Highlights & Strategic Priorities Report

BC Public Health Microbiology & Reference Laboratory

LM LABS
Lower Mainland Pathology and Laboratory Medicine

BC Centre for Disease Control
AN AGENCY OF THE PROVINCIAL HEALTH SERVICES AUTHORITY

2013-2014

Cover and Left Image Credit:
Raymond Ma
Medical Laboratory Technologist,
Virology Program

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Message from the Public Health Laboratory Director

On behalf of the staff at the BC Public Health Microbiology & Reference Laboratory (BCPHMRL), it is my pleasure to present an overview of our 2013-2014 work.

Day-to-day, every year, we organize, consult on, accession, analyze and report over 2.5 million laboratory results. In addition to our day-to-day work, we rapidly respond to change, particularly when the unexpected happens. Every year we respond on average to 450 outbreaks in British Columbia (BC).

Quality remains the touchstone of all we do. And, we are keen to implement faster and better assays to optimize communicable disease prevention and control, in part through effective information management and better quality systems.

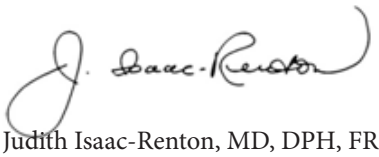
Since the last report, our strategic priorities (within the Guiding Framework for populations health) have been to:

- Build capacity and capability to improve molecular microbiology with partners in the Molecular Network for Public Health.
- Standardize tools and training to improve laboratory data.

We are pleased to report back to you, our clients, on our team's efforts. As well we highlight some of our day-to-day improvements and successes during 2013-2014.

The team's efforts allow us to improve our efficiency and effectiveness as we partner with public health at the BC Center for Disease Control (BCCDC), public health workers across BC and with BC's medical microbiologists and their laboratory teams.

As always, we appreciate your support and look forward to even stronger collaborations and partnerships that align with Ministry, public health, health authority and laboratory strategies.



Judith Isaac-Renton, MD, DPH, FRCPC
Public Health Laboratory Director for British Columbia
Professor of Medical Microbiology, University of British Columbia

Public Health Laboratory Leaders

Administration

GAIL CRAWFORD
Director, Laboratory Operations

AMELIA TRINIDAD
Laboratory Manager

ROSALYN WAGNER
Executive Assistant

YVONNE HARDWICKE
Administrative Assistant

Biosafety Biosecurity Biohazard Containment

NEIL CHIN
Public Health Lead

JOHN TANSEY
Biosafety Officer

Enhanced Water Quality Assurance

DR. NATALIE PRYSTAJECKY
Provincial Coordinator

CORA YEE
Healthy Water Program Coordinator

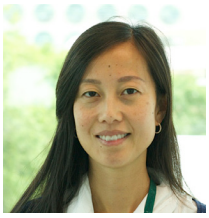
Lower Mainland Labs Information Management

KELVIN LAM
Coordinator

PETER NG
Coordinator

Public Health Laboratory Leaders

Laboratory Surveillance & Outbreak Response

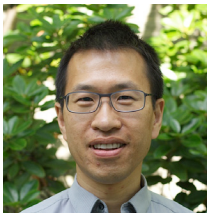


YIN CHANG
Coordinator/Projects Manager

Laboratory Technical Support Services

DR. MABEL RODRIGUES
Section Head

Molecular Microbiology & Genomics



DR. PATRICK TANG
Program Head

ALAN MCNABB
Section Head

DR. WILLIAM HSIAO
Bioinformatician

DR. NATALIE PRYSTAJECKY
Molecular Coordinator

Central Processing & Receiving

DR. JUDY ISAAC-RENTON
Program Head, Pre-Analytical

DR. MEL KRAJDEN
Program Head, High Volume Serology

DR. MUHAMMAD MORSHED
Program Head, Syphilis Serology

ANNIE MAK
Section Head

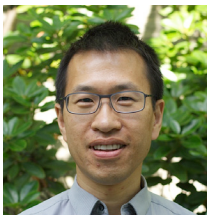
Public Health Laboratory Leaders

Enivronmental Microbiology

DR. JUDY ISAAC-RENTON
Program Head

BRIAN AUK
Section Head

Mycobacteriology/TB



DR. PATRICK TANG
Program Head

DR. MABEL RODRIGUES
Section Head

Parasitology

DR. JUDY ISAAC-RENTON
Program Head

QUANTINE WONG
Section Head

Virology

DR. MEL KRAJDEN
Program Head

ALAN MCNABB
Section Head

Public Health Advanced Bacteriology/Mycology

DR. LINDA HOANG
Program Head

ANA PACCAGNELLA
Section Head

Zoonotic Diseases & Emerging Pathogens

DR. MUHAMMAD MORSHED
Program Head, Zoonotic Diseases & Emerging Pathogens

QUANTINE WONG
Section Head, Zoonotic Diseases & Emerging Pathogens

This is but a small fraction of the dedicated individuals that make up the BCPHMRL. They are the leaders and administrative staff of the various Programs of the public health laboratory.

Our Mandate

- Environmental health testing surveillance and quality monitoring for food and water
- Support to the BC Provincial Health Officer (PHO) for legislated requirements for safety by quality assurance of drinking water testing including ongoing assessments of 17 decentralized laboratories across BC
- Detection, outbreak and cluster investigation for communicable diseases
- Molecular microbial characterization for outbreak and cluster response
- Capacity and capability to urgently develop, validate, implement and share new tests
- Molecular microbiology improvements and troubleshooting for internal programs and, in limited capacity, for other laboratories.
- Specialized services for rare and complex microbiology testing
- Biosecurity, biosafety, biocontainment and bioterror response for communicable diseases
- Confirmatory testing and trouble-shooting for other BC laboratories
- Quality management system leadership for environmental and clinical work
- Integrated information management interpretation and quality assurance for program evaluation, best laboratory practices and integrated communicable diseases surveillance
- Applied academic work (teaching, research) related to public health microbiology

Roles and responsibilities come from:

1. Legislation

- Provincial: BC legislation to protect the population's health
- National: Outbreak early warning, environmental and clinical surveillance, bioterrorism, and biohazard containment response
- Provincial, national and international accreditation requirements.

2. Internationally required capability and capacity: We provide defined Core Functions, value-add services required for all public health laboratories[1] by:

- Sustaining a critical mass of medical/technical experts who enable surge capacity for public health emergencies.
- Recruiting medical/technical specialists to lead complex or rare disease testing, innovate in new assay scientific evaluation and validation, provide confirmatory reference services province-wide. and support troubleshooting for health authority laboratories across BC.
- Leading laboratory surveillance by Quality Assuring and interpreting of results for trending, program evaluation, and best practices principles.
- Leading in efficiency gains such as centralizing or automating services for economies of scale when appropriate to public health work.

We are BC's link with the National Microbiology Laboratory (NML) in Winnipeg, a division of the Public Health Agency of Canada (PHAC). We submit and receive pan-Canadian level reference testing. We also meet with NML and other PHAC staff to coordinate emergency response and develop national and international public health best practices.

[1] Detail from the plans and priorities of the Public Health Agency of Canada is available at: http://www.phac-aspc.gc.ca/rpp/2013-2014/assets/pdf/info-2013-2014-eng.pdf.

Input from Stakeholders

We asked senior public health leaders to provide input on strategic directions, programs and services, using a structured interview process. This input affirmed our work and included feedback on:

Developing a stronger public health laboratory network

Client Comments:

- BCPHMRL is an important central node and a key link to the NML.
- Molecular technologies are increasingly used in public health, including health authority laboratory nodes. A BC-wide microbiology laboratory network should provide leadership in best practices and standards.
- Once a testing system has been designed and is up and running, it can be disseminated to the health authorities. The BCPHMRL has an ongoing role in this and in validating, providing QA, teaching and training.
- BCPHMRL staff members should have the time to collaborate with laboratory and public health staff members, provincially, nationally and internationally.
- There is a tension between centralized and decentralized testing. A balance is important and funding is a key challenge.

Transforming laboratory data into usable information

Client Comments:

- BCPHMRL data can be valuable for health authority analyses related to policy, evidence for practice and program evaluation.
- The BCPHMRL is in the best position to recognize provincial trends and also to develop ways to improve surveillance.
- The BCPHMRL plays a key role in surveillance, alerts and outbreak response.
- The system should recognize local health authority needs so data collection and use must be flexible.
- Key outputs from collected data are most valuable at the population level if results are interpreted, timely, and quality assured.

Providing input for public health labs during system change

Client Comments:

- Public health laboratories must maintain a critical mass of experienced and expert public health staff to lead specialized testing and provide a nimble response.
- As health care providers have primary responsibility to patients, the public health system has a primary responsibility to the population. To that end, appropriate governance of the public health laboratory system is critical.

Strategic Priority 1

Building capacity to evaluate and improve molecular microbiology through thepublic health laboratory networks

Background

Molecular methods are increasingly used in diagnostic laboratories due to their short turnaround times (TATs) and better sensitivities. Our medical and technical leaders have scientific expertise in polymerase chain reaction (PCR), DNA sequencing, Next Gen/Deep Sequencing, Whole Genome Sequencing (WGS), metagenomics, and other molecular characterization methods.

Since commercial assays must be monitored for changes we continually work on ways to improve our ability to detect pathogens of public health importance, and to support network partners across BC.

Activities

We have "Leaned" for better processes and procedures, streamlining the small core Molecular Microbiology and Genomics Program. This "Lean" work has led to more efficient and effective communications with standardized work in support of the growing demand for molecular services in BC laboratories. The opportunity to standardize enables us to improve how quickly we can respond to public health threats and ultimately raises the benchmark for molecular testing across the province.

The BC Public Health Network aim is to standardize collaborative efforts with provincial partners. Standardized response protocols are used and communications are clear and consistent, with a single BCPHMRL Network Manager responsible for coordinating and ensuring action on all requests.[2] When assistance is needed, this system provides a single "point person" for laboratory partners across BC. With respect to use of BCPHMRL in-house assays, we carry out molecular testing solutions that are less costly than commercial counterparts.

Examples of recent work:

- We shared methods and standard operating procedures on norovirus, influenza and herpes PCR assays working closely with staff at Island Health, Vancouver Coastal Health, Providence Health Care and Children's and Women's Hospital Microbiology Laboratory.
- We assisted in troubleshooting when issues related to PCR arose at various laboratories and helped in validation of new health authority commercial platforms such as the new GeneXpert® technology.
- We stood up and verified the NML decentralized assay to detect a Risk Group 4 (RG4) Agent for Ebola virus disease (EVD). While culture was not allowed under Transport Canada and national biosafety regulations, DNA extracts could be shared for use at the provincial level. BC was one of the first provinces to implement EVD PCR.
- We are partnering with Island Health to transition the BCPHMRL-developed triplex assay for herpes simplex viruses 1 and 2 and varicella zoster virus.
- We introduced the standardized processes for the Molecular Network for Public Health to Northern Health, Interior Health, Island Health, Fraser Health and Vancouver Coastal Health.
- We shared our new standardized processes with all members of the BC Association of Medical Microbiologists.

Next Steps

The team will continue pilots of new "Lean" processes in pursuit of a stronger, standardized public health molecular network.

[2] Our Network Manager, Yin Chang, also edits *Laboratory Trends*, a monthly communication that keeps our colleagues informed of changes, trends and surveillance activities in public health. Recipients include members of the Molecular Network for Public Health, public health workers, and partner microbiology laboratory clients.

Strategic Priority 2

Standardizing tools and training to capture and transform data into useful public health information

Background

There is value in integrating the large amount of data the BCPHMRL creates for trending, surveillance and policy guidance (standard setting, guideline development, etc.). Data quality procedures, standardization of analysis and the training of laboratory team members were starting points.

Activities

We developed two teams that report in our quality management system to the Leadership Team:

The Information Skills Development Team

- Led by Mark McCabe and Dr. Linda Hoang, they developed and shared standardized tools for best practices for data management as well as database structure, data entry and basic analyses.
- Enhanced staff skills in managing BCPHMRL information, carrying out data analysis using basic statistics, managing processes for better data quality control, and improving quality of information through standardization.
- Trained subject matter experts to act as channels between Programs, shared opportunities for learning, training and teaching, as well as improved data quality and analysis.

The Advanced Skills Development Team

- Led by Dr. William Hsiao, they introduced genomics analysis tools[3] to the BCPHMRL by workshops with hands-on instruction using tools for microbial genomic analysis.
- Workshops also helped participants learn to organize microbial DNA sequence data into analyzable units and to carry out effective bioinformatic analyses.
- Participants studied current public health challenges using the tools they learned.
- ASDT enhanced our microbial genomics and WGS capacity and is now capable of taking leadership in this new area by promoting standardized practices for increased efficiency, improved data quality, and microbial analyses.
- Work complements several large Genome Canada/Genome BC grants with external funding (over $4M) to assess WGS as a public health tool

Next Steps

Information Skills Development Team:
The team, now called the Information Translation for Laboratories, has enhanced our IM capacity with improved subject matter expert confidence in analyses. This enables improvements such as: improved patient safety by work on pre-analytical errors analysing data captured by a Continuous Quality Improvement team, improved quality indicators through better data capture for a standardized approach, better management using daily operational tools, and review of criteria for effective use of new molecular tools.

Advanced Skills Development Team:
The team now known as Advanced Bioinformatics and Laboratory (ABL), has two sub-groups to work on the WGS areas of practice: Laboratory (library prep, physical laboratory work) led by Dr. Natalie Prystajecky and Bioinformatics led by Dr. William Hsiao. The Advanced Bioinformatics and Laboratory Team is focusing on *Salmonella* infections, a major public health issue in BC and across Canada, leveraging national work, externally funded grants, as well as provincial projects.

[3] Advancement in microbial genomics is poised to provide better tools, such as whole genome sequencing and metagenomics, for improved resolution molecular epidemiology for public health as well as new diagnostics for all laboratories.

Whole Genome Sequencing Training Projects

Members of the Advanced Skills Development Team assigned projects as part of their learning objectives in WGS bioinformatics created and shared the following posters for Research Week. They represent some of the learning and improvements led by this small team. Workshops and support for these posters have greatly benefited from the leadership of Dr. Matthew Croxen and Kim Macdonald.

Photo Credit: M. Donoghue

Characterization of BC *Neisseria skkuensis* isolates using whole genome sequencing

Rob Azana, William Hsiao, Matthew Croxen, Kimberley A Macdonald, Aleksandra Stefanovic, Ana Paccagnella, Linda Hoang

Neisseria spp. are common commensals of mucous membranes, with many species of human origin. *Neisseria skkuensis* is a rarely identified species, first isolated and reported in 2010 from the blood of a diabetic patient with a foot ulcer in Korea, and only identified twice in BC. Identification of the novel species was accomplished by sequence analysis of the 16S rRNA gene. Little else is known about *Neisseria skkuensis*, and no genomic data currently exists for this organism. The BCPHMRL therefore performed Whole Genome Sequencing on 2 isolates of *Neisseria skkuensis* and compared various bioinformatics tools in an attempt to further characterize and study this rare organism.

Application of whole genome sequencing to understand outbreaks of *Clostridium botulinum* Toxin Type B

Yin Chang, Brian Auk, Matthew Croxen, Kimberley A Macdonald, Belinda Wong, Julie Wong, Judith L Isaac-Renton, Natalie Prystajecky

Botulism is a paralytic illness caused by neurotoxins produced by *Clostridium botulinum*. It is an extremely rare illness, but can have fatal outcomes. *C. botulinum* neurotoxins can cause food-borne, infant and wound botulism and be- cause of its potency, it is also a potential bioterrorism agent. Typing approaches are needed to link clinical cases and environmental sources of *C. botulinum*, but current approaches have many limitations. Here we describe the application of whole genome sequencing to aid in the investigation of several botulism toxin type B outbreaks in BC. This approach provides a higher resolution tool for understanding the transmission and genetic features of *C. botulinum*.

Application of whole genome sequencing to speciate and characterize Day-1 positive MGIT cultures

Yin Chang, Diane Eisler, Clare Kong, Matthew Croxen, Kimberley A Macdonald, Will Hsiao, Patrick Tang

The gold standard for laboratory diagnosis of *Mycobacterium tuberculosis* (MTB) is based on culture methods with primary culture and antibiotic sus- ceptibility taking up to six weeks to complete. Application of Whole Genome Sequencing (WGS) technologies for this slow-growing organism may be an alternative for earlier diagnosis. Therefore we initiated an investigation into the feasibility of whether MTB could be reliably speciated and resistance profiles characterized by WGS of Day-1 positive Mycobacteria Growth Indicator Tube cultures. We present some WGS findings and highlight that contamination can be an issue using this method.

Whole genome sequencing of invasive *Haemophilus influenzae* serotype A from British Columbia

Matthew Croxen, Kirby Cronin, Marcus Lem, Linda Hoang

Invasive *Haemophilus influenzae* (iHi) may cause life-threatening infections, including bacteremia and meningitis in children under the age of 5. While the incidence of iHi serotype B (Hib) has decreased due to immunization programs, the incidence of non-Hib infections has increased because current vaccines do not protect against non-Hib serotypes. In British Columbia, there have been a number of cases of invasive *H. infuenzae* serotype A (Hia). Our understanding of Hia and its pathogenesis is limited compared to other iHi. We used whole genome sequencing (WGS) of Hia to use as the basis to look at the differences between Hia, Hib and other non-typeable iHi.

Whole Genome Sequencing Training Projects

Exploring the NGS analysis pipeline for Lyme disease causing agent

Min-Kuang Lee, Clement Tsui, Mark McCabe, Diane Eisler, Alan McNabb, William Hsiao, Muhammad Morshed

Lyme disease is one of the most common vector-borne diseases in North America. This disease is caused by the spirochete *Borrelia burgdorferi* which is transmitted to humans by *Ixodes* ticks. B*orrelia burgdorferi* has a unique and complex genome structure and proves to be an effective invasive pathogen. It is composed of a linear chromosome, and several linear and circular plasmids. Both linear and circular plasmids vary in different isolates. This mosaic genomic content can make assembly and other bioinformatic processes challenging; therefore we performed a comparison of various genome assemblers to evaluate which tools produced the best/most informative assembly of this complex organism.

An assessment of whole genome sequencing for *Salmonella* Enteritidis outbreak analysis in BC

Kimberley A Macdonald, Ana Paccagnella, Linda Hoang, Matthew Croxen

Salmonella Enteritidis (SE) is one of the most common causes of bacterial gastroenteritis in British Columbia (BC). Current methods of subtyping have limited discriminatory power for SE, which hinders outbreak investigations. Whole Genome Sequencing (WGS) provides the highest resolution of an organism at the genetic level, and this information has been used as the basis of outbreak investigations. However, when developing pipelines for inferring epidemiologi- cal linkages using WGS, it is important to use isolates from well-characterized, epidemiologically-linked outbreaks before use in public health. We used such data to evaluate different bioinformatic tools for SE outbreak analysis.

Whole genome sequencing to understand waterborne outbreaks of giardiasis in BC

Clement Tsui, William Hsiao, Anamaria Crisan, Jordan Ho, Patrick Tang, Judy Isaac-Renton, Natalie Prystajecky

While waterborne outbreaks of giardiasis have decreased significantly, British Columbia (BC) still has high reported infection rates. Genomes of over 60 *Giardia intestinalis/ lamblia* strains from human, animal and water sources, including outbreak and non-outbreak related strains, were sequenced using Miseq (Illumina). The data were then analyzed using established in-house bioinformatic pipelines to characterize the genomic variation of outbreaks. We report on the possible use of the genetic tools to better understand the identification and transmission of spread of giardiasis in BC as well as the biology of this important parasite.

There are others underway but some recent examples of externally funded WGS projects include the following:

Applied Metagenomics of the Watershed Microbiome

Genome BC and Genome Canada funded, 2011-2015

Principle Investigators: Dr. J. Isaac-Renton and Dr. P. Tang with Drs N. Prystajecky, F. Brinkmann, C. Suttle. L. Harris, B, Knoppers, W. Hsiao and many others, this was an interdisciplinary team.

Project Goal: Our goal is to change the way we monitor water quality in our watersheds. The new science of metagenomics will be used to discover novel indicators of water pollution to protect the health of our watersheds. Our aims were to use metagenomics to measure the impact of pollution on the communities of microorganisms (the microbiome of viruses, bacteria and protists) in different watersheds, to create novel tests that monitor these changes in the microbiome to detect pollution and pinpoint sources of pollution.

Listeria Detection and Surveillance Using Next Generation Genomics

Genome BC and Genome Canada funded, 2013-2014

Principle Investigators: Dr. L. Chui, Dr J Zhang and M. Gilmour; the BCPHMRL partners were Drs. J. Isaac-Renton and N. Prystajecky,

Project Goal: Lead by Alberta Public Health Labs with the Canadian Food Inspection Agency, the overall goal was to improve ways of detecting foodborne pathogen, Listeria moncytgenes.

Federated Bio-informatics Platform for Public Health Microbial Genomes: Integrated Response to Infectious Diseases

Genome BC and Genome Canada funded, 2013-2015

Principle Investigators: Drs. F. Brinkmann, G. VanDonslear, with Drs W. Hsiao, with J. Isaac-Renton and others

Project Goal: This work intends to develop a better bio-informatics pipeline that can be shared with all partners for a faster response to infectious disease outbreaks.

Our International Core Functions

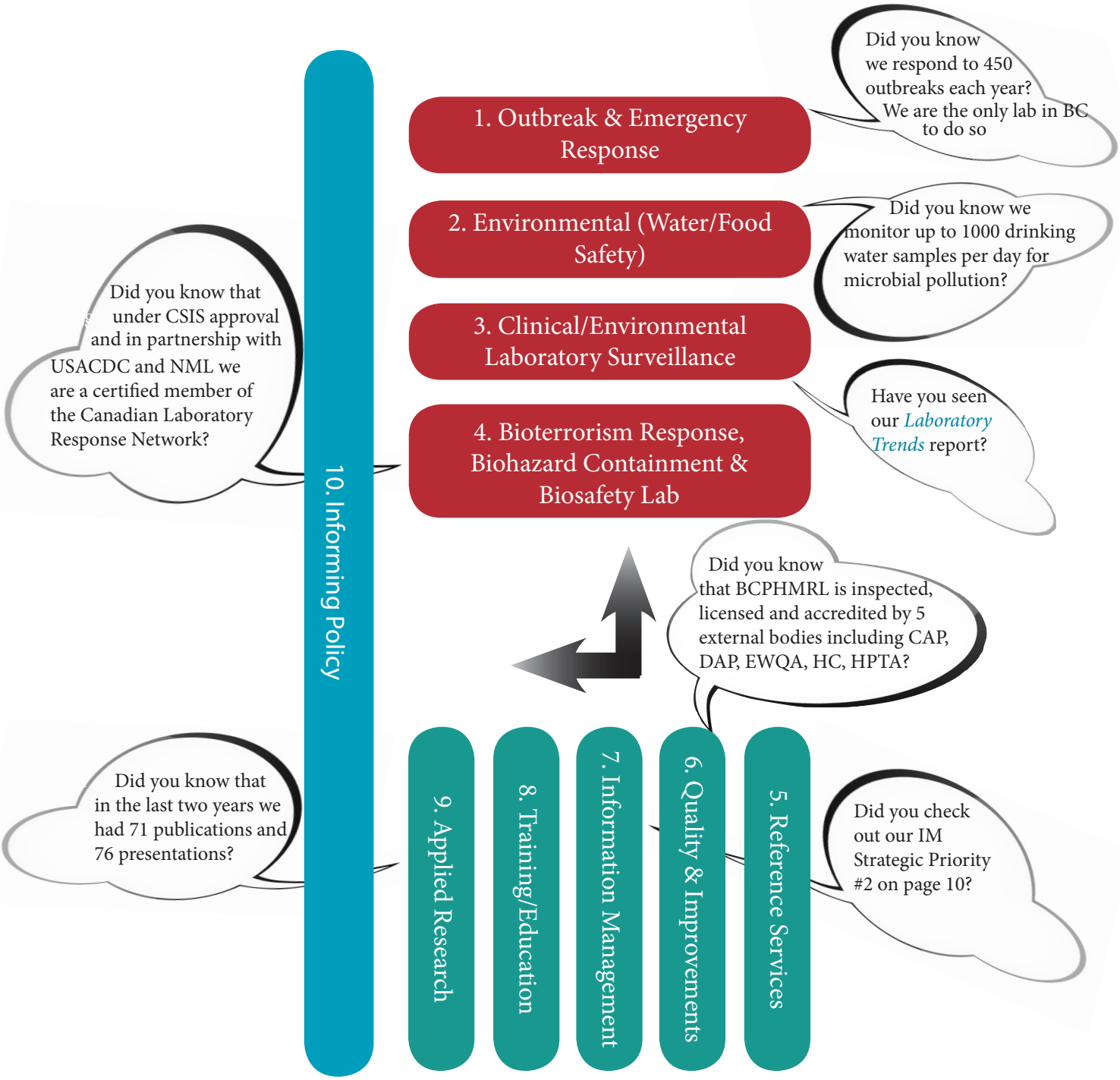


Figure 1. Relationships between 10 Core Functions (CFs) of Public Health Laboratories
KEY OUTPUT CFs (red) are critical functions requiring integration and team work. They also rely on content leaders, experts (medical & technical) and a sustained excellence of ENABLING CFs.
ENABLING CFs (green) are required for day-to-day leadership functions that must remain excellent in order to provide capacity for VALUE ADDS. They enable accurate and timely response for public health and for residents of BC.

2013-2014 Highlights for Core Programs

Our six integrated and cross-cutting groups support all discipline, testing Programs and as well liaise with partners across BC and Canada. They include:

- **Biosafety Biosecrity Biohazard Containment**
- **Information Management**
- **Laboratory Surveillance & Outbreak Response**
- **Laboratory Technical Support Services (Waste Management/Media)**
- **Molecular Microbiology & Genomics**
- **Quality Management Systems**

Highlights from these critical, centralized teams include:

Biosafety Biosecurity Biohazard Containment

- Achieved successful Health Canada (HC) accreditation for our three Containment Level 3 facilities.
- Support response to and preparing for the Human Toxins and Pathogens Act (HPTA) and Regulations.
- Helped create and implement a computer based bio-inventory system for BCPHMRL to allow us to track where and what micro-organisms are stored to ensure we are in compliance for the HPTA.
- Participated in and co-chaired the Biosafety Officers Network for Canada.
- Responded to emergencies across our building (floods and power outages) in the BCCDC building.
- Maintained the Emergency Response Assistance Program for RG4 agents for BC for PHAC
- Supported Island Health, Interior Health and Vancouver Coastal Health exercises testing their EVD responses.
- Evaluated and reported on transport times for samples of Person Under Investigation for EVD in remote sampling sites.
- Supported members for the bioterrorism network, the Canadian Laboratory Response Network.

Information Management

- Participated in activities related to the pan-Canadian public health communicable diseases surveillance and outbreak management project (Panorama).
- Performed laboratory validation of Public Health Reporting Data Warehouse Sexually Transmitted Infections and Bloodborne Infections Datamart.
- Supported projects to move water testing results from a legacy server/database to the Sunquest Laboratory Information System platform.
- Performed scenario and end-to-end testing for the upgrade of Children's and Women's Health Centre Laboratory Laboratory Information System from Sunquest 6.1.2 to Sunquest 6.4.
- Performed validation, scenario and end-to-end testing for change in report distribution vendors (Medinet to Excelleris).

Laboratory Surveillance & Outbreak Response

- Coordinated STAT laboratory testing and surveillance for BC measles outbreaks.
- Worked with Lower Mainland Laboratories Anita Kwong, Cathy Chong and Dr. Mel Krajden and many others (as part of a Provincial Task Force) on EVD preparedness related to specimen testing, transport and standardized response.
- Provided an EVD toolkit and documents for submitting specimens (*Sending Site Transport and ERAP Procedure for Suspect EVD Testing*).
- Enhanced our business continuity plan to include new processes for Surge Teams, and launched three Surge Teams for cross-program coordination and training for influenza testing.
- Coordinated many enteric and respiratory disease clusters/outbreaks across BCPHMRL Programs, BCCDC and health authorities: 427 in 2013 and 461 in 2014.
- Provided national coordination on outbreaks with the Laboratory Liaison Technical Officer Program, NML Winnipeg.
- Participated in national public health laboratory surveillance programs including FoodNet, PulseNet and PulseNet Plus (Whole Genome Sequencing).
- Conducted surveillance for antibiotic resistance for *N. gonorrhoeae*, *N. meningitidis*, Carbapenemase-Producing Organisms (CPOs), and the *M. tuberculosis* complex.
- Conducted outbreak support for vaccine-preventable illnesses and clusters (4 in 2013, 2 in 2014).
- Partnered with the Molecular Microbiology & Genomics Program to enhance our validation processes and procedures for rapid approval by the Public Health Laboratory Director, e.g., in October 2014 we implemented an enterovirus D68 assay.

Laboratory Technical Support Services

- Provided high quality speciality liquid media for the legislated drinking water program.
- Provided specialized culture media for bacterial testing programs.
- Worked with the core BBBC Team to provide safe, efficient biowaste stream management.

Molecular Microbiology & Genomics

- Collaborated with the Public Health Advanced Bacteriology/Mycology Program for the following improvements:
  - ✓ Optimizing use of the elongation factor gene (tuf) sequence to identify *Staphylococci* for clients province-wide.
  - ✓ Development of real-time PCR assays to detect Shiga toxins from isolates and enrichment broths, increasing accuracy and decreasing TAT.
  - ✓ Verification of the sensitivity of current PCR assays for the detection of *Chlamydophila pneumoniae*, *Mycoplasma pneumoniae* and *Legionella pneumophila*.
  - ✓ Development of real-time detection assays for Health Care Acquired Infections (HCAIs) due to emerging CPO pathogens.
  - ✓ Development of a PCR subtyping assay for the six major subtypes of verotoxigenic *E. coli*, increasing accuracy and efficiency.
- Collaborated with the Virology Program for the following improvements:
  - ✓ Urgent validation of PCR assay, then optimization of a real-time PCR assay for enterovirus D68 outbreak surveillance.
  - ✓ Validation of a PCR test targeting the novel coronavirus E protein gene (upE).
  - ✓ Standardization of PCR assays for increased productivity and decreased TATs.
  - ✓ Conversion of the herpes simplex/varicella zoster PCR assay from two duplex to a single four-plex assay, reducing TAT, labour and costs while providing a more sensitive assay.

- ✓ Development of PCR assay templates and reports to simplify loading and reporting of PCR assay results while reducing possible transcription errors .
- ✓ Modification of the PCR assay for the detection of mumps virus to include all circulating strains for improved detection.

- Development of DNA sequencing and PCR capacity for emerging influenza viruses including avian influenza H7 and H5 subtypes.
- Worked with the Mycobacteriology/TB Program to develop an in-house PCR assay for the detection of *Mycobacterium avium/ intracellulare* complex replacing a commercial system to decrease costs.
- Developed a PCR assay to detect Chikungunya virus, partnering with the Virology and Zoonotic Diseases & Emerging Pathogens (ZEP) Programs for this emerging infection.
- Developed a pan-flavivirus PCR assay to detect flavivirus for cerebrospinal fluid detection (including West Nile virus).

Quality Management Systems

- Internal Quality Audits and other accreditation activities for the College of American Pathologists (CAP), including a successful inspection by a USA public health laboratory team of auditors in 2013.
- Accreditation work to ensure Diagnostic Accreditation Program (DAP) of BC successful audit (2014).
- Improved tools, trained auditors then implemented and completed standardized Internal Quality Audits.
- Created standardized analyses, metrics and templates for quality control for nucleic acid amplification testing (NATs), educating and implementing in all Programs.
- Standardized processes related to entry of events into the provincial Patient Safety Learning System.
- Partnered in the improvement of the BCCDC telephone tree communication tool.
- Improved management of Health Shared Services BC testing kits by creating a client database to identify clients/usage.
- Improved Enhanced Water Quality Assurance (EWQA) audit tools for 17 laboratory drinking water systems.
- Collaborated across all Programs through the Continuous Quality Improvement Team for laboratory-wide best practices quality.

2013-2014 Program Highlights

Our seven testing Programs include:

- **High Volume Serology**
- **Environmental Microbiology**
- **Mycobacteriology / Tuberculosis (TB)**
- **Parasitology**
- **Public Health Advanced Bacteriology / Mycology**
- **Virology**
- **Zoonotic Diseases and Emerging Pathogens (ZEP)**

Lane Level – High Volume Microbial Serology

- Rolled out the fully automated syphilis immunoassay for increased efficiencies.
- Improved testing efficiency by automating *Helicobacter pylori* serology testing.
- Updated the instrument technology used for infectious diseases serology by validation and verification of six new high throughput analyzers.
- Provided outbreak serological testing for measles and mumps outbreaks.
- Published on the improvements for care of HIV pooled NAT and the benefits of adopting 4th generation HIV (combined antigen and antibody) testing.
- Partnered with BCCDC Clinical Prevention Services to pilot online testing for HIV, hepatitis C, syphilis (GetCheckedOnline).
- Continued to manage increases in HIV, hepatitis C and syphilis testing related to the Seek and Treat for Optimal Prevention (STOP) HIV/AIDS Project, now rolling out province-wide.
- Receiving/triage staff supprt of Lower Mainland Laboratories Central Call Service when needed.

Environmental Microbiology – Water and Food Safety

- Partnered in water and food safety initiatives with the Fraser Health, NML, Provincial Health Services Authority (PHSA), PHAC including FoodNet and PulseNetPlus.
- Trained on WGS to better understand *C. botulinum*, *Campylobacter* and *Salmonella* advanced genomic tools for food safety.
- Partnered on a large scale (national, interdisciplinary) Genome Canada grant applying metagenomics and WGS for better tools fror water quality.
- Responded to a *Legionella* cluster, developed a better laboratory PCR test and partnered with Fraser Health.
- Detected the source of a large foodborne outbreak of *E. coli* O157.
- Responded to the chia seed food source outbreak of *Salmonella*.
- Introduced a new endotoxin test across BC to meet updated standards for renal dialysis.
- Implemented a new water safety indicator test (PCR) to meet new standards for recreational water testing guidelines.
- Prepared a Canadian Water Network report on molecular methods for better environmental health monitoring.

- Detected and genotyped agents causing disease from over 200 norovirus outbreaks, detecting the emergence of a new (GII.4 Sydney) strain.
- Partnered with Fraser Health on a prospective study to determine pertussis toxin antibody levels in pregnant women.
- Lead Surge Teams including strategic PCR automation methods (Liguid Handler) and Surge Training to support the Virology Program.

Mycobacteria/TB – Lead in Containment Level 3

- Developed a new PCR test for *Mycobacterium avium* complex to improve TATs.
- Updated the hsp65 *Mycobacterium* species database for faster, more accurate identification for patients.
- Extended weekend hours for sample processing and acid-fast bacilli smears to improve TATs.
- Innovated through research collaborations to MIRU-VNTR fingerprint and WGS of TB strains in BC.
- Leveraged research on *M. tuberculosis* genotyping (MIRU-VNTR) to create a database in BioNumerics for improved laboratory molecular epidemiology.
- Performed rapid WGS to determine the epidemic status of a long-term *M. tuberculosis* outbreak in Interior Health.
- Validated a cost-saving immunochromatographic test strip for rapid identification of *M. tuberculosis* from isolates for better TATs.
- Led all Programs with the Biosafety Biosecurity Biohazard Containment Program on better Containment Level 3 pratices.

Parasitology – Reference

- Provided leadership for trans-Canada malaria screening of "Persons Under Investigation" for EVD.
- Developed a new BC Parasitology Telepathology service, improving communications with experts and clinicians and medical microbiologists through image-sharing and reference response.
- Partnered with the ZEP Program to optimize PCR to improve diagnosis by rapid detection of *Entamoeba histolytica* from liver abscesses.
- Ongoing validation of *Toxoplasma gondii* from patients with invasive disease with ZEP experts.
- Continued West Nile virus surveillance with positive mosquito pools confirmed by the ZEP Program using PCR.
- Collaborated with ZEP on questions of exotic parasitic infections with medical microbiologists and infectious disease clinicians across BC such as Baylisascaris, strongyloidiasis.

Public Health Advanced Bacteriology/Mycology – Advanced Public Health and Reference

- Partnered with health authorities, Ministry of Health, NML and the Provincial Infection Control Network (PICNet) on new BC guidelines and surveillance tools for emerging HCAIs for CPOs. Led first year CPO surveillance.
- Responded to outbreaks caused by *E. coli* O157.
- Identified multiple enteric outbreaks including a BC cluster of *Salmonella* Newport.
- Partnered with Environmental Microbiology (food/water) to respond to a large international outbreak of multi-*Salmonella* serotypes (including Newport and Hardford) linked to chia seeds.
- Ongoing response support for outbreaks of pertussis (whooping cough).

- Active surveillance of STI in men who have sex with men (MSM) by testing extragenital sources for chlamydia/gonorrhea by molecular tests.
- Partnered with BCCDC Clinical Prevention Services to pilot testing for gonorrhea and chlamydia testing (GetCheckedOnline).
- Identified recent re-emergence of Lymphogranuloma venereum (chlamydia) in MSM population in BC through enhanced surveillance.
- Heightened surveillance and information sharing of multidrug resistant *Neisseria gonorrhoeae*.
- Implemented automated PCR for *N. gonorrhoeae* and *Chlamydia trachomatis* infections responding to increased test volumes by increased efficiencies.

Virology – Public Health and Reference Services

- Responded to requests for Middle East respiratory syndrome coronavirus.
- Rapidly verified NML EVD PCR, trained staff and implemented with 24/7 on-call EVD response using a new PCR assay for PUI.
- Responded to neurological complications following an increase in Enterovirus D68 and detected 180 cases in this enhanced surveillance.
- Surged to respond to influenza testing and investigated many influenza-like illness outbreaks with public health partners across BC.
- Provided rapid PCR testing for measles and mumps outbreaks.
- Introduced an improved and standardized real time PCR protocol, allowing multiple viruses to be detected in one run.
- Collaborated across other Programs to optimize automation (Liquid Handler) for testing efficiency.

Zoonotic Diseases & Emerging Pathogens – Rare and Exotic Diseases

- Repatriated and implemented *Coccidioides* (invasive fungus) and diphtheria/tetanus immune status testing to reduce costs and TATs.
- Optimized processes in the Public Health Laboratory Network linking decentralized initial (Latent TB) with centralized complex Interferon-Gamma Release Assay testing.
- Expanded the Interferon-Gamma Release Assay Program to five additional provincial sites with the Public Health Laboratory Network.
- Optimized *H. pylori* drug susceptibility surveillance to monitor treatment failure.
- Implemented a real-time, pooled PCR method to detect *B. burgdorferi* DNA for improved Lyme disease detection.
- Applied for and carried out an externally-funded 2-year Lyme field surveillance project (mice and tick sampling) to update distribution of possible Lyme disease vectors.
- Re-located high volume testing for *H. pylori* and syphilis screening to Central Processing and Receiving Microbiology for increased efficiencies and improved ergonomics.
- Optimized a new testing algorithm for confirmatory syphilis testing for better detection of latent cases to improve prevention (by treatment).
- Collaborated to diagnose unusual infections (Baylisascaris, strongyloidiasis, angiostrongylus) with Parasitology Program.

Academic Contributions

Our teams work together on applied public health research projects and here is a summary of some work done in 2013 and 2014.

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Abbreviations & Acronyms

BC	British Columbia
BCCDC	BC Center for Disease Control
BCPHMRL	BC Public Health Microbiology & Reference Laboratory
CAP	College of American Pathologists
CPHLN	Canadian Public Health Laboratory Network
CPO	Carbapenamase-Producing Organisms
DAP	Diagnostic Accreditation Program
EWQA	Enhanced Water Quality Assurance
EVD	Ebola Virus Disease
HC	Health Canada
HCAI	Health Care Acquired Infection
HPTA	Human Pathogens and Toxins Act
MSM	Men who have sex with men
NAT	Nucleic acid amplification testing
NML	National Microbiology Laboratory
PCR	Polymerase chain reaction
PHAC	Public Health Agency of Canada
PHO	Provincial Health Officer
PHSA	Provincial Health Services Authority
PICNet	Provincial Infection Control Network
RG4	Risk Group 4
TAT	Turnaround time
TB	Tuberculosis
WGS	Whole genome sequencing
ZEP	Zoonotics and Emerging Pathogens [Program]