

AMMI Canada Medical Student Research Proposal

Project Title: *Screening and Comprehensive Infection Prevention for Antimicrobial-Resistant Organisms in High Risk Patients in Long-Term Care Facilities: A Cost-Effectiveness Analysis*

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Background

Antimicrobial resistance (AMR) continues to be one of the most significant public health threats facing the world today and it is projected that by 2050, 10 million deaths per year will be attributed to AMR and will surpass the deaths caused by cancer.¹ Residents in long-term care facilities (LTCF) are at increased risk of acquiring life-threatening AMR infections due to not only clinical risk factors, but also several facility-related factors such as residents living in close proximity, participation in social activities, and serial close contact of residents with staff and medical equipment.^{2,3} Common AMR infections in LTCFs include Methicillin-resistant *Staphylococcus aureus* (MRSA), Vancomycin-resistant enterococcus (VRE), Extended-spectrum beta-lactamase-producing organisms (ESBL), *Clostridioides difficile* (*C. difficile*), and more recently Carbapenemase-Producing *Enterobacteriaceae* (CPE).^{4,5} These infections threaten our healthcare system as they diminish our ability to prevent and treat infections, resulting in significant social and economic costs. In the United States (US), approximately 2 million infections occur each year in LTCFs with more than one-third of older adults harboring AMR organisms.⁶ From a study of LTCFs in Germany, the estimated healthcare cost per infected case is \$19,120.⁷ A 2017 survey by Public Health Ontario of 139 LTCFs showed a prevalence of 4.1 MRSA, 2.4 ESBL, and 0.9 VRE infections or colonization per 100 residents.⁸

Despite high prevalence rates, costs, and mortality,⁹ only 80% of the long-term care homes surveyed in Ontario, screen for MRSA and VRE on admission and only 52% of LTCFs have staff certified in infection prevention and control. Comprehensive infection control programs, including infection control education, personal protective equipment (PPE) use, decolonization, and isolation, may significantly reduce the burden of AMR in LTCFs.¹⁰⁻¹⁴

An infection prevention program, which included education, PPE use, and barrier precautions¹⁰ reduced the overall AMR prevalence by 23% for various pathogen acquisitions in a US setting.¹¹ Targeted initial decolonization interventions demonstrated a prevalence reduction of MRSA infections by 65%.¹² Isolation interventions, while undesirable for residents may also be efficacious in reducing the incidence of AMR infections.^{13,14} The large body of evidence on risk factors for AMR acquisition, can be used to identify individuals or groups that would benefit most from screening and comprehensive prevention interventions (e.g. isolation or decolonization) within LTCFs to increase effectiveness of intervention.¹⁵⁻¹⁷

Although the problem of AMR in LTCFs has attracted much attention, and interventions have demonstrated efficacy, the cost-effectiveness of interventions remains largely unknown and warrants further investigation. We were able to only identify one existing cost effectiveness study for universal screening in LTCFs, which was conducted in Switzerland and concluded that screening and decolonization does not improve infection rates. However, this study focused on only one pathogen (MRSA) and prevention intervention (decolonization), and reported lower prevalence rates compared to other jurisdictions.^{18,19} To our knowledge, there are no cost-effectiveness analyses describing the economic value of screening and comprehensive infection prevention programs for multiple emerging AMR microorganisms and prevention interventions in LTCFs in the Canadian setting.

Objective

Our study aims to determine the cost-effectiveness of universal and targeted screening and a comprehensive infection prevention program for important AMR pathogens (e.g. MRSA, ESBLs, and VRE) compared to no screening in Ontario LTCFs from the healthcare payer perspective.

Methods

We will conduct a cost-effectiveness analysis (CEA) from the healthcare payers' perspective to assess the value of AMR screening and targeted prevention interventions (including at least one of infection prevention education, PPE use, decolonization, isolation) in Ontario LTCF settings for all patients, high-risk patients, and no AMR screening. High risk patients for targeted interventions will be defined by risk factor studies; risk factors include previous antibiotic use, previous acute care stays, level of care, and age ≥ 80 years.¹⁵⁻¹⁷

We will develop a health state transition (Markov) model, simulating the patient's care pathway in LTCF, and the natural disease history of AMR infections from the time of colonization to infection (e.g., bloodstream infection) to potential recovery, recurrent infections, or death, following patients over their lifetime. We will conduct targeted literature reviews to inform model parameters (e.g. patient demographics, effectiveness of screening programs and targeted prevention, long-term sequelae, costs, and health state utility values), and supplement with Ontario-specific parameters whenever possible based on reports (e.g., PHO) and health administrative data (available through IC/ES).

We will estimate and report health outcomes averted (e.g. number of AMR colonizations, AMR infection, and deaths subsequent to AMR infections averted), quality-adjusted life years (QALY), total healthcare costs, net health benefit, and the incremental cost-effectiveness ratio (ICER) expressed in 2019 Canadian dollars per QALY. We will report costs and QALYs undiscounted and discounted at 1.5%,²⁰ and assess cost-effectiveness against the commonly used threshold of \$50,000 per QALY gained. We will perform deterministic and probabilistic sensitivity analysis to assess parameter uncertainty, and validate the model using several methods: face validity, cross-validity (comparing to other models) and external validity (comparing to real-world data). We will follow Canadian guidelines for economic evaluations in health.²⁰

Significance and Knowledge Translation

AMR is a current and emerging threat. As framed by the World Health Organization Director General, "A lack of effective antibiotics is as serious as a security threat as a sudden deadly disease outbreak".²¹ The evolving epidemiology of AMR in Canada, and the growing threat of AMR globally, underscore the need for high-quality evidence. Our cost-effectiveness analysis of interventions targeting AMR in LTCFs will provide important evidence to policy makers, inform infection prevention programs, and contribute to improving quality of care in LTCFs.

Findings from this research will be submitted for presentation at future CACMID-AMMI Canada Annual Meeting and publication in a peer-reviewed journal.

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