Introduction to Causal inference: Learning what works

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Course objective: To learn how to determine "what works" using data from observational studies

Description: The course introduces students to a general framework for the assessment of comparative effectiveness and safety, with an emphasis of the use of routinely collected data in healthcare settings. The framework relies on the specification and emulation of a hypothetical randomized trial: the target trial. The course explores key challenges for causal inference and critically reviews methods proposed to overcome those challenges. The methods are presented in the context of several case studies for cancer, cardiovascular, renal, and infectious diseases.

Learning Objectives: After successful completion of this course, students will be able to:
1. Formulate sufficiently well-defined causal questions for comparative effectiveness research
2. Specify the protocol of the target trial
3. Design analyses of observational data that emulate the protocol of the target trial
4. Identify key assumptions for a correct emulation of the target trial
5. Decide when g-methods are required for data analysis
6. Critique observational studies for comparative effectiveness research

Pre-course reading: Chapters 1-3 of the book Hernán MA, Robins JM (2019). Causal Inference. Boca Raton: Chapman & Hall/CRC, forthcoming. The book can be downloaded (for free) from
http://www.hsph.harvard.edu/miguel-hernan/causal-inference-book/

Tentative Outline

1. Introduction: Asking causal questions
   Case study #1: Hormone therapy and coronary heart disease
2. Emulating the target trial
   Case Study #2: Statins and mortality in cancer patients
3. Choosing time zero
   Case study #3: Screening colonoscopy and colorectal cancer
4. Confounding adjustment: emulating randomization
   Case study #4: Statins and coronary heart disease
5. Treatment strategies
   Case study #5: Epoetin dosing and mortality in hemodialysis patients

Further reading:

- Hernán MA, Robins JM. Using big data to emulate a target trial when a randomized trial is not available. *American Journal of Epidemiology* 2016; 183(8):758-764
- Hernán MA, Sauer BC, Hernández-Díaz S, Platt R, Shrier I. Specifying a target trial prevents immortal time bias and other self-inflicted injuries in observational analyses. *Journal of Clinical Epidemiology* 2016; 79: 70-75
- Garcia-Albeniz X, Hsu J, Hernán MA. The value of explicitly emulating a target trial when using real world evidence: an application to colorectal cancer screening. *European Journal of Epidemiology* 2017; 32(6): 495-500
- Hernán MA. How to estimate the effect of treatment duration on survival using observational data. *BMJ* 2018; 360:k182.