Research summary, Project MATINEE (No. 219266, FP7 Marie Curie IIF)

This project uses mathematical models to study and evaluate control policies for the nosocomial transmission of viral infections, particularly rotavirus in pediatric wards. A first article published in the *Bulletin of Mathematical Biology* (Kribs-Zaleta et al., 2010) examined the effects of policies including cohorting, caregiver-patient ratio, preventive hygiene compliance, and vaccination at the level of a single ward. Another article, currently in progress, extends this framework to the level of an entire hospital, with a complex, heterogeneous landscape of infectious contacts. Figures 1 and 2 give the flow structure of the underlying single-ward and multi-ward models, respectively.

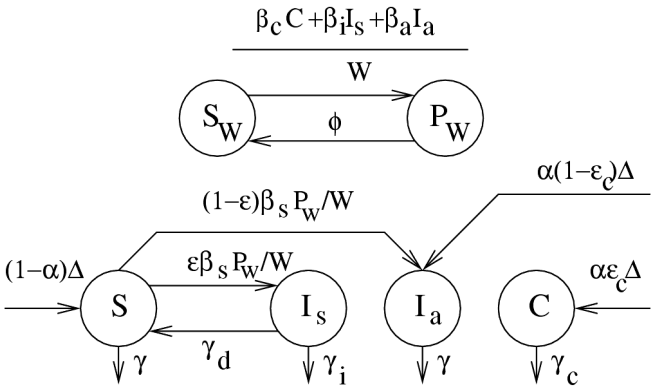
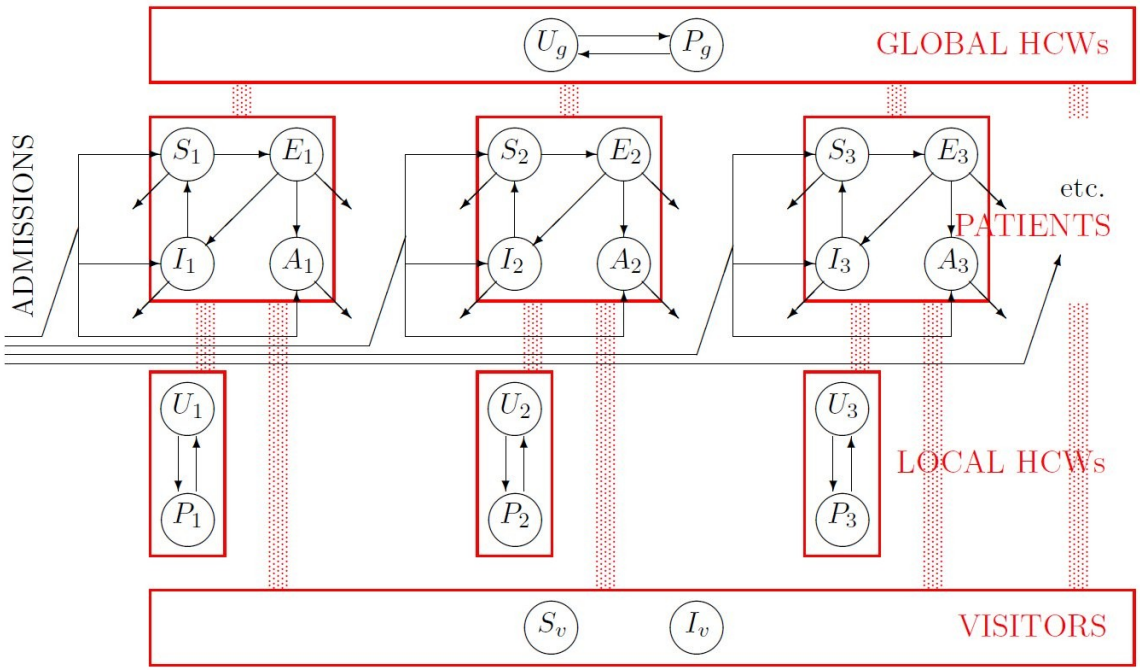


Figure 1 (left). Flow structure for transmission of rotavirus between healthcare workers (upper two compartments) and patients (lower four compartments) in a single ward.

Figure 2 (below). Flow structure for transmission of rotavirus between healthcare workers (upper two compartments) and patients (lower four compartments) in a multi-ward contact structure.



Analysis of cohorting as a control measure in the first paper showed that stochastic discretization effects tend to reduce the overall mean prevalence among patients when the cohort size (or the ward size) is reduced; that is, for small cohorts, the stochastic variations present at the individual level tend to reduce the overall spread of the infection more than what is predicted by simple (homogeneous) deterministic models (see Figure 3 below).

As regards healthcare worker (HCW) compliance with preventive hygiene, and the observed difficulties in maintaining improved compliance, the study found that even short-term improvement in preventive hygiene compliance following contact with symptomatic patients may significantly limit transmission as well, and remains an important control measure, especially where resources are limited. For instance, targeted short-term improvements in hygiene compliance may reduce prevalence by 1/3, 1/2 or more during a single outbreak.

Finally, stochasticity may account for the high interepidemic variability in prevalence (e.g., 2% to 20%), and short-term fluctuations in admissions of community-acquired cases may not be the dominant factor in nosocomial transmission. Indeed, variations in discharge and recovery rates from patient to patient (and corresponding decontamination rates in HCWs) showed a nontrivial (22.8%) probability of making nosocomial transmission self-sustaining for short periods of time, extending an outbreak's duration.

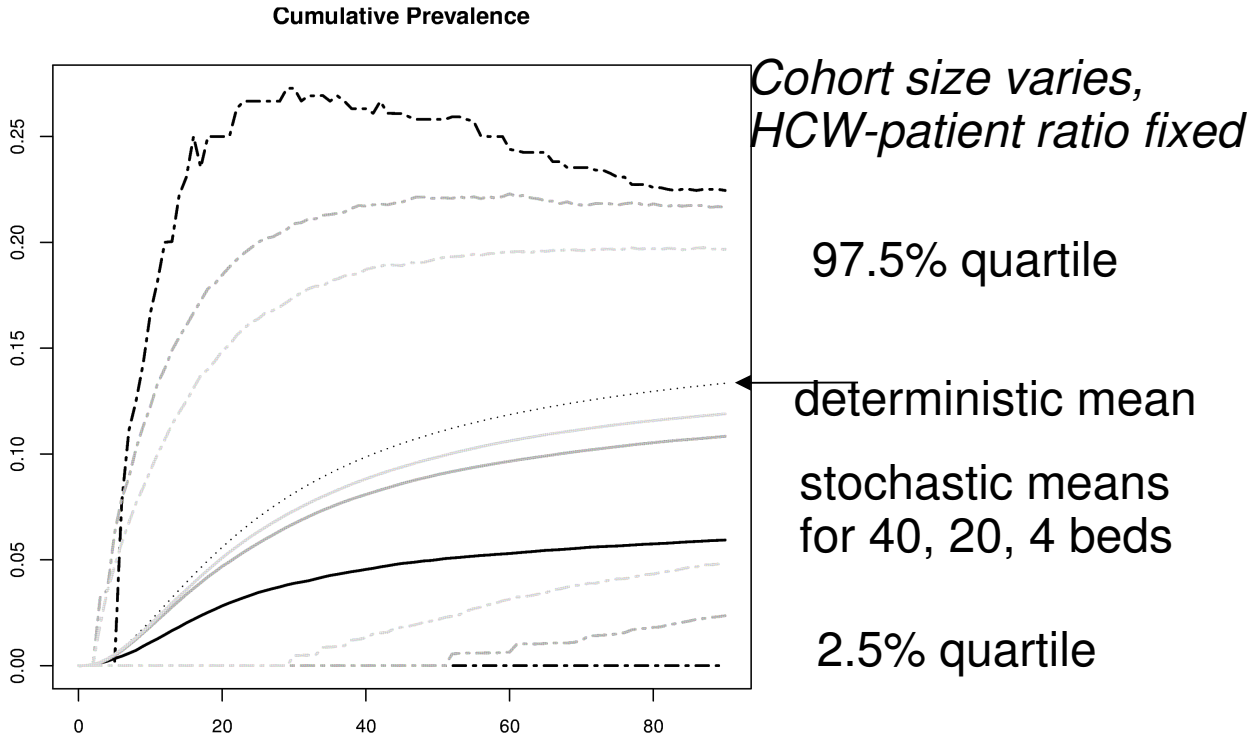


Figure 3. Stochastic and deterministic means for cumulative rotavirus prevalence in a single ward over a 90-day period. Deterministic models, which assume homogeneous wards, yield the same prediction regardless of cohort size, but stochastic models predict mean prevalence decreasing with cohort size.

Project contacts: Dr. Christopher M. Kribs Zaleta, kribs@uta.edu

Dr. Sandrine Charles, sandrine.charles@univ-lyon1.fr