DYNAMIC INTERVENTIONS: OPPORTUNITIES AND CHALLENGES

Linda M. Collins, Ph.D.
The Methodology Center
Penn State

Presented at
Big D.A.T.A. (Data And Theory Advancement) Workshop
September 19-20, 2013
Bethesda, MD
A lot of what I am presenting is drawn from work of

- Danny Almirall (Michigan)
- Susan Murphy (Michigan)
- Inbal (Billie) Nahum-Shani (Michigan)
- Daniel Rivera (Arizona State)
What is a dynamic intervention?

• Idea:
  — Tailoring variable is measured on each individual periodically
  — Treatment may be adjusted (increased, decreased, or switched) depending on value

• These go by a lot of different names
  — Time-varying adaptive interventions
  — Dynamic treatment regimes
  — Stepped care
  — Just-in-time adaptive interventions (JITAI’s)
  — Others
Anatomy of a dynamic intervention

1. Decision points
   Times at which treatment options should be considered based on patient information

2. Tailoring variable:
   Patient information used to make treatment decisions

3. Intervention options
   Type/dose of treatment

4. Decision rule
   Links tailoring variables to intervention options. A dynamic intervention includes multiple decision rules.

5. Outcomes
   Proximal and distal
Approaches to development and evaluation of dynamic interventions

• Classical approach
  — Identify intervention components, assemble treatment package, then evaluate in an RCT

• Multiphase optimization strategy (MOST)
  — Identify intervention components, empirically optimize intervention, assemble optimized treatment package, then evaluate in an RCT
Optimizing dynamic interventions, approach 1

• Sequential Multiple Assignment Randomized Trial (SMART)
• Pioneered by Susan Murphy, Daniel Almirall, Inbal (Billie) Nahum-Shani
• For dynamic interventions with a limited number of decision points
• Variation on the factorial experiment
Optimized dynamic interventions, approach 2

- Based on control engineering
- Pioneered by Daniel Rivera
- For dynamic interventions with many decision points
- View the underlying behavior as a dynamical system
- Collect ILD, experiment, do system ID, build a controller
- Example: development of dynamic intervention to help pregnant women regulate gestational weight gain (recently funded by NHLBI; Danielle Downs (PSU), PI)
Fig C.2. Conceptual Simulation Framework for GWG.

Note. TPB = Theory of Planned Behavior, ATT = attitude, SN = subjective norm, PBC = perceived behavioral control.
Optimized dynamic interventions, approach 3

• Comes from computer science
• Pioneered by Susan Murphy and Inbal (Billie) Nahum-Shani
• Just-in-time adaptive interventions (JITAI’s)
• Collect very ILD using a smart phone or similar
• Use machine learning principles to develop (“learn”) decision rules for each individual

BIG DATA
Challenges

• A lot of methodological work is needed in all three of these areas

• Encouragement for intervention scientists to
  — Take an optimization perspective
  — Collaborate on research with a methodological focus