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Q1 Please discuss the research contributions that led to you being awarded Fellow status by the Infectious Disease Society of America (IDSA) in August 2022.

I have been an active member of the IDSA for the past several years since completing my speciality pharmacy residency in infectious diseases (postgraduate year 2). As an infectious diseases pharmacist and a faculty member, I have been involved in taking care of patients, teaching infectious disease pharmacotherapy, and being engaged in clinical research at my hospital. I have created and implemented several protocols and order sets related to antimicrobial stewardship and presented our results as posters at Infectious Disease Week (IDWeek) meetings. Some examples include the 'Impact of a Two-Step Diagnostic Bundle on Hospital-Onset *Clostridioides difficile* Infection Rates and Treatment Across a Large Health System', 'Impact of Targeted Restrictions for Fluoroquinolones, in Two Community Hospitals', and a 'Multicentre Study to Evaluate the Impact of Antibiotic Time Out in Four Community Hospitals'. In addition, I have published several review articles for continuing medical education credit on various infectious diseases topics, such as 'Managing Clinical Expectations in Infections due to Gram-Positive Bacteria' and 'The Challenges of Hospital-Acquired and Ventilator-Associated Pneumonia and Recent Advancement in Antibiotic Treatment'. My recent research contributions to the literature on infectious diseases include 'Multicentre Project Evaluating the Nephrotoxicity of Vancomycin in Combination with Beta-Lactam Agents: Ceftolozane-Tazobactam vs. Piperacillin-Tazobactam' as well

as a 'Multicenter Point Prevalence Evaluation of the Utilization and Safety of Drug Therapies for COVID-19 at the Onset of the Pandemic Timeline in the United States'. In addition to research, I am closely involved in the day-to-day operations and education of our clinical staff, including pharmacists, nurses, and physicians, and provide regular updates regarding COVID-19 therapeutics, antimicrobial stewardship pearls, drug shortages, and guideline updates to our providers. The IDSA considers the body of contributions to the field of infectious diseases in terms of direct patient care, teaching, and research when awarding Fellow status to its members. I am highly honoured to receive this designation.

Q2 Could you share the principal conclusions from your 2022 EMJ Microbiology and Infectious Diseases paper, 'Antibiotic Stewardship Attitudes and Beliefs Among Frontline Staff Nurses: Impact of Virtual Education'?

Nurses are vital healthcare team members who can play an important role in establishing or expanding antimicrobial stewardship programmes. However, nurses are often underutilised in antimicrobial stewardship activities and barriers to nursing involvement, such as lack of knowledge, scope of practice concerns, and time constraints, persist. This is partly because of the paucity of data on nursing attitudes and barriers towards antimicrobial stewardship, and because of the limited number of educational training programmes regarding antimicrobial stewardship that are

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designed specifically for nurses. This study was conducted to assess frontline staff nurses' baseline attitudes and beliefs towards antimicrobial stewardship, and to see if a virtual education campaign consisting of newsletters and tip sheets would affect those attitudes and beliefs. In our study, over 90% of the nurses surveyed considered themselves to be antibiotic stewards and wanted to participate in antimicrobial stewardship activities, such as assessing adverse drug reactions and educating patients. We also found that virtual education was effective in increasing the familiarity of our frontline nurses with the hospital antimicrobial stewardship programme. Therefore, virtual education may be an option to increase nursing awareness and participation in antimicrobial stewardship programmes, especially in resource-limited settings.

Q3 Your ePoster, entitled 'Impact of Implementing a Multidisciplinary Sepsis Bundle in a Community, Non-Teaching Hospital', was presented at the 31st European Congress of Clinical Microbiology and Infectious Diseases (ECCMID). Please provide an overview of the key take-home messages.

Sepsis is a cause of significant morbidity and mortality in the USA and around the world. The Surviving Sepsis Campaign guidelines, published in 2012, and since revised in 2018, made recommendations for early and goal-directed

therapy in order to improve sepsis outcomes. Treatment bundles for 3-hour and 6-hour timeframes were recommended to improve compliance and outcomes. Guidelines suggest that increases in sepsis bundle compliance contribute to decreased sepsis mortality; however, implementation of these bundles remained a challenge, especially in resource-limited community settings. The purpose of the project was to decrease severe sepsis mortality at our institution to <20%, improve 3-hour bundle compliance to >31%, and improve sepsis alerts called in appropriate patients to >75%. In 2013, the executive leadership at our hospital established a multidisciplinary sepsis steering committee to address an observed sepsis mortality rate of 43.5% and 3-hour bundle compliance of 16%. The implementation of the multidisciplinary sepsis bundle with collaboration between critical care, emergency room, infectious diseases, pharmacy, and nursing was highly successful, and resulted in a bundle compliance of >60% and an average mortality rate of <20 % (28% decline from baseline; $p=0.04$) at our institution. Appropriate sepsis alerts called in also improved to an average of >80%. The success of the programme has been sustained over the past several years, and this initiative has greatly increased awareness of sepsis guidelines, criteria, and application. This study shows that strong administrative-level support, interactive web-based learning, a designated response team, and daily data sharing can lead to a successful sepsis initiative, even in resource-limited community settings.¹



Q4 Please summarise your current research into antibiotic time-out and strategies to reduce rates of *Clostridium difficile*-associated diarrhoea.

Distinguishing acute *C. difficile* Infection (CDI) from colonisation is a challenge due to high rates of colonisation. PCR testing alone is not able to distinguish colonisation from infection, leading to overdiagnosis and unnecessary treatment. The purpose of this study was to evaluate the impact of this two-step testing algorithm bundled with education, antimicrobial stewardship programme support, and order set changes on hospital-onset CDI rates and *C. difficile* treatment across our health system. A two-step testing algorithm (PCR with enzyme immunoassay) was implemented between May 2021 and August 2021 across seven hospitals within the Northwestern Medicine Health System. Multifaceted education was delivered to leadership and clinicians in person as well as electronically. Antimicrobial stewardship team performed daily diagnostic prospective audit, result interpretation, and management support. The results showed that the hospital-onset CDI standardised infection rates reduced significantly from 0.80 to 0.57 ($p < 0.001$). Although treatment of colonised patients remained high, a large number of patients safely avoided CDI treatment. Testing and education bundles can help advance antimicrobial and diagnostic stewardship by improving detection, treatment, and tracking of CDI.

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Q5 How can the penicillin-binding protein 2a assay be used to improve antimicrobial stewardship?

The penicillin-binding protein 2a assay is a fast, precise, and relatively inexpensive test for determining methicillin susceptibility in *Staphylococcus aureus* (methicillin-resistant *S. aureus*). Our team conducted a study using this assay, with and without stewardship intervention, and our results showed that there was a significantly improved time to optimum therapy. The simple assay can be used as a part of stewardship practices, especially in places with limited resources.²

Q6 What effects have COVID-19 and the ongoing mpox (formerly monkeypox) outbreak had on antimicrobial resistance? What opportunities may arise from the pandemic that could help tackle antimicrobial resistance in the future?

The pandemic had a huge impact on antimicrobial resistance. According to the Centers for Disease Control and Prevention (CDC), the rates on resistant hospital-acquired infections and deaths increased by at least 15% during the first year of the pandemic.³ The causes of this were multifactorial. The pandemic led to severe staffing shortages, clinic and laboratory closures, supply chain issues, and overuse of antimicrobials among hospitalised patients, all of which helped set back the efforts made by healthcare teams to combat antimicrobial resistance. We hope that the losses are only temporary, and most infection prevention and infectious diseases teams will be able to regain their full resources to be able to get back to work on this important topic.



Q7 How can a One Health approach be leveraged to combat the rise of drug-resistant infections?

Antimicrobial resistance is a multifaceted problem that requires a multipronged approach to combat it. There is a lot of antibiotic use in our food supply, from farming to meat production, which leads to increased colonisation of resistant organisms, as well as outbreaks of zoonotic diseases. The World Health Organization (WHO) and the CDC have made the multifaceted approach a priority in their effort to promote public health. Education and collaboration between the public, government, private companies, and medical community is needed to combat the threat of antimicrobial resistance.

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Q8 You co-authored 'Standardizing a Centralized Allocation Process for Rarely Used Anti-Infective Medications Across a Health System', which was presented at Infectious Diseases Week (IDWeek) 2022. Please highlight the value of this study and its implications for clinical practice.

Our health system created a centralised allocation process for rare-use anti-infectives so that supply of these medications is easily available to all sites within the system and inventory is maintained at the academic medical centre by the clinical pharmacy team. For example, in two cases of severe malaria, the centralised process prevented delay in obtaining the medication and reduced the time to medication administration significantly. We are considering expanding this process to high-cost,

infrequent-use antibiotics as well. This process is more efficient and promotes fiscal stewardship whilst optimising patient care.

Q9 What advances in research and policy are necessary to address antimicrobial resistance knowledge gaps? Going forward, how will you continue to promote appropriate prescribing of antimicrobials, both at national and international levels?

Data show that in the USA most antimicrobial prescribing happens in the outpatient setting,⁴ where the antimicrobial stewardship efforts are difficult to implement due to logistical barriers. There is a lot of potential to expand the use of rapid diagnostic testing and point of care testing in our outpatient clinics and emergency rooms, where they can be used to determine the cause of infection quickly and hopefully prevent the prescription of unnecessary antibiotics. As an infectious diseases pharmacist, I will keep working on educating our providers and the public, and do my part to make sure that our patients are not being prescribed antimicrobials unnecessarily. ●

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