Proposed problem for the Fields-MITACS Industrial Problems Workshop
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A major concern of public health in national contingency plans for pandemic influenza preparedness is to identify the optimal use of limited resources such as antiviral drugs and vaccines. In case of antiviral drugs, determining the optimal scenario has proven to be rather challenging, in large due to potential emergence of drug-resistance in the population, inadequate supply of drugs, and the surge in demand for treatment with the progression of the pandemic. The underlying problem is quite mathematically interesting and should be solvable, by considering realistic assumptions pertained to the population demographics and influenza epidemiology. This could have important implications for healthcare system in Canada, and can provide solutions to some of the issues that have undergone stark debates in planning strategies.

For healthcare administrators and planners, key challenges for pandemic planning include the degree of surge capacity necessary to maintain safe and effective delivery of healthcare, estimates of likely attrition among healthcare workers during a pandemic, and tradeoffs between worker and patient safety and health, such as those that may arise if antiviral drugs are used for healthcare worker prophylaxis rather than treatment of ill individuals. The latter issue has been a source of some controversy in Canada, as it is unclear whether hospitals would retain control over existing antiviral stockpiles in the event of a pandemic-related emergency. The development of appropriate mathematical models would permit the formulation of policies that would maximize health for the greatest number of individuals in the community. Some specific questions that such models can address with regard to antiviral strategies during pandemic influenza include:

- Determining best allocation of scarce supply of antiviral drugs to achieve the best outcome
- Identifying the priority groups for treatment and prophylaxis among the general population, healthcare workers and essential service personnel
- Developing antiviral strategies that can prevent the emergence of drug-resistance in the population
- Determining the adequate level of antiviral stockpiles, and projecting possible scenarios a shortage of drugs is expected

We propose to focus here primarily on the question of optimal use of antiviral drugs for treatment and prophylaxis of general population, healthcare and community essential personnel. To address this question in a mathematical context, we will require a model for the spread of a pandemic through interconnected subpopulations. Such a model should include the effects of antiviral treatment/prophylaxis on controlling the spread of

the disease, as well as the likelihood that a pandemic virus will mutate to generate resistance to antiviral drugs during the course of an outbreak. Several models have been developed that take steps in this direction, but we are unaware of any that fully addresses the fundamental question of antiviral allocation, while considering all of the realistic aspects of a pandemic propagation in a population.