PHAC-MITACS Joint Symposium on Modeling Sexually Transmitted and Blood-Borne Infections

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The symposium brought together a group of modelers and public health experts in sexually transmitted blood borne infections (STBBI), to identify significant public health knowledge gaps in modeling STBBI in Canada, and to develop opportunities for interdisciplinary collaboration.

The workshop was held shortly after the International STD Research Meeting in Seattle (July 29–August 1, 2007), to ensure maximal impact of the workshop on the Canadian policy towards the study of sexually transmitted and blood-borne infections. One of the objectives of this symposium, set before it took place, is to form a national focus group on modeling sexually transmitted and blood-borne infections that is capable of "making recommendations to research funding agencies". Also, it was anticipated that an immediate goal of this multidisciplinary network is to develop research proposals and apply for seed funding from the Public Health Agency of Canada (PHAC) and to make recommendation to various agencies about the role of mathematical modeling for the management of sexually transmitted and blood-borne infections. The great facility already in place at BIRS facilitated communication between group members of markedly differing backgrounds, to a degree that enhanced the success of the symposium. The quality of the meeting and beauty of the setting led to very enthusiastic support for subsequent meetings[1], which will ensure the long-term impact of this gathering.

The symposium started with remarks by Dr. Tom Wong (PHAC), which described the meeting objectives as 1). to identify and prioritize public health knowledge gaps in modeling STBBIs; 2). to develop STBBI collaborative modeling research teams to draft high public health priority proposals to address gaps; and 3). to give advice to various agencies on the role of mathematical modeling for STBBIs. His open remarks were followed by a brief introduction of Dr. Jianhong Wu (MITACS Centre for Disease Modeling at York University) to the growth of Canadian industrial and applied mathematics facilitated by BIRS, and in particular to the research and outreach activities of a MITACS team on modeling infectious diseases.

Five invited talks were carefully selected in order to stimulate the general discussions for fruitful collaboration. Dr. David Fisman (Ontario Public Health Laboratories Branch) talked about High School-Based Chlamydia Screening: Projected Health and Economic Impact in Philadelphia. In 2002, Philadelphia had the 2nd highest rate of reported Chlamydia infections among major urban areas in the United States. 38% of these cases occurred among 15-19 year olds. Consequently, with the support of the Philadelphia Schools and Health Commissioners, the Philadelphia high-school screening program for gonorrhea and Chlamydia was initiated in January 2003. Because both economic and political forces have the potential to threaten

[1]Indeed, there were multiple sub-projects developed. In addition, a few meetings have been organized to follow-up the agendas of the BIRS Symposium such as the PHAC-MITACS-INSPQ workshop "Genital Herpes and HPV Modelling for Public Health Workshop" held at the MITACS Centre for Disease Modelling on May 29-30, 2008; and a NAHO workshop in Ottawa (May 22-23, 2008) to address the importance with regard to sexually transmitted and blood borne infectious for First Nations, Inuit and Merits Communities.

Philadelphias high school screening program, it became important to evaluate the economic attractiveness of the Chlamydia screening component of this program; in short, to answer the question of whether the program represented money well spent. The study presented by Dr. Fismen chose to base cost, effectiveness and cost-effectiveness estimates on a mathematical dynamic model that takes into account the fundamental transmissibility of a sexually transmitted infection such as Chlamydia. This approach allowed the projection of the health and economic benefits of such important components of the Philadelphia screening program as inclusion of males. Indeed, few available economic analyses of Chlamydia screening incorporate the effects of screening males on downstream health consequences in females. This approach also allowed the assessment of the potential impact of rebounding Chlamydia prevalence on the economic attractiveness of screening. The study projected that school-based screening for Chlamydia in Philadelphia public high schools is likely to reduce both disease and net medical costs. When program administrative costs are incorporated into the analysis, the program remains extremely cost-effective relative to commonly accepted preventive interventions. These findings are robust in the face of wide-ranging sensitivity analyses. It was noted that the use of a model that incorporates transmissibility permits identification of non-linear health and economic effects unlikely to be seen with fixed risk models, including the attractiveness of screening males for Chlamydia, and delineation of the time required for health agencies to break even on their investment in population health. In this analysis, screening of both males and females, or males alone, emerge as likely more efficient and more effective than screening limited to females in a high-school population.

Pauline van den Driessche (University of Victoria) talked about her recent work on spread of gonorrhea among the Ariaal. After some detailed description of the unique culture in the studied region, she depicted the Rendille/Ariaal HIV networks and discussed the available survey data, based on which four subpopulations in Ariaal culture were identified (single males (moran); single females (nykeri and others); married males (wazee); married females (mamas)). She pointed out that the 1996 survey in Ariaal settlement of Karare quantified a high level of heterosexual mixing, and discussed the preliminary goal of modeling analysis as to testing the hypothesis that gonorrhea can spread in this population without a core group (i.e. without CSWs). For this purpose, a further survey was conducted in October 2003 (based on a UNAIDS questionnaire). In this Ariaal 2003 data, 100 individuals in each of four subpopulations responded to questions on behavior and number of partners in the past month and year. This permitted the calculation of the mean and variance of numbers of partners. She then formulated the compartmental model under the assumption that gonorrhea confers no immunity on recovery and has a very short latent period (ignored). Her model takes the form of SIS structure in each subpopulation, and she focused on the 11 year period so there was no change in marital status and no entry into sexually active population. The calculated basic reproduction number is always less than 1 under a variety of biological realities, indicating that gonorrhea is not expected to persist in the population with age-structured mixing. Therefore, persistence of disease must be due to factors not included, e.g. a core group of CSWs and long distance truck drivers, and/or concurrency. That motivated the 2005 survey of CSWs in order to obtain more data for an extended model study.

Tom Wong (PHAC) presented a global picture about Canadian surveillance of STIs and hepatitis C. He summarized the disease features and challenges in terms of surveillance and modeling, for a long list of diseases important for Canadian public health including Chlamydia, Gonorrhea, Syphilis, LGV, HSV, Genital Herpes, Human Papillomavirus and Hepatitis C. He then provided evidences to support the research that takes into account population lens such as street youth and vulnerable populations including immigrants and aboriginal, and these evidences directed greatly the afternoon discussions and the development of a few projects (see below). His talk touched on the interaction of public health, data collection, dissemination and analysis and interpretation, and demonstrated the great opportunity to use modelling to answer high priority public health questions, and the importance of integrating surveillance, research, prevention, treatment & care across sexually transmitted bloodborne infections to reduce disease burden through addressing: common risk factors and common risk populations.

Marie-Claude Boily (Imperial College) gave an overview of the potential impact of male circumcision on HIV and other sexually transmitted infections. She started with a brief discussion of the compelling evidence that male circumcision (MC) reduces male susceptibility to HIV infection from ecological studies, meta-analysis of observational studies, randomized controlled trials of MC, to plausible biological mechanisms. She then discussed various issues related to male circumcision as a prevention tool against HIV(population-level impact as who, when, where; acceptability, safety, cost/feasibility and risk replacement). She then listed a few key modelling questions, and formulated a stochastic model to simulate the MC trial in Kisumu, for

the purpose of determining if MC efficacy against STI and HIV can independently and validly be estimated; to determine whether MC efficacy against STI alone can produce large effectiveness against HIV; to estimate the fraction of all HIV infections prevented in the trials that are attributable to efficacy against STI when both efficacies combine; to look at the population level impact of MC as an intervention. Model based analysis shows that STI are unlikely to explain the large protective effect of MC against HIV, but at the population level male circumcision has the potential to be an effective prevention and additional impact of MC against STI could be quite modest. She concluded with a number of questions emerging from her modeling work such as when the protection against STI can have a substantial incremental impact at the population-level, and what the best circumcision programme are in terms of age and risk group to target, and the potential role of negative outcomes.

Robert Smith? (University of Ottawa) discussed the issue of evaluating HPV vaccination for children vs. adults. His talk covered a wide range of issues related to HPV: the epidemiology of HPV, the details of the vaccine(s), some relevant research questions, the mathematical model appropriate to address these questions, the model based calculation of eradication threshold and relevant recommendations. The issues addressed specifically in his modeling study include: Can a childhood-only vaccination program eradicate HPV? Should an adult vaccination program supplement childhood vaccination? What happens for vaccines with suboptimal efficacy? Can a childhood-only vaccination program eradicate HPV? The model is based on the assumptions that men do not get vaccinated, children progress to the sexually active after 10 years, women and men are in the sexually active pool for 4 years (after this time, they cannot be vaccinated), and the vaccine may not confer 100% protection. He formulated a compartmental model that takes into account the question to be addressed. Using this model, he determined a threshold for eradication of the disease, the amount of vaccination for a childhood only program, the amount by which childhood-only vaccination will be offset by adult vaccination, and the outcome dependence upon the vaccine efficacy and vaccine immunogenicity. His analysis shows that eradication of HPV is feasible, childhood vaccination programs should be supplemented by adult vaccination and adult vaccination is actually more efficient, but less logistically likely. In addition, he shows that there is a critical vaccine efficacy (82%) below which eradication is not possible, and there is a critical vaccine immunogenicity (83%) below which even 100% childhood vaccination cannot eradicate the epidemic. As 77% of parents were in favour of vaccinating their children, which is less than required for eradication ($> 85\%$) if only children are to be vaccinated, he concluded that voluntary adult vaccination should be covered by Canadian health care.

The Saturday afternoon session began with group discussions, followed by three breakout parallel sessions to identify rapporteur and use powerpoint template to answer distributed questions in order to develop ideas for research projects and networks. The whole group then met again on Sunday morning to hear reports from the breakout group discussions, and to finalize the plan to identify a focal point, explore study design, determine next steps and set a follow-up teleconference date. Three projects/themes were identified and are expected to be followed up closely: the Vulnerable Populations & Co-infections; Immune Issues in Modeling STI Modelling; Public Health Interventions. For each of these themes, the following were identified: Public health issues with high priority for modeling; research objective and work plan; Current controversies and policy questions; Current data/surveillance resources; Current work in progress/Existing models; Barriers to modeling, dissemination, or knowledge translation; Key partners; Potential funding agencies; and detailed work plans. There were a few themes that participants felt should be addressed further, but did not receive sufficient discussions due to the tight schedule, these include issues related to blood-borne infections, viral STIs and genital ulcerative disease migration. Blood-Borne Infections, Viral STIs and Genital Ulcerative Disease Migration.

Overall, it was a quite productive symposium that sets a valuable precedent for interaction between mathematicians and non-mathematicians in meeting current public health challenges in Canada. The symposium and its follow-up activities are expected to help to build a strong group as a major public health asset in this country, and this is likely to inspire similar efforts elsewhere.