Symposium Title: Transmission Modeling of Healthcare-associated Infections: Current Progress and Pressing Challenges

Symposium Description (1000 max):
Healthcare-associated infections (HAIs) are a threat to the health and well-being of hospital patients. They are however difficult to study, as healthcare facilities are notoriously difficult venues for research. Patients are clustered by healthcare worker, ward, facility, etc. and interventions can have large indirect effects. Finally, much of the evidence in hospital epidemiology stems from outbreaks, where the patient-care mission demands multiple simultaneous interventions that are difficult to disentangle.

Transmission models can help address these problems, analyzing questions other methods struggle with, improving the design of studies, and synthesizing results across multiple studies to make policy recommendations. The importance of these models have only been heightened during the COVID-19 epidemic. This symposium features research from five sites at the leading edge of modeling HAIs, ranging from the level of a single-ward to regional and national policy.

Presentation Titles and Allocated Time (90 minutes total)

Introduction: 5 minutes

Modeling *Clostridium difficile* infection risk: an agent-based model of a regional healthcare network (15 minutes) – Sarah Rhea

During this presentation, we will discuss development of a representative, geospatially-explicit synthetic population and novel agent-based model of a regional healthcare network, including hospitals and long-term care facilities. With this model, we will describe patient movement through the regional healthcare network and risk of *Clostridium difficile* infection (CDI), the most common healthcare-associated infection in the United States. We will present the model's application in evaluating independent facility-based versus regional-based infection prevention interventions (e.g., interfacility communication when transferring patients) and in directing epidemiologic surveillance activities to reduce the network incidence of CDI.

Modeling for rapid decision support: fast answers that are (mostly) correct (15 minutes) – Eric Lofgren

The complex and highly structured environment of the hospital environment, as well as the small population size, makes modeling healthcare-associated infections using complex agent-based models a natural fit. But these models generally are complex and data intensive, requiring considerable time to program and adapt to a specific hospital setting, as well as time and computing resource intensive to run. This makes the use of these models difficult in rapidly developing environments, such as public health emergencies, and inefficient for highly exploratory modeling. This talk explores the trade-off between speed and validity for several simplified model forms, and considers where they may produce valid inferences – and to what

extent – as well as their use in determining whether or not a more sophisticated model is likely to provide more valuable insight.

Fine-grained spatiotemporal modeling for understanding the spread of hospital-acquired infections (15 minutes) – Aaron Miller

This talk will explore the utility of fine-grained models, built off sensors, detailed building plans and other methods to understand the transmission of healthcare-associated infections in a hospital setting. Using examples from dialysis units as well as whole-hospital models, we show that spatiotemporal details can improve and inform quantitative models of infection transmission within hospitals.

Healthcare worker mediated patient contact networks and the spread of disease (15 minutes) – Eili Klein

This presentation will explore the contact networks between hospitalized patients created by their joint interaction with healthcare workers, and discuss the methods used to incorporate these networks into models of healthcare-associated infection transmission. The utility of these contact networks in the design and evaluation of interventions will also be explored.

Model-based insights on transmission and mitigation of multi-drug resistant organisms in healthcare facilities with high-risk populations (15 minutes) – Damon Toth

Observations from regional outbreaks of multi-drug resistant organisms (MDROs) suggest that healthcare facilities caring for high acuity patients with long length of stay are particularly vulnerable and may amplify transmission within a network of facilities that exchange patients. This presentation will demonstrate how mathematical models and transmission threshold theory can shed light on observable characteristics of healthcare facilities that are consistent with transmission amplification potential and identify scenarios where a modest reduction in a facility's transmission rate can produce a disproportionately large regional benefit.

Comments from the Chair and Panel Discussion: 10 minutes – Rachel Slayton