# Estimating transmission parameters for infectious diseases in small hospital units

Martin C. J. Bootsma

(joint work with Marc J. M. Bonten, Odo Diekmann)

Resistant pathogens in hospitals form an emerging health care problem and effective strategies to prevent their spread are required. However, the efficacy of control measures depends on the nature of the spreading mechanisms. Therefore the identification of the most important route is important. Recently, two articles appeared [1, 2] to determine the relative importance of outgrowth of pathogens, that were already present at an undetectable level, due to antibiotic selection and cross transmission. Both methods have some disadvantages. Both assume constant discharge rates and a constant bed occupancy and cannot distinguish between admission of colonized patients and the outgrowth of already present pathogens. Moreover, the model in [1] assumes that acquisition took place at the moment of detection, while [2] only looks at infection data. However infections only represent the tip of the iceberg as most patients carry pathogens asymptomatically.

We use a Markov chain approach based on likelihood methods, to make optimal use of the available data (date of admission, date of discharge, dates of the microbiological culturing and the results of these cultures) to determine the importance of different routes. This approach does not require genotyping. We use a discrete time framework where the up-dating (on a day by day basis) consists of 4 parts: 1) Evolution according to the mechanistic model, 2) Use of the results of the culturing, 3) Removal of the patients from the state space for which the colonization status is certain, 4) Incorporate new patients in the state space for which the colonization status becomes uncertain. Within the framework, additional patient characteristics can be incorporated as well. In this framework, we glue together state spaces of different size according to the need as exposed by the data.

To determine optimal culture strategies, we simulated a unit of 10 beds. Of course, the more frequent patients are cultured, the faster the most important infection route can be determined statistically significantly. However, for typical values of the parameters, a regime of culturing patients on admission and afterwards twice per week gives the most information per performed culture.

## References

[1] I. Pelupessy, M. J. M. Bonten and O. Diekmann, *How to assess the relative importance of different colonization routes of pathogens within hospital settings*, Proc. Natl. Acad. Sci. **99** (2002), 5601-5605.
[2] B. Cooper, M. Lipsitch, *The analysis of hospital infection data using hidden Markov models*, Biostatistics **5** (2004), 223-237.