THE GRADUATE COLLEGE OF THE UNIVERSITY OF
OKLAHOMA HEALTH SCIENCES CENTER

ANNOUNCES THE FINAL EXAMINATION OF

Casey Cooper

FOR THE DEFENSE OF THE DOCTOR OF PHILOSOPHY DEGREE
GRADUATE COLLEGE

Department of Occupational and Environmental Health

Friday, June 28, 2019, 12:00 p.m. Hudson
College of Public Health, Room 420

Development, Evaluation, and Demonstration of Air Sampling Methods to Assess Airborne Transport of *Clostridium difficile* Spores in the Healthcare Environment

COMMITTEE IN CHARGE: David L. Johnson, PhD, Chair; Margaret L. Phillips, PhD; Aaron M. Wendelboe, PhD; Bradley S. Stevenson, PhD; Jun Wang, PhD

ABSTRACT: *Clostridium difficile* (*C. difficile*) is a significant healthcare acquired infection worldwide with over 100,000 cases annually in the United States alone. Multiple studies have documented the aerosol generation and airborne dissemination of *C. difficile* endospores. These endospores are resistant to environmental stresses and have the potential for airborne transport from a source to other areas in a healthcare setting, thus enabling environmental contamination. This study evaluated air sampling methods in the collection of *C. difficile* aerosol and aimed to: (1) Evaluate low-volume air sampling devices and mechanisms of collection for laboratory-generated aerosols of *C. difficile* spores; (2) Evaluate the retention of culturable *C. difficile* spores in impinger air samplers; (3) Evaluate high-volume air sampling devices in the collection of nebulizer-generated *C. difficile* spore aerosols in a laboratory environment; (4) Demonstrate effectiveness of high-volume air sampling equipment in the collection of *C. difficile* spore aerosol produced from toilet flushing. In aim 1, mixed cellulose ester (MCE) filters demonstrated significantly higher relative sampling efficiencies compared to slit-to-agar impactor (AirTrace™) and liquid impinger air samplers (AGI-30 and BioSampler™). Both impinger types frequently failed to detect the presence of *C. difficile* aerosol. In aim 2, impinger operation produced significant culturability losses and failed to retain *C. difficile* endospores. In aim 3, high volume air sampling using a military Dry Filter Unit 1000 (DFU-1000) resulted in a significantly higher relative sampling efficiency compared to the commercial Biocapture-650, XMX/2L-MIL, and Microbio MB2. In aim 4, high volume air sampling provided a census air sample in a small enclosure similar to a patient's bathroom. Toilet flushing from a contaminated toilet generated a mean of 81 colony-forming units during the first three flushes after contamination. Furthermore, high volume air sampling using the DFU-1000 significantly increased the frequency of airborne endospore detection at low airborne concentrations relative to low volume air sampling. This study demonstrated that sampling stress significantly affects the enumeration and detection of airborne *C. difficile* spores. Furthermore, this study demonstrated an economical air sampling method, MCE filtration, to improve air sampling and risk assessment in healthcare facilities.