BIOS 524: Analytical Methods for Infectious Diseases

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Course Objectives: To familiarize students with (a) basic concepts of transmission of infectious diseases, (b) simple models of transmission, (c) statistical methods for estimation of transmission parameters and effects of interventions, (d) design and analysis of studies to evaluate effects of vaccines and vaccination programs. Examples based on influenza, measles, HIV and other infectious diseases will be used as illustrations.

Evaluation will be based on class attendance, homework, an in-class final exam and a written report.

Textbook:

Epidemiologic Methods for the Study of Infectious Diseases. Edited by J.C. Thomas and D.J. Weber. Oxford University Press, New York, 2001.

More advanced books:

M. E. Halloran, I. M Longini and C.J. Struchiner. *Design and Analysis of Vaccine Studies.* Springer, New York, 2009.

R. Anderson and R. May. *Infectious Diseases of Humans.* Oxford University Press, Oxford, 1991.

N. Becker. *Analysis of Infectious Disease Data*. Chapman & Hall, New York, 1989.

Articles:

Longini, I.M., Koopman, J.S., Monto, A.S. and Fox, J.P. Estimating household and community parameters for influenza. *Amer. J. Epid.* 115:736-751 (1982).

Longini, I.M., Koopman, J.S., Haber, M. and Cotsonis, G.A. Statistical inference for infectious diseases. Risk-specific household and community transmission parameters. *Amer. J. Epid.* 128:845-859 (1988).

Haber, M., Longini, I.M., and Halloran, M.E. Measures of the effects of vaccination in a randomly mixing population. *Internat. J. Epid.* 20: 300-310 (1991).

Haber, M., Halloran, M.E., Longini, I.M., and Watelet, L. Estimation of vaccine efficacy in non-randomly mixing populations. *Biometrical J*. 37: 25-38 (1995)

Haber, M., Watelet, L. and Halloran, M.E. On individual and population effectiveness of vaccination. *Internat. J. Epid*. 24:1249-1260 (1995).

Haber, M. Estimation of the population effectiveness of vaccination. *Statist. in Medicine* 16:601-610 (1997)

Haber, M. Estimation of the direct and indirect effects of vaccination, *Statist. in Medicine* 18:2101-2109 (1999).

Davis, X.M. and Haber, M. Estimation of vaccine efficacy from household data. *Proceedings of the American Statistical Association, Statistics in Epidemiology Section.* (2001).

Davis, X.M. and Haber, M. Estimating vaccine efficacy from household data observed over time. *Statist. in Medicine* 23:2961-2974 (2004).

Haber, M., Shay, D.K., Davis, X.M., Patel, R., Weintraub, E., Orenstein, E. and Thompson, W.W. The effectiveness of interventions to reduce contact rates during a simulated influenza pandemic on attack, hospitalization and mortality rates. *Emerg. infect. Dis.* 13:581-589.

Course Outline

Infectious disease data

Basic concepts; natural history of an infectious disease

Transmission probabilities

A simple model for transmission in partnerships

Transmission in households

Transmission in large populations; the SIR model

The basic reproduction number

Heterogeneous populations

Time to infection data

Vaccine efficacy (VE) – various definitions

VE in a homogeneous, randomly mixing population

VE in a heterogeneous population

VE in partnerships and households

VE from time-to-infection data

Effectiveness of vaccination programs

Direct and indirect effectiveness, herd immunity

Interventions against an influenza pendemic