory medicine has grown exponentially over the past few decades in both scope and complexity of laboratory testing. In order to keep pace with these rapid changes, it is essential to have the correct governance in place to manage it.

At Eastern Health, a review of the laboratory medicine leadership structure is recommended. This is a large reference centre for the province and the scope of testing is broad and complex. Particular attention needs to be focused on the experience, expertise, staffing levels and succession planning for all staff, including Pathologists, Laboratory Physicians, Pathologist Assistants, Technologists, Laboratory Assistants, Administrators, and Managers. Furthermore, succession planning is critical to allow for renewal of expertise due to staffing challenges of an aging workforce. This issue is not unique to Eastern Health but is common to health care organizations across Canada.

It is equally important for the Laboratory to be fully supported by the organization's senior management team. It is essential that the Laboratory be recognized as a valuable clinical resource for other hospital programs so that service requirements and demands are clearly understood by all. It is estimated that between 70 and 80 percent of all clinical decisions are based on the results of laboratory tests.

Lastly, when building and maintaining a Quality Management System, it would be preferred that a Quality Manager or Coordinator with a laboratory background be designated. A quality committee chaired by the Medical Director should be struck to direct and monitor quality activities.

Clinical Practice:

Many organizations such as the College of American Pathologists, AABB and the Clinical and Laboratory Standards Institute have developed guidelines for laboratory practice for most laboratory disciplines. These guidelines are easily accessible to all laboratorians.

All laboratory departments at the Eastern Health should conduct a review of best practices for their respective disciplines and address any gaps in their current procedures or implement new procedures. Standardized operating procedures should also be implemented regionally. Keeping current and looking to the future is equally as important and can best be accomplished

by networking with other hospitals and organizations, attending relevant conferences, vendor meetings, joining relevant societies and researching literature. All of these activities should be strongly encouraged.

In addition, recognized laboratory safety practices have been clearly defined by numerous sources. Eastern Health should review their current laboratory safety program and should implement a single laboratory safety committee with representation from all laboratory departments and job classifications. Standardization and implementation of a sound laboratory safety program will be easier to achieve through this committee's oversight.

Documentation

Document control is an integral component of a Quality Management System. Providing staff with current and up-to-date processes and procedures is crucial to maintaining standardization and ensure good laboratory practices. Although Eastern Health has developed a document control system, it is highly recommended that a document control system be implemented which meets the requirements defined by OLA. There are numerous products on the market that not only control documents but also have other features that assist the laboratory with accreditation requirements such as equipment inventory, compliance and internal audits.

Eastern Health has an electronic Occurrence Management program in place, but the functionality appears to be limited. Feedback regarding incident resolution is not always available. It is recommended that the functionality of the Occurrence Management system be reviewed and/or an alternative system be implemented within the Laboratory.

Infrastructure

To build a good Quality Management System, it is critical to have infrastructure to support it and space in which to house it. There is concern regarding space in the Mass Spectrometry Laboratory and the Molecular/Cytogenetics areas. The Microbiology Laboratory is very compartmentalized, which creates workflow and safety challenges.

The Meditech Laboratory Information System (LIS) is a very good system but the full functionality and report generation capabilities are not utilized. Only a limited number of staff have the expertise to maintain and perform high level LIS functions; the majority of staff members do not appreciate the functionality of the system. It is recommended that a Laboratory Information Team be created and some if not all of the team members should have Laboratory experience.

Lastly, although most of the Laboratory seemed to be adequately equipped, some instruments are reaching the end of their life cycle and should be replaced. A laboratory-wide 5 year capital equipment plan should be developed to guide strategic planning and budgeting for the replacement of ageing equipment and integration of new systems. Eastern Health should be a leader in the province for early adoption of new and innovative technologies.

In conclusion, there has been a lot of focus by the Eastern Health Laboratory leadership team and staff in building their Quality Management System and preparing for Accreditation. Eastern Health should be commended for such support. They must ensure that there is a long term commitment to the provision of needed resources.

We trust that the recommendations put forward will assist Eastern Health in enhancing the quality and sustainability of laboratory medicine services to ensure the success of the clinical programs and to assure the safety of their patients.

C. Observations and Recommendations

The laboratories were evaluated by section. Observations and recommendations are provided in the following manner:

1. Medical Staff
2. Quality Management Systems
3. Biochemistry (detailed report on Mass Spectrometry in Appendix 1)
4. Haematology
5. Transfusion Medicine
6. Microbiology
7. Pathology
8. Cytogenetics
9. Molecular Diagnostics
10. Histocompatibility
11. Specimen Management
12. Point of Care Testing
13. Laboratory Information Systems
14. Safety

1. Medical Staff

Observations

The department services a regional academic hospital and three smaller centres in and around St. John's. The pathology service and the laboratory have been the subject of a judicial inquiry that created considerable strain. Subsequently there has been investment in improvement, however, despite this investment, there are major issues that must be addressed if this department is to provide a sustainable laboratory service.

The key findings include the following:

- a dysfunctional relationship among the various members of the medical staff
- lack of expertise in complex areas of testing
- inappropriate relationships and responsibilities between management and medical staff

The medical staff members are significantly divided. Morale is low and there is suspicion and distrust within the group.

The distinction between those who are members of Memorial University of Newfoundland and those who are not has created a two-tiered system that is not reflective of the realities of training, expertise, ability or contribution to academic goals in research and education.

The previous leadership had identified a select group of individuals who used their leadership positions to avoid contribution to completion of the work of the department. This has been addressed and all members are now contributing appropriately.

The implementation of the Maung system of AP workload distribution was being inappropriately used to determine individual workload as opposed to departmental workload for staffing adjustments. The average daily workload had become interpreted as a daily "maximum workload". While there was truly a need to re-evaluate and equalize workload, the focus on the Maung units must be set aside for the group to function effectively.

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Recommendations

1. **Consolidation to a single site pathology practice at HSC.** The division of staff on multiple sites was a barrier to the goal of integration. The medical staff have recently been moved from St. Clare's to the HSC and this single site model within St. John's has decreased the sense that the two groups have separate work but just happen to be in the same department. The group has started to understand that they represent a single team that is working towards a common goal. Cytology still remains off site at the Miller Centre and this creates a problem for medical staff when they are on the cytology rotation, as they must leave their other work behind, creating an inefficient workflow***. It is recommended that space be identified in the HSC adjacent to the existing labs to relocate cytology and consolidate the activities of the department.***

2. **Consolidation to a single Academic model.** The separation of medical staff into MUN-appointed professors and hospital-appointed staff is divisive and offensive. For this group to function as a team, they must all hold responsibility for academic activities, including teaching, research and publication. The allocation of 20% protected time for academic activities should be applied to all members of the department. Access to MUN

libraries and other resources is a sine qua non for pathologists practicing in this environment, as they must keep current with the medical literature. Annual review of productivity should be carried out as part of the performance assessment for all staff. ***It is recommended that the department be reorganized to accommodate MUN appointments of all medical staff on an equal basis.***

3. **Reorganization of the departmental structure.**
    a. The Clinical Chief and Laboratory Medical Director Position should be a strategic role for the entire laboratory service; this position has been advertised and should be filled by a visionary who understands the needs of all of the disciplines in Laboratory Medicine.
    b. The site chief positions have been eliminated.
    c. ***We recommend the recruitment and appointment of Division Heads who have knowledge in the areas of technical as well as professional practice in Biochemistry and Haematology, Microbiology and Anatomical Pathology***.
    d. The ideal candidate for the Division Head of Anatomical Pathology should be experienced and provide both liaison and leadership to the technical and support areas but also have the experience to mentor and support the development of recently hired pathologists. Anatomical Pathologists would report directly to the Divisional Head.
    e. The Division of Anatomical Pathology should have Directors of Autopsy, Cytology and Surgical Pathology. The people in these roles should have responsibility for scheduling and workload distribution within those areas and should function as the liaison with management. They should be responsible for PA activities and supervision, and for SOPs (see below item 6). ***Oversight of the technical laboratory activities that support these services (Histology, Immunohistochemistry, etc) should be assigned to individuals with expertise in these areas to ensure quality technical products from the laboratories***. Some of these positions have been filled at this point, but there are others that require attention.
    f. Work has been sent out to a laboratory in Ontario when staff numbers were decreased due to unexpected leaves. Staffing has been a challenge but most of the staff members have returned from absences; one has resigned and there is a search for the two leadership positions underway. One position is being held for a physician who is completing subspecialty training in October. ***With the full complement of pathologists, no work should be sent out of the department with the exception of individual case consultations in areas of significant complexity. Referral of cases out of province must follow appropriate protocols and should be pre-approved by the Division Head or Clinical Chief.***

4. **Develop a well considered strategy to achieve sub-specialty practice.** The practice of pathology has grown to a level where no single pathologist can provide the quality of report and knowledge of all areas at the level expected in Canada. The development of organ-specific expertise is important and efforts in this regard have been initiated by the previous Clinical Chief who has hired several young pathologists with subspecialty training. There is considerable resistance to this by some of the staff, but there is recent agreement to ***begin implementation of at least partial subspecialization by all and complete subspecialization by some medical staff.***

5. **Recruit in areas of complex testing.** There are clear needs for more and better medical and scientific staff in the areas of biochemistry, hematology/hematopathology, transfusion medicine, microbiology, molecular diagnostics, cytogenetics and histocompatibility testing. ***The department should focus on recruiting to these areas.*** For example, there is currently one 0.8 FTE Hematologist responsible for hematology, including bone marrows, regional transfusion medicine services and special coagulation as well as university duties and regional CBS NAC leadership role,. This is clearly insufficient for the size, volumes and complexity of the laboratory operations

6. **Implement a telepathology strategy for support of a multisite subspecialty model of Pathology.** The equipment to support this strategy has been recently purchased and installation has begun. Training of Pathologists is underway and this program should be gradually implemented, initially between St. Clare's and the HSC, then to involve Carbonear and Clarenville. This program will ultimately allow coverage of work at various sites as required without interruption and without the need for locum coverage or staff movement during vacations and other leaves. It also will allow inter-pathologist consultation for expert opinion and internal QA processes. The Department should give consideration to establishing a consultation arrangement with a fully sub-specialized group like UHN that also has the capacity to support telepathology in real time to provide timely external consultative opinions.

7. **Implement a Pathology QA program for Medical Staff.** Participation in routine QA processes should be required for all staff. Documentation of correlations between intraoperative consultation and final diagnosis should be performed on all cases with intraoperative consultation. Cytology-tissue correlations should be performed regularly. Cases presented at rounds should be annotated as having undergone QA. The seeking of a second opinion within the department is a useful QA activity, shows management discipline and provides an educational opportunity that is import to the mission of the department**.** Synoptic reports should be implemented for cancer diagnoses**.** ***It is recommended that these QA activities be documented in the LIS and regular reports be obtained to evaluate the workload and quality of Pathologist activities.***

   The QA process should also have a focus on activities in the various areas of Pathology. For example, the Head of Surgical Pathology should work with the pathologists who have expertise in the various organ-based diseases to determine the appropriate grossing protocols and sectioning of tissue. The head of Autopsy should take the responsibility of ensuring correct tissue sampling and retention. The Head of Cytology should be responsible for oversight of technologist screening. ***It is recommended that the department develop written standards, policies and protocols for quality and performance in technical areas*****.**

8. **Improve workflow in technical and clerical support.** There are many issues in the department that are addressed in other parts of this report. Addressing these issues will assist the Pathologists in completing their work in a timely fashion. In particular, the IS is not being properly utilized, and there is too much reliance on paper. The Laboratory Manager and the technical staff are pulled in multiple directions by pathologists, resulting in inefficiency and creating variation in practices that are difficult to manage and create dissatisfaction. ***It is recommended that the LIS be used to decrease opportunities for error and improve access to statistics, and that the New leadership structure be used to reduce the involvement of Management and technical staff in pathologist issues*****.**

2. Quality Management Systems

Eastern Health has assigned eight staff and a program manager to develop the QMS; they are actively engaged and working well together. The program manager does not have a background in laboratory medicine but is very experienced in ISO paradigms and is a valuable asset to the program. To ensure the sustainability of the quality management model, QMS must have very strong linkages to laboratory subject expertise.

The present structure of quality coordinators supervised by one quality manager is sufficient and we recommend that a further review of all site needs with respect to this resource be conducted.

There is a comprehensive plan in place to generate the documentation required to meet Ontario Laboratory Accreditation (OLA) and Accreditation Canada requirements. There is management commitment to this plan in the form of sufficient resources assigned. The timeline of September for completion of this phase of quality system development will be extremely challenging and therefore the timeline should be re-evaluated.

Observations

a. There are sufficient resources assigned for the development of a quality system. There is awareness that education regarding quality systems is essential.
b. Management review process is not formalized and no laboratory quality committee exists.
c. Role clarity in documented job descriptions is not well defined.
d. The appropriate delegation of tasks to each level of staff is not well defined and currently does not match level of experience and responsibilities, e.g. Charge/Tech 3 staff doing inventory checks
e. Good lab practices such as open dates on reagents are not consistently followed.
f. Inconsistent sign-off of quality control (QC) by senior technical staff.
g. Proficiency testing program does not encompass the entire testing menu and procedures are not complete.
h. Uncontrolled documents, bench notes and patient instructions were observed. Blank procedure sign-off sheets are used; these do not ensure that all staff members have complied with review. Document review and approval by the new administrative director is incomplete.
i. Occurrence Management mechanism used enterprise-wide does not notify lab managers of follow-up by clinical managers; data is not available for trending or the identification of opportunities for improvement; corrective action processes within the analytical process are lacking, e.g. temperature charts with entries out of range and with no action noted.
j. Records for the life-span of equipment with regard to maintenance and troubleshooting are not consistently kept or stored; documents to capture these events have not been developed.

Recommendations

1. A quality committee chaired by the medical director and encompassing all labs should be struck and given responsibility for all aspects of the quality system.
2. An individual with a laboratory medicine background be assigned the Quality Manager role. This would facilitate the work associated with accreditation and quality system maintenance for a laboratory; examples are occurrence management, quality reporting and improvement, and keeping current with new laboratory-specific requirements.

3. More educational development should be provided for the quality coordinators with regard to good laboratory practices, procedure writing and quality system development.
4. Roles should be clarified with regard to appropriate tasks for each role level in the technical areas.
5. More education regarding quality systems for all staff is underway but in small measures. Online and other mechanisms should be explored to help orient staff to quality system concepts.
6. Implement ‘quick fixes’, examples are the recording of open dates on reagents or actions taken when expected results or fridge temperatures are not met. Identifying the resources for this change management and implementing changes as soon as possible without waiting for the whole quality system to be in place should be a priority.
7. Engagement of the staff in developing the documents for tasks they perform or will perform is recommended whenever possible, as they are the content experts and will gain commitment to changes through this process.

3. Biochemistry & Mass Spectrometry

The Biochemistry Laboratory is staffed by knowledgeable and dedicated individuals. Change in laboratory structure is recommended, specifically to bring the renal and core biochemistry labs together under one leadership structure.

Observations

a. The Renal and Biochemistry laboratories are separate entities and do not benefit from efficiencies in standardization and management. The Clinical Biochemist from the renal lab would provide needed expertise in the Biochemistry lab.
b. Laboratory staff practices are inconsistent, e.g. labelling of all reagents with receipt and expiry dates.
c. Documentation in the laboratory is incomplete or lacks comprehensiveness and clarity. Critical results reporting procedure lists both SI and conventional units (e.g. Digoxin). The turnaround time procedure does not list times for every test performed. Documents would be better organized by lab section.
d. Space in the urinalysis room is inadequate.
e. LIS support is lacking and the application is not optimized to provide: auto-verification for high volume and immunoassay testing, automated reporting of serum indices and associated interpretative comments for high volume chemistry analyzers, and interfacing of all automated analyzers, e.g. Immulite in Renal lab.

Recommendations

1. Combine the Renal and Biochemistry labs with appropriate Clinical Biochemist resources.
2. Communicate and manage performance of expected laboratory practices, e.g. labelling of all reagents with receipt and expiry dates.
3. Improve the documentation of procedure revisions and remove inaccurate or unneeded sections. Organize documents for optimal accessibility and readability.
4. Reorganize an adjoining section of the laboratory to increase space for urinalysis testing.
5. Enhance LIS support to provide: auto-verification for high volume and immunoassay testing, automated reporting of serum indices and associated interpretive comments for high volume chemistry analyzers, and interface all automated analyzers, e.g. Immulite in Renal lab.

The investigation of a specific incident in Mass Spectrometry is appended (Appendix 4). The summary recommendations are as follows:

1. Review scope of responsibility and levels of staffing for senior technologists and Biochemists.
2. Improve documentation of preventative maintenance procedures.
3. Increase frequency/scope of QMS initiatives – QC documentation, split sampling, method validation.
4. Review space requirements.
5. Collaborate with other testing centres for method development and split sample comparisons.

4. Haematology

Technical Staffing

The Hematology division is well staffed with competent and committed technologists. The charge technologist is extremely knowledgeable. There is an opportunity for leadership renewal and review in this area due to the pending retirement of the division manager.

Physician Staffing

The medical director is responsible for Haematology and Transfusion Medicine; she has a 0.8 FTE appointment but in reality spends a not insignificant part of her time on university duties and on her role as lead for the Canadian Blood Services National Advisory Committee. There are 3 clinical hematologists who assist by reading bone marrows and peripheral blood films. Flow cytometric studies are reported by two anatomic pathologists. It is very difficult indeed for anyone in this environment to be able to attend CME and to take needed vacation or any other leave without seriously exposing the haematology laboratory to vulnerabilities. Urgent consideration should be given to recruiting more laboratory physicians for this division, to provide more stable coverage for the laboratory. Recruitment should include a search for someone with a focus on coagulation and someone with expertise in Transfusion Medicine. These recruitments would achieve appropriate medical staff complement to meet the current scope and complexity within these services, and support the recommendation contained in the Anderson Report. As there is anticipation of increased regional responsibilities by the HSC labs, these recommendations may have to be reviewed upwards.

Equipment, Automation & Facilities

The lab is currently adequately equipped; however, a regular capital equipment renewal cycle should be maintained. The department is proactive with respect to new technology such as Cellavision. The planned implementation of this application will enhance quality and service and requires structures such as LIS support to be successfully completed and implemented.

Closer proximity of the core haematology and coagulation departments would be beneficial with respect to staffing resources and interaction.

Advancement in the documentation of operating processes and procedures is in progress with the appropriate supports. The implementation of Meditech LIS functionality to automate many QC processes and to incorporate Westgard rules should be implemented. Designated staff training of the overall functionality of the Meditech system is strongly recommended.

Analytical process control should be maintained within the scope of the laboratory leadership, for example, Special Coagulation. Clinical programs should be consulted for service expectation review.

Observations

a. Most analyzers use onboard QC packages with limited reference to Westgard Rules. QC processes are in place but not complete.
b. Meditech is utilized minimally.
c. Not all assays have proficiency testing or other forms of quality control.
d. No regionalized inter-instrument comparisons are in place.

e. Haematology analyzers are over 7 years old and at end of life.
f. Two ACL coagulation analyzers at St. Clare's are too small and slow for the test menu on board.
g. Flow Cytometry should use a small haematology analyzer to perform cell counts.
h. Technical accountability for special coagulation testing is inconsistent; corollary testing can be directed by clinical users without authorization by laboratory leadership.

Recommendations

1. Review scope of responsibility of the single Hematopathologist. The leadership structure in Special coagulation should be reviewed.
2. Augment quality control process with inter-instrument comparisons, appropriate Westgard rules and external proficiency testing program enrolment.
3. Update and add equipment for cell counts in routine haematology and flow cytometry, respectively; review coagulation menu needs at St. Clare's for appropriateness and equipment needed.
4. Utilize Meditech functionality already available, e.g. QC module, but not yet in use.

5. Transfusion Medicine

The blood bankers in the lab at Eastern Health are very knowledgeable about blood transfusion science but there is a lack of documented procedures. There is evidence that they are in the early stages of working on this documentation. The document gaps can be best addressed by a review of the standards pertaining to transfusion medicine and aligning the standards with OLA requirements. Comments about the insufficient medical staffing have been remarked upon in the Hematology section of this document.

A utilization manager has responsibilities mostly for the hospitals in St. John's, but there is insufficient follow-up to verify if transfusion practices have changed to meet recommendations. A very positive fact is the implementation of a regional Transfusion Medicine committee as a standing subcommittee of the MAC. There is 1 FTE Transfusion Safety Officer (TSO) for the city; there are also 0.5 FTE positions in each of Rural Avalon and Penninsula, but the bench requirements in those areas preclude availability of those individuals from allocating sufficient time for TSO activity. There is a need for re-evaluation of staffing for the regional program.

Observations

a. Crucial technical documents (e.g. ABO grouping and antibody screen procedures, issuing of blood products) are not complete or up to date and others do not exist. There was no evidence of recent review of the existing procedures to ensure they are up to date and appropriate. Many procedures had verbatim sections from reference material which do not reflect Eastern Health practices.
b. Recording of equipment activities, such as serological calibration of serofuges, was either missing or not consistently applied across sites. Equipment records are not easily accessible as they do not reside in the laboratory areas.
c. Specimen acceptability requirements are not always adhered to as written.
d. Some instrumentation is not interfaced and so critical results must be transcribed into the LIS. Patient safety requirements such as the need for irradiated products are not linked into the LIS to prevent the issuing of inappropriate products. The exception report function is not being used and is not known to staff. An upgrade is required to move to electronic crossmatch capability.
e. Downtime procedure paper card system does not include patient's special requirements, a patient safety concern.

Recommendations

1. Procedures should be followed as written and management oversight processes to monitor compliance. *e.g*. procedures for acceptance of specimens for compatibility testing, are in place but not followed
2. Write procedures for critical processes and ensure they meet the directive and spirit of the standards
3. A review of blood issuing procedures to prevent the acceptability of verbal requests.
4. Duties and responsibilities of the Tech 3 should be reviewed. The Tech 3 should be more involved with the quality resource in preparing the procedures, validating them and training the staff on their content.
5. Review the path of workflow to streamline activities to allow the bench techs to handle their own workload.
6. Downtime procedures do not include all special blood needs like irradiation.
7. LIS support is needed to identify quality issues and risks to patients, to interface the HIS/LIS to instruments that perform ABO typing, and to enable LIS flags for irradiated CMV at crossmatch and issue.

6. Microbiology

Microbiology at Eastern Health has a group of very engaging staff working in a less than ideal area. The lab is divided into very small rooms that present challenges to storage, staff safety and workflow.

There is one very experienced Medical Microbiologist who is aware of the issues and the needs of the department. Unfortunately, the resources available are limited, making it difficult to move the lab forward and to implement the necessary quality improvement initiatives

Observations

a. There was no evidence that there has been appropriate assessment of staffing levels to ensure safe and effective workload management.
b. The department is working towards OLA certification but there were some significant gaps noted with documents (e.g. lack of quality manual, bench manual, etc.), document control, internal audits, access to up written procedures, equipment, reagent control, incident reporting and record keeping.
c. Not all instruments were interfaced to the lab information system.
d. There was no dedicated staff member with Meditech experience in the Microbiology module.
e. There were significant safety gaps noted such as lack of designation between clean and dirty areas, flammable chemical storage, use of flammable liquids using acceptable fume hoods, outdated MSDS, proper signage and glove use.

Recommendations

1. Complete and review a staffing assessment.
2. The Laboratory is working on Health Canada accreditation as well as OLA. A dedicated person within the department as well as a Quality Manager with Laboratory experience would be recommended.
3. Interfacing any equipment that can be interfaced is essential.
4. An LIS staff person with microbiology experience would be an asset.
5. The laboratory should develop a laboratory safety program and committee to address any outstanding safety concerns.

7. Pathology

The pathology department is a busy service group that is currently grappling with complex issues in service delivery. Their management team has worked hard to overcome these, but had been unable to move forward in fully implementing change until recently. There are multiple reasons for this, including the more recent loss of medical oversight, delays in decision making, staff absenteeism and loss, and growing clinical volumes.

The management and technical teams are knowledgeable, committed and caring about the work they do and about the patients they service. Like many laboratories, a great deal of their time is consumed with daily operational issues, leaving little time for strategic planning and implementing new systems effectively. Although their enthusiasm and interest in quality of service is evident, the combination and complexity of issues they have faced has unfortunately delayed their ability to successfully complete the majority of recent projects undertaken thus far

The following are primary areas for improvement:

- Communication within and involvement of staff at all levels
- Development of a comprehensive quality management system that includes documentation of all policies and operating procedures, and software to manage this
- Information systems infrastructure, and support mechanisms for current and new technologies
- Review of duties and responsibilities assigned to staff at manager, supervisor and senior technologist levels

With investment, IT systems support, effective communication and planning, this team will fully realize their goal to meet national and international standards of practice and innovation.

Observations

St. Clare's site

a. There are 2 gross dissection hoods located in a long narrow room adjacent to the histology lab area. There is insufficient space for this activity. They have access to transcription software, but are investigating voice recognition systems that are compatible with MediTech.
b. This site receives an average of 30-40 biopsy & 15-20 surgical specimens daily. Biopsies are sent to the HSC site for gross, surgicals are grossed on-site by pathologist assistants. The Senior PA schedules 1-2 PA's at this site for large specimen grossing. Pathologists are available for gross review.
c. The histology lab resides in a portion of wet laboratory space shared with HLA. It is staffed by 1 technologist and 1 MLA. Specimens are accessioned and prepared for transport to the Health Sciences Centre site (HSC) site as either whole specimens for gross examination, or sections in cassettes ready for paraffin processing. Courier pick-up is 4 times per day, Monday to Friday. All specimens are documented on logs that are sent with the specimens, a copy is retained on-site for reference.
d. Original slides for specimens originating at this site are returned here for file. The file system in place utilizes 4-slide card holders that are filed into cardboard boxes, stored on local shelving.
e. Fresh tissues submitted for frozen section diagnosis are received in a lab area adjacent to the OR's. This space is appropriately equipped, although small in size for pathologist and technologist working together in this lab. The majority of requests for quick section

diagnosis arise from sentinel lymph node, breast, head and neck, and lung surgical cases.

f. Autopsy services are performed by the autopsy technician that rotates between the sites, under the supervision of a pathologist. There are significantly fewer autopsies performed at this site. The autopsy service equipment and space were not reviewed during this visit. .

Health Sciences Centre Site

a. Routine autopsy services are performed by an autopsy technician and resident, under the supervision of a pathologist. Forensic cases comprise the majority of work, and are done in a separate suite. Both suites are equipped and well maintained at time of viewing. Some written procedures are in place, but need to be expanded to include all activities of this service area.
b. The current surgical pathology lab space is unsuitable for need. The ventilation system is insufficient and gross bench workspaces are configured in areas that are too small, or in high traffic locations. The floor plan for the new space was reviewed, and appears to provide more suitably organized and sized physical space for the activities required. Ventilation improvements in the new area were not determined during this visit.
c. A policy to fix all specimens for a minimum of 24 hours is in place, and is monitored. They are currently meeting their turnaround time requirements in the surgical pathology area.
d. Staff recruitment is underway to expand levels to 4 pathologist assistants (PA). One PA has just returned to work on a modified work plan, which will gradually allow the histology technician that was temporarily replacing her to return to his normal duties. They don't have a formal training/competency program in place, however informal feedback from the pathologists, and former medical lead for this area, has occurred sporadically.
e. The PA group is well organized and informed. They would like to see an expansion of the use of gross templates, approved by the pathologist site groups, to provide consistency in gross dictation. The preparation/cleaning of the dissection boards and instruments between specimens might not be consistent, and should be reviewed. Personal protective equipment was appropriate for the tasks.
f. The histology laboratory is short-staffed, and is currently working with a backlog of at least 1 day for non-urgent cases. The manager has taken steps to implement measures that will increase efficiencies, and feels that they can recover as these are fully realized and staffing levels improve. They are establishing benchmarks for productivity, and are evaluating the need/impact of expanding operational hours.
g. On-line ordering by pathologists is not occurring, and instead a manual paper trail is in use. While staff are very efficient in managing this, it is also a labour intensive process.
h. A technician prepares cassettes for surgical pathology staff at both sites, and pre-labels slides for histology. The cassettes for St. Clare's specimens are transported in advance of the specimen being grossed, which works because of the 24hr fixation time. However there is only 1 cassette labeller making it more difficult to prepare additional cassettes as required at St. Clare's. Preparing pre-labelled slides in advance of microtomy is done because there is only 1 labeller, but it potentially introduces an increased risk for error at microtomy without checks in place to compare block to slide. Staff were observed doing this, but it is a time consuming approach.
i. The histology lab installed the new Symphony automated H&E stainer in January but had been unable to get a consensus decision from the pathologists to select a routine staining protocol during their validation phase. This indecision resulted in much higher operating costs to the lab. During this visit the decision on a routine H&E protocol was

made through the assistance of visiting pathologists from UHN. The lab has now successfully implemented this stainer for routine use. The special stain area is equipped with 2 automated Ventana stainers, and a manual stain area for stains that cannot be performed on an automated platform. Quality of staining was not reviewed during this visit. The staining manual should be reviewed for completeness.

j. Histology has a unique role for a "visualization person" (VIP). Their responsibilities include troubleshooting, distributing blocks to the cutters, quality checks, and statistical workload. It is currently filled by a more senior technologist but doesn't require their advanced skill level; it could be rotated amongst staff to build team culture.
k. The immunohistochemistry lab area is staffed by 4 technologists who place pathologist requests for stains in the computer, cut all patient and control slides, immunostain slides using automated Ventana Benchmarks, do immunofluorescence studies on frozen sections (skins and renals), and attend renal biopsy procedures. They are meeting their turnaround time target of 24 hours.
l. The immunohistochemistry lab is fully equipped for all technical and quality control activities; however the Benchmarks are ageing and should be upgraded to XT's, or another vendor platform, to increase their slide capacity and potentially reduce turnaround times. The cover-slipper is also ageing, and could be replaced with the unit currently in histology.
m. The immunohistochemistry lab has a more fully developed quality management system in place, including the documentation and review of operating procedures, quality control, supplies inventory and statistics.
n. Immunohistochemistry quality control reviews are done with medical staff, and are documented. When medical staff members are not available, responsibility is deferred to the senior lab staff. They might consider reviewing their policy that requires medical review of slides, to include parameters under which technical staff could release slides directly to pathologists when controls work appropriate to expectation. When queries or concerns arise, these are appropriately discussed with a pathologist. All developmental slides are reviewed by the Medical Director, who approves changes in procedure/practice.
o. They have stained over 200 cases in a parallel study with Mt. Sinai Hospital for ER and PR immunohistochemistry in breast. Breast pathologists have reviewed the outcomes and a decision to repatriate this work is pending. Validations have included formalin fixation times of minimum 24 hours

Cytology – Miller Site

The Cytology laboratory of Eastern Health processes a high volume of screening gynecologic cytology samples (over 68,000 annually) with a small number of non-gynecologic and FNA samples (approximately 3,400 annually) and provides service to a large part of eastern Newfoundland for gynecologic samples at the St. John's hospitals.

a. The laboratory is housed in a facility separate from the remainder of the Department of Pathology. Clearly, consolidation of the cytology laboratory with the remainder of the department of pathology should be a priority. Although the cytology laboratory currently has ample space, separation for the other parts of the pathology laboratory is detrimental for introduction of ancillary testing, results in some duplication of infra-structural support and necessitates pathologist or slide transportation to allow pathologist review of cases. This physical separation also diminishes pathologist interaction and involvement in the Cytology laboratory on a regular basis. Pathologists who spend time at the Miller site are taken away from other activities, reducing their productivity.

b. The laboratory is staffed by 3.5 Medical laboratory Assistants, 9 level III technologists and 2 Level IV technologists. Cytotechnologist sign-out of negative gynecologic cytology samples is employed with a hierarchical screening process for abnormal cases. The hierarchical screening process for abnormal cases has largely been abandoned by the majority of laboratories and consideration should be given to termination of this process with the abnormal cases given directly to the Pathologist for review. This would diminish the workload for the cytotechnologist which may be further offset by increased application of automated screening.
c. All cytologic samples appear to be processed utilizing the SurePath processing procedure with recent introduction of automated screening for the gynecologic samples. Although this single approach simplifies the processing of samples, it does not necessarily allow for the optimization of sample handling and may potentially limit some information that could be extracted from the samples, particularly non-gynecologic cytology and FNAs. A broader spectrum of processing techniques may be of benefit and particularly facilitate modernization of the laboratory with introduction of additional ancillary techniques to compliment the cytomorphology and immunohistochemical testing performed.
d. Pathologist workload limits have been previously set at low levels and when combined with pathologist staffing levels could potentially result in a situation in which the expected daily output from screening could not be reported by the pathologists. This can result in an increasing backlog of cases for the cytology laboratory. These limits should be set to ensure that the daily output from screening could be completed by the pathologist. It would also be of benefit for the department to draw on pathologists with additional training, experience and interest in cytopathology to foster excellence in cytodiagnosis and facilitate modernization of the cytology laboratory.

Recommendations

1. Realign responsibilities at management and senior technologist levels for operational effectiveness. Some responsibilities could be aligned with senior and bench technologist staff, allowing management greater time to focus on planning and quality improvement initiatives
2. Establish technical productivity and quality benchmarks that are monitored and reported
3. Develop a comprehensive procedure manual for all lab areas, to include policies and procedures for autopsy, surgical pathology, histology, special stains
4. Develop an inventory management and product labelling system in all areas
5. Implement a training and competency assessment program in each lab area
6. Centralize all autopsies to the Health Sciences Centre site. Retain the services of a local funeral home to transport the deceased to HSC for autopsy services.
7. Expand expertise within the pathologist assistants group to support services in autopsy
8. Review procedures and practice for preventing cross contamination at gross dissection
9. Develop a more formal pathologist assistant training and competency assessment plan that includes pathologist feedback
10. Working with site group pathologists, develop more templates for grossing specimens
11. Include PA's in gross rounds with residents, and have PA's lead some of these where expertise exists
12. Perform biopsy/small specimen grossing activities at the St. Clare's site and transport cassetted specimens to the HSC site for histologic processing; send large specimens to the HSC site for gross (reverse of current practice) to allow pathologist review of these specimens by site group
13. Investigate integratable IT systems for barcode tracking and workload management

14. Require pathologists to order additional requests for testing on-line in MediTech
15. Relocate the histology cover-slipper to the immunohistochemistry section
16. Review the procedure for handling forceps at embedding to minimize any potential for cross contamination between cases
17. Consider a rotation for embedding to reduce opportunity for repetitive injury and fatigue, and improve ergonomics of the workstation
18. Purchase additional cassette labelling equipment interfaced to LIS, locate one of these at the St. Clare's site
19. Purchase a new slide labelling system interfaced to LIS that can be located at each microtomy workstation, moving from practice of pre-labelling slides to labelling at time of cutting
20. Rotate the histology VIP position
21. Change the slide file system to cardboard storage boxes commercially available, to reduce time in handling and space requirements
22. File all slides and blocks at HSC for easy filing and retrievals, and to minimize the potential for loss in transport
23. Review policy requirement for medical director review and approval of quality control sections. The technical staff members have developed a high level of expertise, and are at time doing this assessment on their own at the request of the Medical Director.
24. Ventana stainers are ageing, and should be replaced by higher capacity model. A full validation must occur to support this
25. Operational hours in immunohistochemistry may need to be changed to reflect run times and slide volumes
26. Change the cutting workflow for cases with both immunohistochemistry and histology requests to be cut by 1 person. This will save time in both areas, and reduce unnecessary loss of tissue through repeated trimming of blocks
27. Complete the study of breast cancer cases and repatriate, or refer out, as appropriate
28. Consolidate cytology with pathology at HSC.
29. Abandon hierarchical negative cytology sign outs
30. Implement multiple new cytologic methodologies.
31. Discontinue current maximum pathologist sign-out restrictions.

8. Cytogenetics

The laboratory has all of the equipment and technical training needed to fulfill their role as a regional cytogenetics/FISH service. The opportunity to review the leadership structure and communication mechanisms will aid in the institution's success with this important role in the province.

Observations

a. There is little interaction with the laboratory medical director.
b. The lab experienced a significant change in personnel recently due to a number of retirements and the untimely death of the technologist in charge. The current technologist in charge is an experienced general duty technologist who completed the Michener Institute genetics technology program 5 years ago. She is relatively inexperienced in cytogenetics for the role of Charge technologist. The other analysts are all recent graduates of the same program.
c. The staff were friendly and knowledgeable. They had a small backlog of cases pending analysis.
d. A major incubator malfunction about a year ago led to the lab being out of service for at least 8 months. Staff were deployed to other duties, including specimen shipping and receiving, processes they are unfamiliar with and found stressful. The reason for the length of the lab shut down is not clear.
e. The lab SOPs are incomplete and do not reflect current practice.
f. The cytogenetics and molecular diagnostics laboratory are housed in the same space. There should be an appropriate allotment of space for this laboratory.
g. The laboratory equipment is relatively new and appropriate for the needs of EHA.

Recommendations

1. Administrative and medical leadership structure and responsibilities for day to day activities in the laboratory should be reviewed.
2. Completion of the procedure manual, reflecting current practice, should be made a priority.
3. Improve communication and expectations regarding upcoming accreditations for this group.
4. Staff competency program should be developed and documented.
5. The lab staff should stay up to date with best practices and current requirements for quality assurance programs.
6. All staff should be fully competent with current practice and SOPs before expanding the test menu to include amniotic fluids. This expansion of the test menu should be fully validated before it is put into practice.

9. Molecular Genetics

The overarching observation of the laboratory is that the scope of practice is too small for the technical expertise that is available. This is largely due to poor clinical leadership and a lack of communication. Lab morale is very low due to a perceived lack of leadership.

Observations

1. Alignment of the medical and technical strategic direction should be initiated.
2. The staff members are bright and very well trained and would welcome a broader test menu and an expanded scope of testing. Their expertise is underutilized.
3. Most good laboratory practices are in place and more documentation of procedures and processes, already underway, would benefit the analytical process.
4. The Molecular Genetics Laboratory currently has a chief technologist, 3 bench technologists and a temporary technologist (that predominantly deals with sample referrals). They currently receive less than 5,000 samples per year, with the majority of these samples being either banked or sent to other centers for testing.
5. The test menu is small and fairly basic with most of the testing being for thrombosis and hemochromatosis.
6. Although the space is functionally organized as well as it can be, its size and configuration necessitates the performance of multiple tasks in one area; this results in sub-optimal work flow conditions. For example, pre- and post-PCR functions are not physically separated; this is a requirement that is necessary for a lab performing clinical molecular genetics testing.

Recommendations

1. Review of administrative and laboratory leadership to Improve communication and service delivery is recommended.
2. Duties and responsibilities of the Director and the Charge and bench technologists should be clearly defined.
3. A workflow review should be conducted with emphasis on repatriating and developing new tests which are unique and/or common to the Newfoundland population.
4. The sample banking practice should be reviewed for use and efficacy.
5. An emphasis should be placed on documented process, and good practice guidelines should be developed. For example:
    a. Procedure review
    b. Development of a competency program for technologists.
    c. Add to proficiency testing program to ensure biannual external review for all tests.
    d. Adopt and document validation processes for new procedures.
    e. Regular equipment maintenance should be performed and documented for all equipment.
    f. There should be a clear and transparent process in place for incident reporting and follow-up.
6. Review the space available for the molecular genetics and cytogenetics labs; they should remain in close proximity to be functional but require separate and larger space for optimal workflow. A plan to incorporate other labs should be delayed until this review is complete.
7. Suggest regular reviews by an external agency, to ensure that best practice guidelines are in place and being followed.
8. Turnaround times should be documented and benchmarks set based on client needs.

10. Histocompatibility

The dedication of the technologists, their diligence and clear commitment to the patients that they serve is very evident. Overall, the issues can be summed up as lack of directorial resources and insufficient quality practises and test validation for the scope of service.

Observations

a. Medical oversight for bone marrow work is limited and the consultant for bone marrow is not responsible for nor provided the resources to address quality related issues in her current position.
b. No medical director or technical supervisor oversight for solid organ transplant results being reported. Technology staff is extremely uncomfortable with the degree of responsibility they are therefore asked to assume.
c. The lab is understaffed for volume of work received: 3 technologists, >1200 typings annually (very labour intensive platforms), 400 solid organ transplant (SOT) crossmatch workups.
d. There was no evidence of representation/communication of lab/lab issues to clinical programs that they serve or to other laboratories with which they share patient testing (specifically the Halifax HLA Laboratory).
e. Serologic typing is done in parallel with molecular always such that discrepancies would be caught. Therefore HLA typing service was felt to be safe.
f. No documented operating procedures for HLA testing in general and Flow cross-matching. No quality processes in place. No quality resources available to technologists.
g. Validation data for any current testing procedures was not in evidence.
h. One technologist has begun documentation of procedures and quality processes, e.g. monthly QC. These quality control data are now being captured and were easily viewable for SSP HLA typing.
i. Pre and post PCR areas are not in separate airspace, and there are no physical barriers (i.e. different lab coats, gloves etc.) to prevent cross contamination. In addition, the departmental fax machine is in the post PCR room such that admin personnel are freely moving in and out with no “control” of potential contamination.

Recommendations

1. Develop SOPs for all procedures being performed in the laboratory
2. Perform and document test validation for all procedures being performed in the laboratory
3. Implement quality control practises; in particular, the technologist who has begun this process for SSP HLA typing should be given adequate education, time and resources to continue this. Additional staffing may be required to facilitate recommendations 1-3.
4. Directorial oversight of quality practises and reporting should be enhanced and supported.
5. Continue with HLA typing services for the bone marrow programs and SOT programs where required
    a. Dual platforms (serology and molecular SSP) should be continued until appropriate quality standards and processes are implemented such that a sole platform can be relied upon.
    b. Continue with Luminex RSSO typing validation.
    c. Continue with proficiency testing of HLA typing platforms

6. Explore the possibility with Halifax HLA lab to perform crossmatching services for St. John's patients to facilitate better interpretation of crossmatch results.
    a. Eastern Health HLA Laboratory should continue external proficiency testing (ASHI or CAP) of crossmatching and flow crossmatching in the interim.
    b. Consider the possibility of, when appropriate oversight has been obtained, adequate staffing achieved and quality processes are in place for the typing platforms, phasing back in antibody screening, crossmatching etc with concurrent implementation of relevant quality and competency programs.

11. Specimen Management

Processes for the revision of current procedures and the development of others needed to meet OLA and Accreditation requirements are underway. A complete listing of the gap documents was not available at the time of the review.

Observations

a. Specimen procurement manual needs to be reviewed for complete instructions after samples have been procured, i.e. specimen conditions - ice, warm water, etc.
b. No procedure was found for the aliquoting of specimens.
c. No certification was observed for the transport bags used for samples (not blood products) and the pneumatic tube system.
d. Staff members carry around tubes in their hands or lay tubes on the bench instead of using tube racks even though they are available.
e. Time sensitive tests are not identified so that they can be processed within appropriate timeframes.
f. Most staff did not wear gloves; this was also observed throughout the laboratories at both sites visited.
g. The area appeared to be very busy and staff members are required to multi-task.

Recommendations

1. Perform a workflow review of the front end.
2. A thorough review of procedures is needed to ensure staff has procedures for all the tasks they are performing and that these reflect current best practices.
3. Staff should be expected to and wear personal protective device and equipment appropriate to the task they are performing, e.g. gloves, tube racks.
4. A review of process and staffing in the area should be performed.

12. Point of Care Testing

The POCT coordinator role is recent to Eastern Health but is staffed by a very experienced technologist and supported by the division manager who has proven experience managing POCT. They have both begun to engage the organizational stakeholders towards three necessary objectives to ensure success:

- Ensuring the laboratory has responsibility & authority for all POCT within Eastern Health
- Standardization of devices, policies and procedures for POCT across Eastern Health
- Implementation of IT infrastructure to support management and quality assurance for POCT

The new glucose meter program is being implemented currently to reflect these goals and serves as the example for other POCT programs to follow.

Observations

a. Lack of standardization of devices and procedures across Eastern Health
b. IT infrastructure does not optimally support POCT

Recommendations

1. Update POCT policy:
    a. Make Level II policy to give authority across EHA
    b. Assign the laboratory director (or designate) with overall responsibility for POCT
    c. All approved POCT programs are regularly reviewed for effectiveness
    d. Failure to comply requires corrective action or program may be removed
2. Have meeting of POCT committee and approve the policy.
3. Bring glucose meter program into compliance to serve as model for other programs.
4. Identify other POCT programs in EHA and gradually bring into compliance.
5. Update blood glucose monitoring policy:
    a. Consolidate policies from nursing, dialysis, etc. into single policy
    b. Make Level II policy to cover all EHA
    c. Have meeting of blood glucose monitoring committee to approve policy
6. Establish laboratory procedures for:
    a. Validation of new meters and strips
    b. Operation of the data management system
    c. QC review preferably at a more frequent interval (e.g. monthly) *
    d. Troubleshooting and return/removal of meters from service *
    e. Maintaining inventory of meters *
    f. Training and competency checklist
    g. Performance of EQA and process of investigation of flags
    h. Regular comparison (e.g. every 6 months) of meter results vs. laboratory
    i. Implement QC lockout

    *(It is strongly advised to seek a consultant laboratory to assist with items marked with *)*
7. Implement Operator lockout.
8. Implement Positive Patient Identification.
9. Establish a policy on patient self-monitoring for blood glucose.
10. Due to scope of POCT in EHA, as quality assurance activities increase over time additional human resources will likely be required for maintenance.

13. Laboratory Information Systems

Significant resources, with a laboratory background, for in-laboratory LIS support are required.

Observations

a. No auto- verification of results from analyzers.
b. No on-line QC with Westgard rules being applied.
c. Blood bank instruments are not interfaced.
d. Need to have ‘expert-users’ with good knowledge of Meditech system
e. No on-line order entry for Pathologists
f. No synoptic reporting module is available.

Recommendations

1. Implement on-line order entry and synoptic reporting for pathologists
2. Increase technical support expertise for Meditech to improve response time and fast track necessary development plans with resources both in the laboratory and enterprise-wide.
3. Build cross-functional teams to implement and support voice recognition and Telepathology, led by LIS project coordinators
4. Implement auto- verification of results from analyzers.
5. Implement on-line QC with Westgard rules being applied.
6. Interface Blood bank instruments and implement functionality available for special product needs. Electronic cross match should be implemented.
7. Improve knowledge capabilities of the Meditech system for all staff, including building and generating standardized and custom reports.

14. Safety

The laboratory's safety program needs greater organizational attention than is currently being provided. An overall Safety Officer should be identified to chair a lab safety committee composed of members from each laboratory section. The committee should initially focus on implementing the safety section of the OLA requirements and enhancing the current insufficient training of all staff.

Observations

a. Documentation of all required safety procedures and signage is lacking, e.g. signage at main entrance to all labs, hand washing sinks, dirty or clean lab coat racks; evacuation route maps.
b. There is no safety training and regular competency program for lab safety, fire safety (including drills), WHMIS and infection control.
c. Flammable waste is not stored away from the main processing area.
d. The Mass Spec lab does not have a flammable safety cabinet.
e. Microbiology area does not have a biological safety cabinet for the Microscan preparation bench.
f. Cloth chairs were observed in the lab areas.
g. Entry to the St. Clare site laboratory area is not secure.
h. Staff members do not demonstrate good laboratory practice, e.g. personal property in the lab (purses), wearing of gloves when performing venipuncture or handling samples.

Recommendations

1. Designate a Safety Officer to oversee the safety program for all lab sections. The program should include the signage, safety manual documents, annual training and competency testing.
2. Invest in safety equipment: flammable safety cabinet for Mass Spec lab and biological safety cabinet for Microbiology.
3. Communicate and manage performance of expected safety practices, e.g. wearing of appropriate personal protective equipment like gloves, keeping purses out of the lab.
4. Provide a room for the storage of flammable waste.
5. Remove cloth chairs from laboratory areas.

D. Summary Recommendations

Priority level	Recommendation	Timeline short/medium/long
	Medical Staff	
High	Consolidate to a single site pathology practice at HSC.	Medium
High	Consolidate to a single Academic model	Short
High	Reorganize departmental structure	Short
High	Develop a well considered strategy to achieve sub-specialty practice.	Medium
High	Recruit in areas of complex testing	Long
High	Implement a telepathology strategy for support of a multisite subspecialty model of Pathology.	Medium
Medium	Implement a Pathology QA program for Medical Staff.	Medium
Medium	Improve workflow in technical and clerical support.	Medium
	Quality Management Systems	
High	A quality committee chaired by the medical director and encompassing all labs should be struck and given responsibility for all aspects of the quality system.	Medium
High	An individual with a laboratory medicine background be assigned the Quality Manager role.	Medium
Medium	More educational development should be provided for the quality coordinators with regard to good laboratory practices, procedure writing and quality system development.	Long
Medium	Roles should be clarified with regard to appropriate tasks for each role level in the technical areas.	Long
High	More education regarding quality systems for all staff is underway but in small measures. Online and other mechanisms should be explored to help orient staff to quality system concepts.	Medium
Medium	Implement ‘quick fixes’, examples are the recording of open dates on reagents or actions taken when expected results or fridge temperatures are not met.	Short

High	Engagement of the staff in developing the documents for tasks they perform or will perform is recommended whenever possible, as they are the content experts and will gain commitment to changes through this process.	Long
	Biochemistry & Mass Spectrometry	
Medium	Combine the Renal and Biochemistry labs with appropriate Clinical Biochemist resources.	Medium
High	Communicate and manage performance of expected laboratory practices, e.g. labelling of all reagents with receipt and expiry dates.	short
Medium	Documentation of revisions and remove inaccurate or unneeded sections. Organize documents for optimal accessibility and readability.	Medium
High	Reorganize the laboratory to increase space for urinalysis testing.	Medium
High	Enhance LIS support to provide: auto-verification for high volume and immunoassay, automated reporting of serum indices and associated interpretation comments for high volume analyzers, and interfacing of all analyzers, e.g. Immulite in Renal lab.	Medium
High)	Mass Spectrometry (Appendix 4): Review scope of responsibility and levels of staffing for senior technologists and Biochemists.	Medium
Medium	Improve documentation of preventative maintenance procedures.	Short
High	Increase frequency/scope of QMS initiatives – QC documentation, Split sampling, method validation.	Short
Medium	Review space requirements.	Medium
High	Collaborate with other testing centres for method development and split sample comparisons.	Medium
	Haematology	
High	Review scope of responsibility of the single Hematopathologist. The leadership infrastructure in Special coagulation should be reviewed.	Medium
Medium	Augment quality control process with inter-instrument comparisons, appropriate Westgard rules and external proficiency testing program enrolment.	Short
Medium	Update and add equipment for cell counts	Long

	in routine haematology and flow cytometry, respectively; review coagulation menu needs at St. Clare's for appropriateness and equipment needed.	
High	Utilize Meditech functionality already available, e.g. QC module, but not yet in use.	Medium
	Transfusion Medicine	
High	Procedures should be followed as written	Short
High	Write procedures for critical processes	Short
High	Review and update blood issuing procedures.	Short
High	Review and modify Tech 3 duties and responsibilities to be more supervisory	Short
Medium	Review workflow processes to streamline activities	Medium
High	Downtime procedures do not cover patients for all special blood needs like irradiation.	High
	Microbiology	
Medium	Complete and review an assessment of staffing level requirements	Long
High	The Laboratory is working on Health Canada accreditation as well as OLA. A dedicated person within the department as well as a Quality Manager with Laboratory experience would be recommended.	Short
Medium	Interfacing any equipment that can be interfaced is essential.	Medium
High	An LIS staff person with microbiology experience would be an asset.	Short
High	The laboratory should develop a laboratory safety program and committee to address any outstanding safety concerns.	Short
	Pathology	
High	Develop a comprehensive procedure manual for all lab areas, to include policies and procedures for autopsy, surgical pathology, histology, special stains.	Short
High	Develop an inventory management and product labelling system in all areas Implement a training and competency assessment program in each lab area.	Short
High	Centralize all autopsies to the Health Sciences Centre site. Retain the services of a local funeral home to transport the deceased to HSC for autopsy services.	Medium
Medium	Expand expertise within the pathologist assistants group to support services in	Medium

	autopsy.	
High	Review procedures and practice for preventing cross contamination at gross dissection.	Short
Medium	Develop a more formal pathologist assistant training and competency assessment plan that includes pathologist feedback.	Medium
Medium	Working with site group pathologists, develop more templates for grossing specimens	Long
Medium	Include PA's in gross rounds with residents, and have PA's lead some of these where expertise exists.	Long
High	Keep biopsy/small specimen gross activities at the St. Clare's site to expedite handling; send large specimens to the HSC site for gross (reverse of current practice) to allow pathologist review of these specimens by site group.	Short
	Implement the Symphony automated H&E stainer.	
Medium	Require pathologists to order additional requests for testing on-line.	Medium
High	Relocate the histology cover-slipper to the immunohistochemistry section.	Short
High	Review the procedure for handling forceps at embedding to minimize any potential for cross contamination between cases Consider a rotation for embedding to reduce repetitiveness, fatigue and improve ergonomics.	Short
Medium	Purchase additional cassette labelling equipment interfaced to LIS, locate one of these at St. Clare's site.	Medium
Medium	Purchase a new slide labelling system interfaced to LIS that can be located at each microtomy workstation, moving from practice of pre-labelling slides to labelling at time of cutting.	Long
Medium	Rotate the histology VIP position	Medium
Medium	Change the slide file system to boxes commercially available, to reduce time in handling and space requirements.	Medium
Medium	File all slides and blocks at HSC for easy filing and retrievals, and to minimize the potential for loss in transport.	Medium
High	Review policy requirement for medical director review and approval of quality control sections. The technical staff have	Medium

	developed a high level of expertise, and are at time doing this assessment on their own at the request of the Medical Director.	
Medium	Ventana stainers are ageing, and should be replaced by higher capacity model. A full validation must occur to support this.	Long
High	Operational hours in immunohistochemistry may need to be changed to reflect run times and slide volumes.	Medium
High	Change the cutting workflow for cases with both immunohistochemistry and histology requests to be cut by 1 person. This will save time in both areas, and reduce trimming of blocks/tissues.	Short
High	Complete the study of breast cancer cases and repatriate, or refer out, as appropriate.	Short
Medium	Consolidate cytology with pathology at HSC.	Long
High	Abandon hierarchical negative cytology sign outs.	Short
High	Implement multiple new cytologic methodologies.	Short
High	Discontinue current maximum pathologist sign out restrictions.	Short
	Cytogenetics	
HIgh	Administrative and medical leadership structure and responsibilities for day to day activities in the laboratory should be reviewed.	Short
High	Completion of the procedure manual, reflecting current practice, should be made a priority.	Short
High	Improve communication and expectations regarding upcoming accreditations for this group.	Short
High	Staff competency program should be developed and documented.	Medium
Medium	The lab staff should stay up to date with best practices and current requirements for quality assurance programs.	Medium
High	All staff should be fully competent with current practice and SOPs before expanding the test menu to include amniotic fluids. This expansion of the test menu should be fully validated before it is put into practice.	Medium
	Molecular Diagnostics	
High	Review of administrative and laboratory leadership to Improve communication and service delivery is recommended.	Short

High	Duties and responsibilities of the Director and the Charge and bench technologists should be clearly defined.	Short
Medium	A workflow review should be conducted with emphasis on repatriating and developing new tests which are unique and/or common to the Newfoundland population.	Medium
Medium	The sample banking practice should be reviewed for use and efficacy.	Medium
High	An emphasis should be placed on documented process, and good practice guidelines should be developed. For example: a. Procedure review b. Development of a competency program for technologists. c. Add to Proficiency testing program to ensure biannual external review for all tests. d. Adopt and document validation processes for new procedures. e. Regular equipment maintenance should be performed and documented for all equipment. f. There should be a clear and transparent process in place for incident reporting and follow-up.	a) Short b) Medium c) Short d) Medium e) Short f) Medium g) Short
Medium	Review the space available for the molecular genetics and cytogenetics labs; they should remain in close proximity to be functional but require separate and larger space for optimal workflow. A plan to incorporate other labs should be delayed until this review is complete.	Long
Medium	Suggest regular reviews by an external agency, to ensure that best practice guidelines are in place and being followed. Turnaround times should be documented and benchmarks set based on client needs.	Long
	Histocompatibility	
High	Develop SOPs for all procedures being performed in the laboratory	Short
High	Perform and document test validation for all procedures being performed in the laboratory	Short
High	Design and implement quality control practises	Short
Medium	Directorial oversight of quality practises and test reporting should be enhanced and	Long

	supported.	
Medium	Continue with HLA typing a. Dual platforms (serology and molecular SSP) should be continued until appropriate quality standards and processes are implemented such that a sole platform can be relied upon. b. Continue with Luminex RSSO typing validation.	a. Short b. Long
High	Explore the possibility with Halifax HLA lab to perform crossmatching services for St. John's patients to facilitate better interpretation of crossmatch results. a. Continue proficiency testing of crossmatching and flow crossmatching in the interim. b. Consider the possibility of, when appropriate oversight has been obtained, adequate staffing achieved and quality processes are in place for the typing platforms, phasing back in antibody screening, crossmatching etc with concurrent implementation of relevant quality and competency programs.	a. Short b. Long
	Specimen Management	
Medium	Perform a workflow review of the front end.	Long
Medium	A thorough review of procedures is needed to ensure staff has procedures for all the tasks they are performing and that these reflect current best practices.	Long
Medium	Staff should be expected to and wear personal protective device and equipment appropriate to the task they are performing, e.g. gloves, tube racks.	Short
Medium	A review of process and staffing in the area should be performed.	Long
	Point of Care Testing	
High	Update POCT policy: Make Level II policy to give authority across EHA Assign the laboratory director (or designate) with overall responsibility for POCT All approved POCT programs are regularly reviewed for effectiveness Failure to comply requires corrective action or program may be removed	Short
High	Have meeting of POCT committee and approve the policy.	Short

High	Bring glucose meter program into compliance to serve as model for other programs.	Medium
Low	Identify other POCT programs in EHA and gradually bring into compliance.	Long
High	Update blood glucose monitoring policy: Consolidate policies from nursing, dialysis, etc. into single policy Make Level II policy to cover all EHA Have meeting of blood glucose monitoring committee to approve policy	Short
High	Update and establish laboratory procedures.	Short
Medium	Implement Operator lockout	Long
High	Implement Positive Patient Identification Establish a policy on patient self-monitoring for blood glucose	Short
Long	Due to scope of POCT in EHA, as quality assurance activities increase over time additional human resources will likely be required for maintenance	Ongoing
	Laboratory Information Systems	
Medium	Implement on-line order entry and synoptic reporting for pathologists.	Medium
High	Increase technical support expertise for Meditech to improve response time and fast track necessary development plans with resources both in the laboratory and enterprise-wide.	Medium
High	Build cross-functional teams to implement and support voice recognition and Telepathology, led by LIS project coordinators.	Medium
Medium	Implement auto- verification of results from analyzers.	Medium
Long	Implement on-line QC with Westgard rules being applied.	Long
High	Interface Blood bank instruments and implement functionality available for special product needs. Electronic cross match should be implemented.	Medium
Medium	Improve knowledge capabilities of the Meditech system for all staff, including building and generating standardized and custom reports.	Long
	Safety	
High	Designate a Safety Officer to oversee the safety program for all lab sections. The program should include the signage, safety manual documents, annual training and	Short

	competency testing.	
High	Invest in safety equipment: flammable safety cabinet for Mass Spec lab and biological safety cabinet for Microbiology.	Short
High	Communicate and manage performance of expected safety practices, e.g. wearing of appropriate personal protective equipment like gloves, keeping purses out of the lab. Provide a room for the storage of flammable waste.	Short
Medium	Remove cloth chairs from laboratory areas.	Medium

E. Appendices

Appendix 1. Documents reviewed

- Policies
- Operating Procedures
- Process Maps
- Records
- Forms
- Internal quality control
- External quality control
- Quality assurance
- Patient reports

Appendix 2. Schedule of visits

March 11 - 12, 2010 Mass spec lab visit:

March 16 – 18, 2010 Pathology Head and Neck

March 23 – 25, 2010 Pathology Dermatopathology

April 6-10, 2010 Pathology Medical Director Review, Head and Neck, Cytopathology, Operations

April 21 – 23, 2010 Core Laboratory, Hematology, Biochemistry, Blood Transfusion, POCT, Pre-Analytical, Safety, Quality Management System

April 25 – 26, 2010 Histocompatibility, Molecular Genetics, Cytogenetics

June 28 – 29, 2010 Microbiology

Appendix 3. Reviewer biographies

Dr. Sylvia L. Asa, MD, PhD is the Pathologist-in-Chief and Medical Director of the Laboratory Medicine Program at the University Health Network and Professor in the Department of Laboratory Medicine and Pathobiology at the University of Toronto. She received her medical and post-doctorate degrees from the University of Toronto and completed her internship in internal medicine at Toronto General Hospital and the University of Toronto. She received her residency training in pathology at Mount Sinai Hospital, St. Michael's Hospital and the Toronto General Hospital, all affiliated with the University of Toronto. She subsequently was a research fellow in the Department of Pathology at St. Michael's Hospital and the University of Toronto. Dr. Asa is an internationally-recognized expert in Endocrine Pathology; she has co-authored more than 300 articles in high impact journals, more than 50 chapters on endocrinology and related pathology and is the author of 4 textbooks. Dr. Asa has been the recipient of many awards and honors, including the Arthur Purdy Stout Society of Surgical Pathologists (1998), the Novartis Canada Senior Scientist Award (2001), the Professor C.F.A. Culling Memorial Lecture Award of the National Society for Histotechnology (2004), the ICRF Woman of Action Award (2009) and several teaching awards from the University of Toronto. She is affiliated with numerous professional organizations, including The US-Canadian Academy of Pathology, of which she is a Past President (2005-6). As head of the largest pathology department in Canada and Medical Director of Laboratories of 17 hospitals across Ontario, Dr. Asa has made innovative changes to the practice of the discipline, with emphasis on subspecialization, automation, electronic initiatives and telepathology. The department focuses on education and research to understand mechanisms of disease and translate new information into diagnostic and prognostic information for patient care. To ensure public knowledge of the role of Pathology and maintain a direct connection with patients, Dr. Asa is a consultant to several patient groups.

Sally Balmer is the manager of the blood transfusion service at the University health network: Toronto General Hospital, the Toronto Western Hospital and the Princess Margaret Hospital. Sally started her career as a MLT at the TGH blood bank in 1982. Sally rotated as a senior technologist responsible for teaching and quality at TWH and at PMH. She obtained her ART in Transfusion Science in 1994. In 2000 Sally became UHN's first Transfusion Safety Officer and then in 2002 she moved into the blood bank supervisor position. Sally has been the manager of the department since 2004. She was a key player in the team that worked on getting UHN the distinction of AABB and CAP accreditations. She was also integral to UHN's and the Rouge Valley Health System's transfusion services success with their primary OLA certification. Sally has lead the UHN transfusion service team through successful subsequent aaBB, CAP and OLA accreditations. Her assessment experience includes detailed gap analysis of the Rouge Valley blood transfusion service and UHN self assessment exercises.

Shawn Brennan served as a cytogenetics technologist at UHN from 1983 to 1986. In 1986 he was transferred from the clinical cytogenetics laboratory to the then new cancer cytogenetics laboratory. He has been Technologist in Charge of this laboratory since that time. The lab is a cancer specific cytogenetics laboratory offering karyotyping and FISH testing to UHN, MSH and surrounding hospitals. Shawn has completed the CAP assessor training program and has participated in two CAP lab inspections in the United States. Shawn completed the OLA assessor training program and maintains his certification with annual refresher activities. Shawn has participated in numerous OLA self-assessments at UHN and is the key resource for all accreditation activities for cytogenetics at UHN.

Tom Clancy is the Director of Core Laboratory Services and Specimen Management for the University Health Network Laboratory Medicine Program. Tom also has oversight for the UHN Microbiology work performed by the partnership between UHN and Mt. Sinai Hospital.
Tom has over 25 years of Laboratory experience in both the public and private healthcare sector and over 15 years experience in healthcare management. Tom's laboratory focus is multidisciplinary but his specialty is in the field of Haematology where he holds an advanced registered technologist certificate from the Canadian Society of Medical Laboratory Science. Tom is a certified Ontario Laboratory Accreditation Assessor and has participated in many OLA and CAP inspections both as an assessor and as a team leader.

Dr. Eleftherios Diamandis, MD, PhD, is Biochemist-in-Chief at the University Health Network and Division Head of Clinical Biochemistry at Mount Sinai Hospital; he is Professor & Head, Clinical Biochemistry at the University of Toronto, Ontario, Canada. His research activities evolve around discovery and validation of cancer biomarkers, proteomics, mass spectrometry and translational research. Dr. Diamandis received his B.Sc. in Chemistry, Ph.D. in Analytical Chemistry and M.D. from the University of Athens, Greece and a Diploma in Clinical Biochemistry from the University of Toronto, Canada. He is a Certified Clinical Chemist by the Canadian Academy of Clinical Biochemistry and the American Board of Clinical Chemistry. Other major distinctions of Dr. Diamandis include his election as Corresponding Member of the Academy of Athens, Greece (2005) and as Member of the Royal Society of Canada (2008). He has published 87 review papers, 485 research papers and co-authored 4 books and 22 book chapters.

Mary Fountas holds an Honours B.Sc. in Human Biology from the University of Toronto, a Diploma of Health Sciences from the Michener Institute of Applied Health Sciences, as well as a certificate in Clinical Laboratory Quality Management. Mary is a Certified Manager of Quality/Organizational Excellence by the American Society of Quality. In her role as Quality Manager for the Laboratory Medicine Program at UHN, Mary supports all quality system activities including the Quality Management Committee, a steering committee that reports to the UHN board. She is an experienced CAP inspector and OLA assessor and team leader.

Dr. Suzanne Kamel-Reid, PhD, FACMG. Professor of Laboratory Medicine and Pathobiology, University of Toronto, Senior Scientist, The Ontario Cancer Institute, Head, Laboratory Genetics and Director, Molecular Diagnostics, The University Health Network. Her service laboratory is the largest cancer genetics testing laboratory in Ontario and focuses on the diagnosis, prognosis and monitoring of many haematological malignancies as well as solid tumours. Referrals for testing are received from physicians across the province of Ontario, as well as nationally and internationally due to the unique nature of some of the tests that are available and the reputation of this lab as the gold standard for much of this testing. In her research laboratory she has cloned and identified two novel variant fusion genes in Acute Promyelocytic Leukemia and created a mouse model of this disease. She has recently identified important differences in the genetic stability of tumors derived from young versus older patients with head and neck cancer using array technology. Her research program focuses on identifying and understanding the utility of genetic markers of disease progression and prognosis. She has been the recipient of peer reviewed grant funding from the NCIC, CIHR, Cancer Research Society, OICR and Leukemia Research Fund and has published over 100 papers and 200 abstracts in the field of genetics.

Ed Kasprzak began his 31 year career as a Biochemistry MLT at the University Health Network – Toronto Western Hospital site after graduating from the University of Toronto with a degree in Biochemistry. Between 1981 and 1995, through part-time study, Ed obtained his Biochemistry

and Haematology MLT certification, and Biochemistry ART certification. In addition, he obtained a certificate in Quality Management from the Michener Institute in 2005. Ed has rotated throughout the different UHN sites, and is currently stationed at the Toronto General Hospital site as the Biochemistry Supervisor. He is an OLA assessor and CAP inspector and has participated in many formal and mock assessments.

Pauline Lo holds an ART in Microbiology from the Canadian Medical Laboratory Sciences and a diploma from the Michener Institute of Applied Health Sciences. Pauline has been the Quality Coordinator of the University Health Network/Mount Sinai Hospital Department of Microbiology from 1989 to 2008. She is currently the Supervisor for the department. With the current role, she oversees the departmental quality management, procedure manuals and ensuring the optimal staffing levels for its function. She is an experienced CAP inspector and OLA assessor and team leader.

Laurie Mason is the Pathology Manager at UHN, where she provides technical leadership for the technical (120), administration staff working in surgical pathology, histology, immunopathology, flow cytometry, molecular diagnostics, cytogenetics, cytology, electron microscopy and research pathology laboratories. Having worked in pathology for 30 years, she has significant practical laboratory experience in histology, immunopathology, flow cytometry and molecular diagnostics. As a manager for the last 11 years, she has conducted strategic reviews of internal and external services, and implemented changes to enhance cost efficiency and workflow improvement. She has also coordinated several change management projects that included multi-site consolidation, laboratory and office renovations, IT systems implementation, and technological changes for enhanced quality of service.
Laurie's professional affiliations include CMLTO, CLMA, CAP (US) and QMP-LS. In 2000 Laurie was invited to join the QMP-LS Pathology EQA Committee as the first technologist representative, and from 2007-2010 was Chair. This program provides leadership in the development, implementation and evaluation of external quality assurance activities for histology and immunopathology laboratories in Ontario. As Chair, she has also been invited to provide technical expertise to regional and national laboratories requiring consultative support, including Newfoundland's Eastern Health in December 2007. As an accreditation assessor for QMP-LS since 2004, she has participated in several site visits to Ontario laboratories as both assessor and team leader.

Dr. Tony Mazzulli, MD, is Deputy Chief Microbiologist at the University Health Network/Mount Sinai Hospital Department of Microbiology. He is Professor in the Department of Laboratory Medicine and Pathobiology at the University of Toronto. He has performed a number of accreditation site visits (both a as a team leader and assessor) for the College of American Pathologists (CAP), the Ontario Lab Accreditation (OLA) program and for Health Canada.

Dr. Marciano Reis, MD, is a hematological pathologist and Chief, Department of Laboratory Hematology at University Health Network, and Chief, Department of Clinical Pathology, Sunnybrook Health Sciences Centre and Women's College Hospital. He is an Associate Professor in the departments of Laboratory Medicine and Pathobiology, and Medicine, at the University of Toronto. Dr. Reis is the current Chair, Hematological Pathology Specialty Committee, Royal College of Physicians and Surgeons of Canada, and immediate past chair of the specialty's Examination Board. He is also the Chair of the Section of Hematological pathology of the Canadian Association of Pathology, and Medical Leader, Toronto Transfusion Medicine Collaborative. Dr. Reis has been a member or chaired external reviews of hematology and transfusions laboratories, as well has been a CAP assessor. He is the medical leader of the Quality Management Program for the division of Laboratory Medicine at Sunnybrook.

Dr. Kathryn Tinckam, MD, graduated from medical school at the University of Manitoba where she also completed her Internal Medicine Training. She completed a fellowship in Nephrology and then Transplantation at UBC. Following this, she completed a fellowship in HLA Laboratory Medicine at Harvard University (Brigham and Women's Hospital), after which she assumed the role of Assistant Director of the HLA Lab for 2 years before returning to Toronto as Co-director of the UHN Regional Histocompatibility Laboratory. She sits on the Education Committee for the American Society of Histocompatibility and Immunogenetics (ASHI) and is a founding director of ASHI-University (ASHI's Online Continuing Education Program). She is currently the Vice-Chair of the Canadian Blood Services' National HLA Advisory Committee, guiding HLA testing parameters and standards during the development of a national solid organ transplant system. Her research interests focus on the rational use of HLA laboratory testing gin the post transplant period to guide immunological interventions in high-risk patients.

Dr. Paul Yip is a graduate of the University of Toronto completing both his B.Sc. and Ph.D. degrees in Biochemistry. After completing the Postdoctoral Training Program in Clinical Chemistry, he continued with a fellowship in the Hospital for Sick Children in Toronto. Since 2005, he has been with the University Health as a Clinical Biochemist, and cross-appointed as Assistant Professor in the Department of Laboratory Medicine and Pathobiology of the University of Toronto. Dr. Yip's professional interests are in the areas of laboratory informatics and point-of-care testing. He is highly engaged in educational activities, which span undergraduate to post-graduate teaching and also science outreach in the community.

Appendix 4. Mass Spectrometry Incident – Detailed Review

Background Information

At the beginning of February 2010, it was recognized that the Biochemistry Laboratory of Eastern Health, St. John's, Newfoundland, was reporting erroneously low blood levels for the widely used immunosuppressant drug, cyclosporine A, in transplant patients. The incident was investigated by Eastern Health and an internal report was issued on March 9, 2010, describing the sequence of events and actions taken. The internal report raised seven questions to the external reviewers. Answers to these questions are provided at the end of this document.

Eastern Health leadership requested that University Health Network representatives conduct an external review of the incident and provide recommendations.

University Health Network Visit

On March 11 and 12, 2010, Dr. Eleftherios P. Diamandis, Biochemist-in-Chief, Dr. Paul Yip, Clinical Biochemist and Mr. Edward Kasprzak, Clinical Chemistry Supervisor, visited the Eastern Health Clinical Laboratories in St. John's, Newfoundland. The above-mentioned individuals performed a preliminary review of the cyclosporine testing and other biochemistry operations at the Health Science Centre in St. John's. The review included meetings with several individuals such as Laboratory, Medical and Senior Management staff. Preliminary assessment of the laboratory facilities, procedures and records were also performed.

Cyclosporine Testing Incident: Observations and Recommendations

The UHN team reviewed the preliminary internal report, submitted on March 9, 2010, and verified that the described sequence of events related to cyclosporine testing was in accordance with their own findings. The seven questions raised are addressed in detail in the final section of this report.

Mass Spectrometry Instrumentation

Mass spectrometry is a widely accepted analytical technique in clinical chemistry. The technology of liquid chromatography, coupled to mass spectrometry (LC/MS) is in widespread use in clinical laboratories worldwide. While this technology is usually highly specific for the analytes of interest, no analytical technique, including this one, is totally immune from interferences.

At Eastern Health, the Waters Quattro "Ultima" mass spectrometer was introduced in 2003. The cyclosporine method was established on this instrument and was used at Eastern Health since that time without any problems. A newer model of this instrument, Waters Quattro "Premier", was purchased by Eastern Health in 2008. The instrument was installed in 2009 by the Vendor and was certified to work to specifications at that time. Training was provided by the manufacturer and another cyclosporine method was developed utilizing this machine. The method was highly similar (but not identical) to the Ultima method. The UHN team examined maintenance checklists for the "Premier" instrument. Records of routine maintenance activities were not well-documented. While monthly duties were regularly documented, the weekly duties showed gaps or did not indicate reasons for omission. In order to alleviate this problem in the future, we formulated Recommendation #1.

A monitoring chart of the chromatography column on the Symbiosis HPLC system was included with the quality assurance documents. The chart provides a useful record of column usage and can assist with troubleshooting any problems with the chromatography. In order for similar incidences to be avoided in the future, we formulated Recommendation #2.

Following discovery of discordant cyclosporine results on the Premier system, the Vendor was requested to check the instrument's performance. A diagnostic report from the Vendor (dated March 5, 2010) was provided to the UHN review team, which included verification of the Premier mass spectrometer and the Symbiosis HPLC. Operating characteristics of the mass spectrometry parameters were within Vendor specification, while a few minor deviations were identified and corrected on the spot. It is unlikely that any of the minor deviations would have caused the discrepant cyclosporine results. As such, diagnostic procedures by the Vendor are part of preventative maintenance and correction of minor deviations is routine practice.

The UHN team concluded that the mass spectrometer performance was not the reason for the discordant cyclosporine results.

Method Procedure and Operation

The approved procedure for Immunosuppressant Method: Cyclosporine and Tacrolimus (PRC-BIO(MSL)-120 V 2.0 was provided for review. The procedure included aspects of specimen processing, reagent preparation, instrument parameters for LCMS and literature references. This version incorporates both the Ultima and Premier systems. Documentation for review of the procedure by staff was included. The "References" section lists the Vendor's application notes as an information source in the development of the method. The final configuration of the method is slightly modified from the Vendor's method, but this is routine in clinical practice. Specific parameters relating to each system are clearly documented in this procedure.

The UHN team identified the reason for low cyclosporine results with the Premier method versus correct results with the Ultima method. Minor differences in the chromatographic separation between the two methods resulted in co-elution of interfering cyclosporine metabolites with the internal standard (cyclosporine D) with the Premier method, but not with the Ultima method. This interference falsely elevated the readings of the internal standard which, in turn, caused low results in samples containing the interfering substances.

Specific recommendations as to how this interference could have been avoided or identified earlier have been provided (Recommendations #3, 4, 5 and 8).

Premier Method Validation

The approved procedure for Method Comparison and Bias Estimate (PRC-BIO-110) was provided for review, along with supporting documentation for the implementation of the cyclosporine method on the Premier system. The procedure applies widely accepted standards for assessment of quantitative methods prior to implementation.

Supporting documentation of method validation only included a comparison between the Ultima and Premier systems, which was completed in June 2009. Although the correlation between the two methods was good, and the number of specimens tested (n=54) would generally be considered adequate, most values were below 700 µg/L, with only two samples with values > 1,000 µg/L. The method has a measurable range up to 1,786 µg/L and the high range of results was not sufficiently verified. Recommendation #3 may help avoid such problems in the future. See also related Recommendations #4 and 5.

Quality Control

Internal Quality Control (QC) records from May 2009 to February 2010 were provided for review. Appropriateness of QC materials, frequency, and other monitoring practices were found to be acceptable. Overall performance of the method met conventional precision performance goals and indicated that the Ultima and Premier methods were within good analytical control. However, it should be noted that routine QC materials and practices would not be able to detect the interference from cyclosporine metabolites with either method. This is due to the fact that QC materials are usually spiked samples that do not contain cyclosporine metabolites (the offending substances in this case).

The UHN team noted that QC data for both systems were recorded on the same chart without differentiation of the analyzer used. Recommendation #5 would alleviate this problem.

The laboratory uses QC material from Chromsystems and Thermo Fisher, and both products are acceptable for monitoring of analytical testing. The Chromsystems QC provides monitoring at four levels of cyclosporine concentration which span the measurable range. Since all levels are tested with every batch, this provides sufficient monitoring. Thus, the Thermo Fisher QC material can be omitted (Recommendation #6).

External Proficiency Testing (External Quality Assessment)

External proficiency testing records for the UK NEQAS program from February 2009 to February 2010 were provided for review. The program is internationally recognized and provides three blinded challenges every month. Performance of the method met the criteria for acceptable performance and indicated that the Ultima and Premier methods were in agreement with other international LCMS users.

As mentioned earlier (and similarly to internal QC material), external proficiency testing service would not be able to detect interference of cyclosporine metabolites with either LCMS system. This is due to the fact that external quality assessment specimens do not generally contain cyclosporine metabolites. In order to provide additional reassurance of the cyclosporine method at Eastern Health, we provide Recommendation #7.

Additional Quality Assurance Practices

It is a generally accepted practice that when the same assay is performed with more that one instrument/platform, split sample analysis between instruments should be performed regularly to verify equivalent performance. We provide Recommendation #8 to cover this issue.

There are other safeguards which could be followed, in order to avoid, or identify possible method problems such as the one described. Assessment of the chromatographic peak shape for both the drug and the internal standard may reveal co-eluting constituents. Also, monitoring of the intensity or peak area of the internal standard can identify significant deviations (> 20-25%), which need to be investigated for possible interference. Such criteria should be incorporated into operating procedures. See Recommendations 9, 10 and 11.

Investigation of Questionable Results

Concern over questionable cyclosporine results were received in January 2010. The UHN team concluded that appropriate steps were taken by the laboratory at that time to perform repeat testing on the Premier system (the Ultima system was out-of-service at that time). When concerns were raised again in February 2010, the laboratory acted appropriately by sending specimens to an external laboratory. Appropriate action was taken to cease testing and inform Physicians immediately, when the erroneous results were identified. We conclude that the laboratory acted appropriately by ceasing method testing in-house, initiate external testing and begin informing Physicians immediately on the identified problem.

Personnel

Clinical Biochemists: The Division Head, a Certified Clinical Biochemist by the Canadian Academy of Clinical Biochemistry and another Biochemist (non-PhD, non-certified) have experience in mass spectrometry. However, the Division Head responsibilities cover the entire testing of a large Biochemistry Laboratory which, understandably, would preclude close interaction with the Mass Spectrometry Laboratory. The limited availability of Certified Clinical Biochemistry staff within the Division prompted us to formulate Recommendation #12.

Medical Laboratory Technologists*:* Day-to-day operation of the testing in the mass spectrometry area is staffed by 9 Medical Laboratory Technologists and a Senior Lead Technologist (Level 3). However, the area had been supervised by two senior technologists,

but the one responsible for mass spectrometry testing moved to a position outside the laboratory in January 2010. The other senior technologist responsible for Biochemical Genetics is currently filling this role. We provide Recommendation #13 to address this issue.

Space
The Biochemistry Laboratory operates several mass spectrometers (at least 3 LCMS systems and numerous GCMS systems) and the space is clearly not adequate for comfortable operation. We thus provide Recommendation #14.

Scientific Collaborations
Mass spectrometry is an evolving specialty within clinical laboratories that requires both scientific and technical expertise. The laboratories in St. John's serve as a reference centre for the province of Newfoundland and all clinical mass spectrometry testing is concentrated there. To further support ongoing testing development, we provided Recommendation #15.

Recommendations Regarding Cyclosporine Incident

Recommendation #1: Documentation of maintenance procedures should be completed and reviewed on a monthly basis by a senior staff member, to ensure compliance. If specific duties are not required at a given interval, the reason should be documented or the maintenance procedure should be updated, to reflect actual practice.

Recommendation #2: We recommend continuation of monitoring usage of the chromatography columns and, additionally, propose documented review of the usage log, by a specialist user who could identify proactive measures for column usage and to specify acceptable limits that would require corrective action if parameters exceed the limits.

Recommendation #3: For future comparison studies, the UHN team recommends a wide distribution of analyte concentrations, which span the entire measurable range of the assay. The impact of the interference by cyclosporine metabolites is expected to be more apparent at high concentrations and inclusion of specimens with higher cyclosporine concentration in the original validation could have spotted the problem.

Recommendation #4: We further recommend more thorough validation studies with new methods, including data for precision, linearity and measures of sensitivity and specificity. Incorporation of literature reviews for possible interferences would be very helpful. Finally, a longer cross-over period (e.g. 1 month) for patient comparison is highly recommended.

Recommendation #5: We recommend that separate QC charts for each system be immediately implemented, in order to detect long-term precision or drifts with either method. Also, monthly review of QC charts and cumulative performance statistics by a senior staff member will identify such trends and enable proactive troubleshooting.

Recommendation #6: We recommend discontinuation of Thermo Fisher internal QC, since Chromsystems QC material is adequate for internal QC purposes.

Recommendation #7: We recommend participation in the College of American Pathologists (CAP) Calibration-Verification/Linearity Survey for immunosuppressant drugs. The survey assesses the measurable range of the assay and can provide comparative information against other cyclosporine methods.

Recommendation #8: We recommend weekly (and later, maybe less frequent) comparisons between methods for the same analyte to verify equivalent performance over time.

Recommendation #9: For complex assays such as the cyclosporine measurements by LCMS, we recommend careful review of the primary data by experienced personnel, in addition to routine QC measures.

Recommendation #10: We recommend monitoring of monthly medians or means for patient results produced by each LCMS system. Significant differences may help identify possible long-range drifts.

Recommendation #11: Until confidence is restored, we recommend frequent (e.g. bi-weekly or monthly) exchange of a limited number of samples (e.g. 10-20), with another laboratory for verification of cyclosporine results. Criteria for acceptable comparison must be clearly stated.

Recommendation #12: We recommend that an additional Certified Clinical Biochemist, with strength in mass spectrometry, should be hired immediately. This should substantially enhance the quality assurance oversight necessary for the operation of this complex laboratory and possibly support regional laboratory sites which do not have a dedicated Clinical Chemistry Consultant.

Recommendation #13: We recommend recruitment of a senior technologist who would be dedicated to the mass spectrometry LCMS analyzers. This person would have strong technical skills with specialist training on the LCMS systems. Duties would include review of instrument raw data and quality assurance activities, to identify deficiencies or irregularities with certain specimens. Other tasks could include oversight of preventative maintenance, training of new staff, advanced trouble-shooting and support for method evaluation.

Recommendation #14: We strongly recommend expansion and improve quality of space for mass spectrometry testing.

Recommendation #15: We recommend alliance of Eastern Health Laboratories, with centres with proven expertise in diverse areas of Laboratory Medicine, including mass spectrometry, to secure continuous advice and perform co-development and co-validation of complex assays. Access to unique specimens would add robustness to method evaluation studies.

General Comments about Biochemistry Laboratory

During the investigation of this incident, general issues in Biochemistry were addressed:

Staffing and Safety
Staff morale at all levels was found to be low, likely due to the recent events with cyclosporine testing but also, from movement of personnel and retirements. The confidence of the scientific and technical staff on their procedures and quality of results has been compromised. This situation can be partially addressed with Recommendation #1.

Another concern is the repetitive strain injuries that are affecting technical staff, particularly in high-volume areas. This prompted us to formulate Recommendation #2.

Information Technology
Quality Control Practices*:* The Eastern Health Biochemistry Laboratory has begun to implement the LAQC Quality Control software for quality control monitoring. Please refer to our Recommendation #3 for improvements in Quality Control Practices.

Laboratory Information System (LIS)*:* Automated chemistry analyzers are currently interfaced to the LIS. However, results are manually reviewed by the technologists before they are reported to the patient chart. For this item, we formulated Recommendation #4.

Laboratory Accreditation*:* Eastern Health Laboratory Medicine is in the process of seeking laboratory accreditation, either by Quality Management Program – Laboratory Services (QMPLS; A Division of the Ontario Medical Association) or the College of American Pathologists (CAP). Both are highly recognized programs; please see Recommendation #s 5 and 6.

Re-Introduction of Cyclosporine Testing at Eastern Health
The Premier system is working to specifications and can be used to safely analyze cyclosporine, following some revision and careful re-validation of the original method. This will include optimization of the chromatography to exclude the interfering substances. Once the method is optimized, the UHN review team recommends a thorough evaluation, in comparison to the Ultima method, as described already; as well as in comparison to an external method, based on either LCMS or immunoassay, to ensure that interfering substances have been excluded. Based on the above, we formulated Recommendation #7.

<u>Recommendations for the General Biochemistry Laboratory</u>
Recommendation #1: We recommend recruitment of additional personnel to improve workflow and safety. A Safety Officer should be designated to ensure a safer working environment and enforce safety practices, such as use of gloves when handling patient samples. A clerical person with Medical Laboratory background should serve in a client-service role to handle telephone inquiries and requests for add-on testing, so that bench staff can focus on performing patient testing.

Recommendation #2: We recommend implementation of the decapping feature of the pre-analytical module (Power Processor) or purchase of equipment for cap removal (e.g. Pluggo), in order to avoid repetitive strain injuries.

Recommendation #3: We recommend full implementation of LA QC Quality Control software features, including Westgard multi-rules, as soon as possible.

Recommendation #4: We recommend implementation of auto-verification for normal results to reduce the amount of time spent for review, and allow staff to focus on specimens requiring attention (e.g. repeats, dilutions, etc.). As well, the serum indices feature of the high volume chemistry analyzer should be implemented. Reported through the LIS, this feature will allow the automatic and consistent reporting of common serum interferences (lipemia, hemolysis or icterus).

Recommendation #5: We recommend formation of a Quality Improvement Committee for the Biochemistry Division, in order to allow staff to become aware of issues arising from incidents, accreditation, client service or workplace and contribute to solutions. Representation across all areas of the laboratory should be sought to form a group which meets on a regular basis. The group should report to the Quality Manager of all laboratories in conjunction with the Chief of Laboratories.

Recommendation #6: We recommend that Eastern Health Laboratories participate in a Laboratory Accreditation Assessment, such as QM-PLS or CAP, as soon as possible.

Recommendation #7: Cyclosporine testing at Eastern Health Laboratories can be performed safely on either the Premier or Ultima LCMS systems, after method optimization and thorough validation. Special emphasis should be placed on exclusion of the known interfering substances (cyclosporine A metabolites). Please see also our Recommendation #s 3, 4, 5, 8, 9, 10, 11 and 15 for cyclosporine testing, which will ensure not only the re-introduction of the test but also, its safe long-term performance.

Follow-Up Questions for External Reviewers

Below, we provide answers to the seven questions raised by the internal review:

1] **It is a necessary and common practice with the types of techniques used in these assays that small adjustments are made to the Vendor method, to optimize for sensitivity and specificity, for particular target compounds like cyclosporine?**

Yes. Vendors may provide methods or applications which serve as general guidelines for further method development. Due to the complexity and variation of methods based on liquid chromatography-tandem mass spectrometry (LCMS), careful optimization of the conditions of the assay is routine practice in many laboratories. This type of optimization requires a person with technical and scientific expertise with the technology involved (LCMS).

Before implementation into routine analysis, thorough validation of the method is warranted; such validation should include measure of sensitivity and specificity. However, rare or infrequent interfering substances may indeed escape recognition during validation, and identified at later stages, when the method is in clinical use. This is what happened with the cyclosporine testing at Eastern Health Laboratories. In such instances, the laboratory should cease testing on the suspect system (this has been done promptly at Eastern Health) and initiate studies to identify the possible interferences, exclude them, if possible, and report the findings in the literature, if this was not reported earlier. During method development and validation, literature searches are warranted, to identify interfering substances, already reported by others.

2] **What is the best practice regarding the installation and validation of new equipment in the Biochemistry Division of the Laboratory Medicine Program?**

New equipment, especially those of high complexity and technically advanced, are usually installed by the Vendor, who will certify good performance after the installation is complete. Vendors usually provide operator training to one or more users after installation. Periodic preventative maintenance programs ensure continued optimal operation.

Please note that instrument performance and method performance are two different entities. Vendors are only responsible for their instrument performance within specification. At the same time, Vendors may also provide, or assist, in the development of a specific method on their instrument. For a given method, however, the responsibility of defining acceptable performance goals and ongoing monitoring remains with the user.

3] **Was it reasonable that the interfering substance was not considered in the set-up of the mass spectrometry or cyclosporine testing?**

In this case, it was reasonable since the original method on the Ultima instrument has been in use since 2003, without interference from cyclosporine A metabolites, and that an almost identical method was implemented on the Premier instrument in 2009. It was rather unexpected (and unfortunate) that the newer method was vulnerable to an interfering substance that was not interfering with the older method. This problem was not apparent during validation of the Premier method, since the comparison of the two methods prior to implementation was acceptable. Even in the hands of highly skilled and competent investigators, some rare interferences, such as these seen with the Premier method, could escape identification.

4] **Does the Vendor assessment report adequately confirm that the analyzer was working appropriately?**

Yes. The report does not indicate any problem with the mass spectrometer performance. The issue of metabolite interference was related to inadequate resolution during the chromatographic separation and not due to the mass spectrometer performance. Optimal chromatographic performance is not the responsibility of the instrument Vendor.

5] **Is the current organizational structure within the Biochemistry Division adequate to ensure appropriate oversight?**

The Biochemistry Division is led by a highly competent and experienced Certified Clinical Biochemist and is staffed by an experienced technical team. Another Biochemist with practical experience in mass spectrometry is responsible for the technical quality aspects of the cyclosporine assay. A supervisory technologist oversees the team of staff who perform the assay on a daily basis. The Biochemistry Laboratory performs high complexity assays (including the cyclosporine assay) and a large number of mass spectrometers are currently in use. The reviewers highly recommend hiring of an additional Certified Clinical Biochemist to oversee this and other lab areas (please refer to our Recommendation #12). Also, the most recent supervisory technologist in mass spectrometry moved away from the laboratory, and the responsibilities for this area were added to the Supervisor of the Biochemical Genetics section. These reviewers believe that enhancement of professional and technical staff within this area would prevent such occurrences in the future (Recommendation #13).

6] **What best practices or quality measures would have helped identify this problem earlier? Would the full implementation of quality control software, such as LAQC, have assisted in early identification of this issue?**

A more thorough validation of the new cyclosporine method on the Premier instrument would have likely identified the problem earlier. Also, regular split-sample analysis between the older and the newer instruments would have helped achieve the same. Other measures which would have helped to either avoid, or spot the problem earlier, are included in our Recommendation #s 3, 4, 5, 8, 9, 10, 11 and 15.

The quality control software (LAQC) implementation will help the laboratory quality assurance program, in general. However, neither manual, nor software-based monitoring of quality control would have enabled cyclosporine interference identification. The nature of the problem, as exemplified earlier, is such that it could not be routinely identified by either internal quality control programs or external proficiency testing schemes.

7] **Did the cause of the issue that led to the underestimation of cyclosporine levels affect any other testing performed on the Premier analyzer?**

Generally no. The instrument is performing within Vendor specifications and the problem seen with cyclosporine metabolites is unique to this method. Other methods on this analyzer will not be affected.