Mini Symposium Program

Time	Speaker	Presentation
12:00 – 12:45		***Lunch***
12:45 – 13:00		***Short break***
13:00 – 13:45		***Panel discussion coordinated by Pauline van den Driessche and Jianhong Wu***
	Panellists ***Seyed Moghadas (CDM, York);*** ***Greg Pitt (Pitt Researc Ltd);*** ***Beate Sander (Public Health Ontario);*** ***Ping Yan (Public Health Agency of Canada).***	
13:45 – 14:00		***Short break***
	Dan Munther and Yanyu Xiao	*Welcome, Opening and Agenda*
14:00 – 14:20	Marija Zivkovic Gojovic	*Parameter estimation in agent-based models*
14:20 – 14:40	Hongbin Guo	*TB models with immigration and intervention*
14:4 0– 15:00	Iman Soliman	*Studying the effect of immigration on the spread of Tuberculosis*
15:00 – 15:20	Xiaotian Wu	*The Impact of Temperature on the Establishment of Lyme disease Tick Vector Ixodes Scapularis*
15:20 – 15:40	Chunhua Shan	*The dynamics of growing islets and transmission of schistosomiasis in the Yangtze River*
15:4 0– 16:00	Ahmed Abdelrazec	*Optimal Control of West Nile virus in mosquito, birds and humans with Season*
16:00 – 16:20		***Coffee Break***
16:20 – 16:40	Carly Rogers	*Improving HPV Vaccination Programs Across Canada*
16:4 0– 17:00	Rachelle Miron	*Modelling imperfect adherence to HIV induction therapy*
17:00 – 17:20	Naveen Vaidya	*Early Antiretroviral Therapy for Limiting HIV-1 Latent Infection*
17:20 – 17:40	J Ben Wilson	*HIV in the sex-working population of Kibera: a multigroup model for use with network-like data*
17:40 – 18:00	Andreea Pruncut	*Model of Chemotherapy—Induced Myelosuppression with Distributed Delays*

Abstracts

Parameter estimation in agent-based

Marija Zivkovic Gojovic, *Public Health Ontario*

Rapid developments of computational capabilities in the past years led to a growing number of agent-based applications in modeling the spread of infectious diseases. The agent-based approach—in which the agent is defined as an individual and the between-agent interactions are defined as the social interactions that follow the realistic pre-observed behaviour of the population—enabled modellers to design a detailed social environment that can serve as replica of the real world. This so-called "artificial world" is then used as an experimental tool in the decision making process, particularly under the circumstances where the real world experiment is classified as costly, impractical or unethical.

However, in order to successfully approximate a real world experiment, the model design needs to incorporate all aspects of the world's social complexity. This includes the introduction of a large set of model parameters, which on the other hand tends to inject a significant dose of uncertainty in the model outcomes.

Here we present a calibration module designed to estimate the unknown model's parameters using the modified Gradient search method. The objective function of the Gradient method is defined as the square difference between the historically observed results and the model outcomes, while the output is defined as a vector representing the optimal values for the contact parameters obtained through the minimization of the objective function. The estimated results are then compared with the data obtained in recent studies on contact patterns relevant to the spread of infectious diseases.

TB models with immigration and intervention

Hongbin Guo, *Public Health Agency of Canada*

Based on simple deterministic TB models with immigration and intervention, a quick review of this classes of models is given. The model doesn't have traditional disease-free equilibrium anymore and the basic reproduction number no longer exists. Global stability of unique endemic equilibrium of these classes of models is succeeded by a class of global Lypunov functions. We explore numerically the impact of variation of immigration on the disease dynamics and potential disease control.

The Impact of Temperature on the Establishment of Lyme disease Tick Vector Ixodes Scapularis

Xiaotian Wu, *York University*

A stage-structured periodic deterministic model was formulated to simulate the impact of temperature on the tick (Ixodes scapularis) survival and seasonality at Long Point, Ontario, Canada. 7 season-based model coefficients were parameterized using Fourier series analysis by fitting temperature and tick data. We derived the basic reproduction number for the tick population, R0, as the number of new female adult ticks produced by an index female adult tick when there are no density dependent constraints acting anywhere in the life cycle of the tick population. We confirmed that, both mathematically and numerically, the tick would go to extinction when $R0 < 1$, and found the successful tick invasion and persistence when $R0 > 1$. A minimum degree-days threshold in a one year to identify whether the tick population extinct or not was found. A global sensitivity analysis based on popular Latin Hypercube Sampling (LHS) sampling method was performed which demonstrated the mean monthly temperatures in June, July, August were more significantly sensitivity to establish the tick population. Therefore temperature would significantly influence the risk of tick establishment in a habitat.

The dynamics of growing islets and transmission of schistosomiasis in the Yangtze River

Chunhua Shan, *York University*

We formulate and analyze system of ordinary differential equations model for the transmission of schistosomiasis on the islets in the Yangtze River near Nanjing, P.R. China. The impact of the growing size of the islet is investigated by the bifurcation analysis. The cusp bifurcation is found using center manifold theorem and normal form theory. Numerical bifurcation analysis shows rich and complex dynamics of the system. By our modeling analysis, we conclude that when the islet reaches a critical size, the transmission of the schistosomiasis among the mammalian Rattus norvegicus and the Oncomelania snails could be established, and the cycle of mammalian Rattus norvegicus and the Oncomelania snails on the islets serves as a possible source of schistosomiasis transmission in East China area along the Yangtze river.

Optimal Control of West Nile virus in mosquito, birds and humans with Season

Ahmed Abdelrazec, *York University*

In this study, we use mathematical models to study the behavior of the transmission of WNv in the mosquito-bird cycle and human (considering two kinds of birds: corvids and non-corvids in two cases. We study and compare the mathematical model of WNv without the effect of the seasonal variation and the modified model with seasonal variations. Firstly, we proved that the autonomous model undergoes a backward bifurcation. Secondly, we extended the model by adding three control functions: adulticide, larvicide and human protection. Using optimal control theory, we derive the necessary conditions for optimal control of the disease using Pontryagin's Maximum Principle. We also simulated a set of possible control strategies and conclude that: (1) The feasibility of controlling WNv could be dependent on the initial sizes of the sub-population when we have a backward bifurcation. (2) Combining adulticide and larvicide is the most effective strategy to control an ongoing epidemic (in reducing disease cost). (3) The results further emphasized the importance to use the information about quantity of other animals infected and the percentage of the non-corvids bird at any region before applied the control strategies. This is a joint work with Suzanne Lenhart and Huaiping Zhu.

Improving HPV Vaccination Programs Across Canada

Carly Rogers, *University of Ottawa*

The human papillomavirus (HPV) infects about 75% of sexually active adult Canadians. The infection can develop into several types of cancers including cervical, anal, head and neck. To combat this negative impact on the health of Canadians a country-wide vaccination program was launched in 2007. However, vaccinations are under provincial mandates allowing for each province or territory to develop their own programs. Across the country these programs differ by 1) the age the vaccine is given to the girls, 2) the number of doses provided and 3) the proportion of the population that is vaccinated every year. These differences could determine the success or failure of a program. We develop an ODE model to determine the effect of each provincial program on the epidemic as well as suggest ways to improve strategies to further reduce the impact of HPV on the health of Canadians. This is a joint work with Suzanne Lenhart and Huaiping Zhu.

Modelling imperfect adherence to HIV induction therapy

Rachelle Miron, *University of Ottawa*

Induction-maintenance therapy is a treatment regime where patients are prescribed an intense course of treatment for a short period of time (the induction phase), followed by a simplified long-term regimen (maintenance). We use mathematical modelling to investigate the effect of imperfect adherence during the inductive phase. We address the following research questions: 1. Can we determine the maximal length of a possible drug holiday and the minimal number of doses that must subsequently be taken while still avoiding resistance? 2. How many drug holidays can be taken during the induction phase? For a 180 day therapeutic program, a patient can take several drug holidays, but then has to follow each drug holiday with a strict, but fairly straightforward, drug- taking regimen. Since the results are dependent upon the drug regimen, we calculated the length and number of drug holidays for all fifteen protease-sparing triple-drug cocktails that have been approved by the US Food and Drug Administration. Induction therapy with partial adherence is tolerable, but the outcome depends on the drug cocktail. Our theoretical predictions are in line with recent results from pilot studies of short-cycle treatment interruption strategies and may be useful in guiding the design of future clinical trials.

Early Antiretroviral Therapy for Limiting HIV-1 Latent Infection

Naveen Vaidya, *University of Western Ontario*

Human immunodeficiency virus 1 (HIV-1) infection persists for a lifetime despite successful antiretroviral therapy (ART). Establishment of latently infected cells (cells in resting state with integrated HIV-1 DNA) during early HIV-1 infection is conceptually the most challenging obstacle to viral eradication. A burning question of whether early initiation of ART can reduce such latently infected cells still remains unanswered. To address this issue, I will present a mathematical model that accurately predicts observations in experimental data from HIV infected individuals. Using our model I will show that latently infected cells are largely generated before the initiation of therapy during early infection, and that the latently infected cells often decay during initial ART. These results suggest that the latent infection can be limited by early ART during acute HIV infection.

HIV in the sex-working population of Kibera: a multigroup model for use with network-like data

J Ben Wilson, *University of Victoria*

Data collected from sex-workers and their clients in Kibera, Nairobi, indicates that a large majority of interactions between individuals are random and not repeated. Based on this evidence a modified Pastor-Satorras and Vespignani model is developed to examine the behaviour of HIV in the sex-working population of Kibera. The model is parameterized and a sensitivity analysis performed; the effect of parameter change on prevalence, incidence, and risk is discussed.

Model of Chemotherapy-Induced Myelosuppression with Distributed Delays

Andreea Pruncut, *University of Montreal*

We discuss a model of chemotherapy-induced myelosupression using differential equations with distributed delays. Our model generalizes an existing semi-mechanistic pharmacokinetic-pharmacodynamic model developed by Friberg et al (2002). The original model uses a chain of transit compartments to take into account the delay between administration of the drug and the observed effect. We replace the equations of the transit compartments by a single differential equation with a bimodal distribution of delays, and discuss the stability of the new system. A stability chart displaying the boundary of the region of stability in the plane of two parameters of the system is presented.

Studying the effect of immigration on the spread of Tuberculosis

Iman Soliman, *University of Manitoba*

In this study, we consider the immigration between n patches and its effect on spreading TB. The existence and global stability of the disease free equilibrium is proved.