



BCCDC Laboratory Services
 2004 ANNUAL REPORT



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

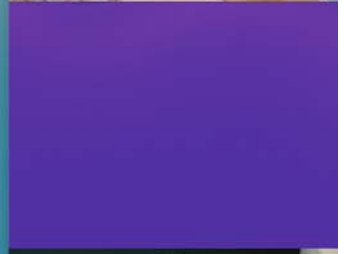


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Transforming Diagnostics. Better Health. Transforming Surveillance & Response. Better Public Health.

Judith L. Isaac-Renton, MD, DPH, FRCPC

Medical Laboratories are essential to health care, to the public health. Due to drivers so familiar to many, sustainability and the ability to improve are threatened. Thus, like all laboratories, the British Columbia Public Health and Reference Unit, BCCDC Laboratory Services, is in a state of ongoing change.

As part of the Provincial Health Services Authority (PHSA), we are working with our laboratory partners, our clients and our many stakeholders, to address the challenge: to remain sustainable in the context of new and expensive technologies, changes in medical practices, enhanced surveillance while improving public health and reference microbiology services. We are creating new synergisms with other PHSA Laboratories as part of the strategy.

Over the past five years, BCCDC Laboratory Services has moved from being the old, familiar “Prov Lab” to being an integrated set of Discipline Clusters supported by our cross-discipline Programs in Biohazard Containment and Biosafety, Molecular Services and the Quality Team. We have been guided by our five year goals:

- To be leaders in Molecular Services
- To be leaders in Quality Management
- To be leaders in Laboratory Informatics

We are proud to be able to point to our success, as a team, in meeting our five-year goals.

We are proud to be able to point to our success, as a team, in meeting those goals. Now, as we integrate more fully into PHSA Laboratories and create other new and exciting partnerships, we have a new vision to guide us forward.

The vision of PHSA Laboratories is: Transforming diagnostics. Better health.

As a key partner in PHSA Laboratories, the BCCDC Public Health and Reference Microbiology Laboratory vision is:

- Transforming surveillance & response. Better public health.

2004 was a challenging year. We responded to an unprecedented number of Norovirus outbreaks. We were part of crucial collaborations in response to the outbreak of Avian Influenza in BC. We continued to introduce new molecular microbiology methods tools including the fingerprinting and DNA sequencing of clusters of Group A *Streptococci*, *Clostridium difficile* and *Neisseria meningitidis*. And we made more progress on previously introduced molecular methods: HSP identification for mycobacterial isolates, further RTPCR and genotyping of Norovirus, PCR for detection and genotyping *Giardia* and *Cryptosporidium* in drinking water, hepatitis genotyping, Influenza A detection and typing, PCR for syphilis fingerprinting and susceptibility testing and the introduction of new molecular West Nile virus tests.

We will continue to be guided by our new vision.

You will see that we have continued to make progress, despite the pressures to change. Now, as we look forward in 2005, change is accelerating; change to our Laboratory Information Systems (we are part of a very large PHSA-wide implementation of Misys System) and change to how we work in partnerships, with new collaborations with key partners such as the Provincial Laboratory Co-ordinating Office (PLCO) on genomics, Healthy Water, Molecular Microbiology and Quality Management Systems. We will continue to be guided by our new vision.

Crucial to our success, as a public health laboratory, has been the support of our partners and I want to take this opportunity to thank them, particularly our public health colleagues, for their continuing support and encouragement to continue to make a difference. This includes our PHSA partners, BC's Provincial Health Officers, the BC Lab Network, BC's Medical Health Officers and Environmental Health Officers and members of the Canadian Public Health Laboratory Network (CPHLN).

My sincere thanks to all the BCCDC Laboratory Services staff for their continuing hard work and support. A particular thanks to those who are going the extra mile to make our vision reality.

Our report this year demonstrates some of the ways in which we are meeting the mandate of a Canadian public health laboratory, how we are improving our capacity to respond to the core functions and capabilities of a Canadian public health laboratory. You will find feature reports that focus on communicable disease surveillance and response, such as the intensive collaboration to detect West Nile virus in BC. A report on our outbreak response capacity highlights the unusually high number of Norovirus outbreaks, especially those related to oysters. We are proud of our efforts to improve the quality of BC's drinking water and we have included a report on those efforts.

The implementation of new molecular microbiology methods in support of public health gets special attention and we have focused, as well, on the substantial educational and research component of our mandate.

Annual reports are an opportunity to highlight achievements and recognize the accomplishments of the year just past. I am pleased to be able to do that. I am also proud of the outstanding work that goes into making up the other 90% of the iceberg that doesn't make it into this report.



Networked & Integrated

PHSA Laboratories

A central focus of the past year has been the construction of the new PHSA Laboratories on the lane level of BCCDC. Once operational, the PHSA Laboratory will provide centralized, automated accessioning of specimens for all referred-in tests for laboratories in the PHSA network and will provide high volume testing facilities, continuing the development of integrated services across PHSA Laboratories.



Once operational this new centralized, efficient “front-end” for all PHSA Laboratories will provide automated accessioning triage and processing for specimens for all laboratories in the PHSA network

The highly automated operations of PHSA Laboratories will accommodate high volume testing (and some related public health testing to achieve optimal efficiencies) from a variety of PHSA agencies





Networks

One of our strengths as a public health and microbiology laboratory is our ability to call on our colleagues within BC, nationally and internationally to compare findings, seek advice and partner on exciting new science. We are partnered directly and through networks of laboratories with the following:

International

- Centers for Disease Control and Prevention, Atlanta, GA
- Washington State Public Health Laboratories
- PulseNet North/Canadian Laboratory Surveillance Net (CSLN)
- ArboNET
- CampyNet

National and Pan-Canadian

- Canadian Public Health Laboratory Network (CPHLN)
- McGill Centre for Tropical Disease Malaria Proficiency Testing Program
- National Enteric Surveillance Program (NESP)
- PulseNet Canada/Canadian Laboratory Surveillance Net (CSLN)
- Canadian TB Laboratory Technical Network
- Laboratory Biosafety Advisory Council
- Canadian Association for Clinical Microbiology and Infectious Disease
- Emergency Response Assistance Plan (ERAP) for British Columbia, ERAP NO: 2-0746-007
- National Enhanced Water Quality Assurance Program (NEWQA)
- Community and Hospital Infection Control Association (CHICA)

Provincial

- PHSA Laboratory Enterprises
- BC Health Officers Council (HOC)
- BC Directors of Environmental Health
- BC Chapter, Canadian Association of Medical Microbiologists (BC CAMM)
- BC Association of Laboratory Physicians (BC ALP)
- British Columbia's Health Authorities
- BC Provincial Infection Control Network (PIC Net)
- Department of Pathology and Laboratory Medicine, University of British Columbia
- British Columbia Institute of Technology (BCIT)

BCCDC

- BCCDC Laboratory Bioterrorism Response Advisory Team (BRAT)
- Laboratory Biosafety Advisory Council
- Executive Management Team

Core Functions & Capabilities

Meeting the Mandate

The mandate of BCCDC Public Health and Microbiology Reference Laboratory is to carry out public health, reference, medical, environmental and specialty microbiology. We lead through integrated, program-based services. As an integral part of the PHSA laboratories, we are part of a team delivering province-wide solutions leading to better health.

The Canadian Public Health Laboratory Network (CPHLN), a collaborative of public health leaders from across Canada, has enunciated the core functions of a Canadian public health laboratory. While recognizing regional differences in both needs and capacity to respond, the CPHLN has identified ten core functions that all public health laboratories in Canada should strive to provide. The document is available at <https://www.cphln.ca/CPHLN/src/documents/CoreFunctionsEnglish2.pdf>.



Core Functions & Capabilities of a Canadian Public Health Laboratory:

- Communicable disease surveillance, prevention & control
- Outbreak & emergency response to communicable diseases
- Environmental health & food safety
- Reference testing, specialized screening & diagnostic testing
- Biosafety, containment & biohazard spill response programs
- Integrated communicable disease data management
- Public health policy development & evaluation
- Laboratory improvement & regulation (Quality Assurance)
- Training & education of health care and public health workers
- Public health-related research & development

BCCDC is seen as a model public health agency in other jurisdictions in Canada. As an essential partner in the BCCDC it is with these core functions and capabilities in mind that we pursue our goals.

Members of the Canadian
Public Health Laboratory
Network



Communicable Disease Surveillance & Response

Communicable disease surveillance, prevention & control is a central mandate of a Canadian public health laboratory. Our efforts over the last year have included a focus on West Nile virus surveillance and an improved response to diagnosing suspected malaria cases.

Mosquito Surveillance in BC for West Nile virus

In the spring of 2004, Parasitology, Zoonotic Diseases & Emerging Pathogens, BCCDC Epidemiology Services and 16 Health Service Delivery Areas throughout British Columbia began a second season of intensive surveillance of mosquitoes. Mosquito surveillance serves as an indicator for West Nile virus activity. It was also to be used to determine which mosquito species might serve as a vector for West Nile virus in BC.

At the beginning of the surveillance season, mosquito traps were set up at predetermined locations within each Health Authority. The contents from each mosquito trap were frozen and sent to the Parasitology Section each week.

No West Nile Virus was found in any of the mosquito pools for the 2004 surveillance season.

By the end of the surveillance season (May 2004-October 2004) 1969 trap containers were submitted to the Parasitology Section. From these 1969 submissions, 4857 mosquito pools (containing a maximum of 50 mosquitoes in each pool) were identified. A total of 52,657 mosquitoes were identified during the 2004 surveillance. The following genera (only *Culex* and *Coquilletidia* were speciated) of mosquitoes was identified in BC this year: *Aedes* spp., *Anopheles* spp., *Coquilletidia perturbans*, *Culex* spp., *Culex pipiens*, *Culex tarsalis*, *Culex territans*, and *Culiseta* spp.. From each trap, mosquitoes were sorted on a chill table (to prevent denaturation of the RNA) and identified to the genera/species level in the Parasitology Section. Mosquitoes from the same genera/species were pooled and forwarded to the Zoonotic Diseases & Emerging Pathogens Molecular Section for PCR. No West Nile Virus was found in any of the mosquito pools for the 2004 surveillance.



Sorting mosquitoes on a chill table



West Nile virus Planning Meeting

On January 27, 2004, Dr. M. Morshed (Zoonotic Diseases & Emerging Pathogens Section, BCCDC) and Dr. M. Fyfe (Epidemiology Services, BCCDC) organized a West Nile virus BC Planning Meeting. Dr. Harvey Artsob, Director, Zoonotic Diseases and Special Pathogens, National Microbiology Laboratory, Health Canada in Winnipeg and Dr. Eric Young, Deputy Chief Medical Health Officer, Saskatchewan Ministry of Health shared their experiences on WNV with the group. Participants included medical health officers, environmental health officers, epidemiologists, microbiologists, veterinarians, wild life biologists, entomologists, communication specialists and other health professionals. A timeline of tasks that required attention to prepare for the upcoming mosquito/WNV season was discussed. These included finalizing the BC Arbovirus Plan; reviewing mosquito species/habitats in different regions of BC; deciding if abatement activities will be carried out at regional/municipal levels; ensuring correct permits/licenses are obtained; establishing corvid surveillance; establishing mosquito testing protocols; developing communications strategies; initiating surveillance (bird, mosquito, human, equine); responding to positive findings; and summarizing end of season results.

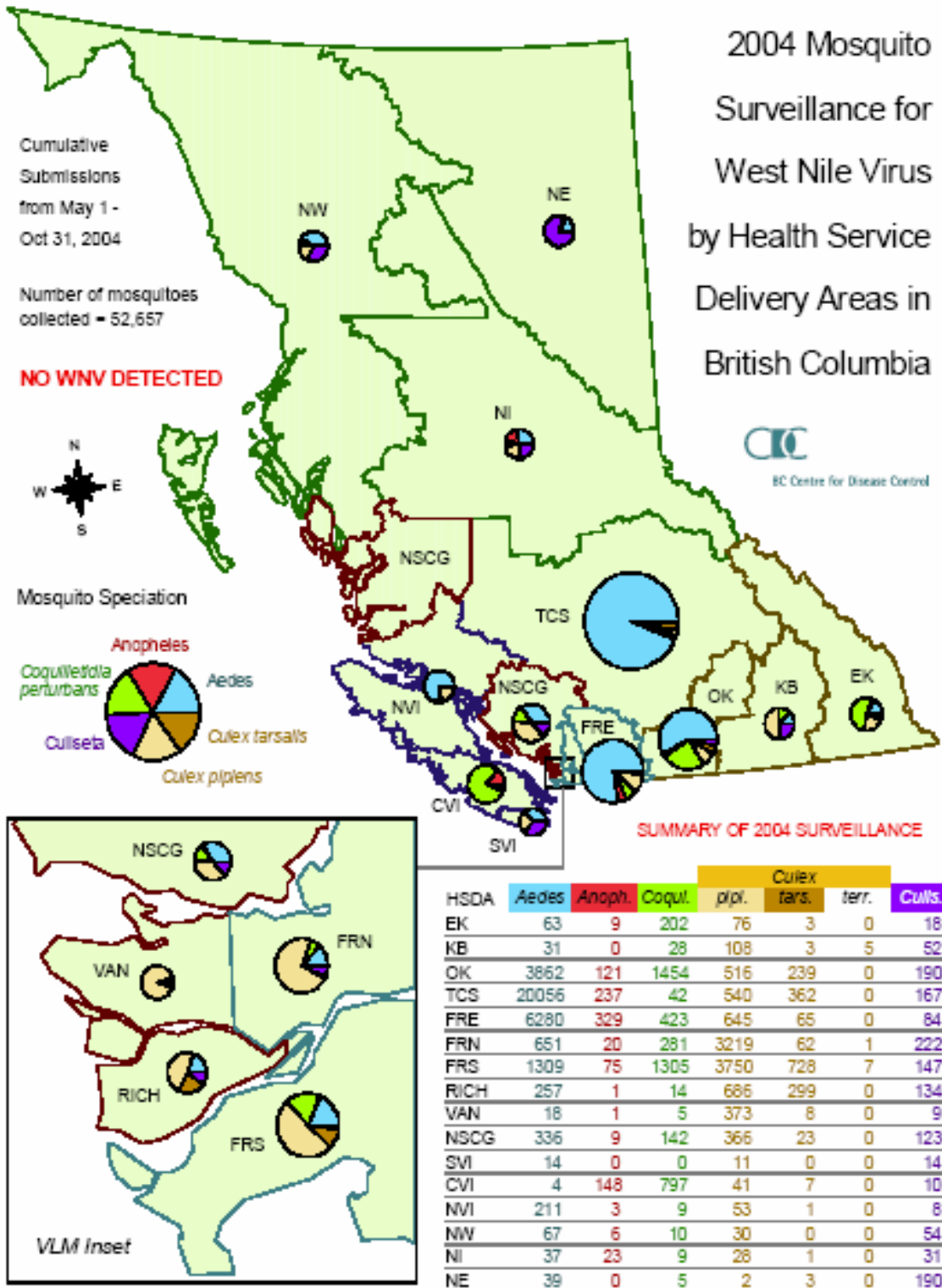
Malaria-on-call

Malaria continues to impose an enormous burden of illness and substantial mortality on the tropical world and in many subtropical regions. In BC we continue to see a number of cases of malaria each year, mainly due to travel or immigration.

Four species, *P. falciparum*, *P. vivax*, *P. ovale* and *P. malariae*, commonly infect humans. *P. falciparum* infection can rapidly progress to severe malaria. As malaria is potentially lethal but preventable, the diagnosis of malaria is an urgent matter. All requests for malaria diagnosis should be handled on a "stat" basis. In 2004, the Section began offering a 24/7 malaria-on-call service for the province.

Malaria Species Identified	
<i>Plasmodium falciparum</i>	12
<i>Plasmodium vivax</i>	8
<i>Plasmodium malariae</i>	0
<i>Plasmodium ovale</i>	2
<i>Plasmodium</i> species	1

2004 Mosquito Surveillance for West Nile Virus by Health Service Delivery Areas in British Columbia



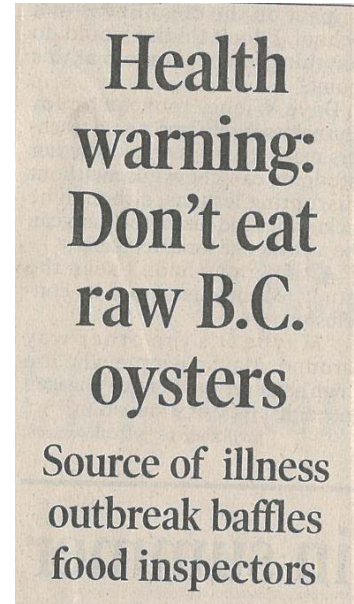
Mosquito Surveillance Map Courtesy of Epidemiology Services, BCCDC

Outbreak Response

Outbreaks of gastrointestinal disease can be caused by a variety of food and water borne pathogens. BCCDC works closely with partners in BC and across Canada to identify and respond to disease outbreaks related to food.



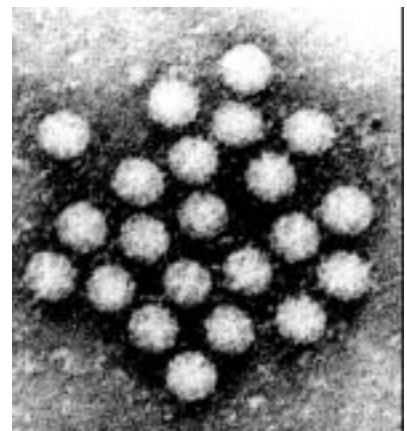
Self-harvested oysters from the Gulf Islands of BC



Norovirus in Oysters

The staff in BCCDC's Environmental Microbiology Food Poisoning Laboratory were challenged by a widespread outbreak of gastrointestinal disease related to oysters in 2004. While most warnings about oyster consumption are seasonal, 30 confirmed cases of Norovirus (and 54 clinical cases) were associated with oysters from early January to March and were widespread with no specific identifying association. BCCDC Laboratory Services collaborated with our colleagues in Epidemiology Services and with the Canadian Food Inspection Agency (CFIA) and the Interagency Research Group on Foodborne Viruses (IARGFV), St. Hyacinth, Quebec. The IARGFV, working with scientists from Agriculture and Agri-Food Canada and from CFIA developed a method to detect Norovirus in the oysters collected during the outbreak. Sequencing analyses confirmed that the strain of the virus found in one of the ill persons was that same as that detected in the oysters. 50% of all individuals confirmed with Norovirus had the same sequence pattern (Genogroup 1, BCCDC 03-028) although they consumed oysters from different harvest areas. Subsequent outbreaks involving oysters caused 300 cases of gastroenteritis (fund raising event) and children (camping trip).

Norovirus



Torovirus-like particles: evidence for an emerging pathogen in BC?

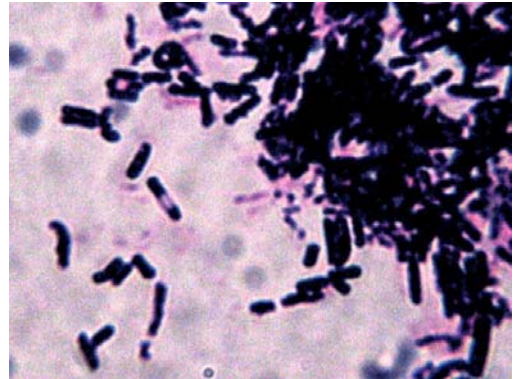
Torovirus is a member of the Coronaviridae family and is known to cause gastroenteritis in paediatric settings. From 1988 to 2000, there were 13 cases of Torovirus-like particles identified by electron microscopy in routinely submitted stool specimens. In 2004 over 80 cases were identified. Cases were evenly distributed by gender and geographically, though the particles were predominantly found in the young and elderly. Three of the outbreaks in 2004 involved catered functions suggesting an association with foods in addition to secondary person-to-person infection. BCCDC Laboratory Services and Communicable Disease Epidemiology Services will monitor the prevalence of Torovirus closely in 2005.

***Bacillus cereus*: continuing cause of food poisoning incidents in BC**

Bacillus cereus is a gram positive spore forming rod-shaped bacterium commonly isolated from environmental sources in soil. The spore is resistant to heat, freezing dry environments and pasteurization. If food is not stored at proper temperatures (below 10°C or above 60°C) the spore can germinate and vegetative cells can multiply to high enough numbers to cause food poisoning, usually associated with rice and noodles. Unusual with the outbreaks in 2004 was the association with BBQ chicken from supermarket delicatessens. We hypothesize that the BBQ sauce was the source of the bacterium and that poor storage practices (not hot enough) allowed multiplication of the bacteria.

Bacillus cereus bacteria and spores
(gram positive bacteria)
Magnification 1000X

Source: Food Poisoning Laboratory,
BCCDC.



Listeria monocytogenes

In 2004 there were 8 clinical isolates of *L. monocytogenes* from invasive sources and 2 from contaminated cheese made at an Ontario dairy. The isolates from the 2 contaminated cheese samples plus a blood isolate from a patient who had consumed the cheese were all serotype 4a. These 3 isolates also showed an identical pattern (Asc1-LMAC1.0185) when subjected to PFGE typing.

Waterborne pathogens are a significant cause of disease in BC, where most of our drinking water comes from surface sources.

We conducted the following investigations of suspected waterborne outbreaks in 2004.

***Campylobacter*- Investigation & Response**

A suspected waterborne outbreak of *Campylobacter* gastroenteritis occurred in the Okanagan region in January 2004. Six drinking water samples collected from different sources in the affected areas were submitted for examination. No *Campylobacter* was isolated from the water samples. Some samples were also tested for coliform bacteria and none was detected.

***Legionella pneumophila* - Investigation & Response**

In early 2004, we attempted to trace the source of *Legionella pneumophila* in a follow up investigation of a case of *Legionella* pneumonia in the Kootenay region. Six water samples were

collected, four from the patient's residence and two from the patient's work location were submitted for examination. No *Legionella* bacteria was detected in the water samples.

***Cyclospora* - Investigation & Response**

In the summer of 2004, a suspected *Cyclospora* outbreak was reported in the lower mainland implicating ditch water from a local farm as the source of the organism. A water sample was collected from a ditch in the farm and submitted for examination. Though *Cyclospora* was not detected in the water, the sample did yield an *E. coli* count of 57 per 100 mL.

***E. coli* O157:H7 - Investigation & Response**

An unusual outbreak of *E. coli* O157:H7 associated with a children's water spray park occurred in interior B.C. in the summer of 2004. In a follow up investigation for tracing the source of contamination, seven water samples from the park were collected and submitted for examination. Three storm drain samples were tested for fecal coliform, *E. coli* and *E. coli* O157:H7. Two chlorinated spray water samples were tested for fecal coliform and *E. coli* and two samples from the surge tank and filter backwash were tested for *E. coli* O157:H7 only. None of the five water samples examined yielded growth of *E. coli* O157:H7. The two spray water samples were culture negative for fecal coliform and *E. coli*. However, two of the three storm drain water samples did yield high counts of *E. coli* with 1,500 and 14,400 organisms per 100 mL of water.



Working in an anaerobic glove box

Cryptococcus Outbreak, Vancouver Island - Investigation & Response

The outbreak of *Cryptococcus neoformans var gattii* on Vancouver Island continued to be investigated. Of 24 isolates of *C. neoformans* submitted for confirmation and/or serotyping, 14 were *var gattii*. Ten additional isolates of *C. neoformans* were recovered from primary specimens in 2004. Of these 10 isolates, 3 were identified as *var gattii*.

Deep Mycoses - Containment Level 3 Testing

A total of 12 Risk Group 3 fungal pathogens were isolated or identified in 2004. Of these, 10 were identified as *Coccidioides immitis* and 2 as *Histoplasma capsulatum*. One of the cultures of *C. immitis* was isolated from a foot abscess which is an unusual source; this fungus is usually isolated from pulmonary sources. The patient from whom the isolate was obtained travels to California on an annual basis.

Molecular Identification of Aerobic Actinomycetes

The assessment of 16S rRNA sequencing for the identification of *Nocardia* species and other aerobic Actinomycetes is nearing completion. The method is proving to be cost efficient while allowing timely identification. These organisms are otherwise difficult to identify with the limited panel of biochemicals currently in use.



Containment Level 3 investigation

Preparedness

Biohazard Containment

During a threat to public health, including those caused by agents of bioterrorism, each province is responsible for safeguarding the health, security and well-being of its people. British Columbia's three certified Level 3 biocontainment laboratory facilities have become an integral part of the rapid response system. Emergency response processes and capabilities are continuously being evaluated and improved by the Office of Biohazard Containment in consultation with First Responders, Medical Health Officers, the Provincial Health Services Authority, the Provincial Health Officer and the Ministry of health's Emergency Preparedness Program.



At work in a Containment Level 3 Laboratory

Recent world bioterrorism events and plausible threats related to infectious agents have increased the need for maintaining accountability of microorganisms that cause disease. The Canadian Public Health Laboratory Network (CPHLN) and the Office of Biohazard Containment are currently developing an "integrated approach" biosecurity initiative for laboratories. As a first step, BCCDC has implemented a Materials Transfer Agreement to ensure both biological safety and biosecurity are accounted for before releasing biological materials to a facility for research or quality control purposes. We are one of the first laboratories in Canada to do so. The Director, the Head, Biocontainment Services and the Deputy Provincial Health Officer are collaborating to keep current our information on potential biological terrorism agents in clinical laboratories. In addition, the following biosecurity considerations will be applied as part of the BCCDC Biosecurity Initiative:

- Biosecurity Management
- Stock Culture Accountability
- Data and Electronic Tracking Systems
- Material Transfer Agreements
- Import/export Permit Procedures
- Transportation of Dangerous Goods (TDG)
- Facility Security Standards and Policies
- Risk Management Processes
- Countermeasure Assessment



The BCCDC Bioterrorism Response Team includes Medical Microbiologist, Epidemiologists, Biological Safety Officers and specially trained Containment Level 3 laboratory staff. The BCCDC Team works closely with the members of Bioterrorism Response Advisory Team, the Provincial Health Officer, local Medical Health Officers, First Responders and the Provincial Health Services Authority.

Representatives from all laboratory sections and the Office of Biohazard Containment serve on **Laboratory Biosafety Advisory Council**. All laboratory safety concerns are addressed at meetings through policy development, training and education.

Emergency Response Assistance Plan (ERAP) for British Columbia, ERAP NO: 2-0746-007

BCCDC Laboratory Services participates by providing a Provincial Response Team and a Provincial Response Coordinator for the federal government's ERAP for Risk Group 4 (RG4) infectious substances affecting humans. Edward Ratnarajah is the Provincial Response Team Leader. The Laboratory Services' medical microbiologist on call (any one of Drs. Isaac-Renton, Krajden, Black and Stephens) is also a member of the Response Team and is responsible to appraise the situation in an Emergency Call Report and to identify critical response issues. In all RG4 incidents, primary responsibility rests with the federal Centre for Emergency Preparedness and Response and with Transport Canada; responsibility for spill containment and clean-up rests with the Provincial Response Team.

Biological Response Advisory Team (BRAT) was a response template developed by Vancouver Coastal Health Authority in collaboration with others, including BCCDC Laboratory Services. This template has been recognized province-wide and across Canada. Biohazard Containment Services is working to ensure the currency of the BCCDC component of the BRAT.

Pandemic planning

The outbreak of avian influenza in BC brought home to us the importance of planning for a potential influenza pandemic. BCCDC Public Health and Microbiology Laboratory is well situated to provide the laboratory surveillance that will alert us to the presence of a pandemic influenza in BC and to provide the molecular testing that will track changes to the virus once it is established here. We continue to work closely with our partners in Epidemiology Services and with others in BC, across Canada and in the US to ensure that BC's health system can respond, should an influenza pandemic occur.

The outbreak of avian influenza in BC brought home to us the importance of planning for a potential influenza pandemic.

Avian Influenza

A large outbreak of avian influenza occurred in, Abbotsford, British Columbia in 2004. The virus that created havoc in BC's poultry industry was identified as H7N3.



BCCDC identified H7N3 in two BC poultry workers who were involved in chicken culling operations. Both workers fully recovered.

Avian influenza is a contagious viral infection caused by the influenza virus which can affect several species of food producing birds chickens, turkeys, quails, geese, as well as pet birds and wild birds. The disease, which was first identified in Italy more than 100 years ago, occurs worldwide.

Avian influenza viruses can be classified low pathogenic (LPAI) and high pathogenic (HPAI) forms based on the severity of the illness caused in birds, with HPAI causing the greatest number of deaths in birds. Most avian influenza viruses are of low pathogenicity and typically cause little or no clinical signs in infected birds. However, some low pathogenic viruses are capable of mutating rapidly into highly pathogenic viruses. There are many influenza subtypes, two of which include H5 and H7. Only the H5 and H7 subtypes are known to have become highly pathogenic in avian species.



In February 2004, the CFIA identified the presence of a low pathogenic H7 avian influenza in the Fraser Valley area of southern British Columbia. Subsequent tests revealed the presence of highly pathogenic H7 avian influenza in March 2004. The CFIA depopulated all infected flocks from which avian influenza was detected (42 commercial and 11 backyard premises) and pre-emptively destroyed all chickens in the surrounding three kilometre risk zones.

While H7N3 strain of avian influenza is not easily transmitted to humans. The BCCDC identified H7N3 in two B.C. poultry workers who were involved in chicken culling operations. Both workers fully recovered. The BCCDC, the BC Cancer Agency's Michael Smith BC Genome Science Centre and the Animal Health branch of the BC Ministry of Agriculture, Food and Fisheries collaborated in sequencing the H7N3 genome.

Better Public Health



Water Quality

The quality of British Columbia's drinking water has been the subject of a provincial auditor's report and requires constant monitoring. BCCDC's Environmental Microbiology provides leadership, surveillance and response plus many other value-added services (education, research) in environmental health. It's Enhanced Water Laboratory specializes in the detection of *Giardia* and *Cryptosporidium*, the two parasites responsible for most waterborne disease outbreaks in BC. The laboratory provides specialized testing service to water utilities and health units throughout BC to help ensure the supply of safe drinking water.

The laboratory is also actively involved in research studies that contribute towards source water protection and watershed management.

The Enhanced Water Laboratory successfully completed the validation of the most current analytical protocol for filtering and recovering *Giardia* cysts and *Cryptosporidium* oocysts from aqueous matrices. The use of the Filta-Max filtering system and immunomagnetic separation complies with USEPA Method 1623 which is now considered to be the international standard for protozoan monitoring and analysis. We performed an evaluation of an alternative immunofluorescence stain and found it to be superior in performance.

Further work is underway to validate a method in which water concentrates are to be extracted from microscope slides and processed for molecular genotyping. This, along with genotyping of zoonotic sources of *Cryptosporidium* and *Giardia*, will contribute to determining the significance of parasitic contamination of drinking water to public health.

Drinking Water Specialists

The Drinking Water Team includes the Head of Quality Management, the Drinking Water Specialists, the Medical Microbiologist for Environmental Services, the supervisor of Environmental Services, the Healthy Water Program Coordinator, and the Enhanced Water Quality Assurance Program (EWQA) Coordinator. This team works with the Ministry of Health Services and the Regional Health Authorities on drinking water testing quality initiatives.

Working with the Ministry of Health and all Health Authorities (Drinking Water Leadership Council), activities related to drinking water testing we are currently working on include:

- Development of best practices
- Education and training
- Public Health Audit program development
- Quality Incident investigation
- Informatics with the Ministry of Health Drinking Water Information Management Program (DWIMP)
- Quality network for drinking water testing
- Support of Provincial Health Officer's EWQA Program

We are currently developing a distance education course in water microbiology for water purveyors of medium to large water systems. This initiative is in collaboration with the British Columbia Water and Waste Association (BCWWA).

This Team currently supports nationally funded external research projects including:

- Canadian Water Network:
 - Watershed Predictors of Waterborne Cryptosporidiosis
 - Watershed Events and Waterborne Transmission of Cryptosporidiosis
 - Examining the relationships between community health data and pathogen occurrence in two geographically distinct watersheds
 - Options and innovations for Non-point Sources of Pollution Prevention and Water Resources management in the Lower Fraser Valley
- Canadian Institutes of Health Research
 - Globally Emerging Food and Waterborne Parasitic Diseases
 - Safe Drinking Water through Source Surveillance: Assessing Impacts of Environmental Factors and Microbial Contamination of Watersheds on Community Health
 - Impact of Water Quality Risk Factors on Gastro-intestinal Illness in a Rural-Urban Community
 - A pilot project on emerging food and waterborne parasitic disease in Vietnam
 - Bridge Program Grant “Bridging Public Health, Engineering and Policy Research”



Molecular Methods

We endeavour to provide better public health through the application of new technologies and molecular methods to public health and reference microbiology laboratory science. We are committed to research and to the development of innovative testing. BCCDC Molecular Core and Surveillance Program provides leadership in nucleic acid techniques for all BCCDC laboratories and serves as a centre for molecular-based platform technologies. Increasingly these technologies are making their way into our routine services. Among the collaborative projects underway are:

- Rapid Bacterial identification using partial sequencing of the 16S rRNA gene
- *Mycobacterium* species identification using partial sequencing of the 65 Kilo Dalton heat shock protein gene (*hsp65*) - decreased TAT to detection (weeks to days)
- Genotyping, lamivudine resistance and pre-core determination of Hepatitis B virus
- Sequencing of Norovirus cDNA to determine molecular epidemiology of the virus
- Detection of *Cryptosporidium* and *Giardia* species from environmental sources by Real-Time PCR
- Confirmation of *Plasmodium* species by real time PCR
- Detection of *Acanthamoeba* and *Mycobacterium* species in Corneal Ulcers by PCR
- Detection of Whipple's Disease bacterium by PCR Assay
- Detection of *Bordetella pertussis* by amplification of the toxin gene promoter region by real time PCR assay
- Detection of agents of atypical pneumonia by real time PCR assay (*Mycoplasma*, *Legionnaires* and *Chlamydia*)

Molecular Services uses species-specific PCR techniques to perform confirmatory identification testing for suspected agents of bioterrorism. These tests are part of BCCDC's Level 3 containment laboratory and Biosafety programs and specifically trained staff are certified to carry out this work.

Molecular Testing for Acanthamoeba

Keratitis caused by *Acanthamoeba* species and atypical *Mycobacterium* species present similarly clinically and are difficult to separate diagnostically.

The free-living amoeba *Acanthamoeba* has gained increasing clinical significance as the causative agent of a serious progressing keratitis, especially in contact lens wearers. Clinical diagnosis of *Acanthamoeba* is based on the presence of keratitis with severe pain and photophobia, stromal infiltrates, radial keratoneuritis and sometimes pseudodendritiform epithelial lesions. Culturing for the cysts and trophozoites of *Acanthamoeba* is the diagnostic gold standard, but is time consuming and requires considerable parasitological expertise.

Certain species of atypical *Mycobacterium* have been associated with keratitis. Like *Acanthamoeba*, culture for these species of *Mycobacterium* is time consuming. Prompt and accurate diagnosis of the organism can lead to appropriate therapy and resolution of the keratitis.

In collaboration with Dr. Simon Holland at the BC Eye Care Centre, eye samples from patients having a clinical picture of keratitis caused by *Acanthamoeba* or Atypical *Mycobacterium* were collected according to an agreed on protocol. The samples are processed so as to evaluate culture (gold standard) and PCR methods for *Acanthamoeba* species and atypical *Mycobacterium* species.

This project is ongoing and involves the Parasitology Section (coordination of this study and *Acanthamoeba* culture), the TB Section (atypical *Mycobacterium* culture) and Molecular Services (PCR for *Acanthamoeba* and atypical *Mycobacterium*) of BCCDC.

Respiratory Virus Diagnosis

Diagnosis of influenza viruses was implemented and assessed for validation from specimens collected from the 2003-2004 respiratory virus season. The procedure included extraction of viral genome nucleic acid with a Bio-robot (Qiagen) and testing for the presence of influenza virus by RT-PCR using a Taqman 7900 sequence detection system. The process enables the laboratory to offer same day to next day diagnosis on up to 96 specimens and has proven substantially more sensitive, specific and robust than direct immunofluorescence microscopy (DFA). Based on these findings we replaced DFA with RT-PCR and at comparable cost.

Enterovirus Diagnosis

A nucleic acid test (Nucleic acid sequence based amplification (NASBA) was implemented and evaluated in comparison with standardized cell culture isolation for validation purposes. This test complemented the previously introduced nucleic acid based tests for herpes simplex virus, herpes-group viruses and West Nile virus. This group of tests is essential for the timely (same day) diagnosis of encephalopathies and meningitides of viral etiology.

Herpes Type-specific Serology.

A Western-blot based approach with adsorption was introduced and partly evaluated for the detection of HSV-1 and HSV-2 specific antibody in patient sera. This test was implemented in response to requests from the STD clinic. The test will be available pending full validation.

Bayer Advia Centaur system

The Bayer Advia Centaur system was evaluated for the available tests for HAV, HBV, HCV and rubella. The findings were used in the awarding of the contract to Bayer to provide the Centaur/Lab Cell platform to promote the automation for high volume serology

Prognostic Assessment For Continuation Of Therapy

In 2003 the laboratory began testing specimens from HCV patients at week 12 of treatment to measure viral load by quantitative RT-PCR to serve as a prognostic assessment for continuation of

therapy. The cost saving to Pharmacare from this process for the treatment of 650 patients was estimated at approximately \$400,000 through 2004. This successful program is expected to continue to generate savings and to support patient management.

Cat Scratch Disease (*Bartonella henselae*)

Cat scratch disease (CSD) is caused by the bacterium *Bartonella henselae*. Most people with CSD have either been bitten or scratched by a cat, developing a mild infection at the point of injury. Lymph nodes, especially those around the head, neck, and upper limbs, become swollen. Additionally, a person with CSD may experience fever, headache, fatigue, and a poor appetite. People with immunocompromised conditions, such as those undergoing immunosuppressive treatments for cancer, organ transplant patients, and people with HIV/AIDS, are more likely than others to have complications of CSD. In 2003 we validated and implemented a commercial serological test. This year we have taken a new initiative to develop a PCR test.

Community Acquired Bacterial Pneumonia

Traditionally, bacterial agents of atypical pneumoniae represent a diagnostic dilemma to the clinician. These agents include *Chlamydia pneumoniae* (formerly *Chlamydia pneumoniae*), *Mycoplasma pneumoniae* and *Legionella pneumophila* (predominantly serogroup 1). Presently BCCDC has only the capability to culture for *Legionella pneumophila* and relies on acute and convalescent serology to detect infections with *M. pneumoniae* or *C. pneumoniae*. Nucleic acid tests (NAT) for these pathogens is both more rapid and more sensitive than culture or retrospective serology testing. We have developed nucleic acid detection assays for these agents from respiratory sources and, once the clinical trials are completed, they will be available as diagnostic tests.

Detection of *Bordetella pertussis*

Bordetella pertussis, the agent of whooping cough, is detected at BCCDC using a culture method supplemented with a validated PCR assay targeting the *Bordetella* species specific insertion sequence IS481. Although this PCR assay is well described in the literature for the detection of *B. pertussis*, the assay is not specific for *B. pertussis* alone. The BCCDC, in tandem with the Institute Pasteur in Paris has developed and is currently clinically testing the use of the new PCR assay specific for *B. pertussis*. The use of this test will exclude false positive results inherent in the use of the IS481 detection assay and also afford a more rapid testing platform as the test will be performed using a Lightcycler® real time PCR platform.



Antimicrobial Susceptibilities

Minimal inhibitory concentration (MIC) testing using appropriate NCCLS protocols is carried out in this section. Tests include the E-test on Mueller Hinton agar (5% sheep blood) for *Neisseria meningitidis*, beta lactamase and MIC tests for *Neisseria gonorrhoeae*. To date all isolates of *N. gonorrhoeae* remain susceptible to cefixime, ceftriaxone and spectinomycin whereas 15% or fewer of isolates are susceptible to penicillin and tetracycline. Resistance of *N. gonorrhoeae* to ciprofloxacin first appeared in 1992 and has risen to comprise 11% of isolates in 2004.

Susceptibility Testing

All new *M. tuberculosis* isolates are tested for drug susceptibility using the radiometric method. Isolates showing resistance to more than one drug are confirmed. Isolates showing resistance to isoniazid or rifampin are automatically tested against pyrazinamide in addition to the second line of drugs. BCCDC participates in the National Surveillance System for monitoring *M. tuberculosis* drug resistance patterns.

Susceptibility testing for *M. avium-intracellulare* (MAC) is available only following consultation. The section uses radiometric broth macrodilution method for determination of minimal inhibitory concentration (MIC). Mycobacteria that are rapid growers are tested for susceptibility to a standard panel of antibiotic agents. NTM isolates are tested for drug susceptibility on request of the physician.

Quality Management

Quality Team

Our quality initiatives in 2004 were concentrated on two major areas: work towards our goal of ISO 15189:2003 compliance and integration of BCCDC Laboratory Services Quality Management into the broader PHSA Laboratory Quality Council initiatives to develop, implement and sustain a Quality Management System (QMS) in all PHSA Laboratory sites. In addition to these initiatives, our accomplishments during the past year have included:

We are working with our partners to implement a Quality Management System in all PHSA Laboratories; our goal remains ISO 15189:2003 compliance

- Continuing work towards College of American Pathologists (CAP) accreditation
- Implementation of the QSI Document Control System. Completed QSI training in all sections. The Quality Manual Volumes I and II and approximately 25% of laboratory SOPs have been approved and released in QSI
- Coordination of Laboratory Services role in the Canadian Council of Health Services Accreditation Survey (survey result - successful)
- Participation on the PHSA Laboratory Quality Council
- Participation in the Quality Metrics sub-group, designated to develop and implement quality indicators to monitor the performance in selected work areas in all laboratory sites and in the new high volume Lane Level PHSA Laboratory
- Participation in the Medical Microbiology Program (MMP) and MMP Quality Team, designated to develop and implement integrated quality management system in all PHSA microbiology laboratories
- Documentation of project approvals using the newly implemented "Introduction and Validation of New Laboratory Methods Protocol for Laboratory Services." In 2004, 15 projects on a variety of public health initiatives including development or evaluation of laboratory test methods to detect microorganisms of public health significance were approved
- Implementation of the Occurrence Management Program in BCCDC
- Development and implementation of the Continuing Education strategic plan for Laboratory Services personnel. New criteria for travel/course attendance approval and employee appraisal have been implemented.
- Working with Staff Development Team on the development of BCCDC Laboratory Services Advanced Education Project Support
- Creation of the Quality Champions Team of representative from all laboratory sections and laboratory administration areas to work with the Quality Team and laboratory staff in implementing all the elements of Quality Management System in the laboratory
- Development and implementation of an enhanced quality assurance program in the laboratory
- Development of distance education course for water purveyors, Environmental Health Officers and Drinking Water Officers near completion
- Liaison with Enhanced Water Quality Assurance Program (EWQA) in the development of the program's quality management system based on ISO 9000:2000. Works closely with the EWQA Program Coordinator on other EQWA initiatives such as development of inspection questionnaires, site inspections and auditor training.
- Developed and facilitated a course module, web-based Certificate Course for Laboratory Quality Managers offered fully on-line through the Program Office for Laboratory Quality Management (POLQM) at the UBC Department of Pathology and Laboratory Medicine

Continuous Quality Improvement

The Continuous Quality Improvement (CQI) team reviews problems and identify methods to improve laboratory competency, efficiency and service use. Our accomplishments this year included:

Enterics

- Evaluation of Staten Institute Salmonella antisera for Salmonella. This was needed to replace sera from other manufacturers and provide very high quality sera.
- Chaperonin 60 ID of "Campylobacter like" organisms. Chaperonin 60 PCR and sequencing of final product gives a quick and accurate ID of Campylobacter/ Arcobacter/ Helicobacter isolates.
- ETEC (Enterotoxigenic E. coli, associated with traveller's diarrhea) PCR was evaluated for use on routine and outbreak stool samples. PCR method

Environmental Microbiology

- Implementation of Filtamax and IMS system for Giardia and Cryptosporidium detection to improve recovery rate and reduce slide reading time
- Work schedule change of laboratory technologists working on weekends to improve TAT and provide better client services
- Computerization of the Food Quality Check Program to improve efficiency of reporting and preparation of data summaries

General Bacteriology

- Introduction of an automated front-end handling system for the Chlamydia PCR test. This new system has reduced the potential for repetitive strain injury previously caused by manual processing.
- Institution of improved quality assurance procedures as recommended in the report for the Internal Quality Assessment (IQA) inspection performed May 2004
- Collaboration with Molecular Services to validate a method for sequencing 16S rRNA genes for the identification of Nocardia sp.

Molecular Services

- Replace the identification by traditional biochemical testing of Accuprobe negative Mycobacterium species with partial sequencing of the 65 Kilodalton heat shock protein and transfer the procedure to the mycobacteriology laboratory. Technology transfer occurred in a preliminary manner in late 2004 with full responsibility for Mycobacteria identification by sequencing transferred to the mycobacteriology laboratory January 1, 2005.
- Submit for publication data and information on partial sequencing of the 65 Kilodalton heat shock protein gene (hsp65) for the rapid identification of mycobacteria from phase two of a three phase study. Manuscript accepted and published in the Journal of Clinical Microbiology 2004; 42: 3000-3011
- Complete and submit for publication phase three of the hsp65 study which entailed the use of partial sequencing of the 54 Kilodalton heat shock protein gene for the rapid identification of mycobacteria directly from primary liquid detection media. Study completed December 2004 and data submitted for publication.

Mycobacteriology

- Heat shock protein implementation as part of the routine workflow for the MOTT bench for faster TAT
- Reporting of Gennprobe negatives to Victoria General Hospital
- Additional NIKON microscope for CL3 to improve the efficiency of reading positive slides in CL3.

Parasitology

- Malaria QA project which will use a light cycler PCR method for quality control of malaria specimens
- Malaria On-call 24/7 service to facilitate better client service.
- Filtering of all distilled water used in malaria slide staining which will eliminate any contaminants from the distilled water supply

Technical Support

- Addition of the autoclave/dispenser log sheets which allows the tracing of each lot of medium back to the autoclave and dispenser that was used.
- Implemented the use of denatured ethanol instead of ethanol to expedite ease of usage
- Allow staffing flexibility from environmental bacteriology to create surge capacity to meet increased workloads

Virology (Isolation and Molecular)

- Implementation of Influenza A and B PCR for the respiratory season to improve TAT and detection of influenza
- Implementation of in-house sequencing methodology to replace the Inno-LIPA for HCV genotyping at a saving of \$43,439.

Virology (Serology)

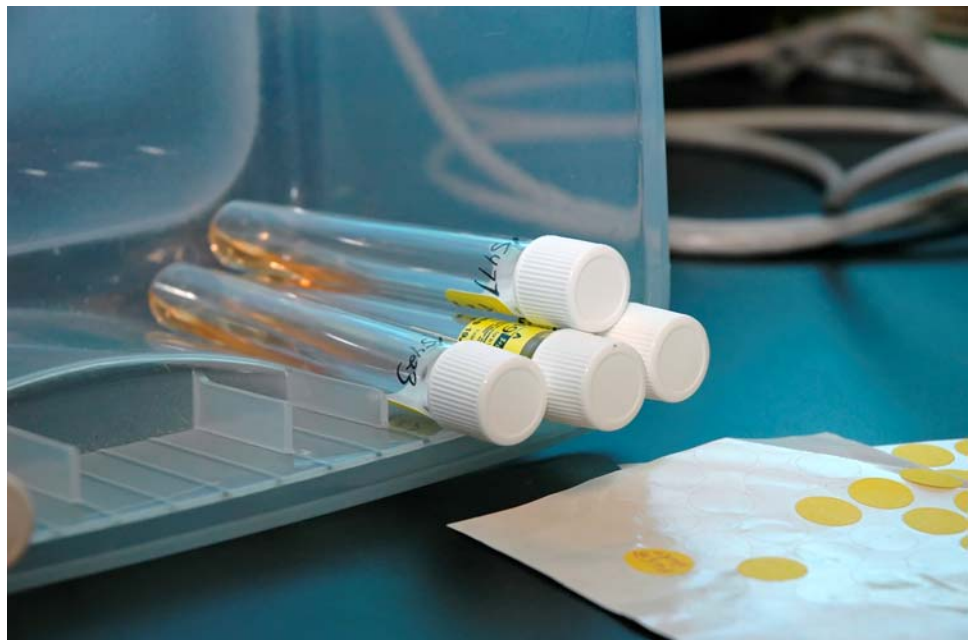
- Implemented an afternoon shift until 8:00 p.m. to improve TAT
- Testing in the primary tube for serology test to reduce the need for aliquotting specimens, improve TAT and reduce error
- Evaluation of Bayer Centaur serology markers in preparation for contract negotiations of high volume automation

Zoonotics & Emerging Pathogens (Serology)

- Evaluation of syphilis EIA on an automated platform to replace the manual RPR card test
- Evaluate plastic vacutainers's effect on results of the RPR test. The plastic vacutainer tubes will reduce the possibility of cuts due to glass breakage and increase the safety for the technical staff.
- Updated and transferred the ZEP serology procedure manual into the QSI system to have a standardized manual.

Zoonotics & Emerging Pathogens (Molecular)

- Implementation of real time PCR detection for WNV from Feather Pulp to increase detection for Corvidae surveillance for WNV
- Azithromycin resistance gene detection by RFLP for rapid screening for drug resistant syphilis
- PCR detection for Cat Scratch Disease to provide a new service of molecular detection in Bartonella spp.



Public Health Research & Development

External Research Funding

The Canadian Institutes for Health Research, the Canadian Water Network, the Natural Science and Engineering Research Council of Canada, and the Michael Smith Foundation for Health Research awarded external research grants to support research projects on SARS, Hepatitis C, and food- and water-borne parasitic diseases.

Canadian Institutes for Health Research (CIHR) Funding

- \$426,000 (2004-2006) to Dr. Isaac-Renton (PI) and others for assessing impacts of environmental factors and microbial contamination of watersheds on community health in a safe drinking water through source surveillance project.
- \$296,500 (2004-2008) to Dr. Isaac-Renton (PI) and others for studying the impact of water quality risk factors on gastro-intestinal illness in a rural-urban community
- \$100,000 (2003-2004) to Dr. Isaac-Renton (CoI) and others for a study on microbial risk assessment as a foundation for informed decision making
- \$96,500 (2004-2006) to Drs. Ong (lead PI), Isaac-Renton (CoPI) and others to study globally emerging food and waterborne parasitic diseases
- \$73,500 (2004-2005) to Dr. Ong (CoI) and others to develop advanced multiplexed diagnostic tools for the detection and molecular characterization of waterborne pathogens
- \$240,000 (2003-2006) to Dr. Krajden (PI) for a mathematical modeling for Hepatitis C virus infection public policy development project
- \$152,000 (2003-2004) to Dr. Krajden (CoPI) and others to develop a Canadian policy model for Hepatitis C: Estimating cost and quality of life
- \$600,000 (2003-2008) to Dr. Krajden (CoI) and others through an interdisciplinary capacity enhancement teams grant
- \$112,500 (2004-2005) to Dr. Krajden (CoI) and others for a study to establish the true prevalence of Hepatitis C co-infection among HIV positive individuals initiating antiretroviral therapy
- \$92,000 (2004-2005) to Drs. Krajden (CoI), Isaac-Renton (CoI) and others to study the impact of self sampling for human papillomavirus and targeted recruitment on uptake of cervical cancer screening in marginalized urban women
- \$500,000 (2003-2004) to Drs. Petric (CoI), Krajden (CoI) and others for a scientific collaboration on SARS to support public health response through vaccination



Canadian Water Network (Networks of Centres of Excellence)

- \$345,500 (2003-2005) to Drs. Isaac-Renton (PI), Ong (CoI), and others for a study on watershed events and waterborne transmission of cryptosporidiosis

Natural Sciences and Engineering Research Council of Canada

- \$116,000 (2003-2007) to Dr. Ong (PI) for a study on novel genotypes of *Cryptosporidium*

Michael Smith Foundation for Health Research

- \$578,000 (2003-2006) to Drs. Morshed (CoI), Isaac-Renton (CoI), Ong (CoI) and others for a research unit on animal determinants of emerging infectious disease
- \$204,000 (2003-2005) to Dr. Petric (PI) for SARS vaccine development

The external research funding we secure supports cutting-edge public health scientific investigation. We are proud of the recognition this represents

Public Health & Professional Committee, Editorial & Review Panel Memberships

Medical and senior scientific staff were invited to review grants submitted to the Canadian Institutes of Health Research, the Canadian Blood Services and the Michael Smith Foundation for Health Research as well as manuscripts submitted to Journal of Virological Methods, International Journal of Systematic and Evolutionary Microbiology and Science of the Total Environment.

Drs. Goh and Krajden serve as members of the Editorial Board of the Journal of Clinical Microbiology. Dr. Krajden is also an associate editor for the Canadian Journal of Infectious Diseases (Virology). Dr. Isaac-Renton is the Vice-Chair of the Canadian Public Health Network and a member of the Expert Working Group on Federal/Provincial Territorial Data Standards for Drinking Water Quality. Dr. Krajden is Chair, Advisory Committee of the National Canadian Research Training Program in Hepatitis C. Dr. Petric is Meeting Secretary and Councillor and Dr. Morshed a Councillor of the Canadian Association for Clinical Microbiology and Infectious Diseases and Dr. Ong is the Secretary, Associate Director of Education and a Board Member of the Stanier Institute. Drs. Petric and Isaac-Renton were also elected to the UBC Department of Pathology and Laboratory Medicine, Appointments, Re-appointments, Promotions and Tenure Committee.

Training & Education of Health Care and Public Health Workers



Academic & Educational Contributions

The training and education of health care and public health workers has been an important element in the success of BCCDC Laboratory Services and in meeting the mandate of a Canadian public health laboratory.

Presentations & Publications

BCCDC Laboratory Service staff published 20 papers, of which 17 were peer-reviewed articles in journals of medicine and science including 4 in the *Journal of Clinical Microbiology* and 3 in *Emerging Infectious Diseases*. Staff presented 66 lectures and posters at scientific meetings and conferences, including 24 invited lectures.

Invited Lectures at International and National Meetings

- 48th Annual Meeting of Canadian Society of Clinical Chemists and Canadian Association of Medical Biochemists
- Western Healthcare Improvement Network
- 2nd Canadian Conference on Hepatitis C
- 4th Annual Grand River Watershed Water Forum, Cambridge, Ontario
- Canadian Society for Microbiology Conference, Edmonton, Alberta
- The Stanier Institute Workshop on Impact of Hygiene in Canada, Vancouver, B.C.
- Canadian Association on Water Quality, Burlington, Ontario
- Emerging Public Health Threats - Tracking Infectious Diseases Across Borders Workshop. Bellingham, Washington
- The University of the West Indies, Mona, Jamaica
- University of Toronto Microbiology and Infectious Diseases Research Day
- Cross-border Terrorism Preparedness, Preparing for When the "What If" Happens, Whitefish, Montana

Invited Lectures at BC Events

- BC Ministry of Health Services Conference for Regulations of Drinking Water
- Hepatitis C Council of British Columbia
- St. Paul's Hospital iCapture Seminar Series
- Environment Canada Pacific Environmental Science Centre
- The 4th Annual Symposium on Zoonotics and Communicable Diseases
- BC Centre Disease Control Public Health Grand Rounds

We had a prominent presence at the 72nd Canadian Association for Clinical Microbiology and Infectious Diseases (CACMID) meeting in Regina in November 2004 where BCCDC Laboratory Services staff made 16 presentations and at the 2nd Canadian Conference for Hepatitis C in Vancouver in March 2004 with 10 presentations.

Other conference contributions included several key roles as:

- Organizer (Dr. Morshed) of 4th Annual Collaborative Meeting of the BC Centre for Disease Control and the Animal Health Branch, BC Ministry of Agriculture & Fisheries at the Ramada Abbotsford Inn and Conference Centre, Sep. 23, Abbotsford.
- Chair (Dr. Morshed) of 59th International Conferences on Diseases in Nature Communicable to Man (INCDNCM), Meeting held in Endicott College, Aug. 7-10, Beverly, Massachusetts, USA
- Organizers (Dr. Ong & Mr. Gamage) and moderator (Dr. Petric) at the Stanier Institute Workshop on the Impact of Hygiene in Canada, Feb. 26-27, Vancouver.
- Chair (Dr. Morshed) of a Symposium on Tick-borne Relapsing Fever and Lyme Borreliosis in North America at the Canadian Association for Clinical Microbiology and Infectious Diseases meeting, Nov. 7-10, Regina.
- Meeting Secretary (Dr. Petric) of CACMID. Coordinator of Program and Abstracts for CACMID Annual General Meeting, Regina, Nov. 2004 and AMMI/CACMID Conjoint Meeting, Ottawa, April 2005.
- Invited participant representing the Mycobacteriology section (Monica Ng) in the 10th annual meeting of the Canadian TB Laboratory Technical Network, March 7-9, Ottawa.
- Invited attendee (Dr. Goh) at the Eupertstrain meeting on European *Bordetella pertussis* molecular diagnostic standardization method and vaccine evasion review in September in Stockholm, Sweden.

Academic contributions at UBC

Medical, senior scientific and laboratory staff contributed significantly in numerous academic and research endeavours. A few of us were invited to sit on 3 graduate student research and thesis examination committees at UBC and at the University of Toronto.

At UBC, the MD Host Defences and Infection (Foundations of Medicine) block was chaired by Dr. Morshed and one of the weeks (Infections in a Global World) chaired by Dr. Ong, the BMLSc Path 327 course on Bacteriology, Mycology, Virology and Parasitology by Dr. Goh and the BMLSc Path301 course on Introduction to Medical Laboratory Science: Biological Chemistry by Dr. Ong. Lectures in these UBC courses as well as others such as those to postgraduate medical residents and pharmacy students were given by Drs. Isaac-Renton, Ong, Petric, Morshed and Krajden.

Three UBC directed studies students in the Pathology (Path 438) and Biology (Biol 448) Departments were also supervised by Drs. Goh and Ong. We also currently have two graduate students (both from the Dept. of Pathology and Laboratory Medicine, Drs. Isaac-Renton and Ong) and have trained 5 Co-operative program students (Drs. Krajden, Petric, Ong, Morshed and Goh) and 1 NSERC-USRA student (Dr. Ong) from various BC Universities (UBC, SFU, UVic). Dr. Petric presented a total of 12 hours of lectures for microbiology postgraduate students at the University of West Indies. He was also a member of the Medical Microbiology Residency Program Committee. Workshops were also organized for postgraduate medical residents, STD public health nurses, UBC BMLSc students, environmental health officers and BCIT Environmental Health students.

Other educational contributions

Our Provincial Infection Control Consultant, Bruce Gamage, participated in 17 public health educational events and presented lectures at 6 of these meetings.

The General Bacteriology section participated in the STD Control Training program (primarily for public health nurses) by holding the laboratory sessions in February, June and October. In March the Mycology section hosted the annual 2-hour mycology workshop for students enrolled in the UBC BMLSc Program. The section also participated in several laboratory tours conducted for community college students. Several Medical Residents spent training time in the section. In March the section hosted a medical microbiology resident and in December a dermatology resident spent a month in Mycology. The Mycology section also hosted a 2-day program in December for 6 medical residents.

As part of BCCDC's longstanding relationship with Vietnam, Ingrid Pocock and Tazim Rahim traveled to Vietnam for 2 weeks in April to assess potential laboratory sites for STD Clinics to be set up in the Mekong Delta. A second 2-week visit was made in November to begin training laboratory staff who will be working at the new laboratory sites. The STD Clinics are part of Laboratory Services work with BCCDC STD Control to set up STD Clinics and an Outreach Program in Vietnam, a CIDA-funded project.

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11. Tweed A, Paul A, Krajden M. Bleach as a Disinfectant for Drug Use Equipment: Questioning the Effectiveness in Preventing Hepatitis C Virus Transmission. In: Program and Abstracts, Second Canadian Conference on Hepatitis C, March 27-30, 2004, Vancouver, BC.
12. Money DM, Remple VP, Doyle P, Krajden M, Cole L, Patrick DM, Bigham M, Pi D, Schechter M, and the Vertical Transmission of Hepatitis C Study Group. Comparison Between the Rate of Detection of Hepatitis C Infection in Pregnant Women to Actual Seroprevalence in Pregnant Women in BC. In: Program and Abstracts, Second Canadian Conference on Hepatitis C, March 27-30, 2004, Vancouver, BC.
13. Buxton J, Patrick D, Wu W, Shadmani R, Krajden M. Epidemiology of Hepatitis C Infection Reported in British Columbia 1992-2003. In: Program and Abstracts, Second Canadian Conference on Hepatitis C, March 27-30, 2004, Vancouver, BC.

14. Shadmani R, Pourbohloul B, Buxton J, Butt G, Patrick D, **Krajden M**. Comparison of Individuals Tested for Hepatitis C and Descriptive Analysis of Hepatitis C Cases in BC. In: Program and Abstracts, Second Canadian Conference on Hepatitis C, March 27-30, 2004, Vancouver, BC.
15. Andonov A, Lin L, Wong G, Hill W, Boulos D, Tweed A, Barichello F, **Krajden M**, Booth T, Identification of Newly Acquired Hepatitis C Virus (HCV) Infection in British Columbia Based on Recent Seroconversion; Genotype Distribution for 2000-2003. In: Program and Abstracts, Second Canadian Conference on Hepatitis C, March 27-30, 2004, Vancouver, BC.
16. Shadmani R, **Krajden M**, Buxton J, Rock N, Butt G, Ford D, Anderson A. Clinical and Laboratory Characteristics of Hepatitis C (HCV) Clinical Cases Referred for Treatment to Vancouver Hospital Health Sciences Centre. In: Program and Abstracts, Second Canadian Conference on Hepatitis C, March 27-30, 2004, Vancouver, BC.
17. Butt G, Wong S, Rock N, Lee J, Dunn P, **Krajden M**, Three Years Experience Providing Comprehensive Viral Hepatitis Workshops. In: Program and Abstracts, Second Canadian Conference on Hepatitis C, March 27-30, 2004, Vancouver, BC.
18. A. Petrich, J. Mahony, S. Chong, G. Broukhanski, F. Gharabaghi, G. Johnson, L. Louie, K. Luinstra, N. Kreisworth, B.M. Willey, L. Chui, F. Jamieson, T. Karnauchow, M. Louie, T. Mazzulli, M. Petric, R. Tellier, M. Smieja, M. Chernesky, S. Poutanen, S. Richardson, Multicentre evaluation for detection of SARS coronavirus nucleic acid in stool specimens. 20th Annual Clinical Virology Symposium, Abst. M6. Clearwater FL, 2004.
19. LD Shaw, K. Ramotar, M. Petric, T. Karnauchow. Evaluation of the Realart HPA coronavirus LC RT-PCR (Artus) and the Light Diagnostics SARS Oligodetect (Chemicon) assays for the detection of SARS coronavirus RNA. 20th Annual Clinical Virology Symposium, Abst. M12. Clearwater FL, 2004.
20. J. Mahony, L. DeKoning, R. Spafford, A. Petric, M. Smieja, M. Chernesky, M. Petric, S. Richardson. Development of a novel amplified ELISA for the detection of SARS coronavirus IgM, IgG and IgA antibody. 20th Annual Clinical Virology Symposium, Abst. M16. Clearwater FL, 2004.
21. M. Smieja, J. Mahony, M. Petric, T. Mazzulli, M. Fearon, G. Hawes, D. Dick, T. Booth, L. DeKoning, R. Spafford, L. Hayes, S. Richardson. Inter-laboratory comparison of SARS serologic testing. 20th Annual Clinical Virology Symposium, Abst. M17. Clearwater FL, 2004.
22. T. Mazzulli, R. Chua, N. Kreiswirth, S. Pong-Porter, Y. Rzyayev, P. Ahkaven, A. McGeer, M. Petric, J. Mahony, BM Willey. Comparison of Euroimmune IFA and ELISA assays for the detection of IgG antibodies against SARS-CoV in serum. 20th Annual Clinical Virology Symposium, Abst. M18. Clearwater FL, 2004.
23. R. Chow, A. Mak, D. Jorgensen, D. Lawrence, R. Gillies, G. McNabb, M. Krajden, M. Petric. Comparison of nucleic acid testing with conventional culture methods for influenza A virus diagnosis. 20th Annual Clinical Virology Symposium, Abst. M49. Clearwater FL, 2004.
24. S.A. Tweed, D.M. Skowronski, S.T. Berger, M. Petric, A. Larder, C. Halpert, D. Lawrence, A Mak, M. **Krajden**, R. Tellier, T. Tam, Y. Li. Human illness due to Avian Influenza H7N3 in British Columbia. CACMID Abst. A4, Regina, 2004.
25. D.M. Skowronski, M. Petric, D. Lawrence, P. Birch, S.A. Tweed, P. Daly, R. Parker, R. Guasparini, D. Patrick, and the SIVI Group. Abst. A2, Regina, 2004.
26. D. Adachi, G. Johnson, E. Nagy, S. Richardson, M. Petric, R. Tellier. Molecular diagnosis of emerging virus strains in the clinical laboratory. CACMID Abst. C2, Regina, 2004.
27. A Mak, V. Lei, R. Chow, G. McNabb, M. Krajden, R. Brunham, SH. Goh, M. Petric. Influenza A virus genotyping. CACMID Abst. C3, Regina, 2004.
28. R. Chow, A. Mak, D. Jorgensen, D. Lawrence, R. Gillies, G. McNabb, M. Krajden, M. Petric. Influenza virus diagnosis: comparison of nucleic acid testing, cell culture and immunofluorescence microscopy. CACMID Abst. C4, Regina, 2004.
29. A. Mak, S. Byrne, R. Chow, V. Lei, D. Lawrence, G. McNabb, M. Krajden, M. Petric. Pan-Influenza A virus diagnosis and subtype identification by RT-PCR. CACMID Abst. C5, Regina, 2004.
30. G. McNabb, L. Difrancesco, P. Cook, P. Tsang, D. Cook, M. Petric, M. Krajden. Comparison of Abbott Architect and Bayer ADVIA Centaur for anti-HCV testing. CACMID Abst. P4, Regina, 2004.
31. G. McNabb, P. Cook, L. Difrancesco, R. Sunderji, P. Tsang, D. Cook, J. Isaac-Renton, M. Petric, M. **Krajden**. Quantifying Anti-HBs immunity: does a person with four watches really know what time it is. CACMID Abst. G2, Regina, 2004.
32. K. Gunadasa, K. Chu, H. Rowe, G. McNabb, D. Cook, M. Petric, M. **Krajden**. Minimal impact of the new linear range for the quantitative Amplicor COBAS HCV Monitor Test on week 12 viral load assessments. CACMID Abst. G3, Regina, 2004.

33. L. McIntyre, L. MacDougall, S. Berger, M. Fyfe, K. Louie, G. Eng, P. Daly, K. Schallie, E. Buenaventura, S. Liem, A. McNabb, J. Isaac-Renton, M. Petric. Norovirus gastroenteritis associated with oyster consumption in British Columbia in 2004. CACMID Abst. I2, Regina, 2004.
34. H. Sarantis, G. Johnson, M. Brown, M. Petric, R. Tellier. Molecular serotyping of adenovirus by PCR and sequencing. CACMID Abst. I3, Regina, 2004.
35. S. David, D. Skowronski, A. Tweed, T. Tuk, G. Danderfer, Y. Li, M. Krajden, M. Petric, G. McNabb, R. Gillies. Influenza A/Fujian in British Columbia, 2003/2004: Impact of a Novel Variant. Canadian Immunization Conference, Montreal, 2004.
36. M.G. Morshed, J.D. Scott, K. Fernando, L. Beati, D.F. Mazeroli, G. Geddes, L. A. Durden. Lyme Disease Spirochete Found in Avian Tick (*Ixodes auritulus*) in British Columbia. 59th International Conference on Diseases in Nature Communicable to Man. Endicott College, Beverly, Massachusetts, USA, Aug. 7-10, 2004
37. M.G. Morshed, L. MacDougal, K. Fernando, W. Bowie, R. Lindsay, K. Kooper, G. Maccauley. "Occupational Exposure to Hantavirus with Atypical Case Presentation in BC, 2002." Canadian Association for Clinical Microbiology and Infectious Diseases. Regina, Saskatchewan, Nov. 7-10, 2004.
38. Y. Simpson, R. Wada, Q. Wong and M Morshed. "Use of Euroimmun Biochip Mosaics for the Serological Diagnosis of Cat Scratch Disease." Canadian Association for Clinical Microbiology and Infectious Diseases. Regina, Saskatchewan, Nov. 7-10, 2004.
39. Adie K., A. McNabb, M. Amos, M. Rodrigues, W. Black, J. Isaac Renton. 2004. Assessment of Partial Sequencing of the 65 Kilo Dalton Heat Shock Protein Gene (hsp65) for the Rapid Identification of Mycobacteria Directly from Bac-T Alert 3D Bottles. American Society for Microbiology Annual General Meeting. May 23-27 2004, New Orleans Louisiana.
40. G. Geddes, A. McNabb, L. Janz, C. Shaw, S. Mithani, L. Stoakes, J. Isaac Renton. 2004. Identification of *Nocardia* species by Partial 16S rRNA Gene Sequencing. Canadian Society for Medical Laboratory Sciences Annual Joint Congress June 13-17 2004, Saskatoon, Saskatchewan.
41. G. Geddes, A. McNabb, L. Janz, C. Shaw, S. Mithani, L. Stoakes, J. Isaac Renton. 2004. Identification of *Nocardia* species by Partial 16S rRNA Gene Sequencing. Canadian Association for Clinical Microbiology and Infectious Diseases, 72nd Annual Conjoint Meeting, November 7-11 2004 Regina Saskatchewan.
42. Adie K., A. McNabb, M. Amos, M. Rodrigues, G. Stephens, B. Black, J. Isaac Renton. 2004. Cost Analysis of Partial Sequencing of the 65 Kilo Dalton Heat Shock Protein Gene for the Identification of *Mycobacterium* species. Canadian Association for Clinical Microbiology and Infectious Diseases, 72nd Annual Conjoint Meeting, November 7-11 2004 Regina Saskatchewan.

Invited Lectures:

1. J. Fung. Health Canada - Environmental Health Services Conference. Review of Coliform Testing on Drinking Water. Kelowna, 9-Dec-04.
2. Isaac-Renton JL, Priest J, Li A, Shay S, Ong C, Khan M and Lammie P. Environmental Effects on Drinking Water, Waterborne Pathogens and Human Serological Response, the British Columbia Experience. Canadian Association on Water Quality, Burlington, Ontario. Feb 10 & 11, 2004.
3. Isaac-Renton JL. Food and Water Infection Control. The Stanier Institute Impact of Hygiene in Canada Workshop. Vancouver, B.C. Feb 26, 2004.
4. Isaac-Renton JL. Drinking Water: Primarily a Health Issue. Canadian Society for Microbiology, Edmonton, Alberta. June 20-23, 2004.
5. Isaac-Renton JL, Ratnarajah E. BC's Public Health Bioterrorism Response. Emerging Public Health Threats - Tracking Infectious Diseases across Borders Workshop. Bellingham, Washington, USA. August 9-11, 2004.
6. Isaac-Renton JL. 4th Annual Grand River Watershed Water Forum. Cambridge, Ontario, Canada. Sept 17, 2004,
7. Isaac-Renton JL. Framework for Monitoring Drinking Water Systems. Ministry of Health Services Conference for Regulations of Drinking Water. Vancouver, BC November, 2004.
8. M. Krajden "Laboratory Assays, HCV." Presented at BC Hepatitis Program: A Forum to Review the 2004 Canadian Consensus Guidelines, Vancouver, BC, Feb 7, 2004.
9. M. Krajden "An Intersectoral Approach to Hepatitis C Prevention and Care." Presented at the Second Canadian Conference on Hepatitis C, Vancouver, BC, March 27, 2004.
10. M. Krajden "Interpreting HCV Laboratory Test Results." Presented at the Second Canadian Conference on Hepatitis C, Vancouver, BC, March 29, 2004.

11. **M. Krajden** "Building the Hepatitis C Clinical Trials Network." Presented at the Second Canadian Conference on Hepatitis C, Vancouver, BC, March 29, 2004.
12. **M. Krajden** "SARS and the Public Safety Net." Presented at the Western Healthcare Improvement Network, Vancouver, BC June 22, 2004.
13. **M. Krajden** "Review of History of Hepatitis C Epidemic, Treatment and Policy Response in British Columbia and Canada" Presented at Strategies and Solutions for Improving Access to Hepatitis C Treatment and Care in British Columbia, Vancouver, BC, November 6, 2004.
14. **M. Krajden** "Hepatitis C as a Roadmap for Integrated Communicable Disease Prevention and Control." Presented at the Hepatitis C Council of British Columbia, Victoria, BC, November 14, 2004.
15. **L. McIntyre.** Health Canada Industry Review Meeting. Norovirus Update. Vancouver, March 30, 2004.
16. **L. McIntyre** 2004 Pacific Rim Shellfish Meeting. Norovirus in Oysters: BC Experience. San Francisco, USA, 25-27-May 2004.
17. **L. McIntyre.** NOWECOMM. Oysters without Borders: infections up and down the coast: a BC experience. Vancouver, October 16, 2004.
18. **L. McIntyre.** La Fondation des Gouverneurs, Les virus d'origine alimentaire et environnementale liens avec la sante. Gastroenteritis Outbreaks in BC - Cruise Ships and Oysters. Seminar on Food Viruses. St. Hyacinth, Quebec, 16,17 Nov 04.
19. **L. McIntyre.** CFIA Education Day. Gastroenteritis Outbreaks in BC - Cruise Ships and Oysters. Burnaby, December 13, 2004.
20. **M. Morshed.** "BCCDC Bioterrorism Event Response" Cross Border Terrorism Preparedness Preparing for When the "What If" Happens. Big Mountain Resort, Whitefish, Montana, May 19-20, 2004.
21. **M. Morshed.** Summary Report of International Conference on Diseases in Nature communicable to Man. 4th Annual Symposium on Zoonotics and Communicable Diseases. Abbotsford, BC, Sept. 23, 2004.
22. **C. Ong.** Environment Canada Pacific Environmental Science Centre, North Vancouver, BC, Nov 2004 (Lecture) "Contamination Source Inference in Waterborne Cryptosporidiosis Outbreaks".
23. **M. Petric** University of Toronto Microbiology and Infectious Diseases Research Day, SARS Experience in BC. Epidemiologic findings, Diagnostic Tests, Vaccine Development. June 2004.
24. **M. Petric** 48th Annual Meeting of Canadian Society of Clinical Chemists and Canadian Association of Medical Biochemists, SARS-CoV: Viral Diagnosis and development of Candidate Vaccines. Jun 2004
25. **M. Petric** 4th Annual Symposium on Zoonotics and Communicable Diseases, Abbotsford, BC. Human Infections with Avian Influenza Virus. Sep 2004
26. **M. Petric** The Second Translational Research in Infectious Disease Thematic Research Symposium. SARS Experience in B.C. Epidemiologic Findings, Diagnostic Tests and Vaccine Development. Dec 2004.
27. **M. Petric** The Department of Microbiology, The University of the West Indies, Mona, Jamaica. SARS Experience in B.C. Epidemiologic Findings, Diagnostic Tests and Vaccine Development. Dec 2004.

Invited Lectures at local BC health authorities, hospitals, public health facilities, UBC, BCIT and BCCDC

28. **B. Gamage.** Tuberculosis Prevention. BC Legal Services Society. January 21, 2004.
29. **B. Gamage.** MRSA presentation. Capilano Care Centre. February 2, 2004.
30. **B. Gamage.** Blood and Body Fluid Presentation. Fraser Health Authority, Westminster House, March 10, 2004.
31. **B. Gamage.** Routine Precautions. Kinsmen Place Lodge, March 25, 2004.
32. **B. Gamage.** MRSA in Prison. Mountainview Penitentiary, June 28, 2004.
33. **B. Gamage.** Infection Control presentation OHSAH training day, June 29, 2004.
34. **B. Gamage.** Blood and Body Fluid Presentation. Capilano Care Centre, Sep 2, 2004.
35. **B. Gamage.** Blood and Body Fluid Presentation. Capilano Care Centre, Sept 30, 2004.
36. **B. Gamage.** APIC Chapter. Emerging Infections. Puget Sound, October 28, 2004.
37. **B. Gamage.** Chain of Infection. Boundary Bay Montessori School, November 30, 2004.
38. **B. Gamage.** Blood and Body Fluid Presentation. Capilano Care Centre, December 15, 2004.
39. **J. Fung.** Enhanced Water Quality Assurance Workshop. QAWG Initiatives for Standardization and Consistency. Vancouver, 27-Oct-04.
40. **Isaac-Renton JL.** Drinking Water Issues for Pediatricians. Children's & Women's Hospital, Vancouver, British Columbia. April 30, 2004.
41. **Isaac-Renton JL.** Public Health Grand Rounds. Enhancing Public Health Surveillance: New Tools and New Approaches. April 2, 2004.
42. **L. McIntyre.** Enhanced Water Quality Assurance Workshop. An Auditor's Experience on Consistency Among Auditors. Vancouver, October 28, 2004

43. L. McIntyre. Fraser Health Authority Education Meeting. Fraser Health Authority In Service. Burnaby, November 24, 2004.
44. M. Krajden Grand Rounds: Hepatitis C. 2004
45. M. Petric Grand Rounds, BC Centre for Disease Control. Avian Influenza. May 2004
46. M. Petric Grand Rounds, BC Centre for Disease Control. SARS-Coronavirus: One Year Report. June 2004
47. M. Petric iCapture Seminar Series, St Pauls' Hospital, Vancouver. SARS Experience in B.C. Epidemiologic Findings, Diagnostic Tests and Vaccine Development. Oct 2004.

Conference Participation (Organizer, Keynote Speaker, etc.)

1. M.G. Morshed. Organizer - 4th Annual Collaborative Meeting of the BC Centre for Disease Control and the Animal Health Branch, BCMAF at Ramada Abbotsford Inn and Conference Centre, Abbotsford, BC. Sept..23, 2004.
2. M.G. Morshed. Chair - Symposium on Tick-borne Relapsing Fever and Lyme Borreliosis in North America. Lecturer: Dr. Tom Schwan, Acting Chief and Senior Investigator, Rocky Mountain Laboratories, Montana, USA. Canadian Association for Clinical Microbiology and Infectious Diseases. Regina, Saskatchewan, Nov.7-10, 2004.
3. C. Ong. Organizer - Stanier Institute Workshop on the Impact of Hygiene in Canada, Vancouver, BC, Feb 2004.
4. B. Gamage. Organizer - Stanier Institute Workshop on the Impact of Hygiene in Canada, Vancouver, BC, Feb 2004.
5. M. Petric. Moderator - Stanier Institute Workshop on the Impact of Hygiene in Canada, Vancouver, BC, Feb 2004.
6. S. H. Goh. Invited Participant. Eupertstrain meeting: European Bordetella pertussis molecular diagnostic standardization method and vaccine evasion review. September 2004, Stockholm, Sweden.
7. M. Ng. Invited Participant. The Canadian TB Laboratory Technical Network 9th Annual Meeting, Ottawa, Mar 7-9, 2004.
8. B. Gamage. Invited Participant. VIRAP Session. Purdy Pavilion, UBC, October 27, 2004.
9. B. Gamage. Invited Participant. VIRAP Session. Richmond Hospital, November 4, 2004.
10. B. Gamage. Invited Participant. VIRAP Session. Richmond LTC (Pine Grove), November 29, 2004.

Educational Contributions

UBC Courses:

11. B. Gamage. HCEP 520. Control of Communicable Disease Course - Principles of IC, March 15, 2004.
12. J. Isaac-Renton. FMED401 P2P2, Host Defense and Infection, UBC Medicine year 1
13. J. Isaac-Renton. PATH327. BMLSc undergraduates.
14. J. Isaac-Renton. OCCH595. Occupational and Environmental Hygiene Seminar
15. M. Krajden MEDI 580A Hepatitis C virus. 2004
16. M. Krajden FMED401 Virology Intro Test validation & diagnostics. 2004
17. M. Krajden FMED401 GI Division Molecular pathology of viral hepatitis. 2004
18. M. Krajden HCEP 520 Lab Methods for the Epidemiologist. 2004
19. M. Krajden CIHR-UBC Strategic Training Program for Translational Research in Infectious Diseases students. HCV Burden of Disease. Feb 20, 2004
20. M. Petric PATH327 undergraduate course BMLSc program. 8 hours of lecture in viral structure, replication and pathogenesis and respiratory viruses, Herpesviruses, HIV, hepatitis viruses and gastroenteritis viruses. 2004
21. M. Petric FMED401 Host Defense and Infection, UBC Medicine year 1. 2 hours of lecture on clinical features, Pathogenesis, epidemiology and diagnosis of Parvovirus B19, CMV, HHV-8, HHV-6, EBV and Hepatitis viruses. 2004
22. M. Petric PGY 2 - 5 BCCDC Medical Microbiology Resident Orientation. Overview of Clinical Virology, 2 hours, 2004-12-01
23. C. Ong. PGY 2 - 5 ID & Med Micro Residents. 1 hr on research projects at BCCDC.
24. C. Ong. PHAR448, Pharmacy undergraduates. 1 hr on Water Pollution (Microbial).
25. C. Ong. PATH301, BMLSc undergraduates. 15 hrs on Proteins

26. C. Ong. PATH521, graduates. Introduction to the Pathogenesis of Human Disease. 1 hr. on Protein Structure & Function. Jul 7, 2004
27. C. Ong. CIHR-UBC Strategic Training Program for Translational Research in Infectious Disease students. Molecular epidemiology of cyclosporiasis. Jul 9, 2004.
28. A. Trinidad. POLQM, web-based Certificate Course for Laboratory Quality Management. Regulatory Framework of Laboratories. February to March, 2004 (4 weeks)
29. M. Morshed. FMED 401, Introduction of Host Defense and Infection Block, 2004.

Other Courses & Educational Activities:

30. M. Petric U. of West Indies, Mona, JA. Microbiology Postgraduate Lecture Series. 12 hour lecture series on structure and replication of DNA and RNA viruses, viral pathogenesis, hepatitis viruses, gastroenteritis viruses, human immunodeficiency virus and influenza viruses.
31. B. Gamage. Medical Laboratory Infection Control. BCIT, May 17, 2004.
32. L. McIntyre. 3rd Year Public Health Inspectors. BCIT ENVH 8400 - Research Methods. Burnaby, September 27, 2004.
33. L. McIntyre Medical Laboratory Assistant Education Day. Infant Botulism and Food Poisoning. Surrey. June 5, 2004.
34. L. McIntyre. Medical Laboratory Assistant Workshop. Introductory Microbiology. Vancouver, September 29, 2004.
35. A. Trinidad. Review of Applications for Approval and Pre-Visit Preparation. EWQA Auditors' Workshop, Vancouver, October 27, 2004. Vancouver