



QUALITY MANAGEMENT PROGRAM— LABORATORY SERVICES

VISION

To be a world-class provider of accreditation, quality assessment and supports to laboratories and related services for diagnosis and treatment of disease, and the promotion of health.

THE PURPOSE/MISSION

To promote quality improvement of laboratories and other related services for the public good and the benefit of health professionals.

VALUES

- *Quality*
- *Collaboration*
- *Integrity*

QUALITY POLICY

QMP-LS commits to provide high quality laboratory accreditation, assessment and education services, that:

- Meet all customers' requirements; applicable regulatory, statutory and contractual requirements; and relevant national/international standards;
- Evaluate and continually improve the effectiveness of the service;
- Ensure this policy is communicated to and understood by all employees;
- Provide a process for establishment, review and modification of quality objectives;
- Review and modify this policy annually for continued suitability.

ACKNOWLEDGEMENTS

Each year, the QMP–LS *Review* summarizes the operation of the Quality Management Program–Laboratory Services (QMP–LS), lists key priorities and provides a comprehensive review of its activities for the year. Most importantly, it reaffirms our purpose—to promote quality improvement of laboratories and other related services for the public good and the benefit of health professionals.

To provide high-class external quality assessment, accreditation and educational services, QMP–LS heavily relies on many individuals who serve as committee members (Appendix A) and volunteers (Appendix B). We acknowledge their commitment and dedication. We would like to thank the following committee members who retired during the 2004/2005 year:

Dr. Monique Arquint
Dr. Yvan C. Bedard
Dr. Peter S. Bunting
Dr. Jeannie Callum
Dr. C. Mark Cheung
Dr. Mario D'Costa
Mr. Kurt Davis
Mr. Mark Donahoe
Dr. Jo-Ann Johnson
Mrs. Suba Krishnan
Mr. John Lafferty

Dr. James Mahony
Ms. Cathie McCallum
Ms. Dawn Ogram
Dr. John Penswick
Dr. Susan E. Richardson
Dr. A. Rocke Robertson
Ms. Marilyn Sarina
Dr. Albert Simhon
Mr. Praniti Soamboonsrup
Dr. Ikuko E. Teshima
Dr. Dick E. Zoutman

We are also grateful to the Ontario laboratories and institutions that allow their staff to serve on our committees.

Our staff (Appendix C) also deserves recognition and thanks. Ms. Carol Major, Consultant Technologist, EQA and Beverley Glenday, Senior Administrative Assistant left during 2004/05. We wish them well.

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The reader is cautioned not to take any single item, or part thereof, of the 2004 Review out of context.

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THE YEAR IN REVIEW

INTRODUCTION

Quality Management Program—Laboratory Services (QMP–LS), a department of the Ontario Medical Association, is committed to provide high quality laboratory accreditation, assessment and education services. The External Quality Assessment (EQA) division provides timely, state-of-the-art EQA programs in laboratory medicine with heightened awareness of the need for total quality management. The Ontario Laboratory Accreditation (OLA) division's function is to help laboratories deliver high-quality, efficient laboratory services by achieving full accreditation. Laboratory quality assessment is complex in nature and international in scope and we are proud that QMP–LS is recognized and respected internationally as a leader in this field. To this end, we collaborate with partners in health care and share our experiences nationally and internationally.

This Review provides an update on QMP–LS' activities in 2004, including:

- Conformance with international standards
- Investigation of discordant findings
- Point-of-Care Testing (POCT)
- Outcome-based external quality assessment, and
- Process-based laboratory accreditation

POINT-OF-CARE TESTING AND THE LABORATORY

QMP–LS EQA division has carried out performance evaluation of blood glucose meters in Ontario health-care facilities since 2001. Normally, the assessment takes place twice a year using three levels of blood glucose challenge in each survey. Again this year, the findings were published and are included in this Review with an overriding conclusion that there is room for improvement in both trueness and reproducibility. Given the increasing use of POCT, the need for quality management becomes ever more paramount.

The QMP–OLA requirements include those on POCT and are assessed during each peer-assessment visit. There remains a lack of clear understanding in laboratories of the role that they are expected to play. The remainder of this section indicates what the international agreement on the oversight and operation of POCT really is.

The advent of in vitro medical devices capable of providing an ever-increasing range of diagnostic testing has had, and will continue to have, a major impact on medical laboratories both within the hospitals and the community. The extent of the impact is difficult to predict, but in all likelihood the role of the traditional laboratory will be to provide low volume and/or sophisticated testing where the economic or health-care benefits do not support distributed testing. The issues are twofold: how will the established laboratory transition to this new reality and how can the quality of point-of-care testing be maintained at a level that is accepted as the expected norm for effective and efficient health care?

POCT is variously defined and many synonyms have been applied. The National Academy of Clinical Biochemistry (NACB) in its forthcoming publication—*Laboratory Medicine Practice Guideline on Evidence-based Practice for Point-of-Care Testing*—defines POCT as “clinical laboratory testing conducted close to the site of patient care, typically by clinical personnel whose primary training is not in the clinical laboratory sciences or by patients (self-testing).” It refers to any testing performed outside of the traditional, core or central laboratory. Advances in technology have resulted in compact, easy-to-use in vitro diagnostic medical devices that form the basis for the increasing popularity of POCT. As the NACB guideline states “when used appropriately, POCT can improve patient outcome by providing a faster result and a shorter time frame to therapeutic intervention. However, when over-utilized or incorrectly performed, POCT presents a patient risk.”

Risk to the patient and to the health facility can be managed by a well-designed, fully implemented, quality management system. The elements of the envisaged system reflect those that have been advanced by broad-based consensus and published by respected authorities such as the Medical Devices Agency in the United Kingdom. By broad category they are:

- A process for the evaluation of new or alternative POCT instruments and systems.
- The formal evaluation and approval of end-user proposals and protocols.
- A mechanism to oversee the purchase and installation of equipment.
- The maintenance of consumable supplies and reagents.
- Training, certification, and re-certification of POCT systems operators.
- Quality control and quality assurance.

Central laboratory testing is heavily regulated throughout most of the world. The requirements for quality and competence are well established and enshrined in the ISO 15189:2003. The introduction of quality management systems and accreditation of laboratories is gaining more and more interest. Not so for POCT at this time, although an International Standard ISO 22870 is in the final stages of development and approval.

The current draft version of this evolving standard provides specific requirements for the management of POCT in health facilities and encompasses the elements described above.

Key considerations on the management side of POCT are:

- The management of the laboratory service shall plan and develop the processes needed for POCT.
- The governing body of the facility is ultimately responsible for ensuring that appropriate measures are in place to monitor the accuracy and quality of POCT conducted within the facility.
- A health professional grouping shall be responsible to the governing body for defining the scope of POCT to be made available.
- The laboratory director, or designate, shall appoint a multi-discipline POCT management group with representation from the laboratory, administration, and clinical programs including nursing to advise on and oversee the provision of POCT.
- The health facility will establish, document, implement and maintain a quality management system for POCT and continually improve its effectiveness.
- The Laboratory Director, or a designated suitably qualified person, shall implement a periodic management review of POCT including clinical need, clinical effectiveness, and cost efficiency.

Technical considerations include:

- Procuring, evaluating and selecting all POCT devices, reagents and systems including quality control materials.
- Establishing protocols for the performance of all POCT and associated quality assurance.
- Defining, implementing and maintaining a process for the training and competency assessment of all POCT operators.
- Developing documentation to allow audit of POCT performance and results.

The expectation is that the laboratory, with its well-established quality practices, remains key to the effective introduction and expansion of POCT. These developments will not be turn-key but will have to be customized to the specific needs of each health facility. The overriding requirement is that POCT will benefit the patient through the provision of results that have the same quality and fitness-for-purpose as those coming from the central laboratory.

The NACB guideline is available online at http://www.nacb.org/lmpg/poct_lmpg_draft.stm.

QUALITY SYSTEM

During 2004, QMP-LS staff was involved with completion of the review and revision of processes and procedures for import into the Quality System software application. In line with a long-standing commitment to a paperless office environment, was the need to develop an electronic file structure to store all QMP-LS records in a controlled environment also. The Quality System software is the repository for documents and internal records. For many years, QMP-LS staff has stored electronic records on a shared server, as opposed to individual desktop hard drives. The first step in transferring these records into the controlled environment involved development of a file structure that reflected the format of the QMP-LS Quality System, which is based on the ISO 9001:2000 structure (see Figure 1).



Figure 1. QMP-LS quality system file structure

Secondly, critical to the success of ensuring that records are readily retrievable from this system was the development of a common file naming convention to be used by all staff. It is anticipated that all required Quality System records will be relocated to the controlled application by March 31, 2005. The intent is that all QMP-LS records will be stored in electronic format from January 2005 onwards.

In fact, two other controlled environments exist for QMP-LS records. The second application is Docushare™, the document server available through the QMP-LS Web site. This houses all records that are shared with laboratory participants. Currently, all OLA records are available to laboratory participants through this document server; and since 2004, EQA Survey Reports and Committee Comments are also available. It is anticipated that most of the remaining EQA survey information will become available on this document server by the end of 2005.

The third controlled environment consists of secured file areas that contain hard copy documents such as participant correspondence and accreditation assessment documents. Correspondence will also be maintained electronically by the end of 2005 and our storage of hard copy files will be diminished over the next few years.

Now the focus for QMP-LS is measurement, assessment and continuous improvement. Performance measures and quality indicators are being established for 2005 and we will be assessing the effectiveness of the processes we have established during the past few years.

EDUCATION

QMP-LS' philosophy in the delivery of education is to focus on problem areas identified through our EQA or OLA activities. We continue collaborating with partners in health care and sharing our experiences nationally and internationally (Appendix D-F). In addition, specific educational activities are detailed in the EQA and OLA Reports.

In 2004, we published articles on significant developments in the medical and scientific literature (Appendix D). Two invited presentations were made at International meetings and seven at local and Canadian national meetings (Appendix E). *QMP-LS News* highlights developments in laboratory medicine, details operational changes at QMP-LS and provides information on upcoming activities and events. *QMP-LS News* is posted on our Web site where additional information on products and services is also available. Supplementary EQA and OLA information is provided to participants electronically via secure, password-protected access.

QMP-LS continued to provide education and professional development to its staff.

Symposia, Workshops and Courses

In 2004, QMP-LS continued its collaboration with the College of Medical Laboratory Technologists of Ontario (CMLTO) and the Ontario Society of Medical Technologists (OSMT) to deliver workshops across Ontario. Mr. Bryan

Hewlett presented a histology workshop entitled *Setting Technical Quality Standards for Histological Staining* in six regions of the province with one pending in the Ottawa region for the spring of 2005.

In October, a training course on *ISO 15189 What to Look For* was presented by Mrs. Linda Crawford and Mrs. Julie Coffey in Mexico City on behalf of the Standards Council of Canada, Conformity Assessment Division for the Inter-American Development Bank (IDB) and Entidad mexicana de acreditación, a.c.

To raise awareness of QMP-LS' evolving role, a display booth providing information about QMP-LS was available at one regional meeting and a staff member was present to address queries.

INFORMATION SERVICES

Improving Service and Reducing Costs

In 2004, Information Services implemented a number of improvements that enhanced the quality of service to our participating laboratories and within QMP-LS, such as:

- The Mobile Assessor component of Q-Accredit™ This application (Figure 2) can be deployed on a notebook or tablet PC and is used by our Ontario Laboratory Accreditation staff coordinators to collate OLA visit response data on-site. Assessment summary reports can be immediately generated and shared with participants.
- Subscription versions of the OLA Requirements and Reference Reports made available to external clients through the QMP-LS Document Server (Figure 3).
- Enhanced Survey Reports (Figure 4) for quantitative surveys. In 2005, these Web-accessible reports will be introduced for all statistically-based participant reports.
- Electronic notification to participants of the availability of their reports was implemented in 2004. This combined with electronic survey report distribution significantly decreased our reporting turnaround times.
- The EQA Provisional Reports (Figure 5) were adapted to allow the use of the document server and the electronic notification system to alert participants of their availability. These revised reports are more printer-friendly.
- A project to rationalize the method component codes across our quantitative surveys was completed. This simplifies laboratory reporting to QMP-LS, as the same method codes are now used across all classes of tests.

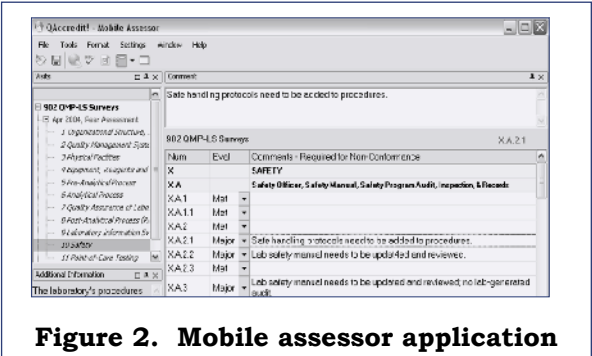


Figure 2. Mobile assessor application

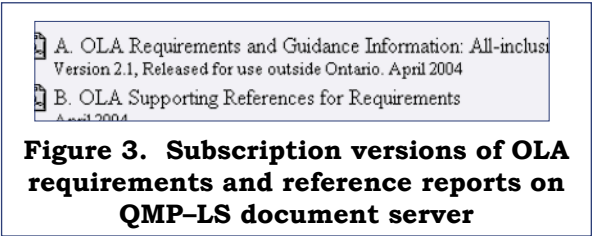


Figure 3. Subscription versions of OLA requirements and reference reports on QMP-LS document server

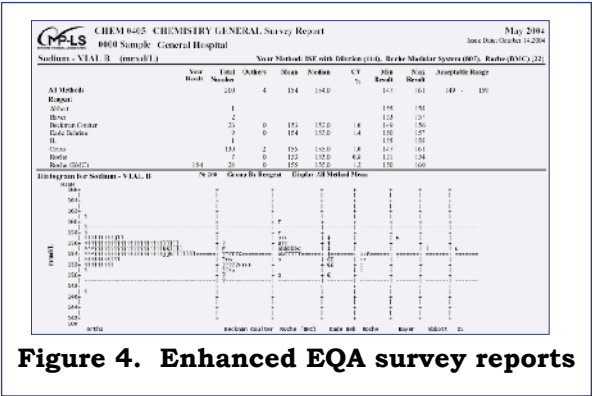


Figure 4. Enhanced EQA survey reports

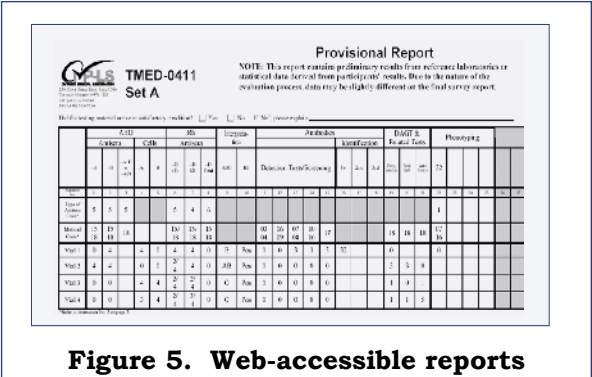


Figure 5. Web-accessible reports

- Within QMP-LS we implemented Fiscal Resource Management software (Figure 6) to manage and maintain the budget process along with the creation and processing of purchase orders, receiving and accounts payables.
- All 2004 EQA survey-related records, including Analysis Worksheets, Survey Reports, Analysis Reports, etc., were electronically archived on our document server. In addition, all EQA survey-related paper-based correspondence was reviewed and categorized for electronic archival or off-site storage. All pre-1997 records identified for disposal were shredded and disposed of. The resultant elimination of paper-based records realized substantial storage cost savings, along with improving access to our laboratory records.
- The Lab Performance History application (Figure 7) was implemented effective January 2004 to enhance the post-survey evaluation phase of the EQA survey administration process. New reports for OLA assessors and integrated survey flagging and error classification are among the improvements.
- The Help Desk application (Figure 8) was enhanced to capture accurate turnaround times for the development and implementation of Occurrence Management Processes and Procedures.
- To enhance our electronic communication capability we installed a RAID-enabled mail server to provide increased availability and reliability for this critical service.

Continuing Collaborative Activities

Nationally, QMP-LS Information Services continues to provide an Internet-based electronic workspace accessible by all members of the Canadian Coalition for Quality in Laboratory Medicine (CCQLM) organization (Figure 9). In 2004, QMP-LS also chaired the CCQLM's Information Technology Working Group.

MANAGEMENT COMMITTEE

The Management Committee consists of members appointed according to the Ministry of Health and Long-Term Care (MOHLTC)/Ontario Medical Association (OMA) Agreement. The membership includes representation from MOHLTC, the OMA, the College of Physicians and Surgeons of Ontario, the College of Medical Laboratory Technologists of Ontario, the respective Chairs of the Professional Advisory Committee, the OLA Advisory Panel and the Managing Director, QMP-LS (Appendix A). The Advisory Council, with representation from the stakeholder organizations (Appendix A), continues to provide

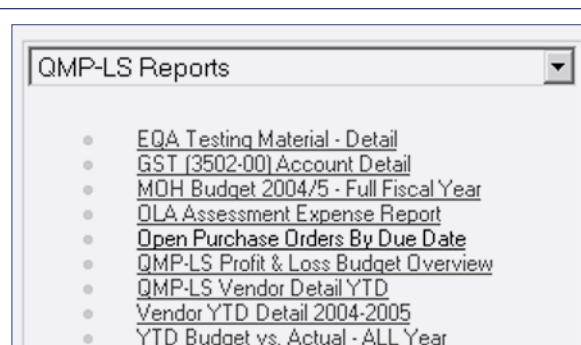


Figure 6. Fiscal resource management software

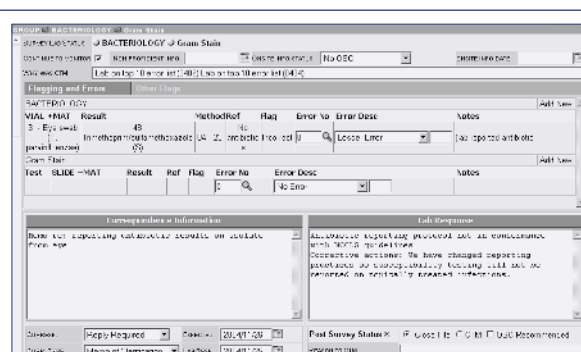


Figure 7. Lab performance history application

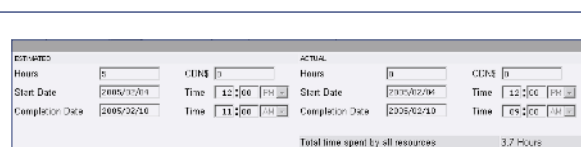


Figure 8. Help desk application

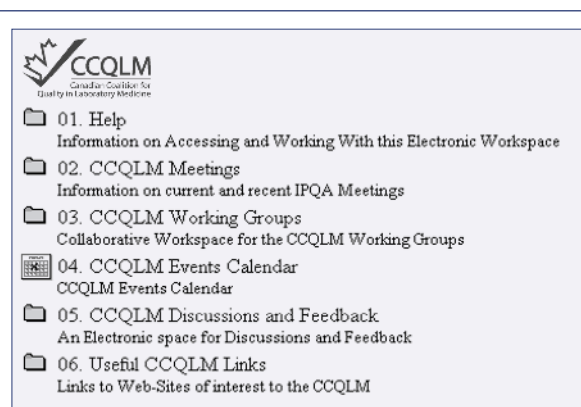


Figure 9. CCQLM internet-based electronic workspace

input to the Management Committee on the development of policies, processes and procedures. Members of the Advisory Council are invited to attend Management Committee meetings.

In 2004, the Management Committee met four times in the year and convened a conference call meeting to review the report of a follow-up On-Site Consultation Visit conducted in a parasitology laboratory.

Regular agenda items included:

- QMP-LS work plan, budget and operational matters;
- Policy issues;
- Progress reports on problem laboratories;
- Working towards the resolution of issues brought forward by the Professional Advisory Committees and operational divisions;
- Updates from the EQA, OLA and Information Services divisions on operational objectives;
- Report on educational activities.

Special issues for 2004 included:

- QMP-LS Quality Policy, the draft Quality Manual and high-level guiding policies;
- Investigation of discordant findings;
- Report of EQA internal review and revision of EQA processes to comply with ISO Guide. 43.1/ILAC Guide 13:2000;
- Update on OLA self-assessment and peer assessments;
- Quality of Care Information Protection Act.

CONJOINT COMMITTEE

The Conjoint Committee (Appendix A) met on four occasions throughout the year, co-chaired between Ms. Marnie Cooper and Dr. Harold Richardson. Laboratories being monitored for poor survey performance by the scientific committees and brought forward on the recommendation of the QMP-LS' Management Committee, were reviewed and appropriate actions determined. In particular, a report of a follow-up On-site Consultation conducted in a parasitology laboratory was reviewed and appropriate action determined. Issues concerning specific laboratories were also addressed when requested by the Management Committee.

Other issues addressed were:

- Appeals process
- Accreditation with Standards Council of Canada
- Sharing data on laboratories not granted full accreditation
- Point-of-Care Testing: Compliance with EQA surveys and OLA requirements
- Late Report notification
- Enhanced Maternal Serum Screening Program
- Updates on the development of the Quality Management System
- Activities of the Test Review Committee
- Quality of Care Information Protection Act.

EXTERNAL QUALITY ASSESSMENT

This was another year of transition for the External Quality Assessment (EQA) division as we moved closer to the goal of conformance with international standards. Much of our focus was associated with internal review and re-organization as we realigned processes developed over the past two decades with these standards, as well as with activities now performed through Ontario Laboratory Accreditation (OLA) assessments. Provision of EQA surveys continued in spite of these changes in activities. In 2004, we administered 110 routine challenge surveys, 3 dry or Web-based challenge surveys, 5 patterns-of-practice surveys and 3 questionnaires. Additional details are provided below and in the discipline reports.

Interaction with Peer and Stakeholder Organizations

EQA staff frequently communicate with national and international peer organizations to share knowledge, benchmark processes and collaborate on procurement of material. This year our interactions included the following:

- Meeting with peer Canadian organizations at the annual meeting of Canadian Coalition for Quality in Laboratory Medicine.
- Host for visiting members of the National Serology Reference Laboratory, Australia.
- Host for visiting physicians and scientists from Russia responsible for HIV testing.
- Collaboration with Royal College of Pathologists of Australia EQA program in Clinical Chemistry for the procurement of endocrinology testing material.
- Collaboration with the UK National External Quality Assessment Scheme in Hematology for the procurement of coagulation material for D-dimer testing.
- Membership of Advisory Committee to Caribbean Epidemiology Centre, Trinidad on a European funded project *Strengthening Microbiology Laboratory Services in the Caribbean*.
- Secretariat for Ontario Women's Health Council project on *Development of a Quality Assurance Program for Enhanced Maternal Serum Screening*.

QMP-LS Scientific Committees

In 2004, we hosted 70 enthusiastic committee members at more than 40 committee meetings to evaluate EQA performance. Communicating with other peer organizations confirms that major strengths of the QMP-LS EQA program are the scientific committee members who support the EQA performance assessment and education processes. Peer review provides benefits to both laboratory participants and the EQA program by ensuring that the selection and assessment of EQA challenges is clinically relevant and that educational comments are valid and provide state-of-the-art information. Many other organizations do not have this peer expertise available to them. We are grateful to our committee members and Ontario institutions for their continued support of our program.

Objectives addressed during 2004 included the following:

CUSTOMER SERVICE

Develop and Implement Web-access to EQA Survey Reports

During 2004, all EQA Survey Reports and Committee Comments were provided electronically to those laboratories with access to the Internet. The electronic reports reside on the QMP-LS document server, which is accessible through the QMP-LS Web site. Participants are notified by e-mail when new reports are posted on the server.

Provision of reports and Committee Comments in this manner facilitates timely and ready access to information by laboratory personnel. In addition, this information will remain readily accessible for a minimum of seven years. Generic survey summary reports, Provisional Reports and Committee Comments are available to all laboratories participating in EQA. Survey Reports containing laboratory-specific information are only available as password-protected files. The few Ontario laboratories without Internet access continued to be provided with hard copy information.

Provide Summary of Survey Discordant Findings to Participants

Investigation of discordant findings, initiated in 2003, was continued in 2004. Following a review of the 2003 findings, each scientific committee modified the original form to reflect discipline-specific issues. A summary for 2004 will be provided to participants as supplementary Committee Comments.

MANAGEMENT RESPONSIBILITY

Develop the Controlled Document Management System for EQA and Populate with EQA Documents and Records

The review and development of more than 150 processes and procedures was a major project for EQA staff during 2004. In addition, the electronic controlled document management system file structure was developed and all hard copy EQA records for the past two decades were reviewed and archived appropriately. Many have been converted to electronic files; some remain as paper files. All records for 2005 onwards will be maintained electronically.

SERVICE REALIZATION

Develop the Statistical Model for Quantitative Surveys

QMP-LS has retained the services of a biostatistician, who is highly experienced in the proficiency testing industry, to review the current statistical algorithms against international standards and rationalize where appropriate. This project is ongoing, and expected to be completed during the first half of 2005.

Rationalize EQA and OLA Processes

Many of the processes performed by the EQA division of QMP-LS were established in the absence of a provincial accreditation program. Now that OLA is in operation, we are reviewing, revising or eliminating processes that duplicate effort or more appropriately belong to the accreditation assessment process. Changes to the EQA processes may occur in a phased manner to accommodate the full implementation and maturity of the accreditation assessment.

Review On-site Consultation Pro-forma

The On-site Consultation process offered through the EQA division of QMP-LS is provided to laboratories that experience continued poor performance in a given discipline over time. It will continue to be made available to laboratories for the foreseeable future. We consider the OLA assessment to be process-oriented, while EQA measures process outcome. The existing EQA On-site Consultation pro-formas are targeted at the discipline procedure level, rather than the process level, but did contain questions now addressed in the OLA accreditation requirements. The existing pro-formas have been reviewed and revised by consultant technologists with their scientific committees to remove these universal elements.

Revise Reporting of Late and Non-Reporting Laboratories

The requirement for laboratories to participate in EQA surveys is mandated through the Laboratory Specimen Collection Centre Licensing Act and now through the OLA Requirements. For the past three years, the EQA division has requested that laboratories address instances of late or non-reporting as a means for laboratories to improve reporting processes. Now that participants are assessed for participation in EQA through the accreditation process, there is no longer the need to be accountable to the EQA division. However, EQA reports of participant non-participation will still be made available to the Ministry of Health and Long-Term Care, Laboratories Branch. This change in process will start with 2005 surveys. Participants were notified of the change in the November and December issues of the *QMP-LS News*.

Provision of EQA Services

As previously discussed, provision of EQA challenges in 2004 consisted of 110 routine challenge surveys, 3 dry or Web-based challenge surveys, 5 patterns-of-practice surveys and 3 questionnaires. The parameters monitored

by discipline are listed in Appendix G. The number and types of laboratories required to participate in the program are shown in Tables 1 and 2. The testing material suppliers for each discipline and the reference laboratories are shown in Appendix H.

In addition to services provided to Ontario laboratories, we provide services to other jurisdictions on a cost-recovery basis. Most jurisdictions simply participate in the Ontario surveys as volunteer participants (see Table 1). However, we also provide separate microbiology surveys to 23 member countries of CARICOM and separate cytology surveys to Alberta laboratories.

Laboratory Performance

The scientific committee evaluation of survey results includes assessment of error based on the clinical significance of discordant findings. Lesser errors are assessed for results that exceed the established acceptable limits and significant errors for results that, in addition, have the potential to cause mistreatment or misdiagnosis. Committees correspond with the participating laboratories regarding the discordant findings, requesting feedback on the cause of the result and implementation of corrective action. Unacceptable or incomplete participant responses may prompt further communication, continuing to monitor survey performance and/or an offer of an On-site Consultation. Three On-site Consultations were conducted during 2004 (Table 3). No laboratories were declared non-proficient during 2004 (Table 4). Summary of committee action is shown in Appendix I.

Table 1. Number of Participating Ontario Laboratories in 2004 vs. Out of Province

Discipline	Ontario	Out of Province
Anatomic Pathology	77	0
Chemistry-General	203	5
Drug Monitoring	167	16
Endocrinology	126	1
Enzymes, Cardiac Markers	195	2
Lipids	135	0
Immunology	65	3
Maternal Serum Screening	NA	NA *
Hematology-General	209	3
Flow Cytometry	22	16
Red Cell Disorders	85	2
Coagulation	198	0
Hematology-Morphology	201	0
Transfusion Medicine	170	0
Bacteriology	105	0
Mycology	22	2
Parasitology	23	0
Virology	72	3
Genetics	11	12
Cytology	85	0
Point-of-Care Testing	195	0

* No surveys conducted in 2004

Table 2. Comparison of Types of Ontario Laboratories Participating in EQA

Laboratory Facility Type	Number of Laboratories			
	2001	2002	2003	2004
Private	53	54	47	44
Hospital	181	182	180	182
Public Health	11	12	12	12
Psychiatric	0	0	0	1
Canadian Blood Services	6	6	6	6
Federal Government	2	1	1	1
Other	1	2	2	1
Total	254	257	248	248

Table 3. QMP-LS On-site Consultations that Occurred During Each Year, 1995–2004

Discipline	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Bacteriology	0	5	3	2	0	4	0	0	0	0
Parasitology	0	1	0	3	1	0	0	1	1	1
Virology	2	1	0	0	1	0	0	0	0	0
Microbiology Total	2	7	3	5	2	4	0	1	1	1
Chemistry	14	5	2	1	1	0	2	1 *	1*	0
Endocrinology	1	0	0	0	0	0	0	0	0	0
Enzymes & Lipids	0	0	0	0	1	2	0	0	0	0
Immunology	0	0	0	0	0	0	0	0	0	0
MSS	0	0	0	0	1	0	0	1	0	0
Chemistry Total	15	5	2	1	3	2	2	2	1	0
Hematology	0	1	0	0	0	2	0	1	0	0
Flow Cytometry	...	...	...	...	...	...	...	0	1	0
Morphology	0	0	0	1	1	0	4	0	0	0
Coagulation	0	0	0	0	0	0	0	0	0	0
Bone Marrow	0	0	0	0	0	0	1	0	0	0
Transfusion Medicine	1	5	1	3	1	3	6	2	3	1
Hematology Total	1	6	1	4	2	5	11	3	4	1
Genetics	1	1	0	0	0	0	0	0	0	0
Cytology	0	0	1	1	0	2	1	1	0	1
Grand Total	19	19	7	11	7	13	14	7	6	3

* Included Enzymes

Table 4. Number of Newly Named Non-proficient Laboratories by Discipline, 1995–2004

Discipline	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Chemistry	0	0	0	0	0	0	0	0	0	0
Hematology	1	0	1	0	0	0	0	0	0	0
Microbiology	0	0	1	0	0	0	0	0	1 *	0
Other	0	0	0	0	0	0	0	0	0	0
Total	1	0	2	0	0	0	0	0	1	0

* Parasitology

Reports to Participants

Reports provided to participants as part of the EQA survey process include preliminary reports of the reference consensus results, summary information of all participant results as well as reports of individual laboratory performance. In addition, the scientific committees provide educational feedback in the form of Committee Comments, Broadsheets and Practice Guidelines. During 2004, the following were provided to participant laboratories:

- 99 Provisional Reports
- 95 Survey Reports
- 87 Committee Comments
- 3 Broadsheets

Late and Non-Reporting Laboratories

During 2004, QMP-LS continued to monitor laboratory participation in EQA surveys for the third full year. The major reasons for laboratories failing to respond or responding late without acceptable reasons are listed in Tables 5 and 6. The number of events that occurred during 2004 was similar to that of 2003. The reasons were largely related to the reporting process.

Table 5. Reasons for Late Participation in EQA Surveys

Reason for Late Report	2003 (Jan-Dec)	2004 (Jan-Dec)
Missed or confused survey due date	2	11
Forgot to fax worksheets	7	10
No reason given	14	9
Unsuccessful fax transmission	7	5
Worksheets lost/misfiled/on supervisor's desk	3	1
Responsible person sick/on vacation	2	2
Faxed wrong worksheet	1	0
Communication breakdown (between staff or sites)	3	0
Protocol not followed	0	1
Worksheet faxed to wrong number	0	5
Total	39	44

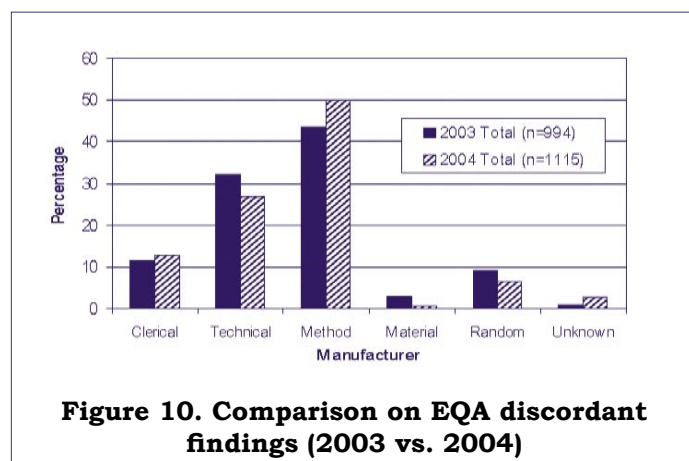
Investigation of Discordant Findings

This is the second year that a form to document the investigation of discordant findings was issued to participants with committee correspondence. Since the original form was only completed by approximately 40% of participants, we decided to develop discipline-specific forms to facilitate improved completion by laboratory staff. In 2004, these forms were completed by more than 70% of participants. Figure 10 compares the overall number of discordant findings reported during 2003 and 2004 in the following disciplines: chemistry, microbiology and hematology (excluding morphology and bone marrow surveys).

Table 6. Reasons for Non-Participation in EQA Surveys

Reason for Non Report	2003 (Jan-Dec)	2004 (Jan-Dec)
Lost record of survey	1	0
Left material in refrigerator	1	0
Misplaced material on site	1	1
Missed submission date	0	1
Faxed worksheets to wrong organization	0	2
Declined (Voluntary surveys including interpretive component)	6	4
No Reason	0	1
Total	9	9

Interestingly, the overall error rate was similar at 1.2% for 2004 vs. 1.1% for 2003. Although there were some minor differences to be found in the percentage categories of error, in general, the nature of the errors was similar to last year. In 2004, methodology remained the leading cause of error (50%) and included problems associated with performance of automated systems and use of inadequately documented methods for patient tests and/or quality control (QC) program. The percentage of technological errors was slightly reduced (27%), with most of the causes being related to lack of attention to procedures, lack of response to QC results and inadequate handling of samples. The third leading cause was clerical error (13%), largely associated with transcription of results to the EQA Analysis Worksheets. Participants still have difficulty in identification and documentation of the root cause of error. However, documented corrective actions seem to be appropriate for the contributing causes. In 2005, root cause analysis is being considered for further educational focus. The types of errors encountered are detailed within the discipline reports.



CHEMISTRY DISCIPLINES

CHEMISTRY-GENERAL

TESTING MODEL

In 2004, surveys for routine serum analytes, HbA_{1c}, blood gases, iron (total iron, unsaturated iron binding capacity [UIBC] and total iron binding capacity TIBC), urine chemistry and albumin excretion rate were distributed.

The computer flagging rules for bias and precision remained the same as those used for the 2003 surveys.

ASSESSMENT OF PERFORMANCE

Routine Serum Analytes

Fourteen routinely performed chemistry analytes (Appendix G) were assessed in three surveys CHEM-0401, CHEM-0405 and CHEM-0410. Each survey included three vials of previously frozen serum in which different analyte concentrations were prepared to challenge both the accuracy and precision of laboratory performance. Committee Comments were published for each survey to provide an interpretation of the data, to comment on method trends and potential assay limitations, and to identify current practice guidelines for individual laboratory consideration.

Table 7 provides a summary of laboratory participation, number of laboratories with flagged results and the number receiving correspondence for discordant results for the three surveys. There was no evidence of a significant difference in the number of flags or letters compared to 2003.

Between-run precision was assessed over six days by distributing duplicate vials in CHEM-0405, resulting in 72 flags and 15 letters for imprecision (6 for total protein, 4 for calcium, 3 for creatinine, 2 for magnesium).

As in 2003, the largest number of computer generated flags and letters of correspondence were related to issues associated with calcium, creatinine and magnesium. In addition, this year a significant number of outliers were noted to be associated with performance of total protein and urea.

Calcium

Performance of calcium resulted in a total of 122 laboratories with computer generated flags, with letters sent to 31 locations. Two samples in the January (CHEM-0401) and May (CHEM-0405) surveys were supplemented to provide

Chemistry (Routine, Quantitative Urine Chemistry, Albumin Excretion Rate, HbA_{1c}, Blood Gases)

No. of Participants (Dec. 2004)	203
No. of Participants (Dec. 2003)	206
No. of Surveys Conducted in 2004	15

Drug Monitoring (Routine, Cyclosporine, Drugs of Abuse)

No. of Participants (Dec. 2004)	167
No. of Participants (Dec. 2003)	169
No. of Surveys Conducted in 2004	9

Enzymes, Cardiac Markers & Lipids

No. of Participants (Dec. 2004)	Enzymes	195
	Lipids	135
No. of Participants (Dec. 2003)	Enzymes	198
	Lipids	135
No. of Surveys Conducted in 2004		9

Endocrinology

No. of Participants (Dec. 2004)	126
No. of Participants (Dec. 2003)	123
No. of Surveys Conducted in 2004	4

Immunology

No. of Participants (Dec. 2004)	65
No. of Participants (Dec. 2003)	71
No. of Surveys Conducted in 2004	3

Maternal Serum Screening

No. of Participants (Dec. 2004)	NA
No. of Participants (Dec. 2003)	7
No. of Surveys Conducted in 2004	0

Point-of-Care Testing (Glucose Meters)

No. of Participants (Dec. 2004)	195
No. of Participants (Dec. 2003)	196
No. of Surveys Conducted in 2004	2

Table 7. Summary of Laboratories Flagged for Bias and the Number Receiving Correspondence by Analyte for Surveys CHEM-0401, CHEM-0405 and CHEM-0410

Analyte	CHEM-0401			CHEM-0405			CHEM-0410		
	No. of Labs	No. of Labs Flagged	No. of Labs Receiving Correspondence	No. of Labs	No. of Labs Flagged	No. of Labs Receiving Correspondence	No. of Labs	No. of Labs Flagged	No. of Labs Receiving Correspondence
Bicarbonate	148	10	2	149	12	3	145	9	2
Chloride	200	0	0	198	2	1	196	3	0
Sodium	202	7	4	200	4	3	198	2	2
Potassium	202	0	0	200	1	0	198	0	0
Glucose	202	1	1	199	0	0	197	0	0
Urea	198	29	6	196	16	2	194	13	2
Creatinine	201	18	7	199	9	2	197	13	5
Bilirubin	...	...	...	191	7	6	...	...	...
Calcium	189	84	18	189	22	7	187	16	6
Phosphate	170	4	2	170	16	0	169	3	3
T. Protein	183	24	8	183	10	2	182	9	2
Albumin	182	8	0	182	13	0	181	5	2
Urate	173	0	0	171	1	1	169	1	0
Magnesium	134	57	1	129	17	5	130	59	8

calcium concentrations close to the upper limit of linearity for some methods. Committee Comments reflected the following: “Concentrations reported by Ortho-Clinical Diagnostics users ranged from 1.87–4.82 mmol/L for Vial A and 3.22–4.77 mmol/L for vial C. Twenty-one participants exceeded the 5% flagging limit for these duplicate vials, and the majority of these were Ortho Vitros users.” A negative bias was observed for Beckman Coulter users’ results for the two vials with high calcium concentrations in the January survey. It is clear from the data that review and validation of assay performance at elevated concentrations is warranted by all laboratories.

Magnesium

The reference result for each of the nine samples was established by atomic absorption; these results compared well with the all-methods’ mean (AMM). However, individual technologies continue to demonstrate bias. As in 2003, Dade Behring users illustrated a negative bias at low magnesium concentrations, while Beckman Coulter and Abbott users’ groups demonstrated a positive bias on some of the samples. Interestingly, samples supplemented with high concentrations of calcium in survey CHEM-0401 yielded results with a slightly negative bias from Beckman Coulter. In 2004, magnesium evaluations resulted in 133 laboratories with computer-flagged results and 14 receiving memoranda for discordant results.

Creatinine

Survey accuracy was based on HPLC analysis of samples performed in a reference laboratory. To avoid the influence of the continuing positive bias demonstrated by Ortho Vitros results, results were compared to the analytical principle mean. The results reported from a reference laboratory using HPLC compared well with the kinetic method means. Forty laboratories’ results had one or more computer flags and 14 received memoranda over the year.

In survey CHEM-0410, participants were asked to include the reference ranges that they use for 40-year-old male and female patients to ascertain whether known creatinine method biases were reflected in appropriate reference range differences. While the observed bias is addressed to some extent in quoted manufacturer reference intervals, information compiled from laboratory responses indicates that a wide range of upper reference limits are used for similar methods within Ontario laboratories. Figures 11A-11E and 12A-12E display the upper reference limits reported by the various instrument users’ groups.

It was noted that while most manufacturers provided different suggested reference ranges for men and women, many laboratories have not implemented sex-dependent reference ranges. Laboratories are reminded of the importance of reviewing their reference intervals with their local clinicians for their various specific patient populations, especially as geriatric and renal patients are apt to attend multiple hospital and community laboratories.

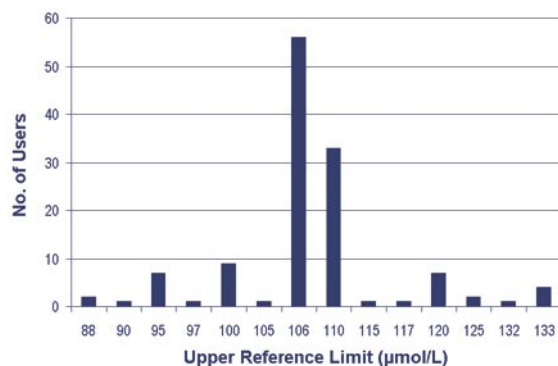


Figure 11A. Female creatinine upper reference limit reported by Ortho Vitros users

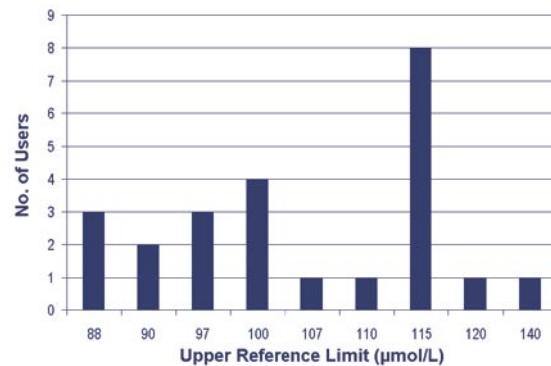


Figure 11B. Female creatinine upper reference limit reported by users of Beckman Coulter instrument systems

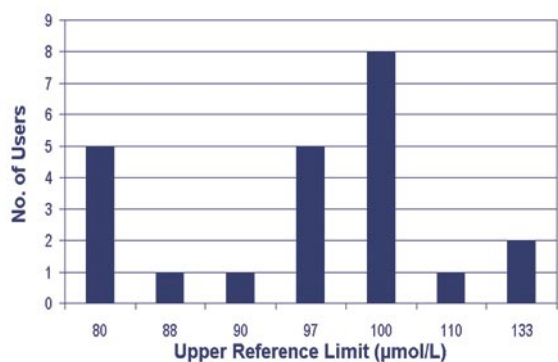


Figure 11C. Female creatinine upper reference limit reported by Roche (BMC) reagent users

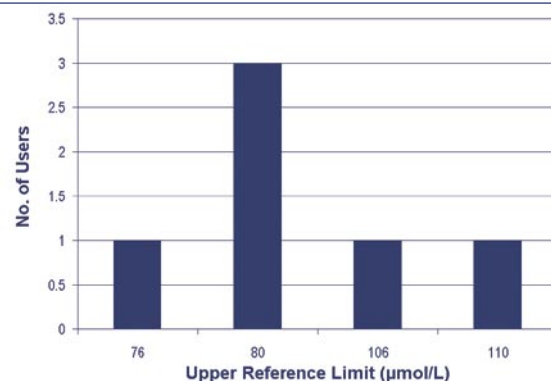


Figure 11D. Female creatinine upper reference limit reported by Roche Cobas Integra users

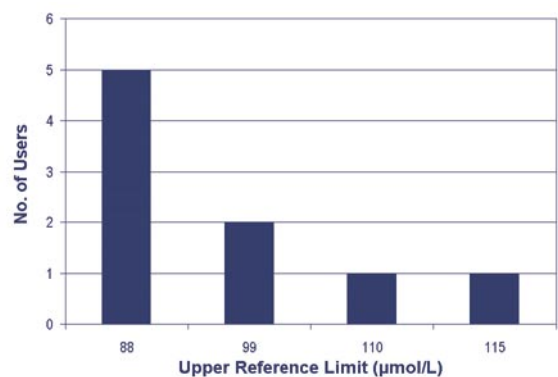


Figure 11E. Female creatinine upper reference limit reported by Dade Dimension and Xpand users

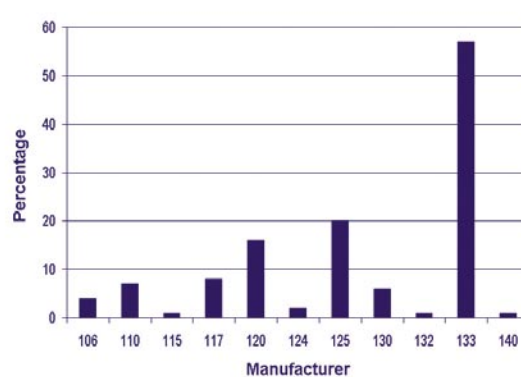


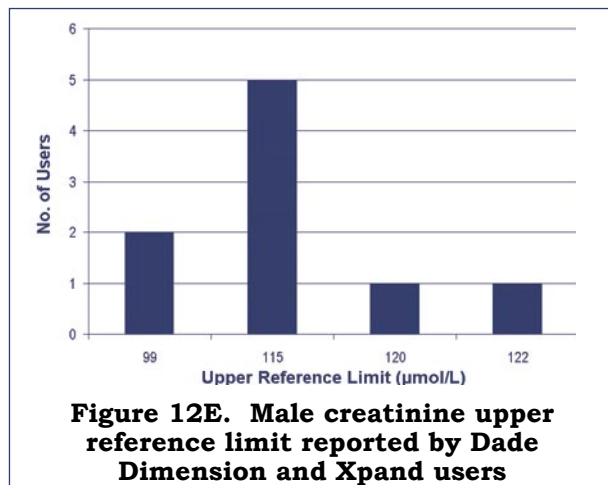
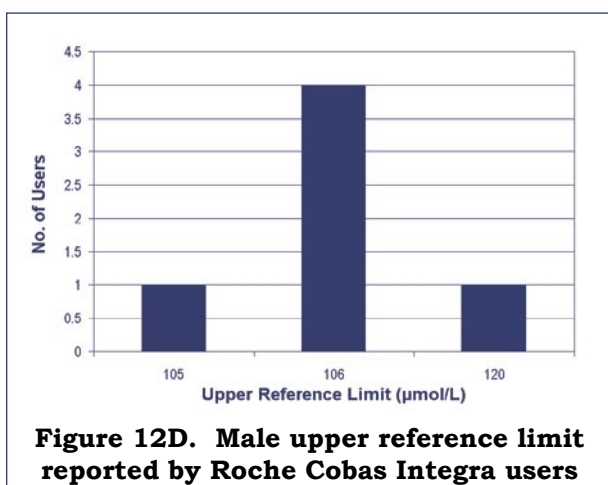
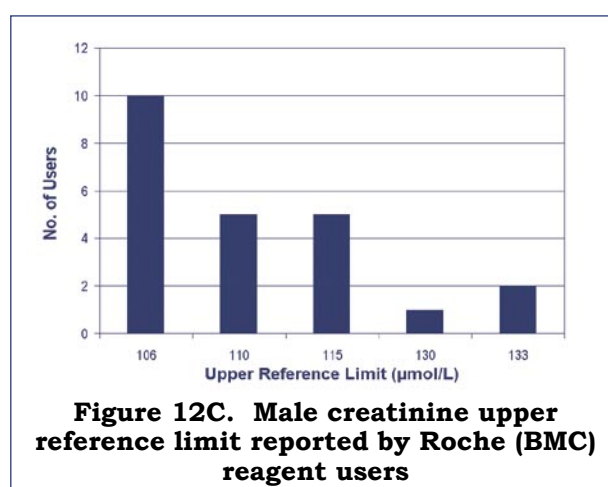
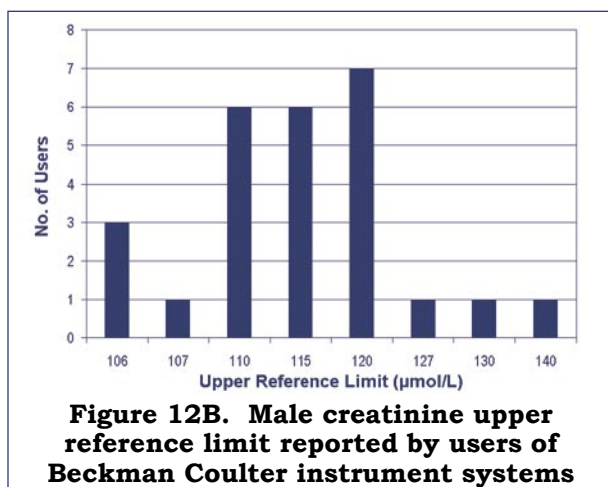
Figure 12A. Male creatinine upper reference limit reported by Ortho Vitros users

Urea

The majority of flagged results for urea occurred on samples with normal concentrations. Although 58 laboratories had one or more results outside the acceptable limits, only ten participants received memoranda for discordant results.

Iron

Two vials of previously frozen serum were distributed in March (CHEM-0403-IR) and July (CHEM-0407-IR) for analysis of total iron, UIBC, TIBC and calculation of the transferrin saturation (TS). Compared to 2003, the number



of laboratories performing total iron assays declined by four to 73 in the July survey. The number of participants measuring TIBC or UIBC increased by ten to 64 in July and the number reporting the TS increased by nine to a total of 57. Committee Comments for survey CHEM-0403-IR questioned the continuing omission by laboratories of TS as the primary clinical indication for measurement of iron and its indices for investigation of anemia, overdose and for screening for hemochromatosis.

Results were computer flagged if they were >10% from the AMM. Five laboratories received memoranda for discordant results for the March survey and six participants received memoranda for results reported in the July survey.

Urine Chemistry

Two vials of urine were distributed in March (CHEM-0403-UC) and July (CHEM-0407-UC) for the measurement of urine protein, creatinine, sodium, potassium and osmolality. Laboratories were asked to report concentrations and daily excretion rates based on the urine volumes indicated on the Analysis Worksheet. Overall performance was acceptable for these surveys.

Urine Osmolality

Sixty-seven laboratories reported results for osmolality. The osmolality values ranged from 166 mmol/kg to 684 mmol/kg across. No results were >5% from the AMM in the March survey; however, in the July survey, three participants reported values outside the acceptable limits of 5%.

Urine Sodium and Potassium

Results were reported by 106 participants. Performance was generally acceptable in the two surveys for both of these analytes. Five participants received memoranda for discordant sodium results and three received memoranda for potassium results.

Urine Protein

Eighty-seven laboratories reported urine protein results. A positive bias in the results reported by participants using the Ortho pyrocatechol violet method was once again evident in the July survey. This bias was not evident in the March survey which had similar protein concentrations. Urine protein assays continue to demonstrate poor interlaboratory precision. In the March survey, a concentration of 0.50 g/L resulted in an all-methods' coefficient of variation (CV) of 9.6% while a concentration of 0.10 g/L resulted in a CV of 18%.

Urine Creatinine

Results were reported by 136 participants. The Ortho Vitros method demonstrates a small negative bias compared to results from other methods. Interestingly, the opposite is true for Ortho serum creatinine results where the Vitros results demonstrate a positive bias. In each of the surveys, two laboratories received memoranda regarding discordant results.

The committee continues to be concerned that some laboratories use serum control material for urine assays, while other laboratories are only running one level of urine control.

Blood Gases

Two blood gas surveys (CHEM-0404-BG) and CHEM-0408-BG) were conducted in 2004. For each survey two ampoules of commercially prepared aqueous material were distributed. Sufficient samples were distributed to test all of the instruments within an institution, including point-of-care devices. Also, facilities were requested to report sodium, potassium, glucose and ionized calcium results if they reported patient samples for these analytes from their instruments. Results for 287 instruments from 158 institutions were obtained.

Performance on these surveys, as seen in previous years, was generally satisfactory. The majority of flagged results in both surveys were related to pO₂ and, as in previous years, were due to sample handling problems.

The second highest number of flags occurred with ionized calcium. There were 27 of 95 results flagged in CHEM-0404-BG and 25 of 101 results in the second survey (CHEM-0408-BG). The reported results varied by analyzer manufacturer with Radiometer users showing a positive bias and i-STAT users showing a negative bias.

Hemoglobin A_{1c}

Three surveys were conducted, in January, May and October 2004. Each survey contained two samples of fresh EDTA whole blood obtained from donors. The six samples were sent to the National Glycohemoglobin Standardization Program (NGSP) at the University of Missouri—Columbia's Diabetes Diagnostic Laboratory for reference values. In each case, the AMMs were in agreement with the reference values.

The number of laboratories reporting HbA_{1c} has risen from 54 to 62 in one year, 23 now use an HPLC method, up from 20 in 2003; 39 use an immunochemical method, up from 34 in 2003. Performance is consistent within the two groups, with HPLC assays providing slightly better precision (Table 8).

Results are flagged if they are >7.5% from the reference values. Thirty-six (10%) of the 358 results reported for the three surveys were outside the flagging limit.

The International Federation of Clinical Chemists (IFCC) has issued changes to reporting of HbA_{1c} and discussion in Ontario is ongoing. The Ontario Society of Clinical Chemists (OSCC) will issue a Practice Guideline and QMP-LS will issue a Broadsheet in 2005.

Table 8. Summary of Performance of the HPLC and Immunochemical Methods for HbA_{1c}

Survey	Vial 1			Vial 2		
	All-methods' Mean	HPLC CV (%)	Immunochemical CV (%)	All-methods' Mean	HPLC CV (%)	Immunochemical CV (%)
January	0.084	3.1	5.5	0.087	2.6	5.5
May	0.062	3.3	4.5	0.057	3.9	3.6
October	0.064	3.1	6.3	0.062	2.7	5.6

Albumin Excretion Rate

Surveys for albumin excretion rate were distributed in January, May and October. The number of vials in each survey were decreased from four to three. Twenty-six laboratories reported results. Participants are requested to report results for urine albumin and creatinine and calculate and interpret the albumin:creatinine ratio.

Urine albumin is measured using nephelometry (13), turbidimetry (11) and enzyme immunoassays (2). Interlaboratory precision is poor at low concentrations of albumin. A sample containing 5.2 mg/L of albumin had a CV of 23.1%, while a sample with an albumin concentration of 81.7 mg/L had a CV of 7.9%.

The performance of urine creatinine was acceptable on the three surveys. The majority of the laboratories interpreted the ratios correctly. However, five laboratories interpreted ratios ranging from 1.9 to 2.4 as abnormal in the January survey and two laboratories interpreted ratios of 1.4 and 1.5 as abnormal in the October survey.

Root Cause Analysis on Discordant Results

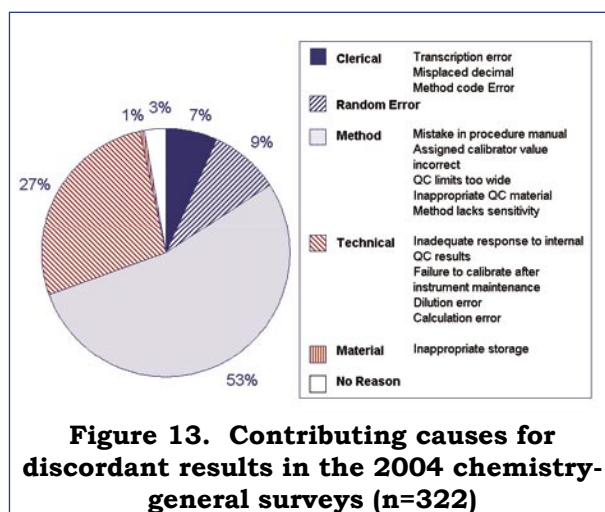
Letters of correspondence revealed a number of technical errors due to dilution error, inappropriate response to QC results, sample mix-ups and errors related to failure to follow written laboratory procedures. Reported method errors were associated with QC limits set too wide, inappropriate choice of QC concentrations, incorrect calibrator value or method imprecision. Other reported sources of error included: clerical errors (transcription, calculation), material errors (possible contamination), random errors and unknown responses.

Laboratories should complete a thorough review of their laboratory practices and procedures before assigning a "random error." While in many instances this is proven as a valid response, often times multiple sample results in the same survey or over adjacent surveys suggest that a systematic bias may exist. Robust lot-to-lot and calibration verification procedures, or patient means analysis may prove helpful in facilitating these investigations. Ultimately, laboratories and manufacturers must share the responsibility for resolution of method challenges in a timely fashion.

Table 9 displays the number of results reported for the chemistry surveys (routine, blood gases, HbA_{1c}, iron, albumin excretion rate and urine chemistry), the number of results generating memoranda and the error rate for the year. Figure 13 displays the contributing causes by percentage for the 322 discordant results.

Table 9. Number of Results Reported for 2004, the Number of Results Generating Memoranda and the Error Rate

Discipline	No. of Results Reporting	No. of Results Generating Memoranda	Error Rate (%)
Chemistry	32 299	322	1.0



DRUG MONITORING

TESTING MODEL

There was a reduction in the number of survey events in 2004 from five to four. Previously frozen serum supplemented with specific drugs continued to be used for three routine surveys. Samples of pooled urine were distributed for each of the three drugs of abuse surveys and whole blood samples were distributed for each of the three cyclosporine/tacrolimus surveys. The drugs tested were:

DRUG-0401	Ethanol, acetaminophen, salicylate, digoxin, lithium, carbamazepine, phenobarbital, phenytoin, theophylline, valproic acid, gentamicin, tobramycin, vancomycin, cyclosporine, tacrolimus and drugs of abuse
DRUG-0405	Cyclosporine, tacrolimus, drugs of abuse
DRUG-0407	Ethanol, acetaminophen, salicylate, digoxin, lithium, carbamazepine, phenobarbital, phenytoin, theophylline, valproic acid
DRUG-0410	Ethanol, acetaminophen, salicylate, digoxin, lithium, gentamicin, tobramycin, vancomycin, cyclosporine, tacrolimus, drugs of abuse

ASSESSMENT OF LABORATORY PERFORMANCE

Routine drug results, with the exception of digoxin, are flagged for committee review when >10% from the all-methods' mean (AMM). Digoxin results are flagged if >0.2 nmol/L from an AMM of ≤ 1.5 nmol/L or >10% from an AMM of >1.5 nmol/L. Cyclosporine and tacrolimus results are flagged when >15% from the AMM. Results for drugs of abuse are compared to results reported by a reference laboratory.

Carbamazepine, Phenobarbital, Phenytoin, Theophylline and Valproic Acid

Overall performance appears to be satisfactory with only a few results outside the acceptable limits of 10%. No major method biases were observed in the two surveys containing these drugs.

Digoxin

Digoxin assays continue to demonstrate poor precision in the clinical range. Table 10 summarizes the performance for each survey sample. In the January survey, the AMM was 2.0 nmol/L and 14 (10.9%) of 128 laboratories reported results that were >10% from the AMM. The performance was worse in the July survey (AMM 2.2 nmol/L) with 48 (38.7%) out of 124 results outside the acceptable limits. Thirty-three (26.2%) of 126 results were outside the acceptable limits in the October survey. The AMM for this sample was 2.0 nmol/L. The enzyme immunoassay method results have a positive bias compared to results from the other methods.

Acetaminophen

Turbidimetric immunoassay methods continue to demonstrate a slight positive bias when compared to the AMMs in the three surveys. Enzyme assays were the most imprecise with coefficients of variation (CVs) of 5.8% for survey DRUG-0401, 9.1% for survey DRUG-0407 and 8.1% for survey DRUG-0410.

Salicylate

Salicylate testing was generally acceptable with the exception of the Dade Behring method that continues to show a significant positive bias relative to the AMMs. QMP-LS has been in communication with Dade Behring regarding this bias. Figures 14A and 14B display the results reported for salicylate in survey vials DRUG-0401-A and DRUG-0410-A.

Table 10. Summary of Digoxin Results for Surveys DRUG-0401, DRUG-0407 AND DRUG-0410

Digoxin nmol/L Survey DRUG-0401	Total Results	Total Stats	Mean	SD	Median	CV%	Min Result	Max Result
VIAL A								
All-methods' mean	128	128	1.98	0.16	2.00	8.0	1.6	2.4
Principle								
Chemiluminescence	27	27	1.94	0.10	1.90	5.3	1.7	2.1
EIA	64	64	2.05	0.17	2.00	8.5	1.6	2.4
EMIT	1	0	...	...	...	...	2.1	2.1
Fluor Immunoassay	1	0	...	...	...	...	2.0	2.0
FPIA	3	0	...	...	...	...	1.7	2.0
MEIA	24	24	1.90	0.10	1.90	5.3	1.7	2.1
Neph/Turb Immunoassay	8	8	1.88	0.21	1.85	11.1	1.6	2.3
Survey DRUG-0407								
VIAL A								
All-methods' mean	126	124	2.23	0.28	2.20	12.7	1.4	2.8
Principle								
Chemiluminescence	27	25	2.12	0.20	2.10	9.5	1.8	2.7
EIA	66	66	2.40	0.20	2.40	8.3	1.9	2.8
EMIT	1	0	...	...	...	...	2.6	2.6
FIA	1	0	...	...	...	...	2.0	2.0
FPIA	3	0	...	...	...	...	1.7	2.2
MEIA	19	19	2.04	0.15	2.00	7.5	1.8	2.2
Neph/Turb Immunoassay	9	9	1.74	0.22	1.70	12.9	1.4	2.1
Survey DRUG-0410								
VIAL A								
All-methods' mean	126	125	2.05	0.24	2.00	12.0	1.5	2.7
Principle								
Chemiluminescence	26	26	1.93	0.19	1.90	10.0	1.6	2.5
EIA	64	64	2.19	0.20	2.20	9.1	1.8	2.7
EMIT	1	0	...	...	...	...	2.2	2.2
FIA	1	0	...	...	...	...	2.0	2.0
FPIA	3	0	...	...	...	...	1.6	2.0
MEIA	19	19	1.84	0.08	1.80	4.4	1.7	2.0
Neph/Turb Immunoassay	11	11	1.86	0.21	1.90	11.1	1.5	2.2

Ethanol

In general, testing for ethanol is performed well. Three of 109 laboratories reporting results in survey DRUG-0407 received memoranda for discordant results. No correspondence was issued for results in the other two surveys.

Lithium

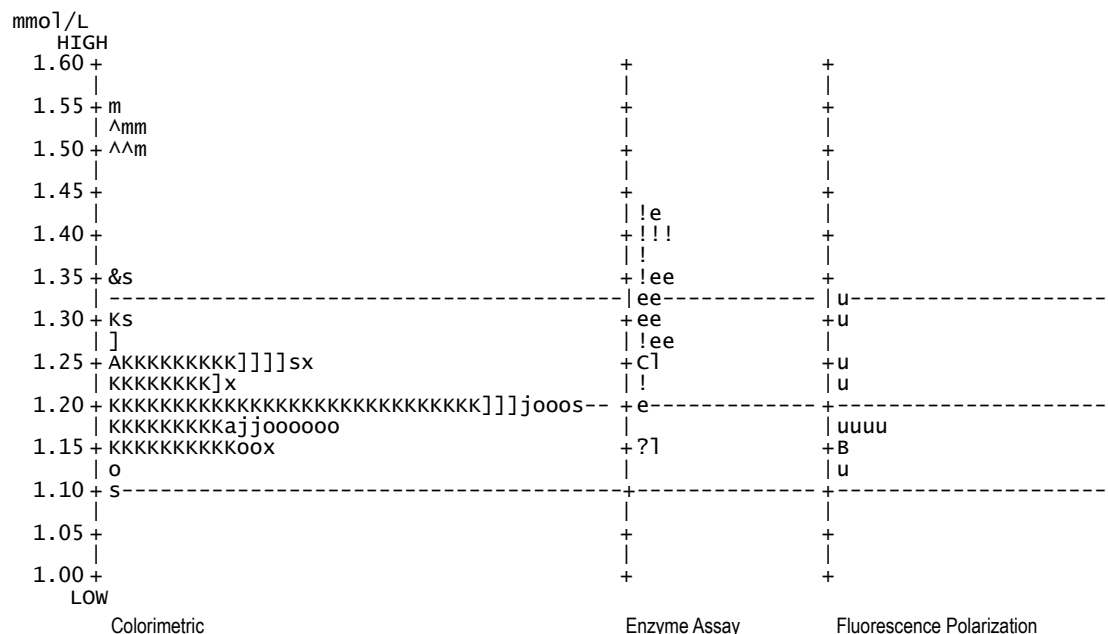
As in the past, Ortho Vitros colorimetric methods used to measure lithium continue to demonstrate a positive bias relative to the ion selective electrode, flame photometry and atomic absorption assays at concentrations within the therapeutic range. This bias was not as evident in survey DRUG-0407 since the concentration of lithium was quite high (AMM=3.05 mmol/L).

Gentamicin, Tobramycin and Vancomycin

The overall performance of tobramycin and vancomycin testing is good. Enzyme immunoassay methods for gentamicin are displaying a negative bias relative to the AMM.

Cyclosporine and Tacrolimus

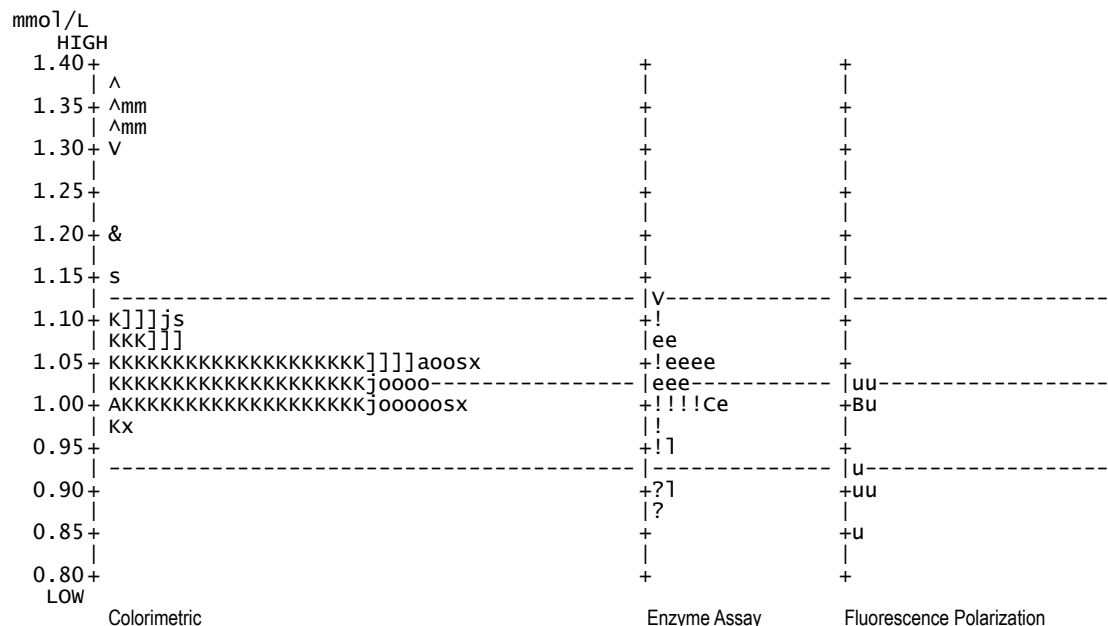
Three surveys, containing three samples each, were conducted. QMP-LS offers cyclosporine surveys to both Ontario and out-of-province laboratories. Twenty-three laboratories reported results for cyclosporine (8 in Ontario, 9 in British Columbia, and 1 each in Alberta, Saskatchewan, Manitoba, Quebec, Nova Scotia, and New Brunswick). Fourteen laboratories report results for tacrolimus (7 in Ontario, 3 in British Columbia, and 1 each in Alberta, Saskatchewan and Quebec).



a – Hitachi 717
e – Beckman Coulter Synchron CX4
j – Ortho-Clinical Diag. Vitros 500
l – Cobas Integra 700-800 Series
m – Dade-Behring Dimension Xpand
o – Ortho-Clinical Diag. Vitros 950

s – Hitachi 911
u – Abbott AxSYM
x – Ortho-Clinical Diag. Vitros 700
A – Hitachi 917
B – Abbott TDx
C – Cobas – MIRA, MIRA S

K – Ortho-Clinical Diag. Vitros 250
! – Beckman Coulter Synchron Lx20, Lx 20 PRO
& – Dade-Behring Dimension AR
] – Roche/Hitachi Modular Systems
^ – Dade-Behring Dimension RxL, RxL Max



a – Hitachi 717
e – Beckman Coulter Synchron CX4
j – Ortho-Clinical Diag. Vitros 500
l – Cobas Integra 700-800 Series
m – Dade-Behring Dimension Xpand
o – Ortho-Clinical Diag. Vitros 950

s – Hitachi 911
u – Abbott AxSYM
x – Ortho-Clinical Diag. Vitros 700
A – Hitachi 917
B – Abbott TDx
C – Cobas – MIRA, MIRA S

K – Ortho-Clinical Diag. Vitros 250
V – Abbott CI 8200
! – Beckman Coulter Synchron Lx20, Lx 20 PRO
& – Dade-Behring Dimension AR
J – Roche/Hitachi Modular Systems
^ – Dade-Behring Dimension RxL, RxL Max

Figure 14. Salicylate results reported for vials DRUG-0401-A and DRUG-0410-A

In 2004, three out-of-province laboratories began performing cyclosporine and tacrolimus assays by tandem mass spectrometry. In general, there is good agreement between the results for cyclosporine obtained by the different assays. Cyclosporine results are more imprecise at low concentrations. The Abbott AxSYM and TDx group represents the largest number of users and also has the largest spread of results.

Tacrolimus is measured primarily by microparticle enzyme immunoassay and EMIT methods and there is good agreement between the two methods. The tandem mass spectrometry results are more precise for tacrolimus than for cyclosporine.

Surveys for cyclosporine and tacrolimus will be discontinued in 2005 due to the small number of participants.

DRUGS OF ABUSE

Three drugs of abuse surveys containing two samples of urine were distributed in 2004. Pooled patient urine is used for the samples. One hundred nine laboratories participated in the surveys. The Biosite Triage Drugs of Abuse Panel and the NCS Multi-Drug Screen Panel are used by the majority of the participants.

The following observations were noted.

- Survey sample DRUG-0405-DA-X contained MDMA/MDA (ecstasy). Only five out of 95 laboratories reported a positive result for amphetamines. All of the Triage and NCS users reported a negative result.
- Survey sample DRUG-0410-DA-Y contained a large amount of oxycodone and its metabolite noroxycodone (Approximately 25,000 µg/L for the total of both). Of the 103 laboratories reporting, 51 (49.5%) reported the sample as negative for opiates.
- Four of six laboratories using the MedTox Verdict II and Profile II ER devices reported positive phencyclidine results for vial DRUG-0410-DA-X. This sample also contained venlafaxine, which may have been responsible for the false positive results.

Investigations by the participants for discordant results has revealed that testing the sample with a different lot of reagent gives the correct result in some cases. This suggests that there are variations between reagent lot numbers. Drug concentrations near the cut-off values tend to cause more false negatives and positives due to imprecision around these values.

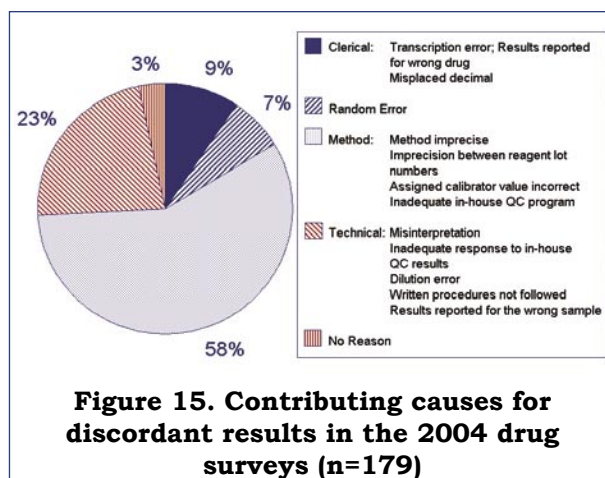
DISCORDANT FINDINGS

Table 11 summarizes the number of results reported for the drug surveys (routine, drugs of abuse and cyclosporine) the number of results generating memoranda and the error rate. The error rate is up slightly from 2003 (1.7%).

Figure 15 displays the contributing causes by percentage for the 179 discordant results. The contributing causes by percentage are similar to those seen in the 2003 report.

Table 11. Number of Results Reported for 2004, the Number of Results Generating Memoranda and the Error Rate

Discipline	No. of Results Reporting	No. of Results Generating Memoranda	Error Rate (%)
Drug Monitoring	7991	179	2.2



ENZYMES, CARDIAC MARKERS AND LIPIDS

ENZYMES AND CARDIAC MARKERS

TESTING MODEL

Reconstituted lyophilized human serum continued to be used for enzyme testing. Previously frozen supplemented serum was distributed for the analysis of cardiac markers.

The survey samples were sent by overnight courier and the participating laboratories are requested to perform the analysis within 24 hours of receipt. All samples may be included in the same test run.

Two enzyme and two cardiac marker surveys were conducted in 2004. The number of survey vials were reduced from five to four in 2004. The enzymes and cardiac markers tested were as follows:

ENZY-0401 Alkaline phosphatase (ALP), alanine aminotransferase (ALT), aspartate aminotransferase (AST), gamma glutamyl transferase (GGT), lactate dehydrogenase (LD), amylase, lipase

ENZY-0403 Total creatine kinase (CK), CK-2, myoglobin, troponin I, troponin T

ENZY-0406 ALP, ALT, AST, GGT, LD, amylase, lipase

ENZY-0410 Total CK, CK-2, myoglobin, troponin I, troponin T

ASSESSMENT OF LABORATORY PERFORMANCE

Cardiac Markers

Four vials of previously frozen serum supplemented with CK-2, CK-3, myoglobin and troponin I (cTnI) were distributed in each of the cardiac marker surveys (ENZY-0403-CM and ENZY-0410-CM). There was one set of duplicate vials in each survey to challenge within-run precision.

Total CK

There were 192 participants in surveys ENZY-0403-CM and ENZY-0410-CM. While a number of results were outside the flagging limit, only three laboratories in each survey received correspondence for discordant results. Precision based on the results from the duplicate vials was excellent with 97% of the laboratories achieving a difference of $\leq 5\%$ in survey ENZY-0403 and 98% in survey ENZY-0410.

CK-2

There were 123 participants in survey ENZY-0403-CM and 116 in ENZY-0410-CM. The number of laboratories performing CK-2 assays has decreased by 15 since October 2003 as laboratories are replacing CK-2 with troponin assays. Performance of CK-2 assays continues to be satisfactory. The chemiluminescence group continues to show three distinct populations with Beckman Coulter Access users reporting the highest results, Ortho Eci users reporting the lowest results and the Roche Elecsys and Bayer ADVIA Centaur results are in the middle. The upper limit of reference range is similar for all of these instruments.

Precision of CK-2 results is not as good as total CK. A difference of $\leq 8\%$ in the results for the duplicate vials was achieved by 87% of the participants in survey ENZY-0403 and 88% in survey ENZY-0410.

Myoglobin

Thirty-eight participants reported results for myoglobin in both surveys. This number has remained stable since October 2003. There is still disagreement in results between methods and within methods. The committee is

concerned about the poor inter-laboratory precision among users of this assay. Within-run precision is also poor with only 90% of the participants achieving a difference of $\leq 10\%$ on the results for the two sets of duplicate vials.

Troponin I

Troponin I (cTnI) results were reported by 112 participants in survey ENZY-0403-CM and 109 in ENZY-0410-CM. The five major vendors for this assay are Beckman Coulter, Biosite Diagnostics, Dade Behring, Ortho and Abbott. The results reported by Abbott AxSYM users are much higher than results from other manufacturers' assays. Therefore, cTnI results were separated into two groups, Abbott and non-Abbott. Results for within-run precision were poor for the March duplicate set of vials with only 57% of the Abbott group and 52% of the non-Abbott group achieving a difference of $\leq 10\%$ in their results.

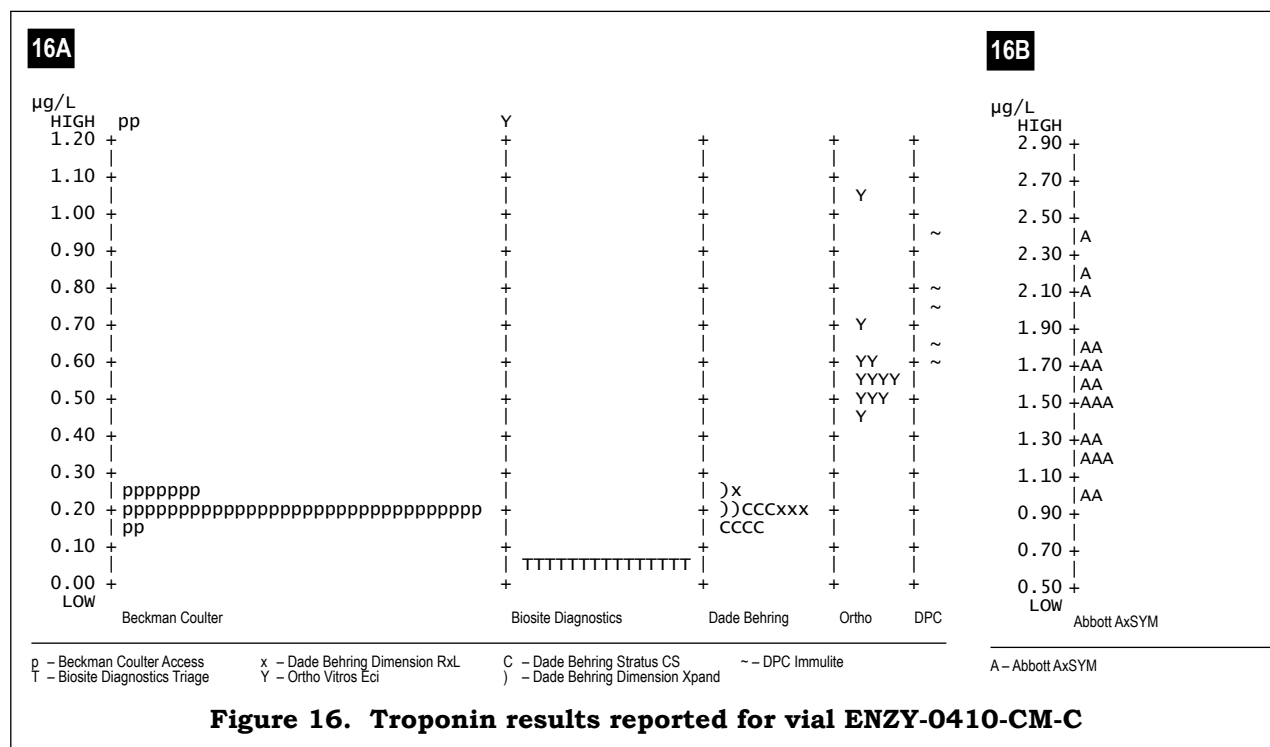
Performance was better in the October survey with 90% of the non-Abbott group and 84% of the Abbott group achieving a difference of $\leq 10\%$ in the results for the duplicate vials.

Due to lack of standardization for this assay, there is still a wide variation in values for troponin I as shown in Table 12 and Figure 16A and 16B. Laboratories are advised to caution

their physicians that the cTnI results are method dependent and must be interpreted against method-specific reference ranges.

Table 12. Comparison of Troponin I Results for Vial ENZY-0410-CM-A

Reagents	Median µg/L	Lowest Result µg/L	Highest Result µg/L	CV (%)
Beckman Coulter	27.3	22.6	33.5	9.2
Biosite Diagnostics	10.2	6.7	17.0	27.0
Dade Behring	23.7	15.7	30.0	16.4
DPC	85.9	72.8	95.1	9.4
Ortho	38.8	37.8	40.5	2.6
Abbott	257.1	50.0	352.8	33.0



Troponin T

Two surveys were distributed for Troponin T (cTnT); one in March (ENZY-0403-TT) and the other in October (ENZY-0410-TT). Each survey consisted of four vials of previously frozen serum supplemented with cTnT. The number of participants reporting cTnT results has increased from 24 in October 2003 to 31 in October 2004 representing a 29% increase.

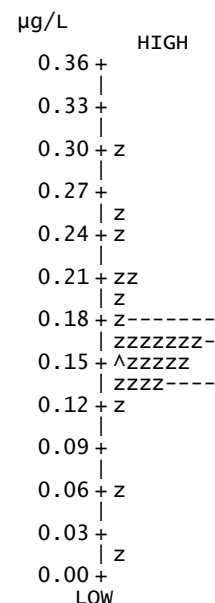
Vials 2 and 4 were duplicates for a within-run precision study in the March survey. The survey medians for these vials were 0.15 µg/L and 0.16 µg/L. Nine laboratories were flagged for imprecision with differences in the results ranging from 13% to >50%. As in previous years, the agreement among participants was poor at levels close to the diagnostic threshold. The results for vial 4 in the March survey ranged from <0.01 µg/L to 0.30 µg/L with a median value of 0.16 µg/L and a CV of 27.6% (see Figure 17)

The levels of cTnT in the October survey were higher than the March survey. The results are summarized in Table 13. The large spread in inter-laboratory results for this analyte was similar to that seen in 2003, which concerns the committee. Thirteen results were flagged for bias but no correspondence was sent since all results were significantly above the manufacturer's cut-off point for significant myocardial damage.

ALP, ALT, AST, GGT, LD, Amylase and Lipase

Four vials of reconstituted lyophilized serum were distributed in January and June 2004 (Surveys ENZY-0401 and ENZY-0406) to assay ALP, ALT, AST, GGT, LD, amylase and lipase. Two of the four vials in each survey were duplicates to challenge the participants for within-run precision.

Determination of these enzymes appears to be acceptable with only three laboratories receiving correspondence for results reported for survey ENZY-0401 and seven for ENZY-0406.



z – BMC Elecsys 1010, 2010
^ – Roche Modular System

Figure 17. Troponin T results reported for vial ENZY-0403-4

Table 13. Summary of Troponin T Results Reported by Participants for Survey ENZY-0410-TT (n=31)

Vial	Median (µmol/L) µg/L	Minimum (µmol/L) µg/L	Maximum (µmol/L) µg/L	CV (%)
ENZY-0410-1	2.39	1.90	2.85	8.4
ENZY-0410-2	1.68	0.84	2.01	7.2
ENZY-0410-3	0.79	0.63	0.86	8.6
ENZY-0410-4	0.30	0.14	0.34	8.7

Table 14. Summary of the Number of Results Reported for 2004, the Number of Results Generating Memoranda and the Error Rate

Discipline	No. of Results Reported	No. of Results Generating Memoranda	Error Rate (%)
Enzymes and Cardiac Markers	12 763	58	0.45

DISCORDANT RESULTS

Table 14 summarizes the number of results reported in 2004, the number of results generating memoranda and the error rate. The error rate has decreased by almost 50% when compared to the error rate for 2003 (0.95%).

Figure 18 displays the contributing causes by percentage for the 58 discordant results. The percentage of discordant results caused by method problems has increased from 24% in 2003 to 63% in 2004.

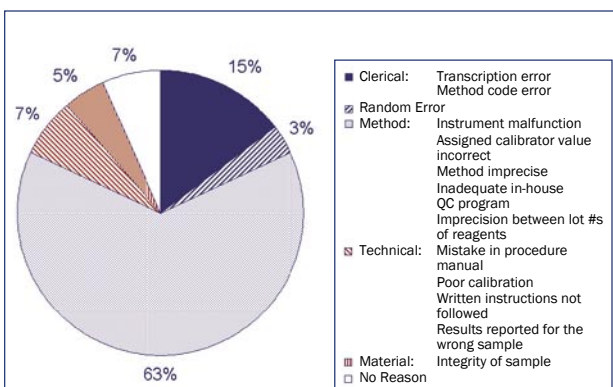


Figure 18. Contributing causes for discordant results in the 2004 enzyme and cardiac marker surveys (n=58)

LIPIDS

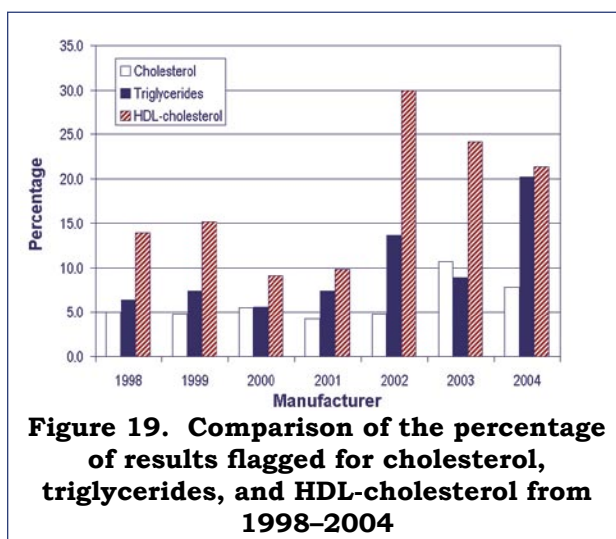
TESTING MODEL

Three lipid surveys were conducted using fresh unadulterated human serum from four donors for each survey. The surveys were distributed in January, June and October. The 134 participants were split into two groups and each group received two of the samples. The samples are shipped by overnight courier; the majority of laboratories receive the sample within 48 hours of collection.

ASSESSMENT OF LABORATORY PERFORMANCE

With each survey, the committee attempts to have all samples analyzed by three reference laboratories to obtain target values for cholesterol, triglycerides and HDL-cholesterol. Only two reference laboratories are available for triglyceride analysis. The mean of the reference laboratories' results, provided they agree within 3%, are used as the reference values. Unfortunately, one of the two reference laboratories analyzing triglycerides experienced difficulty with their assay at the time of the June (LIPS-0406) survey and was unable to report results. Therefore, the triglyceride all-methods' means (AMM) were used as the target values for the June survey.

Figure 19 presents the percentage of cholesterol, triglycerides and HDL-cholesterol results flagged for the years 1998–2004. The flagging rules have remained the same during this period. Increased flagging in the past three years' results has occurred due to the move to comparing results to reference values as opposed to the AMMs. Using the AMM allows methods used by large numbers of participants to influence the mean. Biases in these methods become less apparent.



Total Cholesterol

Performance of total cholesterol testing is generally acceptable. The percentage of results flagged decreased slightly in 2004 compared to 2003.

In 2004, 7.8% of the results were >5% from the reference values where as in 2003, 10.7% were outside of the acceptable limits. Memoranda were sent to 21 laboratories for discordant results on one survey while two laboratories received memoranda for discordant results on two surveys.

HDL-cholesterol

HDL-cholesterol remains an analyte of concern to the committee. Roche (BMC) users' results displayed a positive bias on ten of the 12 survey samples. Ortho users' results had a positive bias on five of the survey samples. A positive bias in Beckman Coulter users' results was observed for three of the samples and on three other samples a negative bias was observed.

There has been, however, an improvement in performance for this analyte overall. The flagging rate has dropped from 30% in 2002 to 21% in 2004.

Triglycerides

The committee is disturbed by the increase in the number of triglyceride results flagged in 2004. The percentage flagged has increased from 8.9% in 2003 to 20.2% in 2004. Ortho users' results displayed a negative bias on samples with triglyceride concentrations >2.00 mmol/L and a positive bias on samples with values <2.00 mmol/L. All of the Ortho users' results were flagged for a negative bias (>8% from the reference value) on a sample with a triglyceride concentration of 2.89 mmol/L. Some of the Beckman Coulter users' results were flagged for a negative bias in the January survey. This bias was not evident in the other two surveys.

For both HDL-cholesterol and triglycerides, the committee is concerned that the calibrator set points for some lot numbers of material appear to be inappropriate in spite of the claim from manufacturers that the calibration of the methods is traceable to the Center for Disease Control and Prevention (CDC)/National Cholesterol Education Program (NCEP) Laboratory Standardization Panel for manufacturers. The committee will continue to address these issues with the manufacturers. Individual laboratories are encouraged to bring these issues to the attention of their suppliers as well.

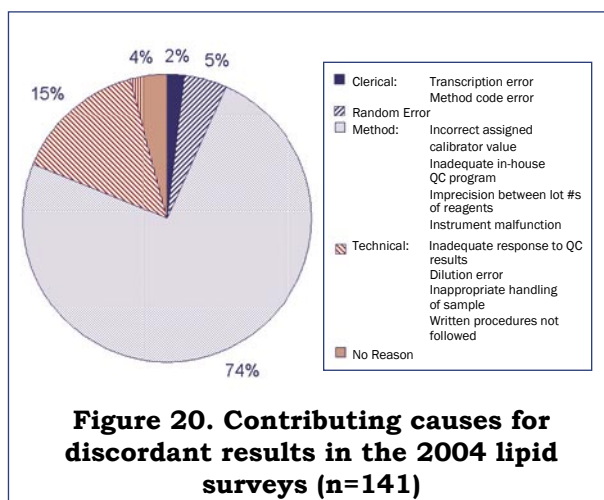
DISCORDANT RESULTS

The number of results received, the number of results generating memoranda and the calculated error rate are shown in Table 15.

Figure 20 displays the contributing causes by percentage for the 141 discordant results. The percentage (74%) of discordant results caused by method problems is similar to the percentage (71%) in 2003.

Table 15. Summary of the Number of Results Reported for 2004, the Number of Results Generating Memoranda and the Error Rate

Discipline	No. of Results Reported	No. of Results Generating Memoranda	Error Rate (%)
Lipids	2 929	141	4.8



ENDOCRINOLOGY

TESTING MODEL

The number of surveys was decreased from five to four in 2004 but the number of lyophilized serum vials was increased from two up to three in each of the four surveys.

One fresh serum challenge was also distributed in each survey. The analytes assessed are displayed in Appendix G.

Analytes assessed using fresh serum samples were:

Prostate specific antigen (PSA) and Free PSA	ENDO-0402, ENDO-0411
Vitamin B ₁₂ and Ferritin	ENDO-0404
Thyrotropin (TSH), Free Thyroxine (FT ₄) and Free Triiodothyronine (FT ₃)	ENDO-0408

Six inter-survey precision studies were conducted during the year using the lyophilized serum samples. The duplicate sets of vials were:

ENDO-0309-A and ENDO-0402-A
ENDO-0402-B and ENDO-0408-C
ENDO-0402-C and ENDO-0408-A
ENDO-0404-A and ENDO-0411-C
ENDO-0404-B and ENDO-0411-A
ENDO-0404-C and ENDO-0411-B

ASSESSMENT OF LABORATORY PERFORMANCE

Computer flagging rules were applied when there were ten or more participants using the same instrument. When there were less than ten, the committee reviewed the results manually.

Results for testosterone, prolactin, progesterone, cortisol, follicle stimulating hormone (FSH), luteinizing hormone (LH), dehydroepiandrosterone sulfate (DHEA-S) and alpha fetoprotein (AFP) were generally satisfactory on the lyophilized challenges for both bias and precision.

Chorionic gonadotrophin results were precise within an instrument group, but continue to show some variability between methods particularly at higher concentrations using lyophilized serum samples.

Vitamin B₁₂ and Ferritin

Vitamin B₁₂ results were reported by 54 participants for the fresh serum vial ENDO-0404-1. The results were satisfactory but there was some variation between methods. The results ranged from 168 pmol/L to 313 pmol/L.

On the same sample, 76 participants reported ferritin results. The results ranging from 6–15 µg/L were satisfactory. Again there was some variation between methods.

ESTRADIOL

Twenty to 22 laboratories reported results for estradiol in the 12 lyophilized serum challenges this year. There continues to be a wide variation in the results between methods. This variation was also apparent on fresh serum samples in previous years. The use of fresh serum samples will be investigated for a recovery and accuracy study in 2005.

Total and Free PSA and PSA Ratio

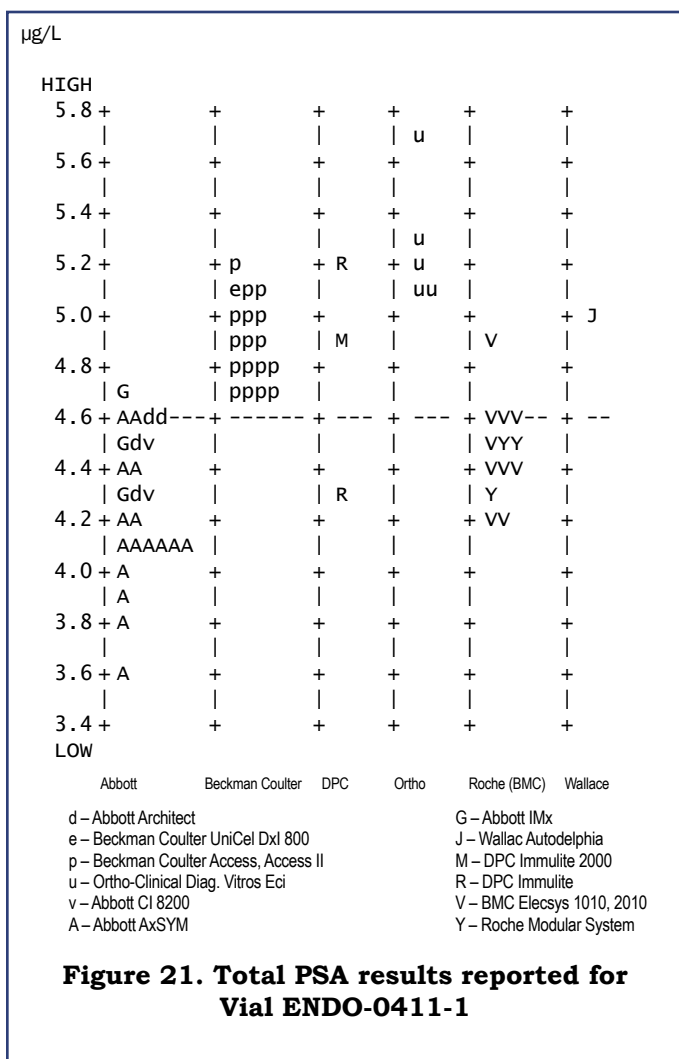
Two fresh serum studies were performed this year. Survey sample ENDO-0402-1 (February) was obtained from a male subject with confirmed benign prostatic hypertrophy (BPH) and survey vial ENDO-0411-1 (November) was obtained from a 64-year-old male subject with no history of prostate disease.

Sixty-one laboratories reported total PSA results for the February sample. The total PSA results ranged from 6.7–10.1 µg/L, which is in agreement with a diagnosis of BPH.

For the November survey, 65 laboratories reported total PSA results ranging from 3.6–5.7 µg/L (see Figure 21).

As in previous surveys the two methods (Beckman Coulter Access and Ortho Eci) standardized to the original Hybritech method report higher results than those standardized to the World Health Organization standard (Abbott and Roche). For this reason it remains important for patients being monitored to have repeat tests by the same method, or at least by a method calibrated with the same standard.

Results for free PSA reported by 29 participants in February and 27 participants in November do not show as much variation between methods. Roche results show a small negative bias when compared to the results from the Abbott and Beckman Coulter assays. The results for free PSA ranged from 1.6–2.5 µg/L for the February survey vial and from 0.6–1.0 µg/L for the November sample.



Abbott users reported the highest free/total PSA ratios on both samples while Roche users reported the lowest. Beckman users' ratios were in the middle range. It may be that the interpretive cut-off for the PSA ratio should be method dependent.

Thyroid Function Tests

A serum donation from a female with a factitiously elevated TSH was obtained and distributed in the August survey to demonstrate interference with the TSH assay. For FT₄, the results ranged from 14–23 pmol/L suggesting a high normal level of this analyte. The FT₃ results ranged from 3.2–6.7 pmol/L, well within the normal reference range. However the all-methods' median (n=107) for TSH was 20.4 mIU/L, which suggests some form of hypothyroidism. The only group not reporting results in the hypothyroid range was the four users of the Bayer ADVIA Centaur. The median result for this group was 4.9 mIU/L. Such discrepancies are uncommon, but laboratories should be aware that they do occur and that the National Academy of Clinical Biochemistry has issued guidelines for follow-up of discrepant TSH results (http://www.nacb.org/Impg/thyroid_Impg_pub.stm).

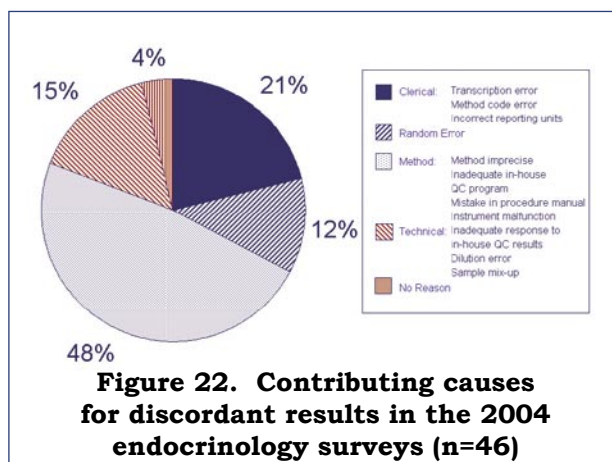
Discordant Results

Table 16 summarizes the number of results reported in 2004, the number of results generating memoranda and the error rate. The error rate has decreased slightly from 2003 (0.75%).

Figure 22 shows the contributing causes by percentage for the 46 discordant results. Clerical errors have increased from 7% in 2003 to 21% in 2004. Technical errors have decreased. In 2003, 26% of the discordant results were identified as technical problems.

Table 16. Summary of the Number of Results Reported for 2004, the Number of Results Generating Memoranda and the Error Rate

Discipline	No. of Results Reported	No. of Results Generating Memoranda	Error Rate (%)
Endocrinology	8240	46	0.56



IMMUNOLOGY

TESTING MODEL

The testing model was changed in 2004. Rather than distributing one survey sample on five occasions, two serum samples were distributed on three occasions during the year (February, August and November). The analytes tested are listed in Appendix G. C-reactive protein (CRP) screen and titre testing was removed from the testing menu after the February survey (IMGY-0402), as it is believed CRP analysis should be performed quantitatively.

Three inter-survey precision studies were conducted during the year. The duplicate vials were:

IMGY-0402-1 and IMGY-0408-1

IMGY-0311-1 and IMGY-0408-2

IMGY-0402-2 and IMGY-0411-2

ASSESSMENT OF LABORATORY PERFORMANCE

Revised computer flagging rules were put into use in 2004 for the quantitative assays.

They are as follows:

IgG, IgA, IgM, C3, C4, RF and albumin	>15% from the all-methods' median (AMM)
IgE and gamma globulin	>20% from the all-methods' median

Flagging rules for anti-TPO, anti-ds DNA, CRP and hs-CRP have not been set. The committee reviews the results manually. The qualitative assays are reviewed for the correct interpretation.

The committee reviewed the inter-survey precision results manually.

Performance on the three surveys was generally satisfactory. Some participants are still having difficulty completing the Analysis Worksheet correctly particularly for the qualitative assays. It was interesting to note that six of 31 laboratories using three different kits indicated the rheumatoid factor (RF) titre was positive for vial IMGY-0402-1. For the duplicate vial IMGY-0408-1, five of the six participants using the same kits as in the February survey indicated that the titre was negative.

Protein Electrophoresis

A myeloma patient sample was distributed in February (IMGY-0402-2) and again in November (IMGY-0411-2). All of the laboratories (n=41) identified the monoclonal band in the gamma region. All of the laboratories performing immunofixation electrophoresis (n=31), except one in the February survey, identified the major monoclonal protein as IgG lambda type. One laboratory identified it as IgG kappa type protein. In the August survey, it was identified correctly by this laboratory. Monoclonal free lambda light chains were detected by 39% of the laboratories in February and 42% in the August survey. The heavy IgG lambda band may have masked the free lambda band in some immunofixation electrophoresis systems.

Survey vial IMGY-0408-2 was a repeat of IMGY-0311-1. Twenty-four of the 40 participants commented on the hypogammaglobulinemia in the serum protein electrophoresis pattern; seven of these laboratories suggested follow-up with a 24-hour urine protein electrophoresis, about the same as for the duplicate vial IMGY-0311-1 (8 out of 26). There is a need to bring more standardization to the comments made on an electrophoresis report.

C-reactive Protein (CRP)

The committee remains concerned about the reporting practices for CRP with respect to routine CRP and high sensitivity CRP (hs-CRP) used for cardiac risk assessment in otherwise healthy individuals. It is not always clear from an individual laboratory's interpretation of the CRP result on a survey sample, whether an hs-CRP result is being reported. In some cases this may result in confusion for the ordering clinician. The committee also suspects that there is considerable confusion about the different levels of imprecision required for these two assays. These issues will be addressed in a future survey.

Titre Assays

There continues to be a wide variation in the practice of reporting assay results as titres. For ANA, the results from laboratories reporting titres can vary significantly (from 1:160–1:2560) depending on whether assays are titred to an endpoint. This has been a persistent observation for the survey results. A patterns-of-practice survey, planned for 2005, will address issues of titres, strengths, endpoints and reporting formats.

ANA Patterns

A few laboratories have some difficulty in interpreting the ANA pattern on ANA positive samples. For vial IMGY-0402-1, 20 participants interpreted the ANA pattern as nucleolar, 9 indicated it was both nucleolar and speckled pattern, and 1 indicated it was speckled. On the same sample in August, 21 indicated it was a nucleolar pattern, 5 indicated both nucleolar and speckled and 1 interpreted the pattern as homogeneous and nucleolar.

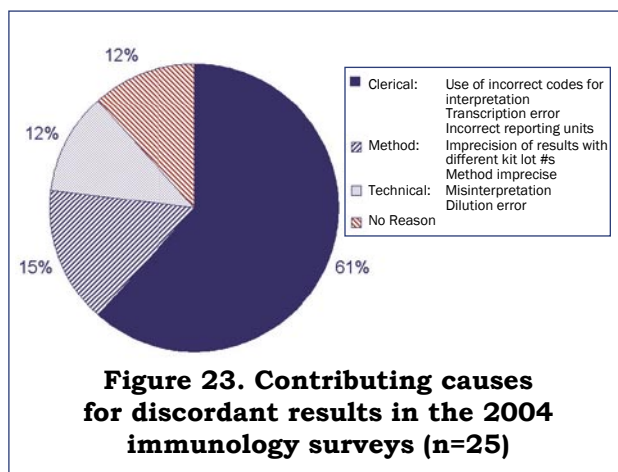
DISCORDANT RESULTS

Table 17 summarizes the number of results reported in 2004, the number generating memoranda and the error rate. In 2004, the error rate decreased slightly from the 2003 error rate (1.7%).

Figure 23 displays the contributing causes by percentage for the 25 discordant results. Clerical errors accounted for 61% of the discordant results. The introduction of a redesigned Analysis Worksheet may be partially responsible for this increase.

Table 17. Summary of the Number of Results Reported in 2004, the Number of Results Generating Memoranda and the Error Rate

Discipline	No. of Results Reported	No. of Results Generating Memoranda	Error Rate (%)
Immunology	2433	25	1.0



MATERNAL SERUM SCREENING

TESTING MODEL

Since 1993, QMP-LS has provided second-trimester serum and amniotic fluid prenatal screening external quality assessment challenges. The testing model was designed to monitor quality assurance (QA) indicators and analytical and interpretive performance. QMP-LS also has an expanded mandate to monitor the performance of laboratories based on data provided by the Ontario MSS Database (OMSSD).

Since 1999, QMP-LS has been monitoring the transition from second-trimester triple marker screening to enhanced screening modalities. The new markers are biochemical and ultrasound based. The reported advantages of these new modalities are that they will decrease the false positive rate (PR) associated with screening while possibly increasing the detection rate (DR). These changes should result in improved patient care and this shift in practice will have an impact on the QMP-LS EQA program.

In 2004, as a QA project for enhanced screening (see below) was underway, and as the three markers analyzed by the committee over the preceding ten years had remained stable, all wet challenges and patterns-of-practice surveys were suspended. The individual marker levels and the false positive rates for Down syndrome, Trisomy 18, and open neural tube defect (ONTD) testing were monitored on a monthly basis using data from the OMSSD. The laboratory monthly volumes are also monitored.

ONTARIO MSS DATABASE

The MSS Database provides outcome assessment on the basis of the PR. As shown in Figure 24, the fluctuation (error bars) for Trisomy 21 PR has remained fairly constant. The decrease in PR over the past 18 months may reflect the increasing use of enhanced screening modalities for older 'high risk' women and, thus, the younger age group of those women undergoing MSS. As maternal age is a factor in the Down syndrome risk calculation, the higher the proportion of younger women in the population, the fewer positive results. The ONTD PR and DR also remains the same. A substantial decline in the prevalence of ONTD has been noted. This has been attributed to two factors—screening for ONTD and the introduction of folate supplementation into wheat flour.

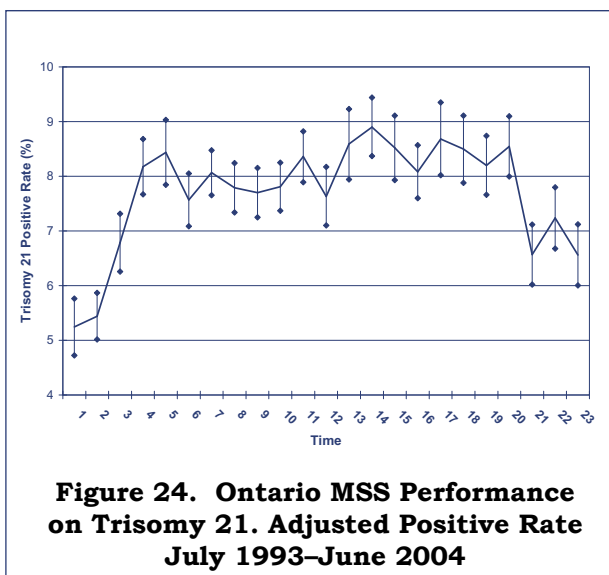
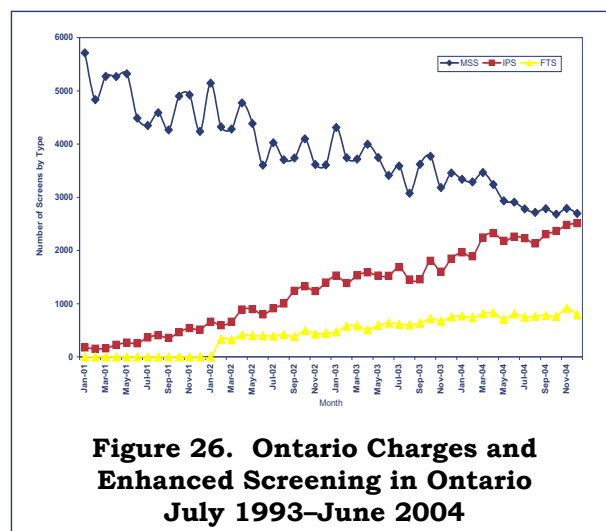
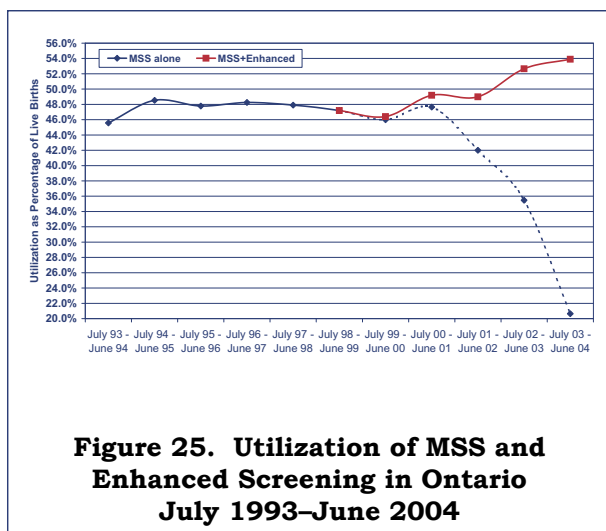


Figure 24. Ontario MSS Performance on Trisomy 21. Adjusted Positive Rate July 1993–June 2004

Since the introduction of enhanced screening, the overall uptake of prenatal screening as a function of live-births has increased and, likewise, the proportion of screened patients who elect to undergo enhanced screening versus traditional MSS has increased (Figure 25). Figure 26 illustrates the changes in screening practice within Ontario, based on the type of screening method.

ENHANCED PRENATAL SCREENING

In the fall of 2003, The Ontario Women's Health Council (OWHC) awarded a grant to QMP-LS, through the Ontario Medical Association, to develop a QA program for both the new biochemical markers and the ultrasound marker nuchal translucency (NT), which comprise the enhancements included in enhanced prenatal screening. The final report of the project will be forwarded by QMP-LS to the OWHC by February 28, 2005. One outcome of this project is that, in 2005, the MSS Committee will start monitoring the three new biochemical markers — pregnancy-



associated plasma protein A (PAPP-A) and free beta human chorionic gonadotropin (free β -hCG) in the first trimester; and dimeric inhibin A (DIA) in the second trimester. These markers will be monitored using data from the OMSSD. The issue of monitoring an ultrasound marker is extremely complex and will require further work on various details before implementation.

As of September 2004, one laboratory temporarily suspended screening services and the samples were redirected to one of the other laboratories. All other six laboratories offered enhanced screening markers.

Table 18 provides a snap-shot of current prenatal screening services. It is expected that by April 1, 2005 all laboratories will offer MSS with inhibin A.

Table 18. Enhanced Screening Modalities Compared to MSS

Screen	Markers	Gestational Timing	No. of Laboratories Offering Screening
MSS*	AFP, uE3, hCG 2nd Trimester	7 (6)	
Quad	AFP, uE3, hCG, DIA	2nd Trimester	2
FTS	NT, free β -hCG, PAPP-A	1st Trimester	2
IPS	NT, free β -hCG, AFP, uE3, PAPP-A	1st & 2nd Trimester	5
Serum IPS	PAPP-A, AFP, uE3, hCG, DIA	1st & 2nd Trimester	5

* As of September, 2004, one laboratory that offered MSS only suspended screening and the samples were redirected to another laboratory.

Quad – quadruple marker screening	hCG – human chorionic gonadotrophin
FTS – first trimester screening	DIA – dimeric inhibin A
IPS – integrated prenatal screening	NT – nuchal translucency
AFP – alpha fetoprotein	PAPP-A – pregnancy-associated plasma protein A
uE3 – unconjugated estriol	Free β -hCG – free beta human chorionic gonadotrophin

POINT-OF-CARE TESTING

GLUCOSE METERS

Testing Model

Two surveys were planned for 2004 to test the performance of glucose meters. The surveys were distributed in April (POCT-0404-GL) and September (POCT-0409-GL), and consisted of three vials of a commercially-prepared suspension of stabilized human red blood cells and known levels of glucose in a buffered medium containing preservatives. Sufficient material was sent to test all of the glucose meters within an institution. The April survey contained one set of duplicate vials for a precision study at an elevated level of glucose.

Participation in the surveys remains voluntary at this time with 193 institutions participating. Ten participants are institutions without laboratories. The users of the glucose meters are expected to perform the testing.

Survey Assessment

Bias

The computer flagging rules for bias remained the same as those published in 2003 Review:

- Glucose ≤ 5.0 : results >1.0 mmol/L from specific glucose meter model mean
- Glucose >5.0 : results $>20\%$ from the glucose meter model mean

If a result is $>15\%$ from the mean of the results reported from within an institution for a specific glucose meter model (or >1.0 mmol/L for glucose ≤ 5.0), it is flagged.

Imprecision

The following flagging rules apply for imprecision:

- Glucose ≤ 5.0 : results >1.0 mmol/L difference in results reported on duplicate vials
- Glucose >5.0 : results $>15\%$ difference in results reported on duplicate vials

Results are compared to the glucose meter model mean rather than the all-methods' mean (AMM), due to matrix effects with the survey material.

Glucose Meter Performance

The participants reported using 23 different models of glucose meters, which were grouped into 18 models of meters for analysis. The most popular glucose meter (by test volume) continues to be the Precision PCx, followed in order by the Surestep Flexx, Accu-Chek Inform, Glucometer Elite and the Precision G.

Survey POCT-0404-GL

A total of 2989 glucometer results were received for each of the three survey vials. Vials 2 and 3 were duplicates with glucometer means ranging between 15.3–19.9 mmol/L. The range for vial 1 was 4.0–7.1 mmol/L. The number of results that were flagged for bias and imprecision is shown in Table 18. Memoranda were sent to five institutions for results flagged for either bias or imprecision.

Table 18. Number of Results Flagged for Bias and Imprecision for Survey POCT-0404-GL

POCT-0404-GL n=2989	No. of Results >20% from Glucometer Mean	No. of Results >15% from Site Mean	No. of Precision Flags on Duplicate Vials 2 and 3
Vial 1 (near-normal)	6	12	...
Vial 2 (elevated glucose)	6	13	6
Vial 3 (elevated glucose)	1	2	...

Survey POCT-0409-GL

A total of 3052 glucometer results were received for each of the three survey vials. The range of instrument means for vial 1 was 11.1–19.8 mmol/L, for vial 2 was 1.1–3.6 mmol/L and for vial 3 was 16.1–22.3 mmol/L. The range of instrument coefficients of variation (CVs) was greater than noted in previous surveys, ranging from 3.5%–12.1% for vial 1, 3.6%–16.6% for vial 2 and 3.3%–15.1% for vial 3. Twenty-nine results were flagged for bias at elevated levels of glucose. Memoranda were sent to four institutions for results flagged for bias. Questions included on this survey asked whether the facility had a policy that specified at what range glucose tests should be confirmed by laboratory testing (170 [88%] participants did) and whether linearity testing was performed on the glucose meters in use (84 [44%] participants responded that it was).

The number of results flagged for bias has decreased since the beginning of the program in 2001, as shown in Table 19.

Table 19. Number of Flagged Results (>20% or ± 1 mmol/L From Glucometer Mean) for 2001–2004

Sample	Target Value (mmol/L)	Flagged Results	Per cent
	High Glucose		
U-0105 Vial 2	20.2	22	0.9
U-0108 Vial 3	18.6	14	0.6
POCT-0205 Vial 2	22.9	15	0.6
POCT-0209 Vial 1	22.4	5	0.2
POCT-0209 Vial 2	13.9	8	0.3
POCT-0309 Vial 2	15.7	4	0.1
POCT-0404 Vial 2	17.2	6	0.2
POCT-0404 Vial 3	17.2	1	0.03
POCT-0409 Vial 1	12.6	4	0.1
POCT-0409 Vial 3	17.5	6	0.2
	Elevated Glucose		
U-0105 Vial 1	7.3	16	0.6
U-0105 Vial 3	7.3	23	0.9
U-0108 Vial 1	8.9	10	0.4
	Normal Glucose		
POCT-0205 Vial 1	4.7	11	0.4
POCT-0205 Vial 3	4.7	7	0.3
POCT-0209 Vial 3	6.7	5	0.2
POCT-0404 Vial 1	5.8	6	0.2
	Low Glucose		
U-0108 Vial 2	2.8	6	0.2
POCT-0309 Vial 1	2.7	1	0.03
POCT-0309 Vial 3	2.7	2	0.07
POCT-0409 Vial 2	2.6	0	0

HEMATOLOGY DISCIPLINES

ROUTINE HEMATOLOGY

TESTING MODEL

Testing material for routine complete blood count (CBC) and automated leukocyte differential counts, representing clinical samples, was obtained from R&D Systems, Inc. of Minneapolis, Minnesota. Survey material included realistic clinical low, normal and high values. The material consisted of human erythrocytes with mammalian leukocytes and thrombocytes in a plasma-like fluid. The variety of blood cell analyzers used in Ontario continues to pose a challenge for this survey since there is no single material that is compatible with all instruments. Depending on the instrument, the CBC and automated leukocyte differential may vary, specifically the hematocrit (Hct), mean cell volume (MCV), thrombocyte and automated leukocyte differential. Participants were divided into eight groups and each received material compatible with their reported blood cell analyzer (Table 21).

Table 21. Instrument Groups for Automated Differential Survey Material, October 2004

Group	No. of Participants
No differential/ 1-, 3-part differential	34
Beckman Coulter 5-part differential	89
Abbott 5-part differential	55
Sysmex 5-part differential	4
Bayer 5-part differential	11
Abbott/Sysmex 3-part differential	7
Beckman Coulter A ^c T 5-part differential	5

The committee continues to have difficulty assessing results from laboratories where there are only a few users of a specific instrument, or in some cases, where the laboratory is the only user of an instrument. A fresh K₃EDTA human whole blood pilot survey was distributed in May 2004 as an alternative approach to this issue. The survey material was obtained from the Hamilton Regional Laboratory Medicine Program. This survey was distributed to a targeted number of participants who use instruments that cannot be adequately assessed using the simulated testing material. The Hamilton Regional Laboratory Medicine Program also supplies fresh K₃EDTA whole blood for the reticulocyte surveys.

The peer method group mean serves as the reference against which the laboratories' results are assessed provided that there are ten or more participants. Where there are less than ten participants, the all-methods' mean (AMM) serves as the reference mean.

Flagging limits are used to alert the committee to values outside the group mean, to unexpected results and/or clinically misleading results. In 2003, QMP-LS revised the flagging rules to allow better comparison of results with

Hematology (Routine, Red Cell Disorders, G6PD, Fetal Maternal Hemorrhage, Bone Marrow)

No. of Participants (Dec. 2004)	209
No. of Participants (Dec. 2003)	217
No. of Surveys Conducted in 2004	17

Hematology-Flow Cytometry

No. of Participants (Dec. 2004)	22
No. of Participants (Dec. 2003)	18
No. of Surveys Conducted in 2004	3

Coagulation

No. of Participants (Dec. 2004)	198
No. of Participants (Dec. 2003)	200
No. of Surveys Conducted in 2004	4

Morphology

No. of Participants (Dec. 2004)	201
No. of Participants (Dec. 2003)	206
No. of Surveys Conducted in 2004	3

Transfusion Medicine (Set A and Set B)

No. of Participants (Dec. 2004)	170
No. of Participants (Dec. 2003)	176
No. of Surveys Conducted in 2004	5

other proficiency testing programs with regard to specificity and sensitivity. The revised criteria are very similar to the proficiency testing flagging scheme for acceptable analytical performance used by the Clinical Laboratory Improvement Act (CLIA) and the College of American Pathologists (CAP). The flagging criteria are shown in Table 22. The committee has noted a decrease in the number of irrelevant flags as a result.

LABORATORY PERFORMANCE

At the end of 2004, 206 laboratories participated in the routine survey, compared to 217 in 2003. For reticulocyte counting, 153 laboratories participated in 2004, compared to 166 in 2003. The number of participating laboratories continues to show a slow but persistent decline.

Challenges were conducted in May and October. Each challenge consisted of 4 vials for routine CBC parameters, 2 vials for CBC and automated leukocyte differential counts and 2 vials for reticulocyte counts. In each survey, two of the CBC vials were from the same lot number and precision studies were conducted.

In addition, the May survey included two vials of fresh whole blood. These samples were distributed to a selected number of participants.

CBC and Automated Leukocyte Differentials

Participants were expected to report leukocyte count, erythrocyte count, hemoglobin (Hb), Hct, MCV, and thrombocyte count for each vial. Laboratories with a 5-part differential instrument were expected to report absolute numbers of lymphocytes, monocytes, granulocytes, eosinophils and basophils. Participants using a 3-part differential instrument were expected to report absolute numbers of lymphocytes, monocytes and granulocytes. Those using a 1-part differential instrument were expected to report only absolute numbers of lymphocytes.

For both surveys, a total of 18592 results were analyzed. Overall performance was, once again, excellent. Survey error rates for combined CBC and automated leukocyte differential were 0.34% and 0.2% in May and October 2004, respectively.

Whole Blood Pilot Survey

Two vials of fresh K₃EDTA human whole blood were distributed—vial 1 was obtained from an individual with a hemoglobinopathy and vial 2 from an individual with a normal CBC and leukocyte differential. Results were not assessed for error, as this was a pilot survey.

Two factors were taken into consideration with respect to determining participation in this survey. The first, that samples would be distributed to laboratories using an instrument where there were few other users or where the laboratory was the only user of that instrument. Second, since samples were composed of fresh whole blood, participants needed to be located close enough to Toronto to ensure that samples could be delivered within a 24-hour time frame. To provide a good comparison, laboratories using instruments in large instrument user groups were also asked to participate. Results were comparable between instruments using a whole blood sample, specifically the Hct, MCV, thrombocyte count and automated leukocyte differential.

The committee was reassured that this survey showed that various instruments produce similar results when the sample used for testing is a fresh K₃EDTA human whole blood sample rather than simulated material.

In addition to the CBC and automated leukocyte differential results, the committee requested participants report their adult male normal reference intervals. Table 23 summarizes these findings. Of note was the variation of

Table 22. Hematology Flagging Limits

Parameters	Deviation Allowed From Mean (%)
Leukocyte count	15
Erythrocyte count	6
Hemoglobin	7
Hematocrit	6
Mean Cell Volume	5
Thrombocyte count	25
Leukocyte Differential	3 SD or ± 0.5

participants' reference intervals using the same instrument. For example, a normal leukocyte count lower reference interval ranged from 3.0 to $4.6 \times 10^9/L$. This is a very wide variation and requires further investigation. In June 2005, the committee will distribute a patterns-of-practice survey designed to determine post-analytical process for establishing of reference intervals. Participants will be asked to provide reference intervals differentiated by age and gender. In addition, the survey will include multiple-choice questions and short answers pertaining to reflex testing of abnormal results, verification and validation of reference intervals.

Reticulocyte Counting

Two whole blood reticulocyte count challenge surveys were distributed in 2004. Participants were requested to perform erythrocyte and per cent reticulocyte counts on receipt of the sample, and from these results, calculate the absolute reticulocyte count.

The two samples were included in the May survey that was obtained from the same individual with a normal reticulocyte count and precision studies were conducted.

In order to assess participants' ability to report a normal reticulocyte count, the committee not only examined the reticulocyte count results but also the relationship of each result to the participant's normal reference interval. Participants are reminded that all reference intervals should either be established by individual laboratories or validated for current patient populations.

Of 157 laboratories, 58.6% reported automated reticulocyte count results while 41.4% are still using manual microscopic methods. The overall coefficient of variation (CV) for vial A was 32.3% and vial B was 33.9%. The automated methods generally yielded lower CVs than the manual methods. Fifteen errors were assessed on this survey with a 1.5% survey error rate. This is comparable to the 1.4% error rate in the previous survey.

In October, a second whole blood survey was distributed to participants. This survey consisted of two vials obtained from separate donors. Vial A was from a person with an elevated reticulocyte and vial B was from an individual with a normal reticulocyte count. Laboratories were expected to report a result for vial A greater than their upper limit of their reference interval and for vial B within their reference interval. Nine errors were assessed on this survey with a 1.0% survey error rate.

Two further challenges will be conducted in 2005.

Discordant Findings Cause Analysis

The contributing causes of discordant findings for routine hematology surveys in 2004 are shown in Figure 27.

Table 24 contains information relating to the number of potential discordant results. It does not indicate the actual number of assigned errors or noted discordant findings.

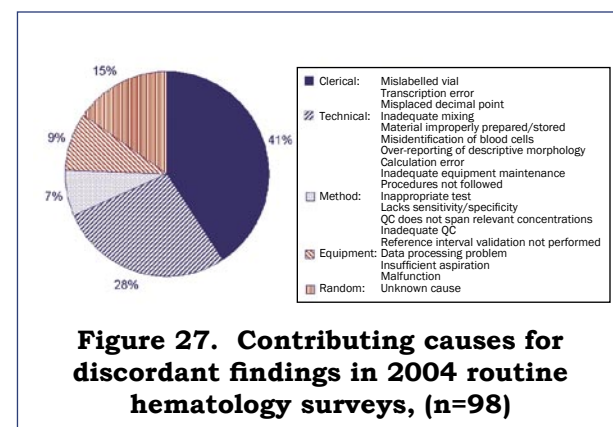


Table 24. Summary of Discordant Findings for Routine Hematology

No. of Potential Discordant Findings	Type of Discordant Finding	No. of Discordant Findings	%
20 950	Clerical	40	0.19
20 950	Technical	27	0.13
20 950	Method	7	0.03
20 950	Equipment	9	0.04
20 950	Random	15	0.07
Total		98	0.46

RED CELL DISORDERS (HEMOGLOBINOPATHY INVESTIGATION)

TESTING MODEL

In 2004, two survey challenges composed of fresh whole blood and one educational paper-based dry challenge were distributed to participants licensed for L452 sickle cell preparation, L453 sickle cell solubility test (screen), L419 hemoglobin electrophoresis or chromatography to include Hb A₂ fraction.

Seventy-nine laboratories in Ontario participated in the Hb S screening survey and 23 laboratories (including one out-of-province) submitted results for the Hb fraction quantitation challenges.

LABORATORY PERFORMANCE

Hemoglobin S Screen

The Hb S screening survey this year focused on the ability of Ontario laboratories to differentiate a negative sample for hemoglobin S (Hb S) from a positive sample for Hb S.

The survey included two samples. Vial A was from a patient negative for Hb S and vial B was from a patient positive for sickle cell solubility screen testing. All laboratories submitted the correct results. The various sickle screen methods used are illustrated in Table 25.

All laboratories follow the QMP-LS recommendation of performing a sickle cell solubility screen test as opposed to a slide-sickling test as their primary screen. One laboratory continues to use the slide-sickling test as an additional screen.

Table 25. Hb S Screening Methods in Use in 2004

No. of Labs	Screening Method
48	Ortho Sickledex
17	In-house sodium dithionite solubility
0	In-house sodium metabisulfite slide sickling
3	Mich Colone Sickle Heme/Sickle Cell Reagent Test Kit
2	Dade Behring Sickle-Sol
8	Nova Century Scientific Sickle Cell Reagent Test
1	Sickle-Chex Solubility Test – Streck Laboratories

Hemoglobin Fraction Quantitation Wet Challenge Survey

The hemoglobin fraction quantitation challenge survey tested the ability of laboratories to differentiate a normal sample from a complex hemoglobinopathy in a patient with sickle cell trait, heterozygous α gene deletion and Hb G.

This survey consisted of two samples. Vial A was obtained from a 28-year-old female presenting for prenatal screening. Her hemoglobinopathy investigation revealed “no hemoglobinopathy detected.” Vial B was obtained from her 30-year-old male partner presenting for prenatal screening. He was diagnosed with a complex hemoglobinopathy which included Hb S trait, heterozygous α gene deletion and Hb G trait. The various hemoglobinopathy screening methods used in Ontario are noted in Table 26. Fourteen laboratories (61%) now use the BioRad Variant or Variant II HPLC method rather than Hb electrophoresis for hemoglobinopathy screening. HPLC is the method of

Table 26. Hemoglobinopathy Screening Methods in Use in 2004

Method	Kit	Manufacturer	No. of Labs
Electrophoresis	Cellulose Acetate	Gelman	1
Electrophoresis	Cellulose Acetate	Helena	1
Electrophoresis	Cellulose Acetate		1
Electrophoresis	Agarose Gel	Beckman Coulter	1
Electrophoresis	Agarose Gel	Sebia	4
HPLC	Cation Exchange (β -thalassemia short kit)	BioRad	9
HPLC	Cation Exchange (Variant II Hb A ₂ /Hb A _{1c} dual kit)	BioRad	5
Isoelectric Focusing, Densitometry Scanning	Agarose Gel	Isolab, Inc.	1

hemoglobinopathy investigation recommended in the *Good Practice Guidelines for Laboratory Investigation of Hemoglobinopathies* published by QMP-LS in *Laboratory Hematology* in December 2003.

Most laboratories (22/23), reported the acceptable interpretation for vial A of “no hemoglobinopathy detected” or “hemoglobinopathy suspected, send to a reference laboratory.” One laboratory reported “ β -thalassemia trait.” Fortunately, this laboratory also reported they would refer the sample to a reference laboratory and was assessed a lesser error for inaccurate quantitation of Hb A₂. The only significant error was attributed to a Hb A level reported as 0.097 (reference result 0.974).

Vial B contained a complex hemoglobinopathy with potentially five identifiable hemoglobin bands on electrophoresis or HPLC including Hb A (approximately 0.420), Hb S (approximately 0.250), Hb G (approximately 0.210), hemoglobin S+G (approximately 0.120) and Hb A₂ (approximately 0.026).

Analysis of this survey was conducted using three criteria:

- That a hemoglobinopathy be identified by the presence (quantification) of an abnormal hemoglobin;
- That the laboratory identify the presence of Hb S and report the Hb S screen as positive;
- That the laboratory report an interpretation, as noted above, or that the report indicate that the sample would be sent to a reference laboratory for further investigation.

This survey was performed very well. Two lesser errors were assigned for not correctly identifying the abnormal hemoglobins **and** not referring the sample to a reference laboratory.

EDUCATIONAL PAPER-BASED HEMOGLOBINOPATHY DRY CHALLENGE SURVEY

The September hemoglobinopathy dry laboratory challenge introduced participants to a patient with hemoglobin H (Hb H) disease, a variant of α thalassemia, which can present in adults. Participants were asked questions regarding the diagnosis, genetics and clinical implications of Hb H disease in prenatal screening. Twenty-two Ontario laboratories participated in the survey. Clinical and laboratory data were provided and participants were asked a series of four multiple-choice questions. No errors are assessed on educational surveys. Performance on this survey was very good with all laboratories identifying Hb H disease in a pregnant patient, the need for investigation of the partner for a hemoglobinopathy and referral for genetic counselling. It should be noted that many laboratories recognized the undiagnosed microcytosis in this case and would have recommended referral to another centre if this had been a real patient sample. The majority of laboratories also recognized the clinical significance of this diagnosis for the patient and the potential risk of having a severely affected child with hydrops fetalis.

SUMMARY

Table 27 provides a summary of the reference diagnoses for the 2004 hemoglobinopathy challenge surveys.

Table 27: Hemoglobinopathy Reference Diagnoses in 2004

Survey	Month	Reference Diagnosis
RCD-0404-HS-A	April	Negative
RCD-0404-HS-B	April	Positive
RCD-0404-A	April	No hemoglobinopathy detected
RCD-0404-B	April	Alpha chain variant, Hb S trait and Hb G trait
RCD-0408-E	August	Hb H disease

DETECTION OF FETAL CELLS

TESTING MODEL

In April 2004, a fetal maternal hemorrhage (FMH) challenge survey was conducted. Each participant received two test vials containing 1 mL fresh whole blood. Both vials contained Rh-negative adult blood. Vial 2 was spiked with ABO compatible Rh-positive cord blood to simulate a FMH. There were 45 participants in this survey.

LABORATORY PERFORMANCE

The survey included two samples simulating the following case scenarios:

A 0-mL FMH where additional Rhlg immune prophylaxis would not be required and a 30-mL FMH where an additional dose of 300 µg of Rhlg immune prophylaxis in addition to the standard post-partum Rhlg dose was required.

The results of this survey confirm the high effectiveness in screening techniques such as the rosette or acid elution techniques to identify patients requiring additional Rh immune globulin (Rhlg) prophylaxis. Sixteen laboratories reported qualitative rosette results. All laboratories correctly reported a negative rosette result for vial 1 and a positive rosette result for vial 2.

Forty-three laboratories reported quantitative results from an acid elution technique. Two laboratories reported they performed flow cytometry but as an additional or confirmatory method. Table 28 shows the statistics per vial for the percentage of fetal cells detected and mL fetal maternal hemorrhage detected on this survey. The CV of 46% in this survey demonstrates the ongoing lack of accuracy in the quantitation of fetal maternal hemorrhage.

Table 28. Statistics for % Fetal Cell Detected and mL Whole Blood Fetal Maternal Hemorrhage Detected in RCD-0404-FH

	Level of Simulated Hemorrhage	Mean Detected	CV (%)	Low Result	High Result
% Fetal Cell Detected					
RCD-0404-FH-1	0.0%	0.00	0.00	0.00	0.840 %
RCD-0404-FH-2	0.6%	0.96	44.0	0.00	5.0 %
mL Whole Blood Fetal Maternal Hemorrhage Detected					
RCD-0404-FH-1	0 mL	00.0	0.00	0.0	42.0 mL
RCD-0404-FH-2	30 mL	46.6	45.7	0.0	227.0 mL

In this survey, ten significant and two lesser errors were assigned due to reporting either a grossly inaccurate fetal maternal hemorrhage or if the Rhlg dosage was inadequate for the laboratory's reported fetal maternal hemorrhage result. Errors were assigned for inadequate Rhlg prophylaxis due to a failure to follow the American Association of Blood Banks' (AABB) and the QMP-LS recommendations regarding administration of Rhlg, which recommends an effective strategy for overcoming the limitations of the acid elution techniques is to add a 300 µg

dose of Rhlg to the dose required for the volume of FMH detected. Of great concern to the committee, given the limitations of quantitation, is the ongoing failure by most participating laboratories to issue adequate Rh immune globulin prophylaxis. In many, but not all cases, this could result in inadequate prophylaxis.

GLUCOSE-6-PHOSPHATE DEHYDROGENASE (G6PD) DEFICIENCY DETECTION

TESTING MODEL

One survey was conducted in September 2004. Each participant received two test vials containing 2 mL of K₃EDTA anticoagulated whole blood. Vial A contained blood from a deficient donor and vial B contained blood from a normal donor. Samples were stored and shipped frozen in cryovials creating a hemolysate. Participants were instructed to handle the hemolysate as if it were whole blood.

LABORATORY PERFORMANCE

No errors were assessed for this survey. All 24 laboratories reporting a G6PD screen obtained deficient results on vial A. Laboratories in this group that performed a G6PD assay all reported results markedly below their lower limit reference interval. The two laboratories reporting only a G6PD assay also reported a deficient result. The results ranged from 0.1 to 1.6 U/g Hb. All 24 laboratories reported a normal G6PD screen on vial B. Laboratories in this group that performed a G6PD assay, all reported results within their reference interval. The two laboratories reporting only a G6PD assay also reported a normal result. The results ranged from 5.1 to 12.9 U/g Hb.

There continues to be a wide range of reference intervals reported by laboratories that perform the assay. Lower interval limits ranged from 4.6 to 7.0 U/g Hb with a mode of 4.6 U/g Hb and upper interval limits ranged from 11.0 to 20.5 U/g Hb with a mode of 13.5 U/g Hb.

DISCORDANT FINDINGS

Figure 28 shows the contributing causes of discordant findings for red cell disorder surveys in 2004. Table 29 contains information relating to the number of potential discordant results. It does not indicate the actual number of assigned errors or noted discordant findings.

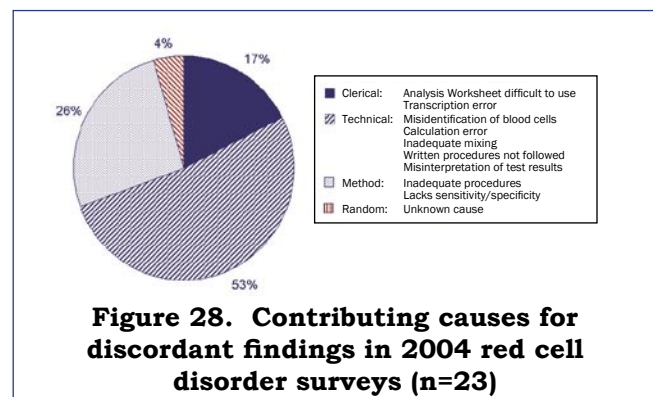


Table 29. Summary of Discordant Findings for Red Cell Disorders

No. of Potential Discordant Findings	Type of Discordant Finding	No. of Discordant Findings	%
342	Clerical	4	1.17
342	Technical	12	3.5
342	Method	6	1.75
342	Unknown	1	0.29
Total		23	6.71

BONE MARROW EXAMINATION

TESTING MODEL

Two rotational slide-based bone marrow surveys were distributed in March and July. These surveys consisted of a peripheral blood film, bone marrow aspirate and relevant clinical and laboratory data. Each laboratory received a case that had not been previously circulated. The March survey material was obtained from a patient diagnosed with chronic myeloid leukemia (CML) in an accelerated phase. Fifty-eight participants returned their Analysis Worksheet on time, seven participants declined to participate. The July survey material was obtained from a patient diagnosed with chronic myelomonocytic leukemia (CMML). Sixty-three (including one out-of-province) laboratories returned their Analysis Worksheet and three declined to participate. In addition to the July slide-based survey, a Web-based survey was conducted utilizing digital images of a case of multiple myeloma. It was distributed to assess response to reporting a standardized set of images. Sixty-four participants returned their Analysis Worksheets on time and two declined to participate. The photomicrographs and multiple-choice questions were posted on the QMP-LS Document Server and were available in a controlled (password protected) folder through the QMP-LS Web site.

Bone marrow surveys were considered educational, participation was voluntary and the surveys were not assessed. QMP-LS did not communicate with laboratories in the event of a discordant finding.

LABORATORY PERFORMANCE

Chronic Myeloid Leukemia in Acute Phase Transformation (CML-AP)

In the March survey (HEMA-0403-BM), the bone marrow aspirate was from a 58-year-old male previously diagnosed with CML and currently receiving chemotherapy. The patient was being assessed for possible acute phase transformation.

REFERENCE RESULTS

Participants were provided with the CBC reference results (Table 30). The differential showed a left shift in the granulocytic series with 1%–3% myeloblasts and an increase in monocytes. The bone marrow aspirate appeared hypercellular with an increased M:E ratio. Erythroid elements were present in reduced numbers with mild dysplastic changes and megaloblastoid features, consistent with treatment with hydroxyurea. The myeloid cells were left shifted with an increase in blasts of 5%–10%. Megakaryocytes appeared in clusters and were significantly increased with several micromegakaryocytes present. Lymphocytes and plasma cells were present in normal numbers. Non-hematopoietic cells were not reported. Cytogenetic analysis revealed a t(9;22)(q34;q11) translocation consistent with CML.

Table 30. Reference Results

Leukocyte count	$13.9 \times 10^9/L$
Hemoglobin	125 g/L
Hematocrit	0.367 L/L
MCV	134.3 fL
Thrombocyte count	$1115 \times 10^9/L$
RDW	16.2%
Erythrocyte count	$2.73 \times 10^{12}/L$

FREQUENCY OF REPORTING

This survey provided a diverse set of diagnostic results (Table 31), mainly due to the fact that it was from a patient being treated for CML with imatinib mesylate (Gleevec®), which may produce morphological changes in the marrow. These abnormal features may be seen in a variety of myeloproliferative and myelodysplastic disorders.

Table 31. Frequency of Reporting

Diagnosis	No. of Laboratories
Chronic myelogenous leukemia	29
Myeloproliferative disorder	38
Myelodysplastic syndrome	16
Essential thrombocythemia	4
Would not report but would refer to an outside laboratory	3
Acute leukemia	3
Megaloblastic anemia	2
Refractory anemia with excess blasts	2

A persistently elevated thrombocyte count of $1115 \times 10^9/L$ in a patient receiving therapy for CML is one of the criteria for reporting the findings as an accelerated phase of the disease according to the WHO Classification. Eight laboratories reported greater than 20% blast cells present, which would by WHO criteria place this patient in either CML in blast phase (CML-BP) or an acute leukemia of some other origin. The reference blast cell count was in the range of 5%–10% and thus below the threshold for the diagnosis of CML in blast phase or acute leukemia.

Chronic Myelomonocytic Leukemia (CMML)

In the July survey, HEMA-0407-BM, the bone marrow aspirate was from a 22-year-old female progressively feeling unwell with no signs of sepsis or underlying disease.

REFERENCE RESULTS

Participants were provided with the CBC reference results (Table 32). The bone marrow aspirate appeared hypercellular. Erythroid elements were present in reduced numbers with mild dyserythropoiesis. The myeloid cells showed a marked left shift with an increase in blasts. Megakaryocytes were present.

Reticulum cells, plasma cells and lymphocytes appeared relatively decreased. Extrinsic cells were not seen. Bone marrow iron stores were reported as present (5+ score), with ringed sideroblasts.

Flow cytometry showed a mixed cellularity, mainly granulocytes, increased monocytes to 13%, 5% myeloblasts, with findings compatible with CMML.

Table 32. Reference Results

Leukocyte count	$22.6 \times 10^9/L$
Hemoglobin	93 g/L
Hct	0.277 L/L
MCV	115.8 fL
Thrombocyte count	$105 \times 10^9/L$
RDW	33.9%
Erythrocyte count	$2.39 \times 10^{12}/L$

FREQUENCY OF REPORTING

The age of the patient is unusual. Although MDS syndromes can occur at any age, the majority of patients are elderly and only about 8% of patients are less than 50 years of age when diagnosed. This fact may have prompted conservatism in the diagnosis but the majority of laboratories reported a malignant diagnosis with 22% reporting CMML as their primary diagnosis (Table 33). Cytogenetics would be critical to the diagnosis and the majority of respondents indicated the need for further studies to confirm the diagnosis.

Table 33. Frequency of Reporting

Diagnosis	No. of Laboratories
Myelodysplastic syndrome	33
Megaloblastic anemia	18
Other	15*
Reactive/Inflammatory/ Leukemoid reaction	14
Chronic myelomonocytic leukemia	14
Myeloproliferative disorder	13
Acute leukemia	4

* Other diagnoses included hemolytic anemia, drug effect, chronic inflammatory neutrophilic leukemia, congenital dyserythropoietic anemia, sideroblastic anemia, iron deficiency, CML, possible recovering marrow, lead poisoning, RBC enzymopathy and thalassemia.

MULTIPLE MYELOMA

The Web-based survey (HEMA-0407-BW) was extremely well diagnosed by participants. Performance on the interpretation of the photomicrographs was excellent with nearly all of the multiple-choice questions being answered correctly.

All laboratories reported the most significant abnormality on slide 1 as rouleaux. With slide 2, all but one participant identified the diagnostic cells as plasma cells. With slide 3, all laboratories reported the test considered most useful to confirm the diagnosis as serum protein electrophoresis.

SUBMISSION OF NEW CASES

Participants are requested to submit interesting bone marrow cases to QMP-LS. Please contact the QMP-LS office to ascertain whether the case would be suitable for distribution. At least 24 well-made, stained and coverslipped peripheral blood and bone marrow aspirate and/or biopsy preparations are required.

FLOW CYTOMETRY

TESTING MODEL

Two wet surveys were conducted in 2004, each consisting of samples of whole blood for HIV investigation and samples accompanied by blood films for the investigation of neoplastic hematologic disorders. Samples for CD34+ progenitor cell enumeration were also distributed. Testing material is sent by overnight courier to allow participating laboratories to conduct their analyses within three days of distribution. Results are submitted on the computer-compatible reporting form that also allows limited textual comment. The reporting form for the hematologic neoplasm investigation allows correlation of blood film morphology with analytical results for diagnostic interpretation. Laboratories are also required to submit sample preparation data, all light scatter and fluorescence histograms and laboratory-generated reports. In November 2004, a CD-ROM dry challenge for hematological malignancies was conducted. This allowed participants to review listmode data using their own computer analysis programs and also to review a case history and digital slides from the case. Results from the dry challenge were posted on the QMP-LS Web site, and significantly more information was made available to enhance the educational aspects of the survey.

LABORATORY PERFORMANCE

Lymphocyte Immunophenotyping for HIV

Samples from HIV positive donors were distributed to 21 participants (17 Ontario and 4 out of province). All laboratories utilized CD45 as gating agent. The majority of laboratories used dual platform analysis, but the number of laboratories that used single platform analysis has gradually increased from two in March 1999 to ten in the September 2004 survey. All laboratories now use 3- or 4-colour combinations. The majority used 4-colour combinations. Surveys for HIV testing have been conducted since 1995 and the performance is summarized in Table 34. There were no significant errors in 2004 but one lesser error was assessed in the March survey.

Table 34. Performance on 1995-2004 Surveys, Lymphocyte Phenotyping for HIV Investigation

Survey Vial	Reference Result	Lesser Errors	Significant Errors	Error Rate %*
H-9509-FC	Normal	0	0	0
H-9603-FC-A	Normal	3	1	22.2
H-9603-FC-B	HIV	8	2	27.8
H-9703-FC-A	HIV	1	2	15.0
H-9803-FC-A	HIV	1	0	14.3
H-9808-FC-A	HIV	0	0	0
H-9903-FC-A	Normal	0	0	0
H-9908-FC-A	HIV	1	0	5.3
H-0003-FC-A	HIV	2	0	11.1
H-0008-FC-A	HIV	2	0	11.1
H-0103-FC-A	Normal	5	0	26.3
H-0108-FC-A	HIV	1	0	4.8
FLOW-0203-HV	HIV	0	0	0
FLOW-0208-HV	Normal	0	0	0
FLOW-0303-HV	HIV	0	0	0
FLOW-0309-HV	HIV	1	0	4.8
FLOW-0403-HV	HIV	1	0	4.8
FLOW-0409-HV	HIV	0	0	1

* Error Rate % = Number of errors × 100/Number of Laboratories

Leukocyte Phenotyping for Neoplastic Hematological Disorders

Two clinical cases were distributed between March and September to 26 participants (14 Ontario and 12 out of province). Participants were expected to include the following in their submissions:

- Blood film morphology
- Flow cytometry analysis results and histograms
- Interpretation of results
- Laboratory-generated reports showing interpretation of results.

The first sample was from a patient with acute myelomonocytic leukemia (AMML). This was a very successful survey, with 88% of participants reporting the case as either AML or AMML. One lesser error was assessed for incorrectly reporting the population of blasts as HLA-DR negative. Participants were reminded of the importance of

appropriate gating strategies. In addition to the blast population, all other cells in the sample should be analyzed to ensure no significant populations are missed.

The second sample was from a normal volunteer donor. All participants except one reported the case as normal. One lesser error was assessed for failure to detect surface immunoglobulins.

CD-ROM Dry Challenge

This was a case of AMML, eosinophilic variant. All laboratories correctly identified the case as an acute myeloid leukemia with 35% of reporting laboratories further identifying the case as myelomonocytic leukemia with eosinophilic differentiation (M4Eo by FAB classification). Two laboratories unexpectedly reported the case as acute promyelocytic leukemia (APL, FAB classification M3). This case was of particular interest, in that it required participants to integrate patient clinical history, information from the CBC and differential, manual film review, bone marrow photomicrographs and flow cytometric data. Laboratories performing this complete analysis were capable of determining not only that this case was AMML, but was the M4 eosinophilic variant, which was confirmed by demonstration of an inversion of chromosome 16 using cytogenetic and fluorescence in situ hybridization (FISH) analysis. Confirmatory results were made available to participants through the QMP-LS Web site.

CD 34 Analysis

Two surveys were conducted in 2004, each consisting of commercially-prepared whole blood and diluted apheresis samples. Due to the uncertainty of the quality of the apheresis sample sent for the March survey, no assessment was performed on it. There were 14 participants for both surveys, half of which were out of province. Over two-thirds of laboratories are performing single platform analysis and almost all are using the ISHAGE gating strategy. The CV average was approximately 20%, not unexpected for this rare event analysis. Inappropriate gating was a contributing factor to lower than expected results in both surveys and in some cases excluding events from the final calculations.

For 2005, the testing model will remain essentially the same with increased attention paid to those laboratories using inappropriate gating strategies in the analysis of leukemia and lymphoma samples. This will be supported by the Web-based case study format, which allows a significant educational opportunity in this area.

COAGULATION

TESTING MODEL

Two coagulation challenge surveys were conducted in 2004. Testing materials were chosen to represent a variable, but clinically meaningful, range of results. Prothrombin time/International Normalized Ratio (PT/INR) testing was monitored using lyophilized coumadinized plasmas supplied by Thrombosis Reference Centre, Manchester, UK. The activated partial thromboplastin time (APTT) lyophilized survey material consisted of normal control plasma and heparinized control plasma supplied by bioMerieux Canada, Inc., Saint Laurent, Quebec. Affinity Biologicals Inc., Hamilton, Ontario provided lyophilized plasma for APTT testing that was spiked with unfractionated heparin giving an anti-Xa activity of 0.47 U/mL. In addition, Affinity Biologicals Inc. supplied QMP-LS with lyophilized immuno-depleted factor VIII and IX samples for factor assay testing. A thrombophilia challenge survey was carried out in September 2004. In this survey, two patients' derived samples were distributed to centres previously identified as performing thrombophilia investigations. The plasma samples were obtained from individuals previously diagnosed with a lupus anticoagulant and an antithrombin deficiency, respectively. Testing was generally well performed. The committee also continued investigations into D-dimer external quality assessment; in September a pilot survey using a panel of lyophilized human-derived samples, provided by the United Kingdom National External Quality Assessment

Scheme (UK NEQAS) in Blood Coagulation, was distributed to Ontario laboratories previously identified as testing for D-dimer.

This survey produced two important results:

- Demonstrated significant variability in the ability of selected commercial D-dimer kits to detect D-dimer, and;
- Confirmed that EQA surveys are possible with whole blood based D-dimer assays if the test plasma is reconstituted with red blood cells prior to testing.

In 2004, the committee issued two broadsheets—*Specific Coagulation Factor Inhibitors* and *APTT Heparin Therapeutic Reference Intervals*. These documents discussed recent changes in laboratory testing, specifically, analysis of specific coagulation factor inhibitors and the monitoring of unfractionated heparin.

Flagging rules, utilized to bring laboratory results to the attention of the committee for review, are noted in Table 35.

Table 35. Coagulation Flagging Limits Used in 2004

Tests	Deviation Allowed From Mean (%)
INR	20% of all-methods' mean*
APTT	20% of reagent mean
Factor VIII and IX Assays	20% of all-methods' mean

* Until further notice, participants using IL Test PT/Fibrinogen Recombinant reagent and an ACL coagulation instrument will be evaluated against their peers.

LABORATORY PERFORMANCE

PT/INR

Routine surveys were distributed in February (COAG-0402) and September (COAG-0409). The previously identified survey material matrix effect, reported by participants using IL Test PT/Fibrinogen recombinant reagent and an ACL coagulation instrument, was apparent throughout the year; and thus, users of this reagent/instrumentation combination were evaluated against their reagent group peers, rather than the AMM.

Laboratories that performed PT/INR testing using lyophilized coumadinized plasmas (Table 36) were assessed four significant errors and one lesser error on the two surveys. The committee is very pleased with the laboratory performance with respect to INR testing in 2004, as the number of errors continues to be exceptionally low considering the number of laboratories that undertake this testing in the province.

Table 36. INR Target Values, All-Methods' Mean and Minimum and Maximum Results

Vial	Material	Target INR	All-Methods' Mean	Min. and Max. Result
Survey COAG-0402				
A	Coumadinized plasma	2.4	2.5	1.9–3.8
B	Coumadinized plasma	2.4	2.4	2.0–4.0
Survey COAG-0409				
A	Coumadinized plasma	1.6	1.6	1.4–2.1
B	INR calibrated plasma	3.4	3.3	2.6–4.6

Progress continues towards the committee's goal of having all laboratories establish and validate their normal reference interval for INR testing. Since the INR system was designed to compensate for variability in the PT, the committee is no longer analyzing, flagging or assessing errors based on PT results. Rather, the committee will only examine PT results in cases where the INR is clearly incorrect. In 2005, the committee will continue to monitor INR testing by reviewing and requesting clarification in instances where normal or therapeutic INR reference intervals are suspect; errors may be assessed if the normal ranges appear grossly inappropriate and cannot be justified. Also, the committee will continue to request that laboratories determine the effect new reagent lot numbers, reagent suppliers or new instrumentation will have on their INR reference intervals.

APTT

APTT testing was included in the February (COAG-0402) and September (COAG-0409) surveys. A total of 16 lesser errors were assessed on the two surveys. Three vials, in two surveys, contained heparinized lyophilized samples to assess the quality of heparin monitoring in the province. The other vial consisted of normal reference control plasma. Two of the heparin samples were identical and precision studies were performed. APTT testing remains good, and the committee has no specific comments concerning routine APTT monitoring except the continued recommendation that laboratories:

- Review their reference intervals;
- Ensure that their reference intervals have been validated, and
- Re-confirm their reference intervals when instrumentation or reagents are changed.

The committee continues to retain the right to assess errors if laboratories report clearly erroneous reference intervals, or reference intervals that cannot be validated.

Factor VIII and IX

In the February survey (COAG-0402-FA), coagulation factor assay analysis was carried out on immuno-depleted factor VIII and IX samples. The factor VIII sample was chosen as it represented a “severe to moderate” deficiency state while the factor IX sample represented a “moderate to mild” deficiency state. Two significant errors were assessed with respect to the factor VIII sample to laboratories reporting results that would have altered the patient’s clinical treatment. A total of 22 laboratories are licensed to perform factor assays. Coagulation factor assays were routinely well performed and the committee does not have any systematic concerns with coagulation factor testing in the province. Proficiency of coagulation factor assays will be assessed with similar assays in 2005.

D-dimer

D-dimer testing remains problematic due to difficulties in procuring suitable EQA survey material. In 2004, we undertook a pilot challenge survey using lyophilized pooled human samples prepared by UK NEQAS. This survey was routinely well done. The survey revealed D-dimer results are reported in many combinations of unit values. This finding confirms the need for accepted international standardized units that will allow calibration of individual machine reagent combinations, as is the case with other coagulation instruments. In addition, the survey showed that with the majority of quantitative assays, once units were normalized, these assays produced consistent results across a range of D-dimer concentrations. Regrettably, as in the 2002 D-dimer pilot survey, QMP-LS noted D-dimer detection kits produced by one manufacturer were routinely unable to discriminate between samples with various levels of D-dimer. The UK NEQAS program also noted this observation. In 2005, QMP-LS will investigate this observed lack of sensitivity by distributing three frozen clinical pooled plasmas for D-dimer detection. Participants will include laboratories using the observed insensitive manufacturer’s kit along with a selected control group composed of laboratories using other D-dimer detection reagent kits. Finally, this survey provided evidence that reconstitution of test plasma in a red cell suspension allows EQA of whole blood-based qualitative D-dimer assays. The results of this survey will form the basis of two abstract submissions that, if accepted, will be presented at the International Society on Thrombosis and Haemostasis (ISTH) meeting to be held in Sydney, Australia in 2005. It is hoped that this cooperative international survey (involving UK NEQAS and QMP-LS) will lead to future collaborative EQA efforts.

Thrombophilia

The September (COAG-0409-TH) survey included two samples for thrombophilia testing. Samples were sent to 12 laboratories performing one or more of the following tests: antithrombin, protein C, protein S, activated protein C

resistance, Russell's viper venom (dilute and confirm) and DNA analysis for factor V Leiden and prothrombin gene mutation. Sample A was obtained from a patient with a known lupus anticoagulant and antiphospholipid antibody syndrome; while sample B was obtained from a patient with known antithrombin deficiency. Both patients were receiving warfarin at the time their plasma was obtained.

Thrombophilia testing in Ontario was uniformly performed perhaps due to the fact this type of testing is confined to referral laboratories. Three significant errors were assessed for reporting clinically misleading results. In addition, the committee identified reporting deficiencies, such as the use of ambiguous comments when reporting thrombophilia results. The committee provided recommendations and examples as to how these results should be reported to ensure the physician clearly understands the result. In the future, QMP-LS will carefully examine both the results and the comments for accuracy and clarity, and will reserve the right to assign errors to laboratories reporting ambiguous thrombophilia comments.

Heparin Assay

The February survey included a pilot heparin assay. The sample (COAG-0402-HA) contained unfractionated heparinized reference plasma with an anti-Xa activity level of 0.47 U/mL. The committee is pleased that EQA results from such plasma samples are routinely well performed and that the variation in measured APTT results, when compared between machine reagent combinations, is quite limited.

DISCORDANT FINDINGS

Figure 29 shows the contributing causes for discordant findings for coagulation surveys. Table 37 contains information relating to the number of potential discordant results. It does not indicate the actual number of assigned errors or the noted discordant findings.

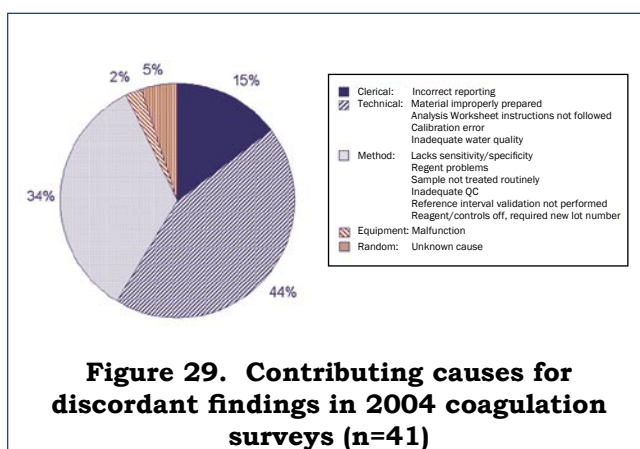


Table 37. Summary of Discordant Findings for Coagulation

No. of Potential Discordant Findings	Type of Discordant Finding	No. of Discordant Findings	%
1820	Clerical	6	0.33
1820	Technical	18	0.99
1820	Method	14	0.77
1820	Equipment	1	0.05
1820	Random	2	0.11
Total		41	2.25

MORPHOLOGY

TESTING MODEL

In 2004, three surveys were conducted in February, July and November. While these surveys were considered educational and participation was voluntary, almost all of the laboratories participated. QMP-LS did not communicate with laboratories in the event of a discordant finding. This put the onus on the individual laboratories to assess how they performed on the morphologic surveys and, if needed, to initiate appropriate educational activity. The Committee Comments issued following each morphology survey provide a readily available educational resource.

LABORATORY PERFORMANCE

Survey MORP-0402

This blood film was from a 59-year-old female presenting with generalized erythroderma due to mycosis fungoides. The main feature of this case was the presence of Sézary and/or lymphoma cells in the peripheral blood, as a manifestation of Sézary syndrome. The blood film showed abnormal lymphocytes (Sézary cells), characterized by slightly larger than normal lymphocytes with cerebriform nuclei. This educational survey was part of a cross-Canada morphologic survey. As an educational survey, this exercise was neither scored, nor assessed for error. The committee is concerned that almost one quarter of the respondents (47/204) did not report Sézary and/or lymphoma cells in the differential, nor in the comments. Therefore, the diagnosis of Sézary syndrome would have been overlooked. As noted in previous surveys, there is over-reporting of erythrocyte descriptive statements, which may detract from findings of more important clinical relevance. Three laboratories reported seeing parasites; for these participants, re-review of this exercise was recommended.

Survey MORP-0407

This blood film was from a 35-year-old male presenting to the Emergency Room with pleuritic chest pain. The patient was originally from Equatorial Guinea, but had lived in Spain for the last five years. The main feature in this case was the presence of microfilariae and eosinophilia. Performance was excellent in this survey, with all participating laboratories either correctly identifying the presence of a parasite, or sending the slide for referral. Most laboratories were more specific, correctly diagnosing microfilariasis. Approximately one-third of the laboratories did not check off the “extra-cellular organisms in background,” but as this comment is located in the erythrocytes’ descriptive morphology section of the analysis worksheet, it was easy to overlook. Adding another category on the analysis worksheet, “Other-Descriptive Morphology (microorganism)” will be discussed. All laboratories correctly identified the presence of eosinophilia. This case was unusual, as the patient was infected with two different microfilarial species, *Loa loa* and *Mansonella perstans*. While *Loa loa* filariae were present in all slides, not all slides showed *Mansonella perstans* as well. Photographs of both microfilariae are available on the QMP-LS Web site for review.

Survey MORP-0411-MW

This survey consisted of a pilot Web-based morphology survey of a case of disseminated intravascular coagulation due to bacterial sepsis. Three images were displayed with each image having a multiple-choice question concerning the correct identification of the morphologic findings. Most laboratories (>95%) correctly identified the images of toxic granulation in neutrophils, intracellular bacteria and schistocytes. However, 1% to 4% of laboratories selected other responses. A few laboratories mistook the bands with toxic granulations for eosinophils or Alder-Reilly syndrome. Other laboratories thought the intracellular bacteria were Döhle bodies; and one laboratory identified the schistocytes as bite cells. While the committee understands that viewing a single digital image is not the same as looking at a slide, the morphologic images were chosen to represent realistic examples. It is recommended that those laboratories, whose findings did not agree with the committee, take the opportunity to review basic morphologic features demonstrated by these cases.

TRANSFUSION MEDICINE

TESTING MODEL

Four wet surveys were conducted in 2004 (Table 38). As in previous years, challenges were based on the laboratory license, using two sets of material from different sources:

Set A is procured mostly from a US supplier and is distributed to laboratories with licences that include antibody identification. The number of participants in this category ranged from 87–89.

Set B is procured from a Canadian supplier and is distributed to laboratories with licences that include antibody detection, but not identification. The number of participants in this category ranged from 81–83.

This tiered approach continues to provide an appropriate level of challenge to all laboratories, while permitting cost containment. Routine assessment of all participants includes ABO and Rh grouping, antibody detection, direct antiglobulin testing and crossmatching.

Set A participants were challenged with:

- A variety of ABO and Rh groups for typing and interpretation.
- Prenatal testing samples/ antibody titration.
- Detection and identification of multiple antibodies and performance of urgent crossmatch.
- Mixed-up samples.
- Direct antiglobulin testing (DAT).

Set A participants completed four questionnaires:

- Policies and procedures for urgent transfusion requests.
- Policies for prenatal testing and performance of antibody titration.
- Sample acceptability.
- Policies for DAT investigations.

Table 38. Samples Distributed in 2004

Set A		Set B	
TMED-0403-1	A Rh Positive, anti-Jka	TMED-0403-7	A Rh Positive
TMED-0403-2	B Rh Negative, anti-D	TMED-0403-8	A Rh Negative
TMED-0403-3	O Rh Positive, R1R1, Jk(a+b+)	TMED-0403-9	B Rh Positive
TMED-0403-4	Rh Positive, R1r, Jk(a+b–)	TMED-0403-10	O Rh Positive
TMED-0405-1	AB Rh Positive, anti-s	TMED-0405-7	AB Rh Negative, antibody present
TMED-0405-2	O Rh Positive, S–s+	TMED-0405-8	B Rh Negative
TMED-0405-3	B Rh Positive, S+s–	TMED-0405-9	A Rh Positive, antibody present
TMED-0405-4	AB Rh Positive, S–s+	TMED-0405-10	O Rh Positive
TMED-0408-1	O Rh Positive, anti-c	TMED-0408-7	O Rh Positive, antibody present
TMED-0408-2	O Rh Positive, anti-E	TMED-0408-8	O Rh Negative, antibody present
TMED-0408-3	AB Rh Negative	TMED-0408-9	AB Rh Positive
TMED-0408-4	B Rh Positive	TMED-0408-10	B Rh Positive
TMED-0411-1	B Rh Positive, anti-Fya	TMED-0411-7	O Rh Positive, antibody present
TMED-0411-2	AB Rh Positive, DAT pos (IgG)	TMED-0411-8	O Rh Positive
TMED-0411-3	O Rh Negative, DAT pos (C3d)	TMED-0411-9	O Rh Negative
TMED-0411-4	O Rh Positive, DAT pos (IgG, C3d)	TMED-0411-10	O Rh Positive
Automation			
TMED-0411-1A	O Rh Negative, anti-D		
TMED-0411-2A	A Rh Positive		
TMED-0411-3A	B Rh Positive		
TMED-0411-4A	Ael Rh Positive, subgroup of A		

Set B participants were challenged with:

- A variety of ABO and Rh groups for typing and interpretation.
- Antibody detection and crossmatch.
- Mixed-up samples.
- Detection of antibodies and performance of crossmatch.
- Performance of DAT.

Set B participants completed one questionnaire:

- Policies for sample acceptability.

AUTOMATION PILOT

- 12 laboratories using automated instrumentation participated in an Automation Pilot survey.

ASSESSMENT OF RESULTS

Scenarios were representative of those commonly encountered in transfusion medicine laboratories, but were designed to be challenging. Clinical information and testing directions were provided for each survey.

Table 39. Committee Assessment of Errors for 2004 Surveys, Set A Only

Error Type	TMED-0403		TMED-0405		TMED-0408		TMED-0411		Total 2004	
	Significant	Lesser	Significant	Lesser	Significant	Lesser	Significant	Lesser	Significant	Lesser
ABO	0	0	0	0	0	0	0	0	0	0
Rh	0	0	0	0	0	0	0	0	0	0
DAT	0	0	0	0	0	0	0	6	0	6
Ab Detection	1	1	4	0	0	0	0	0	5	1
Ab Identification	0	0	1	0	0	0	0	0	1	0
Phenotype	0	0	0	0	0	0	0	0	0	0
Crossmatch	0	0	0	0	0	0	0	0	0	0
Total	1	1	5	0	0	0	0	6	6	7

Table 40. Committee Assessment of Errors for 2004 Surveys, Set B Only

Error Type	TMED-0403		TMED-0405		TMED-0408		TMED-0411		Total 2004	
	Significant	Lesser	Significant	Lesser	Significant	Lesser	Significant	Lesser	Significant	Lesser
ABO	0	3	1	0	0	3	0	13	1	19
Rh	1	3	0	0	0	1	2	1	3	5
DAT	0	0	0	0	0	2	0	2	0	4
Ab Detection	0	0	0	0	0	1	0	1	0	2
Phenotype	0	0	0	0	0	0	0	0	0	0
Crossmatch	0	0	0	0	0	0	2	7	2	7
Total	1	6	1	0	0	7	4	24	6	37

Table 41. Committee Assessment of Errors, 2000–2004

Error Type	2000		2001		2002		2003		2004	
	Significant	Lesser	Significant	Lesser	Significant	Lesser	Significant	Lesser	Significant	Lesser
ABO	3	45	1	43	7	14	2	121	1	19
Rh	2	66	0	57	2	18	2	93	3	5
DAT	0	6	4	11	0	6	1	14	0	10
Ab Detection	3	13	4	21	6	13	0	1	5	3
Ab Identification	5	3	1	3	1	2	2	0	1	0
Phenotype	0	0	0	17	0	12	0	6	0	0
Crossmatch	8	0	4	2	9	1	2	5	2	7
Total	21	133	14	154	25	66	9	240	12	44

The committee's assessment of errors for 2004 is displayed in Tables 39 and 40, and the five-year review of errors is displayed in Table 41. The total number of significant errors is comparable to last year (9 in 2003, compared to 12 in 2004). Significant errors for 2004 were similar for both Set A (5 in 2003 to 6 in 2004) and Set B participants (4 in 2003 and 6 in 2004). However, there was a marked decrease in lesser errors for both Set A and Set B (100 for Set A and 140 for Set B) in 2003, for a total of 240 lesser errors for both sets in 2003 compared to 44 in 2004. This is almost entirely due to the inclusion of a mixed-field survey in 2003; none was provided in 2004 and this type of survey in the past has typically resulted in a large number of lesser errors due to failure to detect a mixed-field reaction.

ABO and Rh

ABO and Rh errors (4 significant and 24 lesser) make up the majority of errors in 2004, and all involved Set B laboratories. This type of error remains of concern to the Transfusion Medicine Committee and recommendations were made in Committee Comments to hopefully decrease the frequency of such errors.

Direct Antiglobulin Testing

Ten lesser errors were assigned in 2004 (6 in Set A and 4 in Set B) compared to one significant and 14 lesser errors in 2003. The committee's expectations for differential DAT testing (anti-IgG and anti-C3) have increased in recent years and will continue to be strictly applied.

Antibody Detection And Identification

There were five significant and three lesser errors in antibody detection and three lesser errors in antibody identification in 2004 compared to only one lesser error in antibody detection and two significant errors in antibody identification in 2003. All five significant errors in antibody detection occurred in Set A laboratories.

Phenotyping

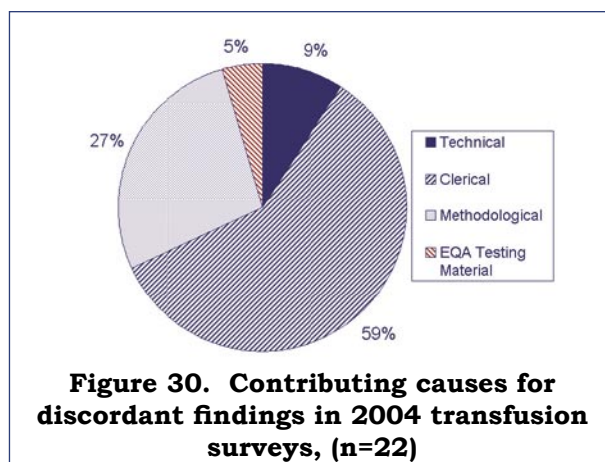
No errors were assigned for phenotyping in 2004 compared to six lesser errors in 2003.

Crossmatching

Two significant and seven lesser crossmatch errors were assigned in 2004 similar to 2003 (two significant and five lesser errors).

CHARACTERIZATION OF ERRORS

Contributing causes of discordant results were characterized as technical (attributable to actions of staff), methodological (problem in test system or procedure), clerical (transcription errors) and material (problem with EQA samples). The contributing causes of errors in transfusion medicine testing, as assessed by the laboratories, are shown in Figure 30.



CORRECTIVE ACTIONS

Extensive analysis and discussion appeared in Committee Comments during 2004 for the following:

- Guidelines for dealing with urgent transfusion requests.
- Procedures for prenatal antibody testing and titrations.
- Policies and procedures for dealing with inadequate or incorrect specimen identification.
- Policies and procedures for DAT investigation.

FUTURE ACTIVITIES

- The first Automation Pilot survey demonstrated that an automation survey using samples from a Canadian supplier was practical and informative. This will become an evolving feature of future surveys.
- A more formal scoring system is being developed and will be piloted in some transfusion medicine surveys in the future.
- A “dry” educational challenge will be piloted in 2005.

MICROBIOLOGY DISCIPLINES

BACTERIOLOGY

TESTING MODEL

The 2004 testing model is shown in Table 42. Sixteen samples containing 17 clinically significant microorganisms for isolation and identification were distributed. Antimicrobial susceptibility testing was appropriate for eight of the organisms in these specimens. Ten samples were lyophilized and six were simulated “fresh” specimens. A novel feature of this year’s testing model was the introduction of “fresh” simulated swab specimens, which constituted four of the challenges. In previous years, “fresh” samples included only blood and faeces. Four vials contained a mixture of organisms, as either representative “normal” flora or multiple clinically significant organisms.

Four unstained smears for Gram staining and interpretation were distributed to laboratories licensed for either bacteriology or Gram stain and four unstained smears for detection of acid-fast bacilli (AFB) were sent to those laboratories licensed to perform this testing.

A questionnaire-based patterns-of-practice survey (BACT-0406-PP) was conducted to determine current biosafety and biosecurity precautions in place in microbiology laboratories.

Table 42. 2004 Bacteriology Surveys

BACT-0402	3 lyophilized cultures 1 “fresh” simulated wound swab
BACT-0402-GM	1 smear for Gram staining
BACT-0404	2 lyophilized cultures 1 “fresh” simulated blood culture specimen 1 “fresh” simulated wound swab
BACT-0404-GM	1 smear for Gram staining
BACT-0404-AF	2 smears for acid-fast bacilli (AFB) staining
BACT-0406-PP	Patterns-of-practice survey: biosafety and biosecurity
BACT-0409	2 lyophilized cultures 1 “fresh” simulated wound swab 1 “fresh” simulated blood culture specimen
BACT-0409-GM	1 smear for Gram staining
BACT-0411	3 lyophilized cultures 1 “fresh” simulated wound swab
BACT-0411-GM	1 smear for Gram staining
BACT-0411-AF	2 smears for acid-fast bacilli (AFB) staining

SURVEY ASSESSMENT

Participants’ results for identification, antimicrobial susceptibility testing, Gram stain interpretation and AFB detection were assessed against the consensus results determined by eight reference laboratories. Results were flagged when they did not agree with the reference results or when an antimicrobial agent was reported that was not appropriate for the specific organism or putative site in the clinical scenario provided and for not reporting the antibiotic of choice. Errors were assessed according to the potential impact a similar error would have on patient care, with a significant error assigned for results that were considered potentially clinically misleading.

Bacteriology

No. of Participants (Dec. 2004).....	105 *
No. of Participants (Dec. 2003)	114 *
No. of Surveys Conducted in 2004	11

Mycology

No. of Participants (Dec. 2004).....	22
No. of Participants (Dec. 2003).....	23
No. of Surveys Conducted in 2004	2

* Includes laboratories licensed for Gram stain only

Parasitology

No. of Participants (Dec. 2004).....	23
No. of Participants (Dec. 2003).....	25
No. of Surveys Conducted in 2004	2

Virology

No. of Participants (Dec. 2004).....	72
No. of Participants (Dec. 2003).....	74
No. of Surveys Conducted in 2004	11

LABORATORY PERFORMANCE

Isolation and Identification

Table 43 summarizes performance in organism isolation and identification. A significant proportion of laboratories (i.e. >90%) isolated and identified only three of the 17 target organisms to species level. A number of laboratories had problems with six of the challenges in particular:

- *Staphylococcus schleiferi* (aspirate, pacemaker site infection [BACT-0409-2]). Ten laboratories misidentified this organism as *Staphylococcus haemolyticus* and two as *Staphylococcus aureus*. All laboratories that reported *S. haemolyticus* used Vitek®, which does not include *S. schleiferi* in its database. Laboratories using commercial systems must be aware of their limitations and put protocols in place to offset any shortcomings. This organism is notable for its ability to bind fibrinogen and thus may be positive in clumping factor assays. Although, inconsistent results for the rapid agglutination and slide coagulase tests were reported for this survey, most laboratories determined that this isolate was a coagulase-negative staphylococcus.
- *Aerococcus urinae* ("fresh" simulated blood culture [BACT-0409-4]). Only 28/98 (29%) laboratories identified this isolate as an *Aerococcus* species. The majority reported either viridans streptococcus/*Streptococcus* species (27%) or Gram-positive coccus (31%). Although laboratories should have recognized that the Gram

Table 43. Organisms Distributed in 2004 and Performance in Identification

Survey	No. of Laboratories Reporting	Organism	% Correct * Identification (Excellent)	% Partial † Identification (Acceptable)	% Incorrect ‡ Identification (Unacceptable)
BACT-0402-1	92	<i>Listeria monocytogenes</i>	68.5	31.5	0.0
BACT-0402-2§	92	<i>Streptococcus pneumoniae</i>	98.9	0.0	1.1
BACT-0402-3	92	<i>Citrobacter freundii/braakii</i>	70.7	28.3	1.1
BACT-0402-4	92	<i>Clostridium septicum</i>	42.4	57.6	0.0
BACT-0404-1¶	99	<i>Bacillus</i> species, not <i>B. anthracis</i>	20.2	77.8	2.0
BACT-0404-2	93	<i>Serratia oderifera</i>	97.8	1.0	1.0
BACT-0404-3	93	<i>Streptococcus constellatus</i>	26.9	68.8	4.3
BACT-0404-4	93	<i>Candida parapsilosis</i>	22.6	74.2	3.2
BACT-0409-1	92	<i>Vibrio vulnificus</i>	89.1	9.8	1.1
BACT-0409-2	92	<i>Staphylococcus schleiferi</i>	31.5	55.4	13.0
BACT-0409-3	92	<i>Haemophilus parainfluenzae</i>	81.5	16.3	2.2
BACT-0409-4¶	98	<i>Aerococcus urinae</i>	28.6#	37.7	33.7
BACT-0411-1A**	91	<i>Enterobacter cloacae</i>	96.7	2.2	1.1
BACT-0411-1B**	91	<i>Streptococcus bovis</i>	56.0	25.3	18.7
BACT-0411-2††	92	<i>Enterococcus faecium</i>	83.7	8.7	7.6
BACT-0411-3	91	<i>Capnocytophaga ochracea</i>	67.0#	22.0	11.0
BACT-0411-4‡‡	93	<i>Neisseria gonorrhoeae</i>	77.4	16.1	6.5

* Identified correctly to species level

† Identified to genus level (without naming a species) or to correct Gram stain characteristics (e.g., Gram positive bacillus)

‡ Identified incorrectly

§ Simulated lyophilized sputum specimen (mixture of *Streptococcus pneumoniae*, viridans streptococcus, *Neisseria* species and *Staphylococcus epidermidis*)

|| "Fresh" simulated wound swab

¶ "Fresh" simulated blood culture specimen

An identification to genus level was considered excellent performance for this challenge

** Mixed culture ("fresh" simulated wound swab)

†† Simulated lyophilized rectal swab for VRE screening (mixture of vancomycin-resistant *Enterococcus faecium*, vancomycin-susceptible *Enterococcus faecalis* and *Escherichia coli*)

‡‡ Simulated lyophilized endocervical swab specimen (mixture of *Neisseria gonorrhoeae* and viridans streptococcus)

stain morphology (Gram-positive cocci in tetrads and clusters) was inconsistent with streptococcus, this challenge was deemed educational and no errors were assessed for misidentification.

- *Streptococcus bovis* (“fresh” simulated abdominal wound swab [BACT-0411-1B]). *Enterobacter cloacae* was also present in this specimen. Fourteen of 91 laboratories (15%) either failed to isolate *S. bovis* (7) or considered it non-significant (7). Several laboratories that did not detect this organism in the mixed culture failed to correlate their Gram stain and culture results. *S. bovis* is strongly associated with malignancy of the colon, although it is not clear if it plays an etiologic role in this disease or is merely a marker for it. Identification of *S. bovis* is relatively straightforward and laboratories are encouraged to report this organism when isolated from patients with a suspected endovascular infection or possible gastrointestinal malignancy.
- Vancomycin-resistant *Enterococcus faecium* (rectal swab for VRE screen [BACT-0411-2]). Of concern, 7/92 (8%) laboratories failed to report *E. faecium*, present in moderate numbers, which was mixed with *Escherichia coli* and vancomycin-susceptible *Enterococcus faecalis*. This was disappointing performance compared with 2001 when only 2/103 laboratories failed to isolate a vancomycin-resistant *E. faecalis* from a “fresh” simulated faecal specimen (B-0109-1). On a more positive note, 77/84 (91.7%) laboratories that reported isolating VRE identified the isolate correctly to species level.
- *Capnocytophaga ochracea* (blood culture from a neutropenic patient [BACT-0411-3]). Two-thirds (66%) of laboratories identified this organism to genus level. Only one identified it as *C. ochracea*. Eight laboratories misidentified it as an anaerobe. Although growth was more luxuriant under anaerobic conditions, the organism did grow in CO₂ after 48–72 hours. While this organism is infrequently encountered in clinical specimens, most laboratories should have been able to identify it to genus level given its typical microscopic and colonial morphologies and growth characteristics.
- *Neisseria gonorrhoeae* (endocervical swab [BACT-0411-4]). Six of 93 laboratories were unable to recover this organism, which was present in small numbers and mixed with viridans streptococcus. It is likely that these laboratories used selective media that did not adequately suppress growth of the viridans streptococcus, which may have inhibited the growth of *N. gonorrhoeae*.

Also of interest was performance on BACT-0404-1, which was a “fresh” simulated blood culture stated to be from a patient with septic shock. This blood specimen contained *Bacillus clausii*, which was selected to mimic *Bacillus anthracis*. The purpose of this challenge was to assess laboratories’ ability to handle a potential bioterrorism agent. Only 77/99 (78%) laboratories recognized the isolate as a *Bacillus* species and only 20 of these noted that it was not *B. anthracis*. Thirty-three laboratories did not document performing a motility test, one of the key tests (in conjunction with colonial morphology) recommended to rule out *B. anthracis* (motility-negative). Laboratories that performed motility testing reported variable results, with 42 reporting a positive result and 24 reporting a negative result. Twenty-one of the laboratories that reported a negative result noted they would refer the isolate for identification. Committee Comments for this survey discussed preliminary identification of *B. anthracis* and how to handle suspicious isolates.

Antimicrobial Susceptibility Testing

A reference result was available for 2520 antimicrobial susceptibility results reported by laboratories and 49 (1.9%) results were flagged as being incorrect (Table 44). This performance is remarkable compared with 2003, when the flagging rate was 4.7% (136/2899) and 2002, when it was 8.5% (183/2156). The only very major interpretive error flags were for ampicillin (15) and cefotetan (1). Twelve of the falsely susceptible ampicillin results were for *Serratia oderifera* (BACT-0404-2) and three were for *Citrobacter freundii/braakii* (BACT-0402-3). As members of the SPICE group (i.e. *Serratia*, *Providencia*, *Morganella*, *Citrobacter*, *Enterobacter*), these organisms are considered inherently resistant to ampicillin and first-generation cephalosporins and should be reported as such, regardless of *in vitro* testing results.

Table 44. Antimicrobial Susceptibility Testing Interpretive Error Flags for 2004

Antimicrobial Agent	Gram Negative Organisms Interpretive Error Flags						Gram Positive Organisms Interpretive Error Flags					
	No. of Tests Reported	Very Major*	Major†	Minor‡	Total Flags	(%)	No. of Tests Reported	Very Major*	Major†	Minor‡	Total Flags	(%)
Amikacin	3	0	1	0	1	(33.3)	0	...	...	...	...	...
Amoxicillin/clavulanate	3	0	0	0	0	(0.0)	0	...	...	...	...	...
Ampicillin	219	15§	0	9	24	(7.8)	20	0	0	0	0	(0.0)
Azithromycin	0	...	...	...	...	...	2	0	0	0	0	(0.0)
Cefazolin	184	0	0	1	1	(0.5)	0	...	...	...	...	...
Cefotaxime	26	0	0	0	0	(0.0)	9	0	1	1	2	(22.2)
Cefoxitin	10	0	0	0	0	(0.0)	0	...	...	...	...	...
Cefotetan	3	1	0	0	1	(33.3)	0	...	...	...	...	...
Ceftizoxime	1	0	0	0	0	(0.0)	0	...	...	...	...	...
Ceftriaxone	31	0	1	0	1	(3.2)	22	0	0	2	2	(9.1)
Cephalothin	51	0	0	0	0	(0.0)	0	...	...	...	...	...
Chloramphenicol	0	...	...	...	...	...	5	0	1	0	1	(20.0)
Ciprofloxacin	151	0	1	0	1	(0.7)	6	0	0	0	0	(0.0)
Clindamycin	0	...	...	...	...	...	110	0	0	0	0	(0.0)
Erythromycin	0	...	...	...	...	...	167	0	0	0	0	(0.0)
Gatifloxacin	1	0	0	0	0	(0.0)	5	0	0	0	0	(0.0)
Gentamicin	242	0	0	0	0	(0.0)	13	0	0	0	0	(0.0)
Imipenem	26	0	0	0	0	(0.0)	0	...	...	...	...	...
Levofloxacin	4	0	0	0	0	(0.0)	54	0	0	0	0	(0.0)
Meropenem	15	0	0	0	0	(0.0)	0	...	...	...	...	...
Nitrofurantoin	85	0	0	0	0	(0.0)	0	...	...	...	...	...
Norfloxacin	25	0	0	0	0	(0.0)	0	...	...	...	...	...
Ofloxacin	0	...	...	...	...	...	3	0	0	0	0	(0.0)
Oxacillin	0	...	...	...	...	...	83	0	0	0	0	(0.0)
Penicillin	0	...	...	...	...	...	220	0	2	9¶	11	(5.0)
Piperacillin	30	0	0	0	0	(0.0)	0	...	...	...	...	...
Piperacillin/tazobactam	6	0	0	0	0	(0.0)	0	...	...	...	...	...
Tetracycline	0	...	...	...	...	...	16	0	0	0	0	(0.0)
TMP/SMX	229	0	0	0	0	(0.0)	127	0	0	0	0	(0.0)
Tobramycin	16	0	0	0	0	(0.0)	0	...	...	...	...	...
Vancomycin	0	...	...	...	...	...	129	0	1	0	1	(0.8)
β-lactamase	127	0	2	0	2	(1.6)	41	0	1	0	1	(2.4)
Total	1488	16	5	10	31	(2.1)	1032	0	6	12	18	(1.7)

* Reporting an antimicrobial result as susceptible (S) when the reference result is resistant (R) (i.e., falsely susceptible).

† Reporting an antimicrobial result as R when the reference result is S (i.e., falsely resistant).

‡ Reporting an antimicrobial result as S or R when the reference result is intermediate (I) or reporting I when the reference result is S or R.

§ 12 for *Serratia odorifera* (BACT-0404-2)

|| 8 for *Serratia odorifera* (BACT-0404-2)

¶ 8 for *Streptococcus bovis* (BACT-0411-1B)

New in 2004, laboratories were asked to provide zone diameter and/or MIC results in addition to interpretive results for all antibiotics reported. Tables and graphical displays of these results, by method used, were presented in Committee Comments. This enables laboratories to compare their results with their peers and provides an additional quality assurance tool to use in conjunction with routine quality control.

Gram Stain Smear Interpretation

Overall performance on staining and interpretation of Gram smears was excellent (Tables 45 and 46). The relatively poor performance on the microorganism component for BACT-0402-GM (*Streptococcus milleri* and *Prevotella melaninogenica*) was due to the presence of organisms that were consistent in size and shape with an over-decolorized *Clostridium* species and, in some cases, appeared spore-like. As a consequence, 20% (23/113) of laboratories reported Gram-positive bacilli. Due to this unusual morphology, an obvious artifact of the simulated material, no errors were assessed for reporting this result.

Laboratories continued to express dissatisfaction with the quality of the smears, particularly with respect to the cellular component. Thus, Gram stain challenges will be suspended until the quality issues are resolved.

Table 45. Performance in Microscopic Identification of Microorganisms for Gram Stain Smears Distributed in 2004

Survey	No. of Laboratories Reporting	Microorganism Component	% Correct* Identification (Excellent)	% Incorrect† Identification (Unacceptable)
BACT-0402-GM ‡	113	Gram-positive cocci & Gram-negative bacilli	71.0	29.0
BACT-0404-GM §	114	Gram-positive bacilli	93.0	7.0
BACT-0409-GM ¶	111	Gram-positive cocci	95.5	4.5
BACT-0411-GM **	103	Gram-positive bacilli	94.2	5.8

* Correct morphology and Gram reaction of microorganism component

† Failure to report microorganism morphotype(s) present or reporting microorganism or morphotype(s) not present in the smear

‡ Simulated smear of liver abscess aspirate for Gram staining (many *Streptococcus milleri* and moderate *Prevotella melaninogenica*)

§ Simulated smear of sputum for Gram staining (many *Nocardia asteroides*, few Gram-positive cocci and few Gram-negative diplococci)

|| Reported Gram-positive bacilli as the predominant organism

¶ Simulated smear of aspirate, pacemaker site infection for Gram staining (many *Staphylococcus schleiferi*)

** Simulated smear of intra-operative wound swab (many *Clostridium septicum*)

Table 46. Performance in Microscopic Identification of Cells for Gram Stain Smears Distributed in 2004

Survey	No. of Laboratories Reporting	Cellular Component	% Correct* Identification (Excellent)	% Incorrect† Identification (Unacceptable)
BACT-0402-GM ‡	113	Pus/white blood cells	92.9	7.1
BACT-0404-GM §	114	Pus/white blood cells & epithelial cells	93.0	7.0
BACT-0409-GM	111	Pus/white blood cells	92.8	7.2
BACT-0411-GM ¶	103	Pus/white blood cells	99.0	1.0

* Correct identification of cellular component of smear

† Failure to report cellular morphotype(s) present or reporting cellular morphotype(s) not present in the smear

‡ Simulated smear of liver abscess aspirate for Gram staining (many pus/white blood cells)

§ Simulated smear of sputum for Gram staining (many pus/white blood cells, rare/few epithelial cells)

|| Simulated smear of sputum for Gram staining (many pus/white blood cells, rare/few epithelial cells)

¶ Simulated smear of intra-operative wound swab (many pus/white blood cells)

AFB Smear Interpretation

Performance on the four prepared smears of concentrated sputa for acid-fast staining and interpretation was also excellent, although the quantity reported for positive smears was variable among laboratories (Table 47).

Table 47. Performance in Microscopic Identification of AFB for Smears Distributed in 2004

Survey	No. of Laboratories Reporting	Quantity of Acid-Fast Bacilli	% Correct* Identification (Excellent)	% Partial† Identification (Acceptable)	% Incorrect‡ Identification (Unacceptable)
BACT-0404-AF-1	39	Moderate AFB present	87.1	10.3	2.6
BACT-0404-AF-2	39	No acid-fast bacilli present	100.0	0.0	0.0
BACT-0411-AF-1	39	No acid-fast bacilli present	100.0	0.0	0.0
BACT-0411-AF-2	39	Moderate AFB present	76.9	20.5	2.6

* Correct quantity of AFB reported

† Presence or absence of AFB correctly identified but quantity reported differed from expected quantity

‡ Presence or absence of AFB incorrectly identified

Patterns-of-Practice Survey

Significant findings from the patterns-of-practice on biosafety and biosecurity were as follows:

- 109/116 (93%) laboratories have at least one biological safety cabinet (BSC) (104 have a class II BSC, 4 have a class I and 1 laboratory reported using a class III)
- 59% of laboratories set up all specimens using a BSC
- 30% did not use a BSC when performing work on isolates, including high-risk pathogens
- 27% did not use physical barriers when handling specimens and 33% when handling isolates
- 9% did not have a written protocol for handling biohazardous spills
- 28% did not have a centrifuge with sealed specimen buckets and 32% of those that do, do not unload buckets in a BSC
- 12% did not have a biohazard sign at the laboratory entrance and 32% did not control access to the laboratory
- 49% did not have a protocol for handling specimens from patients with suspected SARS or Avian influenza
- 77% did not have a biosecurity manual.

Findings and best-practice recommendations were distributed as Committee Comments and included reference to the specific Ontario Laboratory Accreditation requirements where applicable.

ERROR RATES

Tables 48, 49 and 50 show the errors assessed for isolation/identification, incorrect antimicrobial susceptibility testing results and inappropriate antimicrobial agents/failure to report antibiotic of choice, respectively. The error rate for isolation and identification (4.9%) was slightly higher than in 2003 (3.4%). Most of the significant errors (22/33) occurred for survey BACT-0411 for failing to report VRE in vial 2 and *N. gonorrhoeae* in vial 4 and misidentifying *C. ochracea* in vial 3, as discussed earlier. The error rate for incorrect antimicrobial susceptibility testing results (2.6%) was also slightly higher than in 2003 (1.5%) in spite of the fact that the flagging rate was lower in 2004. The number of errors for inappropriate antimicrobial reports (38) was similar to 2003 (35). No errors were assessed for failure to report the antibiotic of choice.

Table 48. Errors Assessed for Organism Isolation and Identification

Survey	No. of Laboratories	Opportunities for Error*	No. of Significant Errors (%)	No. of Lesser Errors (%)	No. of Total Errors (%)
BACT-0402	92	368	2 (0.5)	4 (1.1)	6 (1.6)
BACT-0404	99	378	4 (1.1)	10 (2.6)	14 (3.7)
BACT-0409	98	374	5 (1.3)	14 (3.7)	19 (5.1)
BACT-0411	93	458	22 (4.8)	16 (3.5)	38 (8.3)
Total	...	1578	33 (2.1)	44 (2.8)	77 (4.9)

* Number of participating laboratories × number of organisms for isolation/identification

Table 49. Errors Assessed for Incorrect Antimicrobial Susceptibility Results

Survey	No. of Laboratories	Opportunities for Error*	No. of Significant Errors (%)	No. of Lesser Errors (%)	No. of Total Errors (%)
BACT-0402	92	884	3 (0.3)	4 (0.5)	7 (0.8)
BACT-0404	93	439	14 (3.2)	19 (4.3)	33 (7.5)
BACT-0409	92	492	0 (0.0)	8 (1.6)	8 (1.6)
BACT-0411	91	709	3 (0.4)	14 (2.0)	17 (2.4)
Total	...	2524	20 (0.8)	45 (1.8)	65 (2.6)

* Number of participating laboratories × number of antibiotic results reported (with reference result available)—includes β-lactamase errors

Table 50. Errors Assessed for Reporting Inappropriate Antimicrobial Agents (for Organism and/or Site) or Failure to Report Antibiotic of Choice

Antimicrobial Agent	Organism	No. of Significant Errors	No. of Lesser Errors
Ceftizoxime *	<i>Streptococcus constellatus</i> †	0	1
Ciprofloxacin	<i>Serratia oderifera</i> ‡	0	10
Clindamycin	<i>Streptococcus constellatus</i> §	6	0
Erythromycin	<i>Streptococcus constellatus</i> §	7	0
Gentamicin & TMP/SMX	<i>Listeria monocytogenes</i> †	0	1
Penicillin	<i>Bacillus</i> species, not <i>B. anthracis</i> †	0	1
	<i>Streptococcus constellatus</i>	0	2
β-lactamase	<i>Serratia oderifera</i>	0	2
	<i>Streptococcus bovis</i>	0	2
Not applicable	<i>Enterococcus faecium</i> (rectal swab, VRE screen) ¶	0	2
	<i>Haemophilus parainfluenzae</i> (eye swab) #	0	2
	<i>Vibrio vulnificus</i> **	0	2
Total		13	25

* Antibiotic code transcription error

† No NCCLS interpretive criteria for this antibiotic/organism combination

‡ Inappropriate for neonate

§ Inappropriate for brain abscess

|| No NCCLS disk diffusion interpretive criteria for this organism

¶ Inappropriate to report antimicrobial results for an isolate from a surveillance specimen

No NCCLS criteria for topical therapy

** No NCCLS interpretive criteria for this organism

The majority of errors for Gram stain interpretation were attributable to the microorganism component (Table 51) or the physician report (Table 53). Very few errors were assigned for the cellular component due to problems with apparent deterioration of the cells over time (Table 52). Only two errors were assessed for AFB interpretation (Table 54).

Table 51. Errors Assessed for Incorrect Gram Stain Interpretation – Microorganism Component

Survey	No. of Laboratories	Opportunities for Error*	No. of Significant Errors (%)	No. of Lesser Errors (%)	Total No. of Errors (%)
BACT-0402-GM	113	226	6 (2.7)	1 (0.4)	7 (3.1)
BACT-0404-GM	114	342	4 (1.2)	3 (0.9)	7 (2.0)
BACT-0409-GM	111	111	1 (0.9)	4 (3.6)	5 (4.5)
BACT-0411-GM	103	103	3 (2.9)	3 (2.9)	6 (5.8)
Total	...	782	14 (1.8)	11 (1.4)	25 (3.2)

* Number of participating laboratories × number of microorganism morphotypes present

Table 52. Errors Assessed for Incorrect Gram Stain Interpretation – Cellular Component

Survey	No. of Laboratories	Opportunities for Error*	No. of Significant Errors (%)	No. of Lesser Errors (%)	Total No. of Errors (%)
BACT-0402-GM	113	113	0 (0.0)	1 (0.9)	1 (0.9)
BACT-0404-GM	114	0 †	...	...	...
BACT-0409-GM	111	0 †	...	...	...
BACT-0411-GM	103	103	0 (0.0)	0 (0.0)	0 (0.0)
Total	...	216	0 (0.0)	1 (0.9)	1 (0.9)

* Number of participating laboratories × number of microorganism morphotypes present

† No errors assessed—unsatisfactory cellular component

Table 53. Errors Assessed for Incorrect Gram Stain Interpretation – Physician Reports

Survey	No. of Laboratories	Opportunities for Error*	No. of Significant Errors (%)	No. of Lesser Errors (%)	Total No. of Errors (%)
BACT-0402-GM	113	113	0 (0.0)	2 (1.8)	2 (1.8)
BACT-0404-GM	114	114	3 (2.6)	3 (2.6)	6 (5.3)
BACT-0409-GM	111	111	0 (0.0)	1 (0.9)	1 (0.9)
BACT-0411-GM	103	103	0 (0.0)	3 (2.9)	3 (2.9)
Total	...	441	3 (0.7)	9 (2.0)	12 (2.7)

* Number of participating laboratories × number of physician reports

Table 54: Errors Assessed for Incorrect AFB Interpretation

Survey	No. of Laboratories	Opportunities for Error*	No. of Significant Errors (%)	No. of Lesser Errors (%)	Total No. of Errors (%)
BACT-0404-AF	39	78	1 (1.3)	0 (0.0)	1 (1.3)
BACT-0411-AF	39	78	0 (0.0)	1 (1.3)	1 (1.3)
Total	...	156	1 (0.6)	1 (0.6)	2 (1.3)

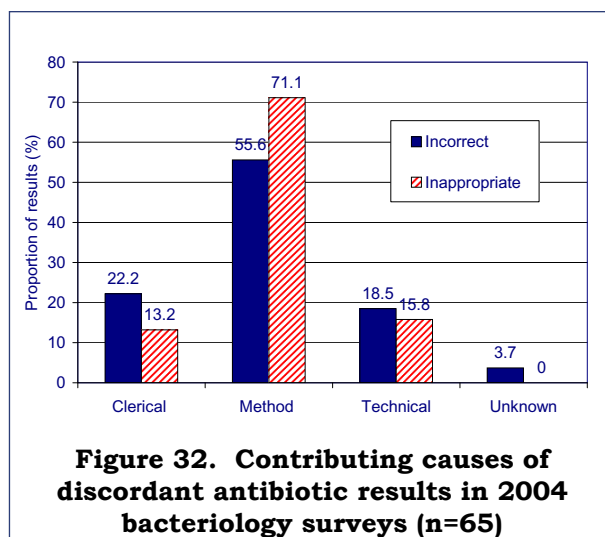
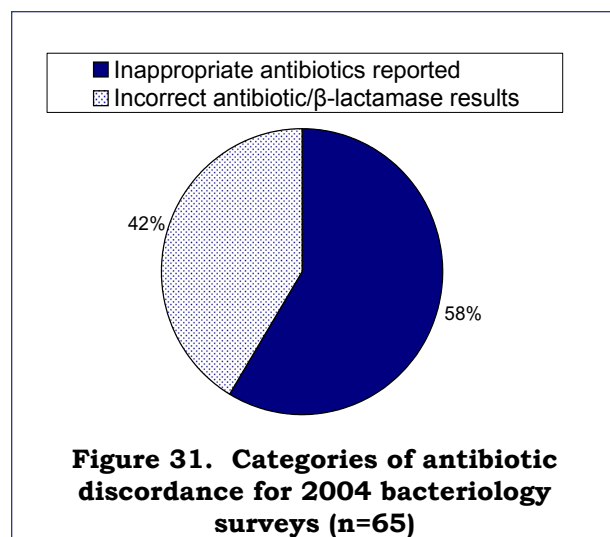
* Number of participating laboratories × number of slides

CAUSE ANALYSIS

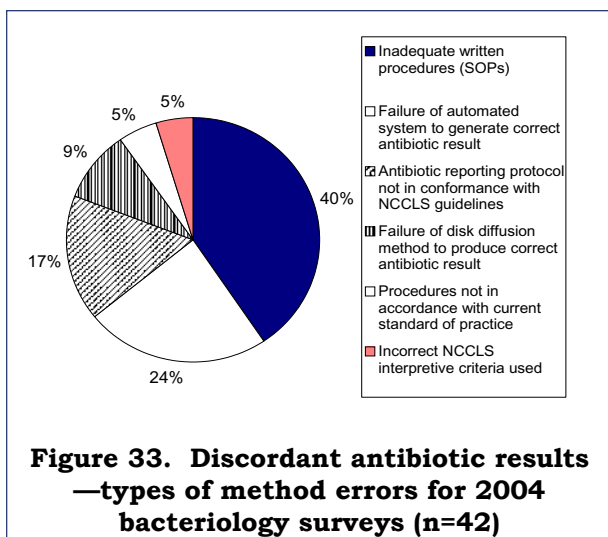
For the second consecutive year, laboratories were asked to complete an investigation form to assist them in performing cause analysis for their discordant results on QMP-LS surveys. This information was assessed and collated to determine the factors that contributed to reporting of discordant results on bacteriology surveys.

Antibiotic Susceptibility Testing

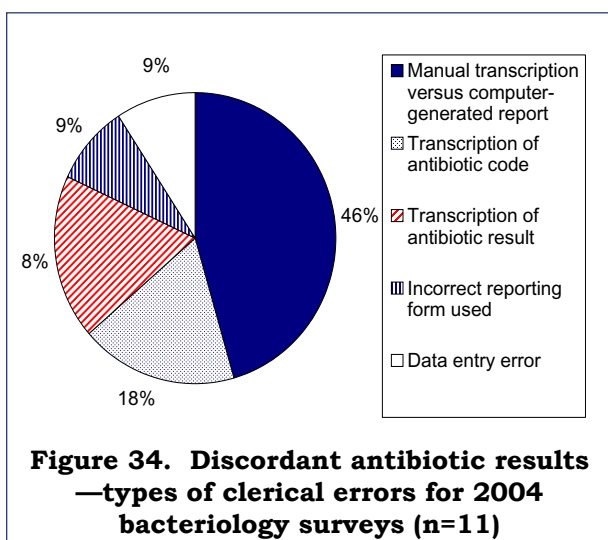
There were two categories of antibiotic discordance in 2004—incorrect antibiotic results (including β -lactamase testing) and reporting inappropriate antibiotics for the organism and/or site. The relative proportion of discordant results for these categories is shown in Figure 31. Contributing causes were classified as clerical, technical, method or organization-related. The majority of discordant antibiotic results for both categories of antibiotic discordance were due to method-related problems followed by clerical and technical problems (Figure 32). These results are similar to those in 2003, except that the proportion of clerical-related errors has decreased.



The bulk of method-related errors were due to inadequate Standard Operating Procedures (SOPs) (e.g. reporting erythromycin or clindamycin for *S. constellatus* isolated from a brain abscess aspirate), an inaccurate method (e.g. false susceptible ampicillin result for *C. freundii* by MicroScan®, false susceptible meropenem for *E. cloacae* by Vitek®) or antibiotic reporting protocols that were not in accordance with NCCLS guidelines (e.g. using NCCLS criteria, which are based on achievable serum levels, to report results for an eye swab, which is usually treated with topical agents) (Figure 33).



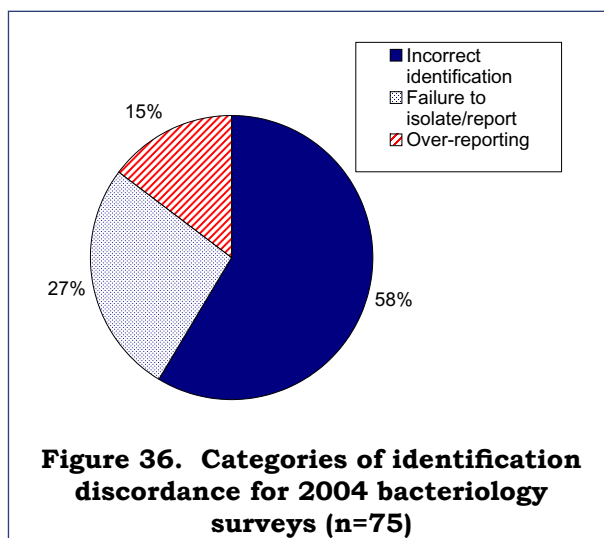
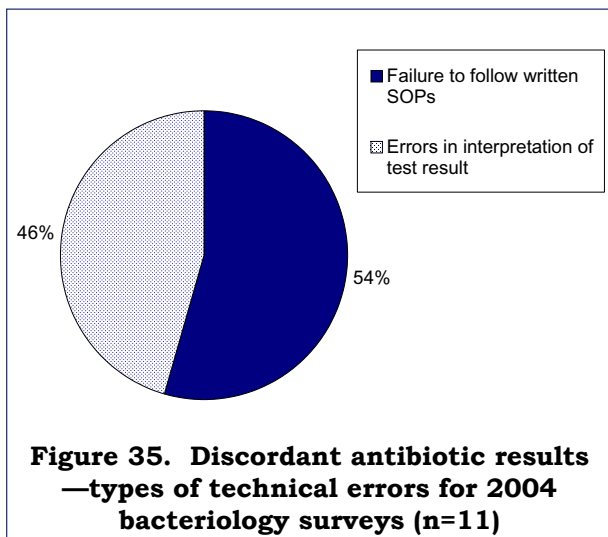
Almost half of the clerical errors (46%) were due to manual transcription of results to the QMP–LS Analysis Worksheet as opposed to issuing a computer-generated report, which is the usual practice for patient specimens (Figure 34). An example was the reporting of ciprofloxacin for *S. oderifera* stated to be from a neonate (BACT-0404-2), a result that would have been automatically suppressed by the LIS for a patient report. Other clerical-related problems were due to transcription of the antibiotic code or the antibiotic result. As noted in 2003, transcription errors only become a concern when they occur repeatedly as this signals a lack of attention to detail that may affect the quality of a laboratory's operations.



Technical-related errors were due to either failing to follow SOPs or an error in the interpretation of a test result (Figure 35). Examples of deviation from SOPs included not using a selective medium for isolation of VRE although this was the usual laboratory practice and reporting a β -lactamase result for organisms such as *Serratia oderifera* or *Streptococcus bovis* even though this was not part of the documented protocol.

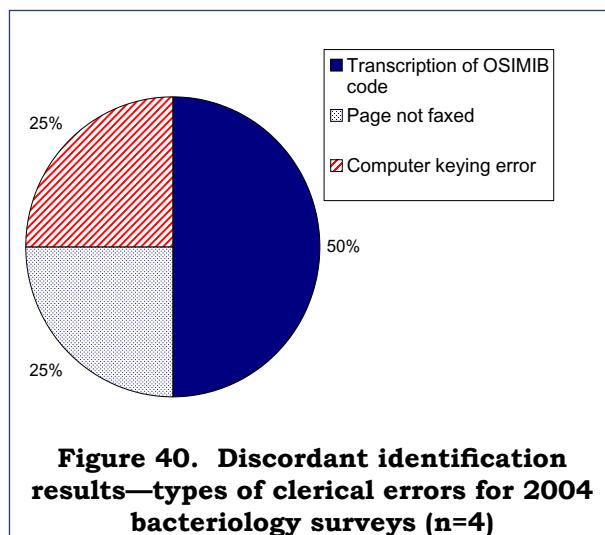
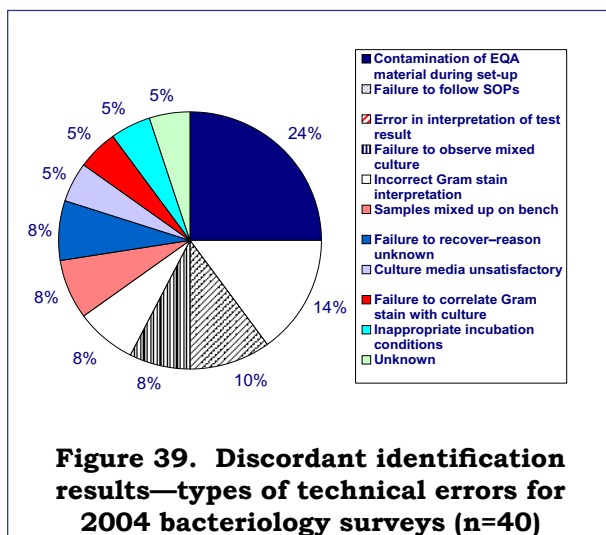
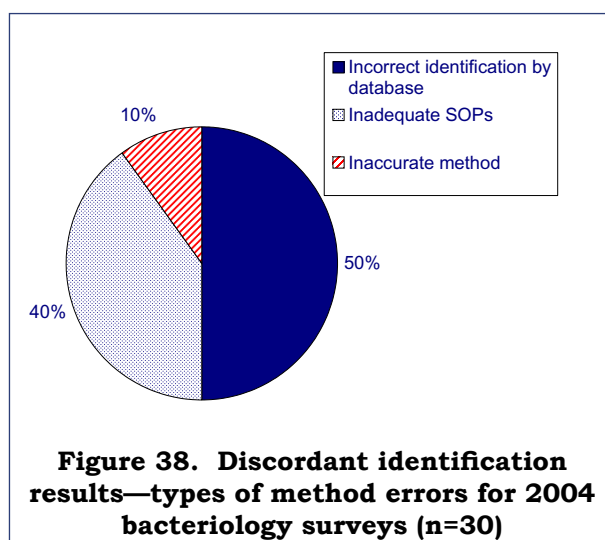
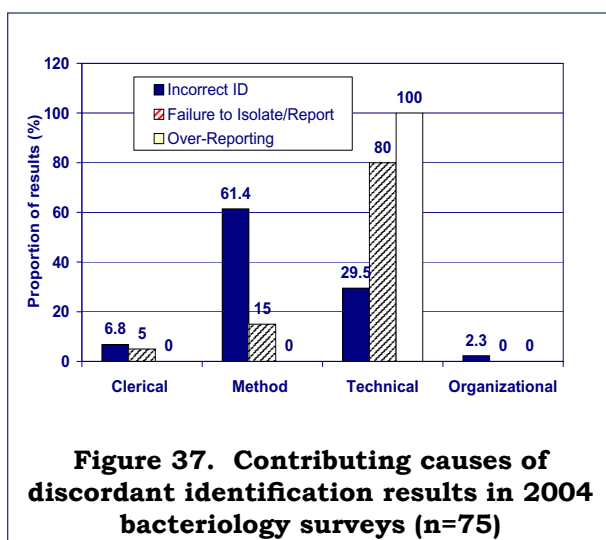
Isolation and Identification

There were three categories of identification discordance —incorrect identification, failure to isolate or report the target organism and reporting an organism that was not present in the sample (i.e. over-reporting) (Figure 36). Incorrect identification results were primarily due to



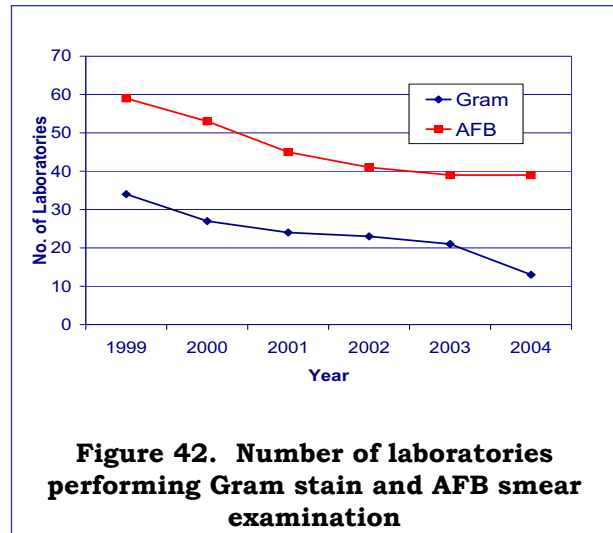
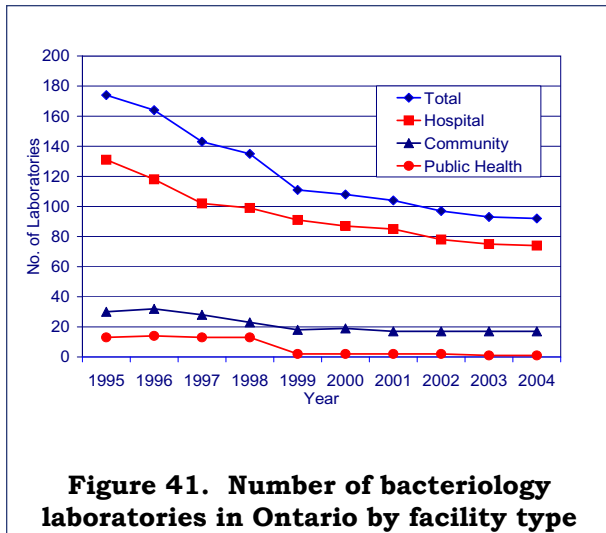
method-related problems and technical problems were the major contributing factor in failing to isolate or report an organism and for over-reporting errors (Figure 37). One laboratory indicated an incorrect identification was due to inadequate training of staff to perform the task (organizational-related).

One-half of method errors were the result of an incorrect identification by a commercial system's database (e.g. identification of *S. schleiferi* as *S. haemolyticus* by Vitek®), 40% were due to inadequate SOPs (e.g. flow chart for VRE identification did not include *E. faecium*) and 10% were the result of an inaccurate method (e.g. use of X, V and XV-factor disks to identify *H. parainfluenzae*) (Figure 38). A variety of factors contributed to technical errors such as contamination of the survey material during the set-up process, failure to observe a mixed culture, mixing samples up and unsatisfactory culture media (Figure 39). Similar to 2003, clerical errors were mainly due to transcription of the Ontario System for Identification of Medically Important Bacteria and Fungi (OSIMIB) code (Figure 40).



NUMBER OF PROVIDERS

The number of laboratories that provide a comprehensive testing menu in bacteriology decreased by one in 2004 (Figure 41). Eight laboratories licensed for Gram stain have dropped this testing since 2003 and the number of laboratories licensed for AFB smear interpretation remained the same (Figure 42).



MYCOLOGY

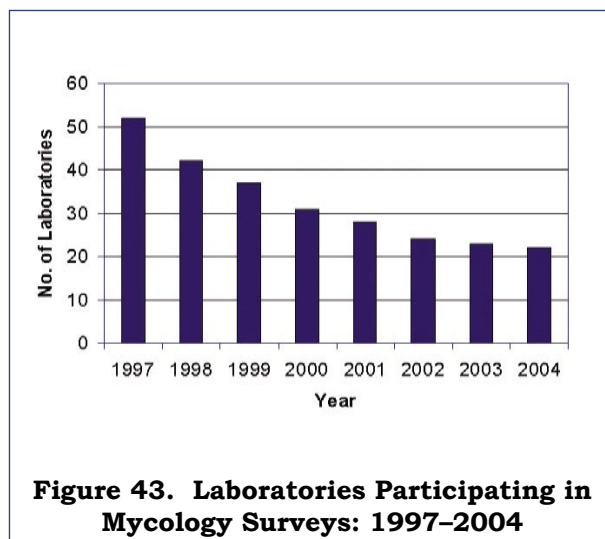
TESTING MODEL

Two surveys were conducted in 2004, consisting of nine challenge samples. As in previous surveys, the challenges were selected from the three groups of medically significant fungi—dermatophytes, yeasts and moulds. Testing material was distributed to laboratories as live cultures on agar slants. The type of specimen, hypothetical microscopic information and a limited clinical history were provided to participants on the Analysis Worksheets. Laboratories were required to process the cultures as if they were patient specimens. The licence to perform mycology culture includes yeasts and/or dermatophytes and/or systemic fungi. Some laboratories may not routinely culture specimens in all categories. All challenge samples are sent to laboratories and each laboratory defines the level of practice. Performance assessment of submitted results is correlated with that laboratory's stated level of practice. Three reference laboratories include the Toronto Public Health Laboratory, Wadsworth Centre for Laboratories and Research, Albany, New York, and Laboratoire de Santé Publique du Québec.

The identification of organisms by the OSIMIB code is the only component of the survey that is scored; however, all information provided by participants on the Analysis Worksheets (isolation media, macroscopic and microscopic findings, other identification features, reporting to clinician) is reviewed for appropriateness. Errors are classified as lesser or significant, depending on their potential impact on patient care. Comprehensive Committee Comments for each organism include a review of the identification of the organism and its clinical significance as well as a review of participant performance. In 2004 laboratories also received photomicrographs of distinguishing microscopic characteristics of the fungi used in the challenges. The photography was generously provided on the actual cultures used in the challenge by Dr. James Scott, University of Toronto, Faculty of Medicine.

LABORATORY PARTICIPATION

There has been a steady decline in the number of laboratories licensed to perform mycology since the program started in 1997, when 52 laboratories participated in the initial pilot survey. The number of laboratories participating in Ontario at the end of 2004 was 22 (Figure 43). Most laboratories (19/22) identify yeasts as part of their routine microbiology practice. However, some of these may not attempt to isolate yeasts associated with systemic infection and choose to refer out such specimens. In 2004, 18/22 laboratories handled dermatophytic fungi from superficial skin specimens, while 20/22 licensed laboratories cultured fungi from systemic specimens. Specimen referral patterns for identification of organisms varied with the nature of the agent isolated.



OVERALL PERFORMANCE

Challenge Surveys

Overall, performance on survey MYCO-0403 was good (Table 55). Of four challenge organisms (*Trichophyton mentagrophytes*, *Scedosporium prolificans*, *Scopulariopsis brevicaulis* and *Candida guilliermondii*) only one significant error was assigned with one laboratory reporting *Scedosporium prolificans* as *Sporothrix schenckii*. One lesser error involved a laboratory reporting *Trichophyton mentagrophytes* as *T. rubrum*.

Survey MYCO-0409 contained four challenges (*Epidermophyton floccosum*, *Scytalidium dimidiatum*, *Sporothrix schenckii* and *Rhodotorula mucilaginosa*) and *Phoma* spp. as an educational sample. The number of errors was few (Table 55) with one laboratory incorrectly speciating *Rhodotorula mucilaginosa* as *R. glutinis*. Ten of 22 laboratories successfully identified *Phoma* spp. with one participant mistakenly identifying the culture as *Chaetomium* spp.

It is difficult to assess general performance with many variables intrinsic in the testing model—variability in the level of cultural identification attempted by participants, and fewer participants. The number of errors are few; however, variably only between 30.0% to 78.9% of cultures are fully identified to species level. This suggests that the number of laboratories retaining expertise in identification may be of concern.

Table 55. 2004 Organism Distribution and Survey Performance

Survey	No. of Labs Reporting	Organism	Correct * Identification (%) (Excellent)	Partial † Identification (Acceptable)	Incorrect ‡ Identification (%) (Unacceptable)
MYCO-0403-1	18	<i>Trichophyton mentagrophytes</i>	10 (55.6)	7	1 (5.6)
MYCO-0403-2	19	<i>Scedosporium prolificans</i>	10 (52.6)	8	1 (5.3)
MYCO-0403-3	18	<i>Scopulariopsis brevicaulis</i>	11 (61.1)	7	0
MYCO-0403-4	19	<i>Candida guilliermondii</i>	15 (78.9)	4	0
MYCO-0409-1	18	<i>Epidermophyton floccosum</i>	14 (77.8)	4	0
MYCO-0409-2	19	<i>Scytalidium dimidiatum</i>	12 (63.2)	7	0
MYCO-0409-3§	21	<i>Sporothrix schenckii</i>	16 (76.2)	5	0
MYCO-0409-4	20	<i>Rhodotorula mucilaginosa</i>	6 (30.0)	13	1 (5.0)
MYCO-0409-5§	21	<i>Phoma</i> spp.	10 (no species designation required)	10	1 (4.8)
TOTAL	173		104 (60.1)	65 (37.6)	4

* Identified correctly to species level (or to genus level when appropriate)

† Identified genus level (without naming a species) or correct to general classification (e.g. yeast, mould, filamentous fungi, dermatophyte)

‡ Identified incorrectly

§ Educational challenge

PARASITOLOGY

TESTING MODEL

Two surveys were conducted in 2004, each consisting of three vials of SAF-preserved faecal specimens. Laboratories were required to prepare both a concentrate and stained slide from each sample and report findings from both preparations.

SURVEY ASSESSMENT

Performance was evaluated by comparing participants' results to the consensus results of ten referee laboratories. The ten participating laboratories with the highest average score over the preceding four surveys were designated as the referee group for each survey. The collated results of these laboratories were used to determine the scoring scheme and flagging criteria. A result was scored if more than 50% of the referee laboratories reported it. Three marks were awarded for each correct stage and quantity of parasite reported and two marks were awarded if the quantity reported fell outside the expected range. Three marks were deducted for reports of parasite species not present in the sample (i.e. over-reporting).

Errors were assigned only when a parasite was not reported in both the concentrate and stained slide or if a parasite not actually present in the specimen was reported in either the concentrate or stained smear. Errors for failing to report a parasite were not assessed unless there was at least 90% agreement among the referee laboratories.

LABORATORY PERFORMANCE

Performance on the two surveys is summarized in Table 56. The six samples contained a total of 14 different parasite species, including 5 amoebae, 3 coccidia, 3 flagellates and 3 helminths. Detection of small numbers of organisms (A–B quantities), particularly when a mixture of parasites was present, continues to be a challenge for some laboratories. Otherwise, performance was good, notably:

- All laboratories reported *Cyclospora cayetanensis* in PARA-0405-3. Of five previous surveys beginning in 1996, this was the first time that all laboratories successfully detected this organism (Table 57). However, one-half of laboratories, both participant and referee, did not report *C. cayetanensis* in PARA-0410-1 where it was present in A quantities (1–5 per coverslip) along with E quantities (1 or more per high power field) of *C. parvum* oocysts.
- All laboratories reported *Isospora belli* in PARA-0410-3. This parasite was last used as a survey challenge in 1990 when only 86% of participants reported its presence.

Ten significant and 19 lesser errors were assessed for an overall error rate of 5.8%, which is almost identical to 2003 when it was 5.7% (Table 58).

Table 56. Overall Performance of Referee and Participating Laboratories in 2004

Survey	Expected Parasite	Quantity	Referee Agreement (%) (n=10)	Participant Agreement (%) [*] (n=23)
PARA-0405-1C (Concentrate)	<i>Chilomastix mesnili</i> cysts	A	100	88
	<i>Endolimax nana</i> cysts	A	80	56
	<i>Entamoeba hartmanni</i> cysts	B	100	84
	<i>Entamoeba histolytica/dispar</i> cysts	C	100	100
	<i>Giardia lamblia</i> cysts	A	100	76
	<i>Iodamoeba buetschlii</i> cysts	D	100	100
PARA-0405-1S (Stained slide)	<i>Chilomastix mesnili</i> cysts	A	100	88
	<i>Chilomastix mesnili</i> trophozoites	E	100	100
	<i>Endolimax nana</i> cysts	A	80	52
	<i>Endolimax nana</i> trophozoites	B	90	76
	<i>Entamoeba hartmanni</i> cysts	B	100	92
	<i>Entamoeba hartmanni</i> trophozoites	B	90	84
	<i>Entamoeba histolytica/dispar</i> cysts	C	100	100
	<i>Entamoeba histolytica/dispar</i> trophozoites	C	100	100
	<i>Giardia lamblia</i> cysts	A	100	92
	<i>Giardia lamblia</i> trophozoites	A	100	88
	<i>Iodamoeba buetschlii</i> cysts	D	100	100
	<i>Iodamoeba buetschlii</i> trophozoites	E	100	100
PARA-0405-2C (Concentrate)	<i>Ascaris lumbricoides</i> ova	C	100	100
	<i>Giardia lamblia</i> cysts	B	100	96
PARA-0405-2S (Stained slide)	<i>Ascaris lumbricoides</i> ova	B	100	96
	<i>Giardia lamblia</i> cysts	B	100	96
PARA-0405-3C (Concentrate)	<i>Cyclospora cayetanensis</i> oocysts	C	100	100
PARA-0405-3S (Stained slide)	<i>Cyclospora cayetanensis</i> oocysts	C	50	36
	<i>Dientamoeba fragilis</i> trophozoites	B	100	96
PARA-0410-1C (Concentrate)	<i>Cryptosporidium parvum</i> oocysts	E	100	100
	<i>Cyclospora cayetanensis</i> oocysts	A	50	52 †
PARA-0410-1S (Stained slide)	<i>Cryptosporidium parvum</i> oocysts	E	100	96
	<i>Cyclospora cayetanensis</i> oocysts	A	40	26 †
	<i>Dientamoeba fragilis</i> trophozoites	C	100	100
	<i>Endolimax nana</i> trophozoites	B	90	96
	<i>Entamoeba coli</i> trophozoites	A	100	91
	<i>Entamoeba hartmanni</i> trophozoites	A	90	74
PARA-0410-2C (Concentrate)	<i>Schistosoma mansoni</i> ova	A	80	70 †
	<i>Strongyloides stercoralis</i> larvae	A	100	91
	<i>Endolimax nana</i> cysts	B	100	100
PARA-0410-2S (Stained slide)	<i>Schistosoma mansoni</i> ova	A	30	22 †
	<i>Strongyloides stercoralis</i> larvae	A	100	70
	<i>Endolimax nana</i> cysts	B	100	100
	<i>Endolimax nana</i> trophozoites	B	100	100
PARA-0410-3C (Concentrate)	<i>Isospora belli</i> oocysts	B	100	100
PARA-0410-3S (Stained slide)	<i>Isospora belli</i> oocysts	B	100	100

Helminths: A-occasional, 1–4 per coverslip; B-few, 5–20 per coverslip; C-moderate, 11–20 per coverslip; D-many, 1 per low power field; E-numerous, 1 or more per high power field

Protozoa: A-occasional, 1–5 per coverslip; B-few, 6–25 per coverslip; C-moderate, 1 per low power field; D-many, 1 per high power field; E-numerous, 1 or more per oil immersion field

* All laboratories including referee laboratories

† No errors assessed due to low referee agreement

Table 57. Laboratory Performance in Identification of *Cyclospora cayetanensis* 1996–2004

Survey Number	Quantity	No. Labs Reporting <i>C. cayetanensis</i> /Total Labs (%)
T-9605-2	B	41/57 (72)
T-9705-2	B	39/49 (80)
T-9810-2	B	32/35 (91)
T-9910-1	B	29/32 (91)
PARA-0405	C	25/25 (100)

Table 58. Errors Assessed in Parasitology in 2004

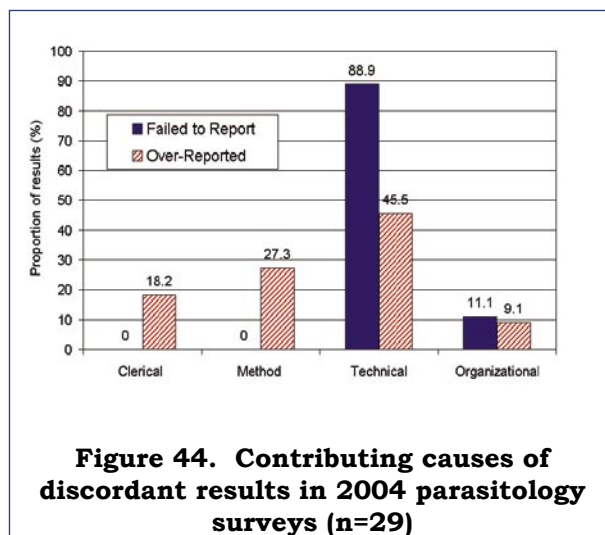
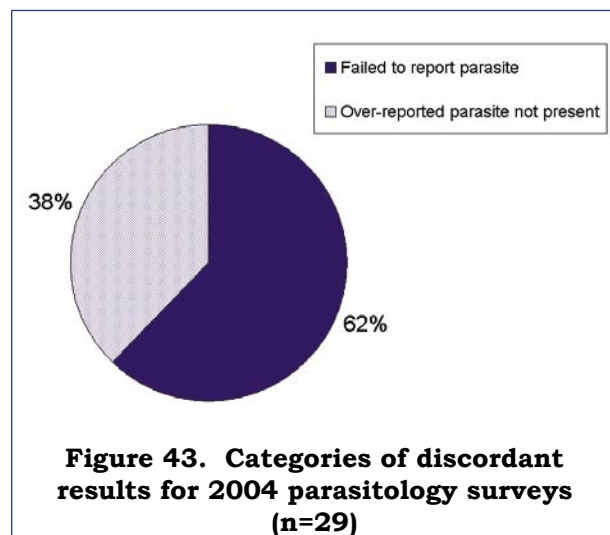
Survey	No. of Laboratories	Opportunities for Error*	No. of Significant Errors (%)	No. of Lesser Errors (%)	No. of Total Errors (%)
PARA-0405	25	250	4 (1.6)	11 (4.4)	15 (6.0)
PARA-0410	23	230	6 (2.6)	8 (3.5)	14 (6.1)
Total	...	480	10 (2.1)	19 (3.9)	29 (6.0)

* Number of participating laboratories x number of parasites present

CAUSE ANALYSIS

For the second consecutive year, laboratories were asked to complete an investigation form to assist them in performing cause analysis for their discordant results on parasitology surveys. This information was assessed and collated to determine the factors that contributed to reporting of discordant results.

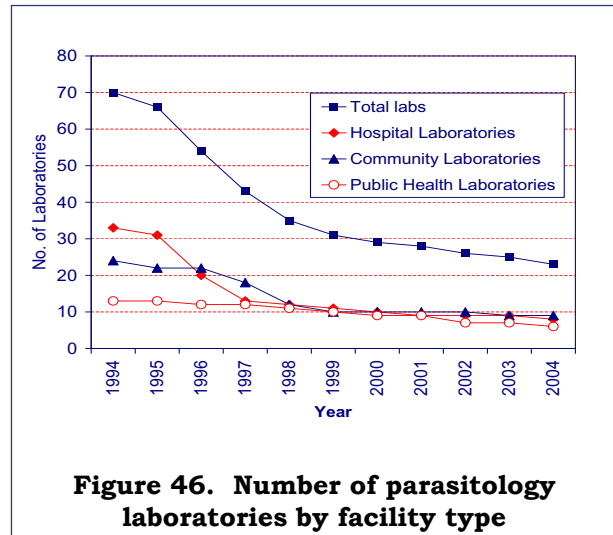
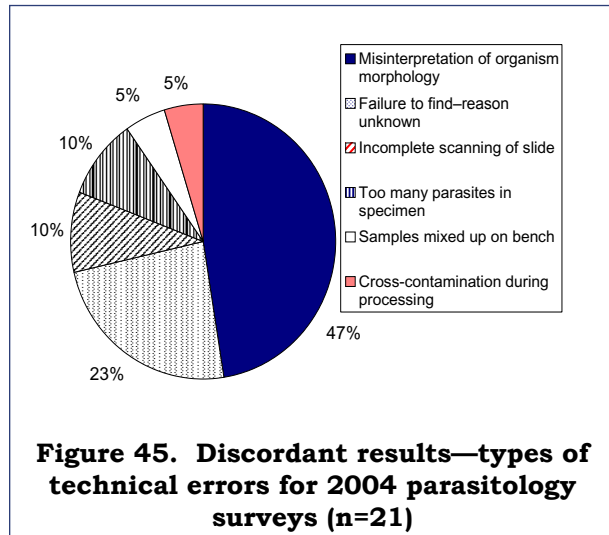
There were two categories of discordant results for 2004 parasitology surveys—failing to report a parasite that was deemed to be present by the referee laboratories (i.e. under-reporting) and reporting a parasite that was not present in the specimen (i.e. over-reporting). In contrast to 2003 when 100% of the discordant results were for over-reporting, 62% of discordant results in 2004 were for failure to report (Figure 43). Contributing causes were classified as clerical, technical, method or organization-related. The cause of almost 90% of under-reporting errors was related to technical factors, while over-reporting errors were the result of a variety of factors (Figure 44). Organizational factors (e.g. number of specimens too low to maintain expertise) contributed to both types of



discordant results. Examples of technical errors were misinterpretation of organism morphology, incomplete scanning of the slide, mixing up samples and cross-contamination of specimens during processing (Figure 45).

NUMBER OF PROVIDERS

The number of parasitology laboratories in Ontario decreased by two (one hospital and one public health laboratory) since 2003 leaving a total of 23 testing facilities (Figure 46).



VIROLOGY

TESTING MODEL

Ten challenge surveys were conducted during 2004. Additionally, a patterns-of-practice survey, VIRO-0402, included a request for laboratories licensed to perform any respiratory virus antigen testing to submit requisitions, interim, final and reference reports for the last positive and last negative specimens submitted during January 2004. Table 59 shows the number of samples in each survey and the number of laboratories participating.

Table 59. Number of Ontario Laboratories Participating in Viral or Chlamydial Surveys

Survey		No. of samples/No. of participants reporting results*						
Survey	Samples per Survey	Hepatitis A, B, C	HIV	Rubella	VZV	CMV	<i>C. trachomatis</i>	Respiratory
VIRO-0402	15	...	...	5/27	5/12	5/11	5/18	5/49
VIRO-0403	10	5/41	5/18	...	...	...	...	...
VIRO-0410	15	...	...	5/26	5/12	5/9	5/17	5/49
VIRO-0411	10	5/40	5/18	...	...	...	...	...

* Numbers include out-of-province laboratories (1 chlamydia, 2 hepatitis A/B/C, 1 respiratory)

The challenge material for hepatitis A virus (HAV), hepatitis B virus (HBV), hepatitis C virus (HCV), human immunodeficiency virus (HIV) and rubella/varicella-zoster virus (VZV)/cytomegalovirus (CMV) surveys was either serum or plasma, not heat- or otherwise inactivated. The plasma used for hepatitis and HIV testing was kindly provided by the Canadian Blood Services. Serum for rubella, VZV and CMV testing was obtained from donors, based on their immune status. Material for rubella was purchased from commercial sources and pre-tested to required specifications before purchase. Material for chlamydia, respiratory syncytial virus (RSV), influenza A, B and parainfluenza 3 challenges was obtained from a commercial source.

Packaging and shipping of all samples complies with federal regulations for transportation of dangerous goods. Participants are notified that the specimens are not inactivated and are instructed to process the samples as they would handle routine clinical specimens using standard precautions. In addition, participants are reminded that serum and plasma samples have been previously frozen and they should observe manufacturer's instructions for processing frozen material.

In addition to the Ontario laboratories participating in the surveys, three out-of-province laboratories also participate in portions of the virology surveys (one each for hepatitis, chlamydia and the respiratory panel).

SURVEY ASSESSMENT

Participant results were compared to those obtained from reference laboratories using similar methods, and where appropriate, with peer groups (participants using the same methodology). Results that are discordant from the reference results were flagged. Errors were assessed as being either significant or lesser errors depending on the potential impact of the reported results on patient outcomes or risk for disease transmission. The summary of errors is shown in Table 60.

Precision studies were conducted and discussed in the Committee Comments; however, no errors were assessed based on precision.

Table 60. Error Assessment for Ontario Laboratories for 2004

Analyte	No. of Laboratories	Opportunities for Error	Significant Errors	Lesser Errors	Total Errors	Error Rate (%)
Chlamydia	35	175	1	0	1	0.57
HIV	36	180	0	0	0	0.00
HCV	63	315	0	1	1	0.32
Hepatitis A and B	378	1890	3	1	4	0.21
Rubella/VZV/CMV	88	560	1	2	3	0.54
Respiratory antigen*†	195	1326	0	17	17	1.28
Total		4446	5	21	26	0.58

* VIRO-0410 testing material produced many false positive results with one manufacturer's EIA test kit; survey not scored

† Error assessment scheme not yet published

OVERALL PERFORMANCE

Chlamydia trachomatis

The number of participating Ontario laboratories was 18 in 2004 compared with 16 in 2003. The performance for chlamydia improved in 2004 as the overall error rate declined to 0.57% from 0.71% in 2003.

Hepatitis A, B and C

The performance of hepatitis testing improved in 2004 with an error rate of 0.21% for hepatitis A and B compared with 0.78% in 2003, and 0.32% for hepatitis C compared with 0.76% in 2003. This error rate combines significant and lesser errors for a number of markers including HBsAg, anti-HBs, anti-HBc and anti-HCV antibody. There were only five errors in total—four false positive results (anti-HBs, anti-HBc, anti-HBe, HCV screen) and one misinterpretation of a positive anti-HBs reported non immune (antibody level >100 mIU/mL).

HIV Antibody Detection

Eighteen laboratories participated in two surveys and there were no HIV errors. In 2003, the error rate was 0.66%. One sample (a gift from Dr. John Kim of the National HIV Reference Laboratory in Ottawa) was HIV 1 indeterminate, HIV 2 positive. It was included in the challenge to test the performance of laboratories with various systems and their ability to detect HIV 2 subtypes. Early HIV testing systems were designed to detect only HIV 1 subtypes. All laboratories reporting results successfully identified the HIV 2 challenge. One laboratory did not report a result for this challenge but indicated they failed to obtain a valid result using the Abbott Prism instrument.

Rubella Antibody Detection

Twenty-seven laboratories participated in the March survey and 26 participated in October. Both surveys included five samples. No significant errors were reported in either survey (error rate 0.7%). In 2003, the error rate for rubella was 1.39%.

The March survey included one sample with an antibody level close to the immune interpretive cut-off value (10 IU/mL). The mean value reported by participants was 9.4 IU/mL. This compares favourably with the results achieved for the same material in VIRO-0201-1 at 10.1 IU/mL. Overall, there was an improvement in coefficient of variation (CV) between the two surveys with 15.6% CV for VIRO-0402-1 compared to 30% for VIRO-0201-1. Participants were reminded to include the clinical interpretation on their reports to physicians regarding the immune status and the follow-up required.

The October survey included a sample with a low antibody level (approximately 40 IU/mL). Two laboratories reported equivocal results. Though the antibody level was low for this sample, it was above the international value defined as immune (10 IU/mL).

VZV Antibody Detection

The sera provided for rubella form a panel to be tested for rubella/VZV/CMV antibody. Twelve laboratories tested for VZV. No errors were assessed for varicella antibody testing.

CMV Antibody Detection

Eleven laboratories tested for CMV antibody in March and nine in October. All participating laboratories reported correct results for all specimens.

Respiratory Antigen Detection

Patterns of Practice

Fifty-one laboratories sent reports for review. Forty laboratories sent reports generated by computerized laboratory information systems and 11 laboratories sent manually completed reports. Laboratories interpreted instructions variably. Some sent positive and negative reports for RSV, some for influenza A virus and some for culture. Some laboratories sent reports for both RSV and influenza A. The committee expected one positive and one negative report. The Virology Committee reviewed the reports for the following parameters that are data elements required and/or recommended for patient records by various regulatory and/or accrediting bodies: patient demographic information, specimen information, clinical information, test information and report elements. Comparisons with the patterns-of-practice survey conducted in 2002 (VIRO-0203) were made. A complete summary of results, observations and recommendations were summarized in the form of Committee Comments. While errors are not assessed on the patterns-of-practice surveys, the committee sent memoranda of clarification to laboratories to address outstanding issues discussed in the Committee Comments. Memoranda were also sent for scores lower than the mean in the 2002 survey (VIRO-0203-PP). Fourteen laboratories scored lower than 2003 survey (VIRO-0302) with eight falling below the mean for laboratories reporting in VIRO-0402. These laboratories were requested to review their data handling processes for virus antigen testing and reporting.

Simulated Specimen Challenge

For the February survey (VIRO-0402), there were five specimens in the panel containing three respiratory antigens—influenza A, influenza B and RSV. Laboratories were asked to test all survey samples for their range of respiratory antigens. Forty-eight Ontario laboratories and two out-of-province laboratories reported results. For the October survey (VIRO-0410), there were five specimens in the panel, containing four respiratory antigens—influenza A, influenza B, parainfluenza 3 and RSV. Forty-nine Ontario laboratories and one out-of-province laboratory reported results. Table 61 shows the number of participants and the viral antigen reported in 2003 and 2004.

Respiratory Panel Issues

The February survey revealed 18 errors out of 614 opportunities for errors—a 2.7% error rate (Table 62). The committee conveyed to participants the importance of understanding the limitations of rapid testing and of communicating limits to clients. While products must be registered by Health Canada, there are no requirements in Canada for demonstration of product reliability, sensitivity or specificity prior to sale. Some microbiology laboratory staff undertake use of viral test kits for direct antigen detection without experience in virology, specifically without having knowledge of virus isolation as a reference standard. In view of the importance of respiratory screening,

Table 61. Number of Participant Laboratories Reporting Viral Antigen Detection Results in Respiratory Panels

Viral Antigen	No. of Laboratories Participating in VIRO-0410 (2004)	No. of Laboratories Participating in VIRO-0402 (2004)	No. of Laboratories Participating in VIRO-0311 (2003)
Adenovirus	6	5	5
Influenza A	35	36	30
Influenza B	29	28	25
Parainfluenza 1	6	5	4
Parainfluenza 2	6	5	4
Parainfluenza 3	6	5	4
RSV	49	49	50

Table 62. Overall Performance – Respiratory Panel VIRO-0402

Viral Antigen	False Positives	False Negatives	Total Errors/Opportunity for Error	(%)
Influenza A	1	0	1/180	0.5
Influenza B	0	7	7/168	4.1
Parainfluenza 3	3	0	3/21	14
RSV	3	4	7/245	2.8
Total	7	11	18/614	2.7

especially post-SARS, and given the implications for outbreak control, the correct identification of respiratory viruses is extremely important. Public Health officials rely on laboratory results to take action in outbreak situations. Laboratories were reminded to check the published literature for independent assessment of performance characteristics and to validate methods themselves before implementing new procedures.

Use of viral techniques can pose many difficulties. DFA tests are very subjective and require well-trained staff. Different methodologies show significant differences in sensitivities and specificity that impact performance. Combination tests that are designed to detect more than one virus (like influenza A + B) often demonstrate lower sensitivity and specificity than single antigen tests. Careful development of specific algorithms for testing is required. Further investigations, including virus culture and/or PCR on negative specimens, may be required in specific circumstances, as well as confirmation of positive results.

A summary of the results entitled *External Quality Assessment of Laboratory Performance when Screening for Respiratory Viruses* was presented at the Canadian Association of Clinical Microbiology and Infectious Diseases (CACMID) meeting in November 2004.

The October survey (VIRO-0410) revealed unexpected results (Table 63) when participants using BD Directigen™ kits reported many false positive results for influenza A, B and RSV (12 influenza A, 20 influenza B and 30 RSV false positive results). A small number of participants reported false negative results for one vial containing both influenza A and B.

The false positive results are being attributed to a matrix effect caused by the presence of cellular material obtained from tissue culture, placed into the simulated sample. Material was supplied by a commercial company according to specifications that requested a liquid suspension of RSV, influenza A, influenza B or parainfluenza

Table 63. Results of Respiratory Antigen Detection October Survey (VIRO-0410)

Viral Antigen	Vials	No. of Laboratories	Opportunities for Error	Significant Errors	Lesser Errors	Total Errors	% Errors
RSV	5	49	245	0	30	30	12.24
Influenza A	5	36	180	0	21	21	11.67
Influenza B	5	29	145	0	20	20	13.79
Influenza A + B	1	36	36	0	9	9	25.00
Adenovirus	5	6	30	0	0	0	0.00
Parainfluenza 1	5	6	30	0	0	0	0.00
Parainfluenza 2	5	6	30	0	0	0	0.00
Parainfluenza 3	5	6	30	0	0	0	0.00

infected cells (in separate vials) mixed with non-infected cells and extracellular virus. Ontario participants use either EIA or DFA techniques for viral antigen detection. Non-infected cells are included in the testing material to simulate respiratory cellular material that would be present in clinical specimens viewed microscopically for laboratories using DFA. The same material is used for participants using EIA. Some manufacturers of EIA kits do indicate their test kits are not valid for confirmation of viral antigen from tissue culture. Many participants using BD EIA kits (Directigen™) did report false positive results in these specimens. Interestingly, participants using EIA kits from other manufacturers did not achieve false positive results and the number of false positive results seen in the February survey by participants using BD Directigen was not remarkable. Nonetheless, participants cannot be scored when simulated samples reveal this type of matrix effect caused by an artefact in the testing material. No errors were assigned.

The false negative results noted for influenza A in a simulated sample containing both influenza A and B is being attributed to low influenza A viral load in the specimen. In addition, participants may not have expected a sample containing both viral antigens.

Follow-up investigation by the commercial company supplying the material showed that if testing material was centrifuged to remove cellular material, EIA using BD Directigen™ gave the expected results with no false positive results. QMP-LS also contacted the Virology Technical Specialist for the College of American Pathologists (CAP) quality assurance program who indicated they have been experiencing the same issues for about four years.

In future, QMP-LS will request laboratories using EIA techniques to test the supernatant prepared by centrifuging the sample to remove cellular material prior to testing.

CORRECTIVE ACTIONS

All errors assessed to a laboratory result in correspondence from QMP-LS. Laboratories are required to respond by completing the QMP-LS Discordant Findings Form and may provide specific information regarding the error and their own assessment of the situation. The Virology Committee reviews the response for knowledge and implementation of appropriate corrective action. A partial summary of replies (n=17) to discordant findings form is shown in Figure 47. Discordant findings data are not yet available (to match total errors [n=26] from Table 2) as correspondence has not yet been received for survey VIRO-0410 and VIRO-0411. In 2004, 6% were transcription errors, 29% were related to method, with low sensitivity of test kits (especially for antigen detection of Influenza B), 6 % were due to problems with QMP-LS material (fluorescence microscopy and low antigen load), 41% were technical errors in interpretation of test results, 6% were failures that resulted from not following instructions for

technical procedures (failure to centrifuge material before testing) and 12% were unexplained or random errors.

For the benefit of all laboratories, Committee Comments address general issues that arise as a result of each survey. In 2004, the need to carry out methods validation, prior to using viral respiratory antigen detection kits, was discussed in the Committee Comments.

NUMBER OF PARTICIPANTS

Table 64 shows the number of laboratories participating in respective surveys by constituent. The number of laboratories testing for virology constituents/markers in 2004 was similar to that of 2003.

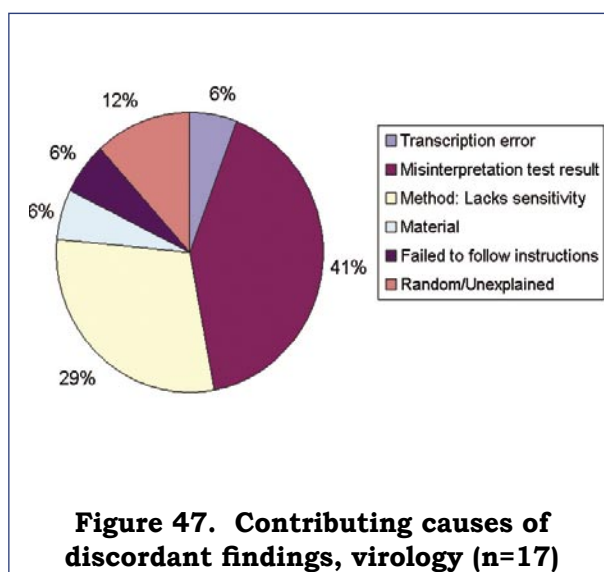


Figure 47. Contributing causes of discordant findings, virology (n=17)

Table 64. Number of Ontario Participants Testing Virology by Constituent and/or Marker

Virus	Constituent/Marker	2000	2001	2002	2003	2004
Hepatitis	HB _s Ag	50	44	42	41	40
	Anti-HB _s	43	39	35	35	37
	Anti-HB _c	32	31	31	30	32
	Anti-HB _c IgM	13	13	13	12	13
	HB _e Ag	11	11	11	11	11
	Anti-HB _e	10	10	10	11	10
	Anti-HAV	20	20	20	20	21
	Anti-HAV IgM	23	22	22	21	22
Hepatitis C	HCV Screening Tests	26	24	31	32	31
	HCV Supplementary Tests	4	6	...	17	17
Rubella	Rubella Ab	29	29	28	27	26
	Rubella IgM	4	4	4	3	1
VZV	VZV Ab	13	13	10	12	12
CMV	CMV Ab	...	...	...	10	9
HIV	HIV Ab	21	19	15	20	18
Chlamydia	<i>C. trachomatis</i> Ag or NA	26	26	20	16	17
Respiratory Panel	Influenza A	...	...	...	30	36
	Influenza B	...	...	...	25	29
	RSV	...	48	50	50	49
	Other viral antigens	...	...	...	5	6

Note: The last survey in each year was used for comparison for each of the constituents. The numbers relate to Ontario participants only and do not include markers tested by out-of-province laboratories.

ANATOMIC PATHOLOGY

TESTING MODEL

Two histotechnology staining external quality assessment surveys were distributed in 2004. The immunohistochemistry survey, PATH-0402, was distributed to 55 laboratories licensed to perform immunohistochemistry (L731) on March 2, 2004. Each participant received a total of ten unstained paraffin sections broken down as follows:

- 1) Four sequential sections from a composite tissue block containing nine different tissue samples. These samples included: 4 different breast tumours, 2 samples of lung tissue, and 1 each of tonsil, liver, and kidney. Participants were requested to perform a stain for the estrogen receptor (ER) protein. Participants not having the ER stain available were requested to substitute a stain for the S-100 protein.
- 2) Six sequential sections from a block containing a single sample of liver tissue. Participants were requested to stain for both Cytokeratins (wide spectrum) and Vimentin.

The routine and special stain survey, PATH-0409, was distributed to 76 laboratories licensed to perform surgical pathology (L720) on September 20, 2004. Each participant received six sequential unstained paraffin sections from a composite tissue block containing heart, kidney, liver, and lung representing a single case of disseminated *Blastomycosis*. Participants were requested to perform a routine oversight stain (H&E, HPS, etc.), a trichrome stain, a reticulin stain, and a Grocott stain for fungus.

PERFORMANCE ASSESSMENT

PATH-0402

Four committee members, using the criteria and scoring system previously published as Committee Comments, independently assessed the submitted slides.

Despite the detailed slide labelling instructions provided in the survey bulletin, eight laboratories were assigned a significant error for mislabelling slides.

The average score for those laboratories performing ER staining (47.3% of licensed laboratories) reflects an acceptable overall standard of performance. One laboratory was assessed a significant discordance in result. The average score for those laboratories performing the alternate S100 stain (52.7%) reflects an acceptable overall standard. No discordances in result were assessed.

The average score for laboratories performing cytokeratin staining (96.4% of licensed laboratories) reflects an acceptable overall standard of performance for this stain, an improvement over the previous survey. Three laboratories were assessed a significant discordance in result.

The average score for laboratories performing vimentin staining (94.5% of licensed laboratories) reflects only an adequate overall standard of performance for this stain, significantly lower than the previous survey. The committee, suspecting the problem was largely antibody-related, undertook further analysis of the causes for these lowered scores.

Two different monoclonal antibody clones are in use. Anti-vimentin clone V9 is used by 59.6% of laboratories. The average score for these participants was almost double the average score achieved by the 40.4% of laboratories using anti-vimentin clone 3B4.

Concerned this may be related to some hidden aspect of sample quality, the committee undertook a detailed investigation at one of the reference laboratories, prior to releasing these results. The outcome of this investigation was discussed at the February 2005 committee meeting.

When optimized, anti-vimentin clone 3B4 is capable of excellent staining of the survey sample. Participants using the clone 3B4 and achieving low scores in this survey, will receive a non-punitive explanatory letter from the committee. The results of this survey are published as Committee Comments.

PATH-0409

Four committee members, using the criteria and scoring system previously published as Committee Comments, independently assessed the submitted slides.

The committee finds it encouraging that no errors were assigned for mislabelled slides in this survey.

The average score for laboratories performing H&E staining (92% of licensed laboratories) reflects an acceptable overall standard of performance for this stain. The average score for laboratories performing HPS staining (8% of licensed laboratories) also reflects an acceptable overall standard of performance. No discordances were assigned for the routine oversight stains.

The average score for laboratories performing a trichrome stain (94.75% of licensed laboratories) reflects an acceptable overall standard of performance. Two laboratories were assigned discordances in result.

The average score for laboratories performing a reticulin stain (92.1% of licensed laboratories) reflects an adequate overall standard of performance. Six laboratories were assigned discordances in result.

The average score for laboratories performing a Grocott stain for fungus (92.1% of licensed laboratories) reflects an adequate overall standard of performance. Five laboratories were assigned discordances in result.

Further analysis is currently underway and results will be published as Committee Comments.

SUMMARY OF OTHER ACTIVITIES

In partnership with CMLTO and OSM), six staining workshops were presented across the province. Attendance has been tremendous and the workshops have been well accepted.

2005 PLANS

Two histotechnology staining external quality assessment surveys are planned for 2005. The committee is working hard to build a bank of suitable test materials and to increase the number of stains, with established criteria, available to test.

Anatomic Pathology

No. of Participants (Dec. 2004)	77
No. of Participants (Dec. 2003)	79
No. of Surveys Conducted in 2004	2

CYTOLOGY

TESTING MODEL

Until issues associated with discoverability of QMP-LS information and jurisdiction of assessment of cytology, interpretive smears have been resolved to the satisfaction of QMP-LS senior committees. The model for examination of cytology smears has been modified to be educational and voluntary. The existing model was administered annually with a total of 20 slides and did not contain liquid-based gynecological smears. The survey has been redesigned to meet recommendations from the QMP-LS internal review and address concerns of the Cytology and Management Committees.

A new survey model that meets QMP-LS criteria for interpretive surveys was developed during 2004. This revised model of the Cytology survey now includes both direct (conventional) and liquid-based gynecological smears and non-gynecological smears for all Ontario laboratories to review and report. Surveys will contain a total of 11 smears and be administered twice during 2005. To test the new model, a pilot survey, CYTO-0410, was administered in mid-October.

PERFORMANCE ASSESSMENT

The pilot survey, CYTO-0410, did not close until the end of January 2005 and an analysis of results is currently underway. Committee consensus diagnoses continue to be based on an independent review of the slides, with agreement of at least two committee members. An overall 80% participant consensus diagnosis is required for the slide to remain in the survey pool. Results will be reported back to participants with associated frequencies but there will be no grading or correspondence associated with discordant results. Educational Committee Comments will also be published.

PATTERNS-OF-PRACTICE SURVEY

The cytology patterns-of-practice survey, CYTO-0406-PP, allowed for comparison with the previous surveys CYTO-0302-PP, CYTO-0203-PP, Y-0103, Y-0003, Y-9904, and Y-9806. The purpose of this survey was to assess general trends in distribution of cases, screening, reporting, and quality assurance of gynecologic and non-gynecologic cytology. Another intent was to monitor the implementation of the Ontario Quality Assurance Program in Gynecologic Cytology. The results are undergoing final analysis for publication as Committee Comments.

SUMMARY OF OTHER ACTIVITIES

Two slide surveys, CYTO-0404 and CYTO-0406, were conducted and reviewed for the Alberta Laboratory Quality Enhancement Program (ALQEP) of the College of Physicians and Surgeons of Alberta in 2004. A new inventory database and a more secure filing system was created for all available survey materials. The updated database was transferred to the new LEQA database.

PLANNED INITIATIVES FOR 2005

The Cytology Committee will continue using the new model slide survey with expansion of the slide collections. The patterns-of-practice survey will be modified with revision of the Standards of Practice Guidelines for Cytology.

Cytology

No. of Participants (Dec. 2004).....	85
No. of Participants (Dec. 2003)	88
No. of Surveys Conducted in 2004	2

GENETICS

The Genetics Committee membership has representation from both cytogenetics and molecular genetics.

CYTOGENETICS

TESTING MODEL

The cytogenetics EQA model remains essentially unchanged. Four clinical challenge surveys were scheduled. One survey was determined to be educational only and laboratories were not assessed. A participating laboratory provides the testing material for each survey. The ongoing involvement of participating laboratories in survey development is an important feature of the program. This involvement enabled the test challenge to be a bona fide clinical specimen of human whole blood or tissue culture obtained from a single donor. Participants are required to culture, process, karyotype and provide an interpretive report on the case. Laboratories submitted their results using the same reporting format as patient results to physicians. Participants who do not perform long-term culturing received fixed culture survey material.

All results, karyotypes and photographs submitted by each laboratory were reviewed and evaluated. Each laboratory has been routinely assessed on the technical procedure and interpretive report. Due to issues surrounding the assessment of the interpretive component, the scoring system used in 2003 was continued to be applied to surveys in 2004 and only the technical component was assessed. Until the assessment of interpretation has been resolved, only educational comments will be provided.

Committee Comments were published for each survey detailing the clinical case report provided by the supplying laboratory, the committee's expectations and minimum requirements for assessment—karyotypes submitted and a model report.

LABORATORY PERFORMANCE

The Ontario cytogenetic laboratories continue to perform well and the results were within acceptable limits.

MOLECULAR DIAGNOSTICS OF INHERITED HUMAN DISEASES

The development continued on a testing model for molecular diagnostics of inherited human diseases. One patterns-of-practice survey on cancer genetics testing was sent out to all Ontario molecular genetics laboratories. One challenge survey was sent to Ontario laboratories performing BRCA1 and BRCA2 mutation analysis.

OTHER ACTIVITIES

QMP-LS continues to provide EQA services to 12 out-of-province cytogenetics laboratories. One laboratory participates in the oncology challenges only. Interest has been expressed by out-of-province molecular genetic colleagues to participate in the surveys for molecular diagnostics of inherited human diseases. This will be explored further as the survey model is developed.

QMP-LS Genetics Committee was asked to review OLA Requirement Cytogenetics CG012. The committee recommended that no changes be made to this requirement.

Laboratory Genetics Subcommittee, Ontario Ministry of Health Predictive Cancer Genetics Services developed an EQA program for BRCA1 in collaboration with QMP-LS. The poster titled *Standardization of assays for mutation screening of the BRCA gene amongst seven Ontario molecular genetics laboratories* was presented at the 2004 American Society of Human Genetics meeting.

Genetics

No. of Participants (Dec. 2004)	11
(plus 12 out-of-province laboratories)	
No. of Participants (Dec. 2003)	10
(plus 13 out-of-province laboratories)	
No. of Surveys Conducted in 2004	6

ONTARIO LABORATORY ACCREDITATION

The year 2004 was a noteworthy year for Ontario Laboratory Accreditation (OLA) and all laboratories in Ontario. Our peer review accreditation program was fully implemented, and has become an integral part of laboratory quality management across the Province of Ontario.

The first six peer assessment visits occurred in 2003 as part of our pilot process. In January 2004, OLA peer assessments continued at the rate of four to five per month for a total of 55 in 2004.

Concurrently, self-assessments are coordinated by OLA. In July 2003, an accelerated round of self-assessments began with the objective that all Ontario licensed laboratories would self-assess within one year. Notifications and submissions continued on a weekly basis throughout the remainder of 2003, and into 2004, culminating in the completion of a self-assessment in all laboratories by late October 2004.

Our 2004 experience with the initial self-assessments and peer assessments has provided opportunities for improvements to our processes and procedures. More importantly, the combined data accumulated from the peer assessments and self-assessments provide an encouraging affirmation of the ability of Ontario laboratories to meet rigorous accreditation requirements.

CUSTOMER SERVICE

Sharing Program Information and Assisting Laboratories to Prepare for Accreditation

QMP-LS News was used as a vehicle to share information within Ontario. The April 2004 issue of *QMP-LS News* contained an article titled *Accreditation and Creativity: Finding our Hidden Talents*, which announced the availability of information from participating laboratories on some electronic tools they had developed to facilitate the accreditation process. The November issue's lead article titled *Ontario Laboratory Accreditation—How Do We Stack Up So Far?* presented conformance data on the first 49 peer assessments.

We continued to enhance the information about the OLA program on our Web site by introducing an *OLA Program Information* manual—a downloadable PDF file comprising all of the information contained on separate pages of our Web site.

A series of teleconferences were convened in order to assist laboratories with the preparatory steps for self-assessment. Led by OLA staff, these began in 2003 and continued periodically until June 2004. In total, 17 teleconferences were offered to 817 individual participants in 223 facilities. Through these teleconferences, it was observed that those laboratories with a trained OLA assessor on staff were able to complete the self-assessment with very little assistance from OLA staff.

Collaborative Efforts

In 2004, Linda Crawford chaired five meetings of the Canadian Coalition of Quality in Laboratory Medicine Accreditation Working Group. The accreditation working group's purpose is to work towards a common process of medical laboratory accreditation and a common standard, to allow us to share resources across the country. The goal in 2003–2004 was to identify and work towards commonalities amongst existing medical laboratory accreditation programs. In 2004, issues discussed included: assessment means and follow up, the best way to utilize checklists, and point-of-care testing (POCT). With regard to POCT, it was determined that in all provinces with a mandatory accreditation program, the accreditation body has the mandate to accredit POCT in hospital facilities. Long-term care facilities or physician-operated laboratories are excluded. Laboratory management is encouraged to control all POCT in the facility.

Linda Crawford spoke at the Insight National Forum on Laboratory Reform on *Accreditation: New and Emerging Standards for Laboratory Systems*. She gave a presentation by the same title at the meeting of the Canadian Society for Medical Laboratory Science (CSMLS) in Saskatoon. A presentation titled *OLA: How do we stack up so far?* was also given by Linda at the Ontario Society of Medical Technologists (OSMT) conference held in Thunder Bay.

Linda Crawford and Julie Coffey delivered a five-day training course in Mexico City on ISO 15189:2003 to experienced assessment personnel, on behalf of Standards Council of Canada (SCC) and the Entidad mexicana de acreditación. Twenty-four individuals attended the course, which included a series of lectures and group exercises translated simultaneously to Spanish. Content was drawn from *Plus 15189 the ISO 15189:2003 essentials—a practical handbook for implementing the ISO 15189:2003 standard for medical laboratories* (Canadian Standards Association, 2004).

Linda Crawford and Joanne Bishop participated in a focus group session to discuss the OSMT Medical Laboratory Assistant/Technician (MLA/T) Certification examination process. OLA staff also served as facilitators at the CLMA Trillium Chapter education day titled *Training and Competence Assessment in the Medical Laboratory*.

Monitoring Provincial, National and International Initiatives

Representatives from the Capital Health in Halifax, the Institute national de santé publique du Québec and the National Serology Reference Laboratory in Australia visited QMP-LS, as did an individual who was part of a visiting delegation from Russia.

The OLA Advisory Panel supports continued staff efforts to establish a partnership with the SCC in the delivery of accreditation to Ontario's laboratories. Linda Crawford and Dr. Harold Richardson continued to attend the SCC meetings in order to further this initiative.

Linda Crawford was appointed to the Accreditation Council of the Canadian Association for Environmental Analytical Laboratories.

MANAGEMENT RESPONSIBILITY

The responsibility for ensuring that OLA's operational procedures, processes and procedures are documented, controlled and monitored falls to OLA staff. In 2004, a total of 121 operating protocols were in use (many in draft form). These include processes and procedures for self-assessment coordination, peer assessment visits, administration, assessor recruitment, screening and training.

RESOURCE MANAGEMENT

Assessor Training and Utilization

OLA assessors receive advance training and certification. Prior to 2004, 184 individuals who volunteered to serve as Ontario assessors received training and certification. In April 2004, we refined the assessor training course. Two training sessions were held in May with a total of 33 participants and two observers. Two further sessions occurred in November and December, bringing the current total number of available assessors to 243. There are 104 applicants who are awaiting training. Plans are underway to conduct four training sessions in 2005.

A refresher exercise for certified assessors was created and implemented in 2004. The exercise included 20 case scenarios. For an assessor to be annually certified he/she must either participate in a peer assessment or complete the refresher case studies.

For the 55 peer assessments conducted in 2004, 34 teams were formed for which we engaged 107 individuals. We strive to team up "novice" assessors with those who have participated on at least one prior assessment visit;

thus 36 individuals were invited to participate on more than one team. A database has been developed to maintain assessor records, training records and records of assessment activities. This facilitates selection of assessment teams based on assessor's expertise and preferences.

Ontario Laboratory Accreditation Advisory Panel

The members of the OLA Advisory Panel (Appendix A) continued to provide valuable advice and assistance throughout 2004. The panel met by teleconference four times in 2004. Web-based communication tools facilitated additional information-sharing and consultation throughout the year. Business conducted by the panel included:

- The criteria for conducting multi-site peer assessments.
- The process for the review of corrective actions post peer assessment.
- The process for the review of exception report post self-assessment.
- The content of reports on OLA activities and laboratory conformance data.
- The process for investigating errors of fact.
- The process for the biannual review of requirements.
- The process for certificate issue and application for certificate upgrade.
- Review of laboratory corrective actions.
- Review of applications for certificate upgrade.
- Review of self-assessment conformance data.

SERVICE REALIZATION

Self-assessments

Self-assessments are intended to assist laboratories in determining the degree to which they meet accreditation requirements. Self-assessments ensure that:

- Laboratories continue to monitor their own conformance to accreditation requirements.
- QMP-LS can identify the degree to which laboratories meet requirements.
- QMP-LS can determine requirements that may be difficult to achieve.

The implementation of the OLA program began with an accelerated self-assessment phase (2003–2004) in which all laboratories in Ontario were required to submit to QMP-LS the results of a formal self-assessment. Each laboratory received 120 days' notification of self-assessment, and was invited to attend an informational teleconference conducted by OLA staff. The first notifications were sent in July 2003 and subsequent notifications occurred at the rate of five laboratories per month throughout the first half of 2004. Twenty laboratories received a peer assessment prior to April 2004, and were therefore excused from self-assessment at this time. The initial self-assessment phase concluded in late 2004, by which time 230 self-assessment exception reports had been submitted to QMP-LS for review.

The purpose of this accelerated rollout was to:

- Facilitate quicker implementation of accreditation
- Foster a level and fair playing field
- Demonstrate trust in laboratories
- Encourage laboratories to be proactive in identifying their own deficiencies and initiating corrective action.

Initial self-assessments:

- Provided a window to the laboratory's progress in implementing requirements
- Helped identify "problem" requirements across laboratories
- Helped identify any specific issues of concern for QMP-LS in an individual laboratory
- Provided the laboratory with direct feedback in the form of a statistical performance summary and reiteration of the laboratory's non-conformances (within 30 days).

This accelerated self-assessment phase resulted in benefits to QMP-LS and to Ontario's laboratories. With the initiation of the self-assessments over a relatively short period of time, laboratories were encouraged to prepare for their eventual peer assessment visit. The rapid introduction of self-assessments gave life to the mandatory accreditation program. Feedback indicated that in many laboratories the self-assessment notification prompted swifter action to achieve conformance. The accelerated self-assessment also fostered a level and fair playing field in that all laboratories were prompted to action within the condensed time frame. In addition, each laboratory was expected to perform the same task and submit the same quality of report. To ensure fairness, a number of laboratories (7%) were randomly selected and requested to submit their completed master checklists. Statistical data in the form of a performance summary were provided to all laboratories within 30 days. The initial self-assessment served as an excellent gap analysis and enabled laboratories to identify which accreditation requirements they did not meet and what tasks were required. It provided QMP-LS with a window to the progress of the provinces' laboratories in implementing the requirements and helped to identify challenging requirements.

OLA reviewed submitted self-assessment exception reports to:

- Confirm that the laboratory has actually performed a self-assessment
- Observe the laboratory's progress in implementing requirements
- Identify "problem" requirements across laboratories
- Identify any specific issues of concern for QMP-LS in an individual laboratory
- Provide the laboratory with direct feedback in the form of a statistical performance summary and reiteration of the laboratory's non-conformances (within 30 days).

Additional information was sought only for the clarification of data. Dates by which tasks would be completed were not challenged. The report back to laboratories did not endorse nor criticize a laboratory's findings.

A summary of self-assessment conformance data is presented in Table 65. Of the 230 reports submitted, self-assessed conformance ranged from 51% to 100%, with an average conformance of 89%. The number of major non-conformances self-reported ranged from 0 to 168. The number of minor non-conformances self-reported ranged from 0 to 125.

Table 65. Summary of Self-assessment Non-conformances (n=230)

Section	No. of Majors	Mean	No. of Minors	Mean	Per cent Met	Mean
I. Organizational Structure	0-15	2	0-12	2	58-100	90
II. QMS	0-48	5	0-20	4	0-100	80
III. Physical Facilities	0-4	<1	0-7	1	27-100	91
IV. Equipment, Reagents, Supplies	0-82	2	0-26	5	18-100	84
V. Pre-Analytical	0-24	3	0-34	4	32-100	88
VI. Analytical Process	0-8	1	0-7	2	0-100	78
VII. Quality Assurance	0-10	1	0-13	2	34-100	91
VIII. Post-Analytical	0-15	1	0-12	2	50-100	90
IX. LIS	0-24	3	0-20	4	38-100	86
X. Safety	0-50	3	0-27	5	51-100	93
XI. Point-of-Care	0-45	4	0-69	6	0-100	85
Total	0-168	24	0-125	35	51-100	89

Subsequent peer assessment visits confirmed that the self-assessments did help laboratories to prepare for peer assessment. The number of non-conformances observed during peer assessment visits was almost universally less than that reported in self-assessments (see Table 66).

One requirement was self-reported as a non-conformance in more than 50% of laboratories:

I.B.10: The facility shall evaluate staff skills to perform assigned tasks following training and periodically thereafter.

However, a large portion of laboratories were able to correct this non-conformance successfully prior to peer assessment as attested by conformance statistics to this requirement during the peer assessment. Requirement I.B.10 was cited 13 times in 55 peer assessments, and does not appear on the list of the “Top Ten” (most frequently cited) non-conformances cited during peer assessments (see Table 69).

One discipline-specific technical point under Transfusion Medicine was self-reported as non-conforming in more than 50% of laboratories:

TM019 : *Blood products shall be visually inspected before shipment and this shall be documented.*

Peer assessments from 2004 have yielded only two instances of minor non-conformance against TM019.

Peer Assessments Conducted in 2004

OLA requirements are based on ISO 15189:2003, applicable legislation and generally accepted principles of good practice. Guidance information is available on the application of requirements to medical laboratory practice. During the peer assessment visit, conformance to requirements is assessed through observing practice, interviewing staff, and reviewing documentation. Non-conformances are classified as either major or minor in nature. Laboratories have three months to correct all major non-conformances and initiate satisfactory corrective action for all minors. When this is confirmed, 5-year accreditation certificates are issued. If majors have not been corrected but a satisfactory action plan is in place, 2-year certificates are issued.

Table 67 summarizes OLA's activity with peer assessments in 2004. Notifications of an upcoming peer assessment visits were sent to 56 laboratories, and 55 visits were conducted (one of these laboratories was assessed in early 2005). Thirty-Five certificates were issued in 2004—three 2-year certificates and 32 five-year certificates. The remaining laboratories either have yet to submit corrective action plans or they are under review. No laboratories failed to achieve an accreditation certificate.

Table 66. Laboratory Improvement From Self to Peer Assessment (32 Labs)

Section	Mean % Improvement
I. Organizational Structure	6
II. QMS	11
III. Physical Facilities	6
IV. Equipment, Reagents, Supplies	5
V. Pre-Analytical	5
VI. Analytical Process	2
VII. Quality Assurance	-1
VIII. Post-Analytical	7
IX. LIS	7
X. Safety	2
XI. Point-of-Care	14

Table 67. Peer Assessment Activity 2004

Number of Notifications Sent	56
Number of Assessments Completed	55
Number of Corrective Action Reports Received	41
Number of Corrective Action Reports Late	3
Number of Error of Fact Reports Received	6
Number of 2-Year Certificates Issued	3
Number of 5-Year Certificates Issued	32
Number of Applications for Upgrade Received	1
Current Number of Licensed Laboratories	248

Whether large or small, all Ontario laboratories are subject to the same standards of accreditation. Of the 55 peer assessments conducted in 2004, conformance ranged from 82% to 100%, with an average conformance of 94%. Figures 48 and 49 display the number of major and minor non-conformances assessed per visit. The number of major non-conformances observed ranged from 0 to 49. It is notable that over 30 laboratories were assessed

with less than five major non-conformances. In general, the incidence of minor non-conformance was greater, the number of minor non-conformances ranged from 0 to 59. The greatest number of laboratories can be categorized in the level of 10 to 19 minor non-conformances.

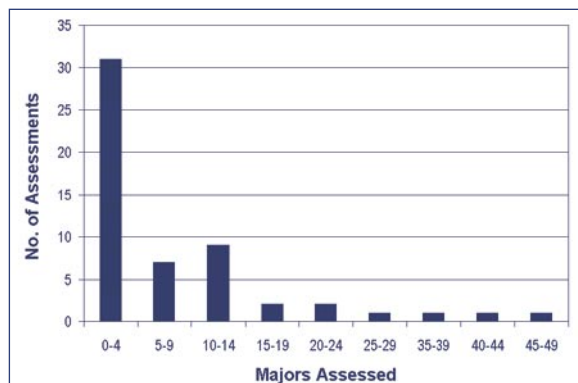


Figure 48. Major non-conformances assessed in peer assessment visits in 2004 (n=55)

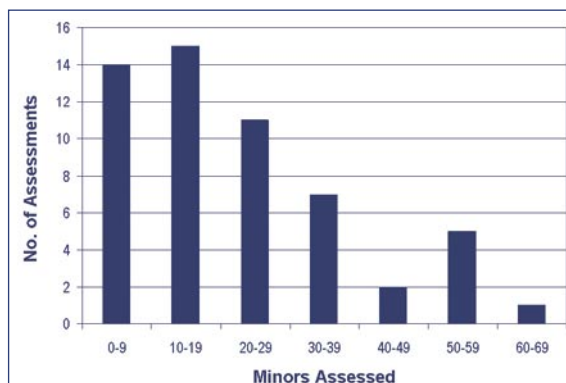


Figure 49. Minor non-conformances assessed in peer assessments conducted in 2004 (n=55)

More detailed conformance data are shown in Table 68 and Figure 50. The greatest number of minor non-conformances (219) occurred in section IV that deals with laboratory equipment, reagents and supplies, however the number of major non-conformances in this section is relatively low (33). This reflects the fact that the non-conformances cited tend to be isolated incidence of laboratory non-conformance to its own procedures, such as a periodic lapse of record keeping. The greatest number of major non-conformance occurs in section XI, point-of-care testing. It is the area of POCT that has had the greatest total number of non-conformances. Common observations include:

- Overall responsibility for POCT not defined (XI.A.1);
- Scope of the POCT program not defined (XI.A.3);
- POCT quality management system does not include POCT in the facility, such as urinalysis;
- No evidence of a multi-disciplinary advisory management group for POCT (XI.A.5);
- Content and frequency of POCT training sessions not defined (XI.B.11);

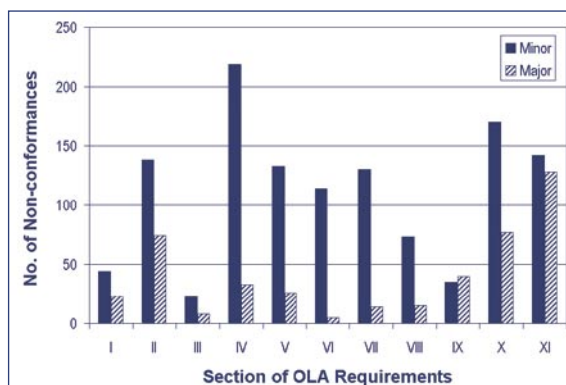


Figure 50. Number and type of non-conformances cited during peer-assessments in 2004 (n=55)

Table 68. Peer Assessment Conformance Data by Section of OLA Requirements, 2004 (55 Labs)

Requirement Section	No. of Minors	No. of Majors	Total Non-conformances
I. Organizational Structure, Personnel Policies and Laboratory Management	44	23	67
II. Quality Management System	138	74	222
III. Physical Facilities	23	8	31
IV. Equipment, Reagents and Supplies	219	33	252
V. Pre-Analytical Process	133	26	159
VI. Analytical Process	115	5	120
VII. Quality Assurance	130	14	144
VIII. Post-Analytical Process	73	15	88
IX. Laboratory Information System	35	40	75
X. Safety	170	77	247
XI. Point-of-Care Testing	142	128	270

- Lack of equipment records (XI.F.1.3);
- The authority to withdraw POCT equipment not defined (XI.I.4);
- Correlation of glucose meter results to laboratory glucose values not done (XI.I.5);
- No written procedure for dealing with non-compliant POCT operators (XI.I.5.2);
- Patient record for POCT testing results does not include a reference interval (XI.J.3).

The “Top Ten” non-conformances observed during the peer assessments conducted in 2004 are presented in Table 69. The most frequently cited non-conformances are minors under Requirement VI.1 and VI.3. Both of these requirements contain a large number of discipline-specific technical points within the Guidance Information, all of which must be met to achieve conformance to the requirements VI.1 and VI.3. The most frequently cited discipline-specific points are:

- CH014: Microscopic urinalysis shall be performed only if the urine is less than four hours old, if casts or crystals are suspected, or on request if leukocyte esterase, blood or protein is positive.
- CH016: The laboratory staff shall correlate positive results from a urine microscopic analysis with the macroscopic (visual/dipstick) results, if performed.
- TM058: For emergency transfusion, there shall be written policies for the issue.
- TM061: If an Rh-negative woman delivers an Rh-positive fetus, the maternal blood shall be tested for fetal-maternal hemorrhage to ensure that the standard dose of Rh Immune Globulin will provide adequate prophylaxis.
- TM094: An error reporting system shall be established and shall ensure that all errors and accidents are reviewed and significant errors and accidents are investigated and documented. Documentation of corrective action taken should be included in the error management system.
- TM081: Procedures for the transfusion of blood products shall include a mechanism for the informed consent for recipients.
- TM082: Procedures for the transfusion of blood products shall include the written notification of recipients when they have been transfused.

Table 69. The “Top Ten” OLA Non-Conformances in 2004

No.	Requirement	Total Non-conformances	Total Majors	Total Minors
VI.1	All laboratory examinations shall be based on methods cited in published peer-reviewed texts or journals, or be recommended by international, national, or regional guidelines. If in-house developed procedures are used, they shall be validated for their intended use and fully documented.	27	0	27
VI.3	All laboratory procedures, including manufacturer’s instructions used as procedures and electronic instructions, shall be documented and available at the workstation for relevant staff.	27	0	27
II.F.11	Document control processes shall ensure that obsolete documents are removed and only currently authorized versions of appropriate documents are available for active use at relevant locations.	22	4	18
IV.14	Maintenance of laboratory equipment shall ensure proper performance and assure accurate and reliable test performance.	21	1	20
IV.2	Laboratory management or the facility shall define a process and/or procedure for inspection, acceptance/rejection and storage of consumable materials. The inventory control system shall ensure continuity of supply and minimize shortages. Records of actions taken shall be maintained.	18	2	16
XI.I.5.2	There shall be a written procedure for dealing with non-compliant POCT operators.	16	13	3
II.A.3	The policies, processes, and procedures pertaining to the quality management system shall be documented, communicated to and understood by all personnel, and be readily available to appropriate staff.	16	2	14
VII.1	Quality control processes shall consist of goals, policies, procedures, tolerance limits and corrective actions taken in the event that observations fall outside the defined expectations.	16	3	13
II.F.1	Laboratory management shall define, document and maintain a policy, process(es) and procedures to control documents and records. Documents and records may be maintained and stored on any appropriate medium.	15	6	9
IV.4	There shall be an inventory control system for supplies that includes the recording of lot numbers of all relevant reagents, control materials and calibrators, the date of receipt in the laboratory, and the date the material is placed in service.	14	0	14

Many refinements were made to our processes and procedures over the course of 2004 to accommodate multi-site peer assessments. OLA staff reviewed laboratory structures in Ontario and grouped laboratories based on common factors such as ownership, directorship, management and regional laboratory program. We have determined that there are potentially 49 arrangements involving 157 laboratories. Multi-site visits are conducted whenever laboratories demonstrate the existence of a single management structure and quality management system. The allowable distance between sites is one-hour travelling time (except for northern extremes, where distances between laboratories are much greater), and no more than one week should elapse between site assessments. Each laboratory receives its own assessment report.

The multi-site process ensures consistency between the sites, and eliminates unnecessary duplication of assessment activities. Of 55 laboratories assessed in 2004, 26 were single site assessments, and 12 were multi-site assessments involving two to five laboratories (see Table 70). In other cases, a single team was used to conduct multiple assessments within a specific geographic region. These are not included in Table 70 since the assessments were entirely separate and the facilities involved did not share a single management structure and quality management system. Conducting multi-site assessments and combining assessments regionally helps to contain costs.

Table 70. Multi-site Peer Assessments Conducted in 2004

No. of Laboratory Sites	Visits
1	26
2	10
3	0
4	1
5	1

Test Review Committee

The Test Review Committee continued to advise Laboratories Branch, MOHLTC, throughout 2004 on quality requirements for tests that are not currently listed in the Schedule of Benefits for laboratory services. Membership remained unchanged until December 2004 with the resignation of one member (Appendix A). Although the committee did not meet in person in 2004, electronic communications have proved efficient and effective.

During the months of March–May 2004, MOHLTC submitted lists of tests for consideration by the Test Review Committee. With the exception of two reports for 7-dehydrocholesterol (Provitamin D3) and mycophenolic acid that are under review, by the end of 2004 expert opinion reports for all tests were provided to MOHLTC. In December 2004, a request was received for review and revision of reports submitted in 2003 for troponin and myoglobin, which is being dealt with expeditiously.

Elements included in the report are:

- Quality requirements
- Patient preparation
- Collection and handling of specimen
- Quality assurance process, quality control procedures and quality indicators
- External quality assessment through interlaboratory comparisons
- Analytical policy and technical procedures
- Practice guidelines
- Clinical utility
- Health cost implications.

Tests submitted by the Laboratories Branch to the Test Review Committee in 2004 are shown in Table 71. For the “well-established” category, preliminary comments with the relevant characteristics of note (clinical utility, external quality assessment, health cost implications, etc.) were provided to the Laboratories Branch and were accepted.

Table 71. Final Quality Criteria Completed and Sent to Laboratories Branch for 2004

Serotonin	Arylsulfatase A
Paraquat	Arylsulfatase B
Foetal Fibronectin	Arylsulfatase C
Factor Inhibitors (Bethesda Units)	Fluoxetine (Prozac, Sarafem)
Domperidone	Thiosulfate (Urinary)
Vitamin E	Topiramate (Topamax)
Lamotrigine (Lamictal)	Intrinsic Factor Antibodies
Fructosamine	IgG subclasses
Carnitine	Glycoprotein Hormones – Alpha Subunit
Phytanic Acid	Amylase Isoenzymes
Anti-SSA Antibody (Anti-Ro)	Bile Acids – Total and Fractionation
Anti-SSB Antibody (Anti-La)	Beta-Endorphin
Anti-Sm Antibody (Anti-Smith)	Glucagon
Anti-RNP Antibody	CA 15-3
Anti-histone Antibodies	Anti double stranded DNA Antibodies (Anti-ds DNA)
Dihydrotestosterone	Leptin
Beta Trace Protein	Adiponectin
Sex Hormone Binding Globulin (SHBG)	Beta-2 Glycoprotein 1 Antibodies (β -2 GP-1)
Apolipoprotein A and B	Natriuretic Peptide – Brain (BNP)
Acetylcholine Receptor Antibody	Natriuretic Peptide – Atrial (ANP)

The existing processes concerning appeals, unmet quality criteria and tests not requiring quality criteria (as outlined in the 2002 review) have continued to allow prompt communication between Laboratory Licensing and Inspection Service and the Test Review Committee and as a result, minor modifications have been made to a few reports in response to queries received from laboratories.

The function of the Test Review Committee is greatly enhanced by the services of external advisors, and current or former scientific committee members who have willingly assisted in sharing specific knowledge and expertise in the preparation of expert opinion reports. Their contributions are greatly appreciated.

MEASUREMENT AND ANALYSIS

OLA monitors its own performance through a variety of means:

- Periodic environmental scans of other accreditation programs throughout the world
- The analysis of process evaluations submitted by participating laboratories and assessors
- The monitoring of turnaround times for key activities (see Table 72).

OLA is the only accreditation program in North America, and one of the first two in the world, to assess medical laboratories against ISO 15189:2003 *Medical laboratories—Particular requirements for quality and competence*. Ontario's laboratories are among the first to achieve accreditation against this international standard, a significant accomplishment that demonstrates the commitment of Ontario laboratory professionals to quality.

Laboratories submit evaluations following an OLA peer assessment visit, on which they provide feedback on the visit process, performance of the assessment team and the requirements for accreditation. Most laboratories report that the peer assessment process

Table 72. OLA Turnaround Times: January–December 2004 (n=35)

Time from visit to certificate issue
Target = 150 days (5 months)
Actual mean = 135 days
Range = 13–175 days
Time from corrective action to certificate issue
Target = 60 days
Actual mean = 51 days
Range = 0–85 days
Time from visit to receipt of corrective action
Target = 90 days
Actual mean = 82 days
Range = 0–95 days

is positive. With few exceptions, laboratories reported that OLA's assessors are congenial, insightful and fair in their assessment, and assessments are conducted in a non-judgemental, non-threatening manner. In a few cases, it was suggested that the individual assessors should spend more time interacting with frontline staff. Often, the comment was made that the opening meeting set a positive tone for the visit. Some laboratories expressed appreciation that key hospital partners were involved through the client interview process, enabling them to share in the experience and understand the accreditation process.

Feedback indicates that a number of requirements are in need of review and revision. Some of the requirements remain open to broad interpretation, a frustration shared by facility staff undergoing assessment and by the assessors themselves. A complete review of the requirements and the accompanying guidance information will be initiated in 2005.

Similar evaluations by OLA assessors reveal that the assessment experience is excellent and that the assessor training is invaluable. The experience is an intense one, with assessors putting in long working days. The OLA staff are meticulous when preparing visit agendas and making travel arrangements to alleviate undue stress on volunteer assessors. A number of assessors have commented that when there is excellent preparation on the part of the laboratory undergoing assessment, their job is much easier.

Many improvements were made over the course of 2004 to OLA processes and procedures. Revisions were made to allow for multi-site assessments when appropriate. The process for the review of corrective actions after peer assessments was refined. It now requires the OLA Staff Coordinator, the Team Leader and an Advisory Panel member to review facilities' corrective action plans following peer assessments. All three reviewers are required to sign off that all majors are satisfactorily addressed and the action plan for all minors is acceptable. If this is the case, a 5-year certificate is issued. If not, the case is presented to the entire advisory panel for an extensive corrective action review. A process was developed whereby a laboratory may submit an "error of fact" report following a peer assessment. These applications are reviewed by the OLA Staff Coordinator, Team Leader and the OLA Advisory Panel. Our most significant improvement was the development of an electronic tool to aid in the collation of conformance data. This "mobile assessor" was piloted and implemented in 2004 and has resulted in significant improvement to the quality of summation meetings. Through its use, the laboratory benefits from the preparation of a draft report on-site, showing the statistical performance and detailing all non-conformances.

FUTURE PLANS

After a successful first year of peer assessments, OLA will continue with peer assessments at the rate of four to five assessments per month. Since all laboratories have completed an initial self-assessment, there will be a brief hiatus in the self-assessment process. However, notifications of self-assessment will resume in mid-2005. We will offer four assessor training sessions in 2005, and a revamped refresher will be sent electronically to all current assessors. Our bi-annual review of requirements will occur in 2005 which will include a comprehensive review of feedback from laboratories, stakeholders and assessors, a review of all references, and consultation with all QMP-LS scientific committees and the OLA Advisory Panel.

Processes and procedures will be refined based on feedback from assessors and laboratory staff. The "mobile assessor" software will be improved to facilitate timely preparation and distribution of peer assessment visit summary reports.

In 2005, peer assessment visits are scheduled for 51 laboratories and 35 coordinated laboratory self-assessments are scheduled. Staff plan to continue to pursue a partnership with SCC, initiate a program evaluation to validate processes for accreditation and confirm consistency with ISO 17011:2004 *Conformity assessment—General requirements for accreditation bodies accrediting conformity assessment bodies*. OLA and EQA staff will work together to achieve an integrated quality management program.

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Ms. Leela Prasaud

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TOPIC/ EVENT	DATE	LOCATION	QMP-LS REPRESENTATIVE
<i>How Safe is your Health Care?</i> American Society for Quality (ASQ) Hamilton Chapter	January	Hamilton, Ontario	Dr. Harold Richardson
<i>Accreditation: New and Emerging Standards for Laboratory Systems</i> National Forum on Laboratory Reform Insight Information Company	March	Toronto, Ontario	Mrs. Linda Crawford
<i>External Quality Management Systems</i> 2004 Canadian Symposium on Prenatal Screening Mount Sinai Hospital and Maternal Fetal Medicine Seminars	June	Toronto, Ontario	Ms. Joanne Miyazaki
<i>Accreditation: New and Emerging Standards for Laboratory Systems</i> Canadian Society Medical Laboratory Science (CSMLS)/Saskatchewan Society of Medical Laboratory Technologists (SSMLT) Congress	June	Saskatoon, Saskatchewan	Mrs. Linda Crawford
<i>QMP-LS Update</i> Canadian Coalition for Quality in Laboratory Medicine (CCQLM)	July	Saskatoon, Saskatchewan	Dr. Harold Richardson
<i>Investigation of EQA Discordant Findings</i> European Committee for External Quality Assurance Programmes in Laboratory Medicine (EQALM) Symposium 2004	September	Vienna, Austria	Ms. Jane Gun-Munro
<i>OLA: How do we stack up so far?</i> Ontario Society of Medical Technologists (OSMT) Conference	September	Thunder Bay	Mrs. Linda Crawford
<i>Evolution of External Quality Assessment of Microbiology Services: QMP-LS and The World</i> Medical Microbiology/Infectious Diseases Rounds	November	Sunnybrook & Women's College Health Sciences Centre	Dr. Harold Richardson
ISO 15189:2003—Medical Laboratories Particular Requirements for Quality and Competence. Entidad mexicana de acreditación	October	Mexico City, Mexico	Ms. Julie Coffey Ms. Linda Crawford

EVENT/TOPIC	DATE	LOCATION	PLANNERS/ PRESENTERS/ MODERATORS
Joint QMP-LS/Ontario Society of Medical Technologists/College of Medical Laboratory Technologists of Ontario Workshops <i>Setting Technical Quality Standards for Histological Staining</i>	February	The Michener Institute for Applied Health Sciences	Toronto, Ontario Mr. Bryan Hewlett
	March	Mohawk-McMaster Institute for Applied Health Sciences	Hamilton, Ontario Mr. Bryan Hewlett
	April	St. Joseph's Health Centre	London, Ontario Mr. Bryan Hewlett
	April	Thunder Bay Regional Health Centre	Thunder Bay, Ontario Mr. Bryan Hewlett
	May	St. Joseph's Health Centre	Sudbury, Ontario Mr. Bryan Hewlett
	October	Queen's University	Kingston, Ontario Mr. Bryan Hewlett

OTHER WORKSHOPS

National Society for Histotechnology Annual Symposium/Conference <i>Quality Issues in Immunohistochemistry</i>	September	Toronto Convention Centre	Toronto, Ontario Mr. Bryan Hewlett
Ontario's EQA Program for Anatomic Pathology Laboratories			Ms. Laurie Mason Mr. Bryan Hewlett

OTHER

On-line education courses

<i>Introduction to Hematology: The Erythrocyte</i>	Introduced in 1997 (Discontinued April 2004)	Mr. John Lafferty
<i>Erythrocyte Disorders: Detection and Diagnosis</i>	Introduced in 2000 (Discontinued April 2004)	Mr. John Lafferty

CHEMISTRY**Chemistry-General**

Albumin
 Albumin Excretion Rate (AER)
 Bicarbonate
 Bilirubin, Total
 Blood Gases (pH, pCO₂, pO₂, Na⁺, K⁺, Glucose, Ionized Calcium)
 Hb A_{1c}
 Calcium, Total
 Chloride
 Creatinine
 Glucose
 Magnesium
 Phosphate
 Potassium
 Protein, Total
 Sodium
 Total Iron, TIBC, UIBC, Transferrin Saturation
 Urate
 Urea
 Urine Chemistry (Quantitative Protein, Sodium, Potassium, Creatinine, Osmolality)

Drug Monitoring

Acetaminophen
 Carbamazepine
 Cyclosporine
 Digoxin
 Drugs of Abuse
 Ethanol
 Gentamicin
 Lithium
 Phenobarbital
 Phenytoin
 Salicylate
 Tacrolimus
 Theophylline
 Tobramycin
 Valproic Acid
 Vancomycin

Endocrinology

Total Triiodothyronine (TT₃)
 Thyrotropin (TSH)
 Free Thyroxine (FT₄)
 Free Triiodothyronine (FT₃)
 Vitamin B₁₂
 Ferritin
 Cortisol
 Total Testosterone
 Follicle Stimulating Hormone (FSH)
 Luteinizing Hormone (LH)
 Progesterone
 Prolactin
 Chorionic Gonadotropin (CG)
 Alpha Fetoprotein (AFP)
 Estradiol
 Prostate Specific Antigen (PSA)
 Free PSA
 Dehydroepiandrosterone sulphate (DHEA-S)

Enzymes, Cardiac Markers & Lipids

Alkaline Phosphatase (ALP)
 Alanine Aminotransferase (ALT)
 Amylase
 Aspartate Aminotransferase (AST)
 Gamma Glutamyl Transferase (GGT)
 Lactate Dehydrogenase, Total (LD)
 Lipase
 Total Creatine Kinase (Total CK)
 CK-2
 Serum Myoglobin
 Serum Troponin I
 Serum Troponin T
 Cholesterol
 Triglycerides
 HDL-cholesterol (HDL-C)
 LDL-cholesterol (LDL-C)

Immunology

Antinuclear Antibody (ANA)
 Rheumatoid Factor (RF)
 Antimicrobial Antibody (MAH)
 Anti-TPO
 C-reactive Protein (CRP)
 High Sensitivity CRP
 Anti ds-DNA
 Specific Proteins:
 IgG
 IgA
 IgM
 IgE
 C3
 C4

Protein Electrophoresis

Maternal Serum Screening

Serum Analytes:
 Alpha Fetoprotein (AFP)
 Chorionic Gonadotropin (CG)
 Unconjugated Estriol (μE₃)
 Multiple of Median (MoM):
 AFP, CG, and μE₃
 Initial Positive Rate (IPR):
 Trisomy 18
 Trisomy 21
 Open Neural Tube Defect (ONTD)

HEMATOLOGY**Bone Marrow**

Aspirate and Biopsy

Coagulation

Prothrombin Time (PT)
 International Normalized Ratio (INR)
 Activated Partial Thromboplastin Time (APTT)
 Heparin Assay
 Factor VIII
 Factor IX
 D-dimer
 Thrombophilia Investigation:
 Activated Protein C (APC) Resistance
 Antithrombin
 Protein C
 Protein S
 Factor V Leiden
 Prothrombin Gene Mutation

Flow Cytometry

Lymphocyte Immunophenotyping (HIV)
 Leukocyte Immunophenotyping
 (Hematological Investigation)
 CD34+ Stem Cell Enumeration

Red Cell Disorders

Hemoglobin S Screen
 Hemoglobin Fraction Quantitation
 Fetal Maternal Hemorrhage
 Glucose-6-phosphate Dehydrogenase (G6PD)

Morphology

Peripheral Blood Film:
 Differential Leukocyte Count
 Descriptive Morphology
 Clinical Relevance

Routine Hematology

Leukocyte Count
 Erythrocyte Count
 Hemoglobin
 Hematocrit
 Mean Corpuscular Volume
 Thrombocyte Count
 Reticulocyte Count
 Automated Leukocyte Differential

Transfusion Medicine

ABO and Rh Grouping and Interpretation
 Antibody Detection
 Antibody Identification
 Direct Antiglobulin Testing (DAT)
 Crossmatching
 Phenotyping
 Titrations

MICROBIOLOGY**Bacteriology**

Aerobic and anaerobic isolation and identification of organisms from:

Blood
 Genital specimens
 Throat swabs
 Urine
 Body fluids
 Other swabs/pus
 Sputum
 Stool samples

Serological grouping and identification
 Quantitative urine cultures
 Interpretation and reporting of cultures
 Antimicrobial susceptibility testing
 Interpretation and reporting of susceptibility findings
 Gram stain interpretation
 Special stains

Mycobacteriology

Detection of acid-fast bacilli from direct smears
 Quantification of acid-fast bacilli

Mycology

Isolation and identification of:
 Dermatophytes
 Moulds
 Yeasts
 Wet preparations for fungal elements

Parasitology

Wet preparation examination of stool samples
 Preparation of faecal concentrates
 Staining of samples for gastrointestinal parasites
 Identification and quantification of parasites
 Use of special stains

Virology

Antibody detection:
 Cytomegalovirus
 Hepatitis A and B
 Hepatitis C
 HIV
 Rubella
 VZV
 Antigen Detection:
Chlamydia trachomatis
 Respiratory Syncytial Virus
 Influenza A virus

GENETICS**Cytogenetics**

Blood
 Bone Marrow
 Tumour
 Tissue
 Amnion Cells

Molecular Diagnostics of Inherited Diseases

ANATOMIC PATHOLOGY**Histopathology****Histotechnology**

Routine stains
 Special stains
 Immuno-histochemistry stains

Cytopathology

Gynecological
 Non-Gynecological
 Respiratory:
 Sputum
 Bronchial washings
 Bronchial brushings
 Urinary
 Body fluids
 Fine needle aspiration of breast
 Fine needle aspiration of head and neck:
 Thyroid
 Lymph node
 Salivary glands

OTHER**Point-of-Care Testing**

Glucose Meters

TESTING MATERIAL SUPPLIERS**CHEMISTRY DISCIPLINES****Chemistry**

Bio-Rad Laboratories (Canada) Ltd.
Hamilton Regional Laboratory Medicine Program, Hamilton,
Ontario
The Credit Valley Hospital, Mississauga, Ontario

Drug Monitoring

Centre for Addiction and Mental Health, Toronto, Ontario
Toronto General Hospital, University Health Network,
Toronto, Ontario
The Credit Valley Hospital, Mississauga, Ontario

Endocrinology

Randox Laboratories, Mississauga, Ontario
Consolidated Technologies, Inc, Austin, Texas
Toronto General Hospital, University Health Network,
Toronto, Ontario

Enzymes, Cardiac Markers & Lipids

Hamilton Regional Laboratory Medicine Program,
Hamilton, Ontario
Kingston General Hospital, Kingston, Ontario
The Credit Valley Hospital, Mississauga, Ontario

Immunology

SeraCare Life Sciences, Inc (formerly Biomedical Resources),
Hatboro, Pennsylvania

Point-of-Care Testing (Glucose Meters)

Hematronix Inc., Plano, Texas
Bio-Rad Laboratories, Benicia, California

HEMATOLOGY DISCIPLINES**Hematology–Routine**

Hamilton Regional Laboratory Medicine Program,
Hamilton, Ontario
R&D Systems, Inc., Minneapolis, Minnesota

Hematology–Red Cell Disorders

Hamilton Regional Laboratory Medicine Program,
Hamilton, Ontario

Hematology–Flow Cytometry

London Health Sciences Centre, London, Ontario
R&D Systems, Inc., Minneapolis, Minnesota

Coagulation

Affinity Biochemicals Inc., Ancaster, Ontario
Hamilton Regional Laboratory Medicine Program,
Hamilton, Ontario
bioMerieux Canada, Inc., Saint-Laurent, Quebec
Thrombosis Reference Centre, Manchester, U.K.
U.K. National External Quality Assessment Scheme for Blood
Coagulation, Sheffield, U.K.

REFERENCE LABORATORIES

Reference Laboratory, Ortho Clinical Diagnostics Inc.,
Rochester, New York
Diabetes Diagnostic Laboratory, University of Missouri-
Columbia, Columbia, Missouri

Centre for Addiction and Mental Health, Toronto, Ontario

Wadsworth Center for Laboratories and Research, New York
State Department of Health, Albany, New York
Reference Laboratory, Ortho Clinical Diagnostics Inc.,
Rochester, New York
Northwest Lipid Research Core Laboratory, University of
Washington, Seattle
Lipid Research Laboratory, Toronto, Ontario

Hamilton Regional Laboratory Medicine Program,
Hamilton, Ontario

Hamilton Regional Laboratory Medicine Program,
Hamilton, Ontario

Hamilton Regional Laboratory Medicine Program,
Hamilton, Ontario

TESTING MATERIAL SUPPLIERS**Morphology and Hematology–Bone Marrow**

Various laboratories throughout the province

Transfusion Medicine

Immucor/Gamma, Houston, Texas

London Health Sciences Centre/Canadian Blood Services,
London, Ontario

MICROBIOLOGY DISCIPLINES**Bacteriology**

London Health Sciences Centre, London, Ontario

Gram Smears

Clinical Microbiology Proficiency Testing Program

AFB Smears

Central Public Health Laboratory, Toronto, Ontario

Mycology

Purchased from culture collections

Parasitology

Hamilton Regional Laboratory Medicine Program—
St. Joseph's Site, Hamilton, Ontario

Centre for Travel and Tropical Medicine—Toronto General
Hospital, Toronto, Ontario

The Credit Valley Hospital, Mississauga, Ontario

Virology

The Canadian Blood Services and selected volunteer donors
Hamilton Regional Laboratory Medicine Program,
Hamilton, Ontario

London Health Sciences Centre, London, Ontario

Meridian Bioscience Inc, Cincinnati, Ohio

ANATOMIC PATHOLOGY

Various participating laboratories

CYTOLOGY

Various participating laboratories

GENETICS

Various participating laboratories

REFERENCE LABORATORIES

Princess Margaret Hospital, University Health Network
William Osler Health Centre, Memorial Hospital Campus
Brampton, Ontario

The Ottawa Hospital, General Campus, Ottawa, Ontario

The Credit Valley Hospital, Mississauga, Ontario

Royal Victoria Hospital, Barrie, Ontario

Sunnybrook and Women's College Health Sciences Centre,
Toronto, Ontario

Central Public Health Laboratory, Toronto, Ontario

London Health Sciences Centre, London, Ontario

Lakeridge Health, Oshawa, Ontario

Mount Sinai Hospital, Toronto, Ontario

Kingston General Hospital, Kingston, Ontario

The Credit Valley Hospital, Mississauga, Ontario

The Ottawa Hospital, Ottawa, Ontario

Hamilton Health Sciences Corporation, Hamilton, Ontario

Central Public Health Laboratory, Toronto, Ontario

Wadsworth Centre for Laboratories and Research, Albany,
New York

Laboratoire de santé publique du Québec, Ste-Anne-de-
Bellevue, Quebec

Canadian Blood Services, National Testing Laboratory,
Ottawa, Ontario

Central Public Health Laboratory, Toronto, Ontario

National HIV Reference Laboratory, Health Canada, Ottawa,
Manitoba

Hamilton Health Sciences Corporation, Hamilton, Ontario

Hospital for Sick Children, Toronto, Ontario

Sunnybrook and Women's College Health Sciences Centre,
Toronto, Ontario

Toronto Medical Laboratories, Toronto, Ontario

Appendix I

Summary of Committee Action in 2004

	Chemistry							Drug Monitoring				Enzymes				Lipids							
	CHEM							DRUG				ENZY				LIPS							
	0401	0403	0404-BG	0405	0407	0408-BG	0410	0401	0405	0407	0410	0401	0403	0406	0410	0401	0406	0410					
Number of Surveys	3	2	1	3	2	1	3	3	2	1	3	1	2	1	2	1	1	1					
Total Receiving Survey	205	151	156	203	146	158	201	169	111	162	167	197	196	196	195	135	133	134					
Total Presented Surveys	142	67	48	93	65	62	104	87	37	79	102	51	110	58	82	90	69	106					
Significant Error	89	21	24	63	17	19	67	66	39	21	46	2	27	9	13	63	35	36					
Lesser Error	6	2	1	6	5	0	0	7	0	0	0	0	7	0	0	2	5	0					
Correspondence	50	26	24	40	14	14	33	48	34	27	34	2	22	11	5	41	28	25					
OSC recommended	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
	Endocrinology							Immunology			Point-of-Care Testing												
	ENDO				IMGY			POCT															
	0402	0404	0408	0411	0402	0408	0411	0404	0409														
Number of Surveys	1	1	1	1	1	1	1	1	1														
Total Receiving Survey	125	124	125	127	70	66	65	182	181														
Total number of labs presented	24	13	13	15	43	31	29	17	3														
Significant Error	13	5	5	0	6	3	0	0	0														
Lesser Error	9	0	2	0	3	0	0	0	0														
Correspondence	22	3	5	8	22	9	10	5	3														
OSC recommended	0	0	0	0	0	0	0	0	0														
	Hematology					Red Cell Disorders		Flow Cytometry			Coagulation		Morphology										
	HEMA					RCD		FLOW			COAG		MORP										
	0403-BM	0405	0406-PP	0407	0410	0404	0408	0403	0409	0411-HD	0402	0409	0402	0407	0411-MW								
Number of Surveys	1	4	1	2	3	3	2	3	3	1	3	3	1	1	1								
Total Receiving Survey	66	209	207	66	208	85	31	19	19	12	200	196	204	201	200								
Total number of labs presented	0	43	0	0	43	29	0	3	7	3	40	14	0	0	0								
Significant error	0	5	0	0	6	11	0	0	1	0	2	7	0	0	0								
Lesser Error	0	24	0	0	13	5	0	2	1	0	13	4	0	0	0								
Correspondence	0	36	0	0	41	18	0	2	2	1	32	14	0	0	0								
OSC recommended	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0								
	Transfusion Medicine																						
	TMED																						
	0403	0405	0408	0411																			
Number of Surveys	2	2	1	3																			
Total Receiving Survey	173	171	170	170																			
Total number of labs presented	16	38	31	53																			
Significant error	2	7	0	4																			
Lesser Error	7	4	6	30																			
Correspondence	14	14	19	45																			
OSC recommended	0	0	0	0																			
	Bacteriology				Mycology				Parasitology				Virology										
	BACT				MYCO				PARA				VIRO										
	0402	0404	0406-PP	0409	0411	0403	0409	0405	0410					0402	0403	0410	0411						
Number of Surveys	2	3	1	2	3	1	1	1	1					4	2	3	2						
Total Receiving Survey	114	116	117	114	109	22	23	25	24					66	43	64	42						
Total number of labs presented	42	76	10	43	47	3	2	17	12					29	10	6	2						
Significant Error	11	26	0	6	28	1	0	4	6					1	1	1	2						
Lesser Error	13	35	0	27	37	1	0	11	8					7	2	4	0						
Correspondence	30	56	0	32	44	3	1	9	7					31	8	5	1						
OSC recommended	0	0	0	0	0	0	0	0	0					0	0	0	0						
	Anatomic Pathology				Cytology		Genetics																
	PATH				CYTO		GENE																
	0402	0409			0406	0410	0402-CG	0405-CG	0408-CG	0410	0411-CG												
Number of Surveys	4	5			1	6	1	1	1	2	1												
Total Receiving Survey	54	78			85	85	10	10	10	22	10												
Total number of labs presented	54	0			0	0	0	0	0	0	0												
Significant Error	4	0			0	0	0	0	0	0	0												
Lesser Error	1	0			0	0	0	0	0	0	0												
Correspondence	25	0			0	0	11	9	6	0	14												
OSC recommended	0	0			0	0	0	0	0	0	0												