

Revolutionizing the Diagnostic of Infectious Diseases with SMART CDs that “read” DNA in a Few Minutes

MICHEL G. BERGERON, MD FRCPC
Professor and Chairman

Division of Microbiology and Infectious Diseases Research Center
Université Laval, Québec City, Canada
2705, boul. Laurier, Sainte-Foy (Québec) G1V 4G2

In 2005, infectious diseases continue to be the primary cause of mortality in the world. The recent episodes of SARS, *Clostridium difficile*, SARM, West Nile, Wakerton *E. coli* episode and mad cow disease remind us of the impact of infectious diseases. Today, as in the time of Pasteur, it still takes at least two days to identify microbes responsible for infections or for environmental disasters. Most diagnostic technologies are expensive, slow, require highly skilled personnel, and are not practical for point-of-care or field applications. This lack of rapid tests results in imprecise diagnosis, inappropriate therapy, over-use of antibiotics, development of drug resistance, high health care costs, and difficulty in controlling epidemics. To be useful to physicians and their patients, results need to be available in less than one hour. The development of rapid and affordable molecular and DNA-based diagnostic tests for human infections is the most highly rated category of the top ten WHO priorities for health improvement in the developing world.

Since the elucidation of DNA structure in the 1950s, increasingly sophisticated molecular technologies, such as PCR, large-scale automated sequencing, and microarrays have been developed. While these technologies are useful for research scientists, direct applications of genomics impacting the life of the average citizen are still in their infancy.

Our team has made numerous important breakthroughs in molecular diagnostics by exploiting genomic information to develop useful tests for the rapid (<1h) detection of DNA and RNA targets from infectious agents. For example, we developed the first and only two FDA-approved real-time PCR assays to detect Group B Streptococci and Methicillin-resistant *Staphylococcus aureus* (MRSA). We are also currently developing rapid detection tests for Vancomycin Resistant Enterococci (VRE) and multi-resistant *Streptococcus pneumoniae*, SARS and *C.difficile*. Now we need new technologies for detection of many more microbes simultaneously and their antimicrobial resistance genes.

To be able to detect multiple microbes simultaneously in the doctors' office, we are developing "smart" point-of-care compact discs (CD) that will read the DNA (finger prints) of microbes responsible for infections like pneumonia which, for example, may be caused by up to 30 different pathogens or even septicemia which may be caused by more than 200 microbes. By merging genomics, nanotechnologies, microfluidics, biosensor technologies and microarrays, we are now developing low cost point-of-care SMART CD devices that can combine sample preparation, nucleic acids' (DNA-RNA) extraction, concentration, purification and detection without the need for prior amplification.

As more of these point-of-care rapid (< 1 h) tests are developed, they will revolutionize clinical practice and give public health authorities the tools of the future to better control epidemics like SARS, recognize bioterrorism threats or detect unsafe drinking water. The worldwide market of nucleic acid detection devices for infectious diseases will reach 10 billion \$US in 2010. These technologies will also have broad applications for human, animal, plant and other microbial genetic analysis. The overall economic impact of these new diagnostic technologies should be substantial, as it will generate employment in high tech sectors (e.g. biotechnologies, micro-nanofabrication, optics, DNA chips), specialized manufacturing facilities and high value added products.

These SMART diagnostic tests will also save lives, improve health and diminish health care costs.

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