

STAFF NURSES' ANTIMICROBIAL STEWARDSHIP
PRACTICES AND PERFORMANCE CONFIDENCE
RELATIVE TO PATIENT SAFETY CULTURE

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Dedication

This dissertation is dedicated to my parents, Margaret and Larry Vaught. Both of my parents expressed their deep commitment to learning and emphasized finding joy in our work, through connecting with and seeking the wisdom of others. They fostered curiosity, innovation, initiative, and determination, which have been influential factors in all aspects of my life. I am grateful for their support, patience, but most importantly, I have always felt secure. That security gave seed to imagining novel, bold ideas and creating plans to achieve them. With that, thank you.

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Staff Nurses' Antimicrobial Stewardship Practices and Performance Confidence
Relative to Patient Safety Culture

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Abstract

Current antimicrobial stewardship guidelines from the Centers for Disease Control and Prevention (CDC) suggest staff nurses play a key role in the stewardship process. The American Nurses Association (ANA) supports the CDC guideline and has charged nursing leaders with allotting organizational resources and aligning their workplace culture to support nurses' role. Despite national attention on nurses' involvement in antimicrobial stewardship, there is neither research describing practices used by nurses that impact antimicrobial stewardship processes; nor, is there understanding about how organizations' patient safety culture influences nurses' role in stewardship. Therefore, the purpose of this dissertation study is to determine pediatric and adult staff nurses' understanding of current practices that support antimicrobial stewardship, nurses' confidence to perform stewardship practices, and the influence of organizational patient safety culture on practices.

CHAPTER ONE

GENERAL INTRODUCTION

Antimicrobials, which include antibiotics, antifungals and antivirals are one of the most commonly used therapeutic agents across care settings and are often inappropriately used, which has led to increasing concerns about the public health consequence of antimicrobial resistance (CDC, 2015). Unlike all other pharmacologic therapies, antimicrobials are the only agents that lose efficacy over time and use (Spellberg, Srinivasan, & Chambers, 2016). As Tom Frieden, Director, U.S. Centers for Disease Control and Prevention (CDC) warned:

The loss of effective antibiotics will undermine our ability to fight infectious diseases and manage the infectious complications common in vulnerable patients undergoing chemotherapy for cancer, dialysis for renal failure, and surgery, especially organ transplantation, for which the ability to treat secondary infections is crucial (CDC, 2013, p. 5).

Judicious use of antibiotics is a major goal in the fight against antimicrobial resistance (CDC, 2013; World Health Organization, 2015). The collective response in treating infectious diseases and their associated complications has come under increasing scrutiny and nurses, the largest of the clinical disciplines, has been curiously absent in initiatives designed to enhance antibiotic use (Olans, Olans, & DeMaria, 2015). As part of their daily work, nurses perform practices that influence therapeutic decision-making and optimization of antibiotic therapies, yet little is known about how they perceive their role as antibiotic stewards. Therefore, the purpose of this dissertation project is to use survey methodology to describe clinical practices that nurses' associate with the process of antibiotic stewardship, their perceived confidence to perform those

practices, and to examine the influence of organizational patient safety culture on nurse stewardship.

Impact of Injudicious Antimicrobial Use

In the United States (U.S.), the CDC estimates that antimicrobial resistance (AMR) directly results in 2 million illnesses and 23,000 deaths annually (CDC, 2013). *Clostridioides difficile* infections (CDIs), a recognized complication from antibiotic exposure, mirrors the trend of multi-drug resistant organisms (MDROs). Annually, nearly 250,000 patients require hospitalization for CDI, which contribute to 14,000 deaths (CDC, 2013). The impressive toll on U.S. morbidity and mortality accounts for over 20 billion of additional healthcare spending each year and 35 billion in lost productivity each year (CDC, 2013). Major gaps exist in surveillance and data sharing to estimate the true global prevalence, however, in 2014 the United Kingdom commissioned a scholarly review that identified AMR could cause 10 million deaths by 2050 (O'Neill, 2014). These recent approximations based on available data galvanized the antibiotic stewardship movement and accelerated the implementation of drug expertise programs designed optimize drug regimens.

The need to improve the use of antibiotics is not a new concept in the U.S. Following Alexander Fleming's penicillin discovery in 1928, he cautioned that promiscuous use would lead to reduced therapeutic efficacy (Bartlett, Gilbert, & Spellberg, 2013). As projected, the misuse of antibiotics continues to fuel current resistance rates, place patients at risk of acquiring infections that cannot be adequately treated with existing antimicrobial therapy, and contribute to adverse drug reactions, drug interactions, cross-sensitivity of drugs and medication errors (Barlam et al., 2016). More than 50% of hospitalized patients receive antibiotic therapy and often it is inappropriate (CDC, 2017). The CDC has reported more than 30% of antibiotics used in

outpatient settings are unnecessary or prescribed incorrectly and more than 40% of orders in nursing homes lack important prescribing details (CDC, 2017). Five years ago, following the CDC (2013) publication on growing problem with multi-drug resistant organisms, such as, carbapenem-resistant enterobacteriaceae, news and other media sources began reporting the transition into the post-antibiotic era. While there has been a decline in some inappropriate antibiotic prescribing, between 2006 and 2012 use of some of the most powerful antibiotics, carbapenem and vancomycin, has increased by 40% and 30%, respectively.

Traditional Models of Antimicrobial Stewardship

In response to national concerns on resistance, antimicrobial stewardship programs (ASPs) are being required by regulatory and accrediting agencies to enhance the quality and safety through infection prevention and optimization of antimicrobial therapies (CDC, 2014). Antimicrobial Stewardship Programs have effectively reduced antibiotic use and improved patient outcomes while reducing acute care hospital costs (Barlam et al., 2016). The proven benefits of ASPs led to national initiatives to expand and build ASPs across health care settings (The White House, 2015). In 2014, the CDC released the *Core Elements of Antibiotic Stewardship* which provided a guide of the structural and functional components associated with effective ASPs (CDC, 2014).

Traditionally, ASPs have utilized pre-prescription authorization and post-prescription antibiotic review with feedback as the main strategies to steward antibiotic use in acute care hospitals (Barlam et al., 2016; Dellit et al., 2007). These interventions although successful and valuable are resource-intensive and limit the number of patients the antimicrobial stewardship team are able to impact. Development of dashboards and other electronic tools have eased ASPs' workload by facilitating quick identification of abnormal drug levels, drug-microorganism

mismatch, or use of restricted antibiotics needing review (Forrest et al., 2014). Yet, there is still substantial time commitment to review each case. Furthermore, these interventions occur after microbiology cultures have been obtained and antibiotics have already been started. It has been well-documented that once there is a positive culture result, a significant number of prescribers will treat based on this information even in the absence of clinical signs or symptoms suggestive of infection. For example, up to 60% of positive urine cultures in hospitalized patients represent asymptomatic bacteriuria (ASB), and 40% of these patients receive inappropriate treatment (Grein et al., 2016; Trautner et al., 2015). A similar trend has been observed with sputum cultures (i.e., antibiotic prescriptions triggered by positive respiratory specimens in patients without clinical evidence of pneumonia) (Katsios et al., 2012). Obtaining cultures or other interventions at earlier moments of antibiotic decision-making to determine if patients have infections are necessary.

A Role for Nurses in Antimicrobial Stewardship

The CDC and The Joint Commission as well as various nursing organizations and constituencies, such as the American Nurses Association, American Academy of Nursing, and National Institute of Nursing Research have identified the importance of nurse inclusion in stewarding efforts (Manning, 2016). The growing position statements and endorsement for nurses as antibiotic stewards is encouraging, but research is lacking. As found in Chapter 2, Monsees, Goldman, & Popejoy (2018) examined approximately 10 years of literature and found only 13 articles referencing a role for direct care nurses roles in stewardship initiatives. Since the publication of the manuscript, work on this important topic is beginning to emerge at research conferences, suggesting interest in nursing's role in ASP is increasing (Raybardhan, 2017).

Recent studies have shed light on nurses' perceptions of their potential contribution to stewardship efforts in acute care hospitals, their perceived limitations to accomplish their role as stewards, and suggestions to overcome these limitations (Carter et al., 2018; Greendyke et al., 2018; Monsees, Popejoy, Jackson, Lee, & Goldman, 2018). As described in Chapter 3, when nurse stewardship role and confidence were examined, nurses possessed a high degree of confidence with certain practices assessing for an adverse drug reaction, obtaining cultures prior to antimicrobial initiation, participating in family education and notifying providers of dosing errors (Monsees et al., 2018). Conversely, nurses were less confident or reluctant to perform a 48-hour antimicrobial time out or de-labeling a penicillin (PCN) allergy (Carter et al., 2018; Monsees et al., 2018).

Conclusion

As stewardship shifts beyond academic institutions where infectious disease support is readily available, emerging literature suggests the complex relationship between various disciplines will become an integral factor in advancing stewardship practice across medical providers' roles and care settings. Recognition of how nursing practices support the process of stewarding continues to unfold, however, nurses may be called into broader service as a function of their constant presence throughout the healthcare continuum. This dissertation project attempts to address a significant research gap by employing a systems perspective to examine organizational features influencing nurse stewardship. As such, Chapter 4 outlines the Society for Healthcare Epidemiology of America proposal submitted for funding and describes the methods used to complete this project. Chapter 5 includes the preliminary manuscript reporting the results and findings from this multisite study. Finally, Chapter 6 synthesizes the entire

scholarly work product of this dissertation and illustrates its findings and significance to nursing practice.

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CHAPTER TWO

STAFF NURSES AS ANTIMICROBIAL STEWARDS:

AN INTEGRATIVE LITERATURE REVIEW

Monsees, E., Goldman, J., & Popejoy, L. (2017). Staff nurses as antimicrobial stewards: An integrative literature review. *American Journal of Infection Control*, 45(8), 917-922. doi:10.1016/j.ajic.2017.03.009

Abstract

Guidelines on antimicrobial stewardship emphasize the importance of an interdisciplinary team but current practice focuses primarily on defining the role of infectious disease physicians and pharmacists; the role of inpatient staff nurses as antimicrobial stewards is largely unexplored. Whittemore and Knafel's integrative approach guided a systematic appraisal of 13 articles spanning January 2007 to June 2016. Quantitative and qualitative peer-reviewed publications including staff nurses and antimicrobial knowledge or stewardship were incorporated into the analysis. Two predominant themes emerged from the review: 1) nursing knowledge, education, and information needs and 2) patient safety and organizational factors influencing antibiotic management. Focused consideration to empower and educate staff nurses in antimicrobial management is needed to strengthen collaboration and build an inter-professional stewardship workforce. Further exploration on the integration and measurement of nursing participation is needed to accelerate this important patient safety initiative.

Keywords: antimicrobial stewardship, antibiotic resistance, staff nurse

Antibiotics are a shared community resource and the only class of pharmaceutical agents that lose effectiveness over time and repeated use due to bacteria's ability to develop resistance (Spellberg, Srinivasan, & Chambers, 2016). Inappropriate antibiotic utilization results in increased antimicrobial resistance that jeopardizes the health and welfare of patients (Centers for Disease Control and Prevention [CDC], 2013). In the United States (U.S.), the CDC estimates that antimicrobial resistance directly results in 2 million illnesses and 23,000 deaths annually (CDC, 2013). Global and national concerns have prompted the development of antibiotic stewardship programs (ASPs) designed to enhance the quality and safety of clinical care through antibiotic management (CDC, 2016).

Within U.S. hospitals, ASPs guide interventions involving antibiotic selection and administration to optimize antibiotic treatments and minimize unnecessary use. Traditionally led by infectious disease physicians and pharmacists, The Joint Commission (2016) is requiring inpatient ASPs to demonstrate interdisciplinary engagement to address core performance elements and expand stewardship reach. Staff nurses have important roles in antibiotic optimization, including obtaining appropriate cultures prior to initiation of antibiotics and administering and monitoring antibiotic therapy. Despite these activities being in their scope of practice, the impact of staff nurse contributions is largely unstudied (Olans, Olans, & DeMaria, 2015). This integrative literature review examines the extant literature on the role of staff nurses in antibiotic stewardship to develop strategies to enhance nursing participation in ASP.

Method

Whittemore and Knafl's integrative review method (2005) was selected to systematically appraise data from both qualitative and quantitative research traditions; thus allowing disparate studies to be used in analyzing literature about nurses' contribution to ASPs. Integrative review

is a useful framework for evidence-based practice integration and policy development (Whittemore & Knafl, 2005).

Search strategy

A literature search to identify articles indicating the need for inpatient staff nurse involvement in ASP was conducted by a health sciences librarian in collaboration with the lead author using the following databases: PubMed, Cumulative Index to Nursing and Allied Health Literature (CINAHL), and Scopus. Dellit et al. (2007) published one of the first ASP implementation articles, thus the search was limited to the years 2007 to June 4, 2016 and was restricted to English language articles. Figure 1, further describes details of search strategies and databases. The search retrieved 468 citations. Reference lists of included articles were checked and no additional articles were selected for review.

Article Selection

The process for article selection included removing duplicates and using inclusion criteria to assess citation titles and abstracts for full text review (see Figure 2). Two researchers then verified the selected articles met inclusion criteria. Finally, all three authors agreed upon eligibility and data extraction results. Retained articles acknowledged or included staff nurses in stewarding efforts. The majority of the articles were descriptive with a focus on: (a) nursing knowledge of antimicrobial resistance (AMR), (b) nursing role and activities in ASP, (c) eHealth decision-support systems on improving nursing access to antimicrobial information, or (d) hierarchical determinants influencing ASP involvement.

Two articles addressed the role of staff nurses specific to advancing stewardship efforts were excluded (Edwards, Drumright, Kiernan, & Holmes, 2011; Olans et al., 2015), despite the pivotal positions they have in garnering topical attention, as the purpose of the review was to

summarize and report research findings. Likewise, it is vital to note other nurse leaders have clearly acknowledged the importance of staff nurse inclusion in stewardship activities, with their articles serving as advisory recommendations for clinical practice (Edwards et al., 2011; Ladenheim, Rosembert, Hallam, & Micallef, 2013; Manning, Pfeiffer, & Larson, 2016). Excluded were expert recommendations lacking qualitative findings or quantitative data, publications that had a general focus on infection prevention strategies, infection control nurses, or the prescribing patterns of advance practice nurses. Additionally, studies specific to other settings e.g. ambulatory or long-term care were excluded. Finally, literature evaluating the influential nature of nurses on general prescribing practices or publications targeting behavioral or cultural changes were excluded as the focus of the review was to examine staff nurse participation as antimicrobial stewards.

Results

The review identified 13 studies addressing or including staff nurses in stewardship programming efforts. Two predominant themes emerged from the review: 1) nursing knowledge, education, and information needs and 2) patient safety and organizational factors influencing antibiotic management. Table 1 describes publications included in this integrative review. Eight publications used quantitative approaches (Abera, Kibret, & Mulu, 2014; Cotta et al., 2014; Gillespie, Rodrigues, Wright, Williams, & Stuart, 2013; Hamilton et al., 2015; McGregor et al., 2015; Murni, Duke, Kinney, Daley, & Soenarto, 2015; Toska & Geitona, 2015; Wentzel et al., 2016), four utilized qualitative methodologies (Charani et al., 2013; Cotta et al., 2015; Wentzel, de Jong, van Gemert-Pijnen, Nijdam, & van Drie-Pierik, 2014; Wentzel, van Velsen, et al., 2014), and one applied mixed methods design (Olans et al, 2015). No articles used theories or models to guide the research, except for Cotta (2015) who completed a thematic

analysis guided by Azjen's theory of planned behavior to explore the attitudes of specialists, peer antibiotic use, and prescribing behavior.

Nursing Knowledge, Education, and Information Needs

Nursing knowledge. Ten studies indicated the need to enhance nursing knowledge, education, and information support to strengthen ASP practices (Abera, Kibret, & Mulu, 2014; Cotta et al., 2014; Gillespie et al., 2013; McGregor et al., 2015; Murni et al., 2015; Olans et al., 2015; Toska & Geitona, 2015; Wentzel, de Jong, van Gemert-Pijnen, Nijdam, & van Drie-Pierik, 2014; Wentzel et al., 2016; Wentzel, van Velsen, et al., 2014). A good example of this work is Olans et al. (2015). This study evaluated interdisciplinary publications to assess for nursing presence in ASP. There were 900 articles on ASP identified from medical, pharmacy or microbiology journals but only 11 publications were found in nursing journals, revealing the striking lack of literature on the staff nurses' roles in antimicrobial stewardship initiatives (Olans et al., 2015). Only Columbia University in concert with multiple campuses in the New York Presbyterian network has deployed a nurse survey on knowledge about ASP activities (Greendyke et al., 2016). Despite the attention on ASPs, there is a dearth of literature on how staff nurses perceive their participation in ASPs, particularly in the United States.

The growing global presence of AMR, disparity in antibiotic regulations, and expanded staff nurse roles due to infectious disease physician shortages has prompted study by international researchers (Abera et al., 2014; McGregor et al., 2015; Toska & Geitona, 2015). The only literature addressing nursing knowledge assessments was reported in three international studies conducted in Scotland, Ethiopia, and Greece (Abera et al., 2014; McGregor et al., 2015; Toska & Geitona, 2015). The Scottish National Health Service has designed programs to enhance nursing recognition in stewardship (2016). McGregor et al. (2015) studied the

knowledge and familiarity of antimicrobial stewardship in over 900 staff nurses and midwives practicing in Scotland. Though the sample is a mixture of staff and advance practice nurses, only 36% ($n = 321$) identified their stewardship knowledge as “good” or “very good” and just over 21% ($n = 191$) of the respondents were familiar with the term “antimicrobial stewardship” (McGregor et al., 2015).

Two cross-sectional studies published in Ethiopia and Greece, specifically examined nursing knowledge and perceptions of practices to mitigate emergence of AMR (Abera et al., 2014; Toska & Geitona, 2015). A self-administered knowledge assessment was provided and assigned a score of 1 if correct; scores lower than 0.72 were considered under the acceptable average (Abera et al., 2014). The nursing respondents mean score was 0.63 ($p = 0.001$), suggesting slightly over half of the nurses had limited knowledge of antimicrobial resistance (Abera et al., 2014). Toska and Geitona (2015) suggested that nurses working in pediatric centers might demonstrate higher sensitivity to AMR due to professional exposure to academic and specialty services. While the awareness of global resistance was implicit, limited education among staff nurses translated to a general underappreciation of the AMR problem within their respective institutions (Abera et al., 2014; Toska & Geitona, 2015).

Nursing education. Gillespie et al. (2013) assessed the clinical impact of nursing-specific antibiotic management education in Australia. A willingness to question providers on the necessity of intravenous (IV) administration of antibiotics changed from 14% (95% CI [7.9-22.4]) to 42% ([31.9-54.7]; $p < .001$) while gaining a new appreciation for the relationship between IV administration and risk of line-associated infections 38% (95% CI [28.5-48.3]) to 70% ([59.6-80.6]; $p < .001$) demonstrated statistical significance (Gillespie et al., 2013). Similarly, a pre-intervention and post-intervention study conducted in Indonesia examined the

impact of education on hand hygiene, hospital-associated infections, and antimicrobial use (Murni et al., 2015). Although antibiotic use did not decline, the relative risk of healthcare-associated infections (HAIs) decreased from 22.6% to 8.6% post intervention RR = 0.38, 95% CI [0.31 to 0.46].

Information needs. Three articles from a clinical informatics perspective reported nursing input on the design of an eHealth application aimed to support the staff nurse's specific antibiotic information needs (Wentzel, de Jong et al., 2014; Wentzel et al., 2016; Wentzel, van Velsen et al., 2014). The resulting antibiotic information application (AIA) synthesized discrete data sources used to support nursing antibiotic management tasks, such as, administration, warnings, and drug interactions, into one application. Wentzel et al. (2016) assessed pre-implementation and post-implementation user satisfaction using a 5 point Likert-scaled instruments designed to examine usability, communication, teamwork, safety and stewardship behaviors. The areas that had significant changes pre and post ASP implementation were unobtrusiveness ($p = .000$), relevance ($p = .002$), user friendliness ($p = .000$), and speed ($p = .000$)

Patient Safety through Antimicrobial Management

Given the breadth of patient safety, a few publications comprised in the review had content consistent with both themes identified in this review: patient safety and nursing knowledge, education and information needs. Eight studies in this review measured the impact of specific clinical processes (e.g. modifying route of medication administration) or conversely, explored the influence of behavioral attributes on team interactions and stewardship practice (Charani et al., 2013; Cotta et al., 2015; Gillespie et al., 2013; Hamilton et al., 2015; Olans et al., 2015; Wentzel, de Jong, et al., 2014; Wentzel, van Velsen, et al., 2014; Wentzel et al., 2016).

Hamilton et al. (2015) developed, piloted, and evaluated a point-of-use tool to improve antibiotic prescribing. Unlike other studies examined for review inclusion, this article had a team of pharmacists, physicians, and nurses who initiated the intervention. Respondents (18 of 19) reported workflow was not impacted by the tool and the findings illustrated the importance of interdisciplinary engagement and collaboration among clinical champions whose primary responsibilities are for direct patient care (Hamilton et al., 2015).

In addition to examining the presence of stewardship in the literature, Olans et al. (2015) queried and analyzed responses from nurse educators on activities to enhance staff nurse participation in ASP. Focus group data revealed the educators' recommendations to empower nurses as patient safety advocates included specimen collection and microbiology interpretation, ability to differentiate between colonization and infection, sepsis recognition, antibiotic de-escalation and IV to oral alternatives, and communication strategies. In deference to the latter, Charani et al. (2013) identified that accepted cultural rules and overt hierarchical roles held by clinicians have an impact on the willingness of nurses to talk about antimicrobial therapies. Interestingly, the perception among nurse educators in Olans et al. (2015) study was that staff nurses needed to build confidence interacting with providers. This is particularly salient because other disciplines believe nurses are uniquely positioned to intervene and question antibiotic plans due to their non-threatening clinical station (Cotta et al., 2015).

Discussion

The CDC Core Elements of Hospital Antibiotic Stewardship Programs (2015) acknowledge ASP must be a multifaceted, coordinated approach among interdisciplinary professionals. Similarly, beginning in 2017, to gain accreditation by The Joint Commission, critical access hospitals and long-term care centers are required to have a formalized ASP and

convey antimicrobial use and resistance patterns data to all relevant staff, including staff nurses. Anticipating that interest in appropriate allocation of healthcare resources to improve patient safety through antimicrobial management will continue, augmenting ASP efforts with nursing capital will require focused consideration and more research.

Nursing has long served as the central hub for healthcare operations (Olans et al., 2015). The appeal of increasing staff nurse engagement is due to their unique clinical positioning as patient advocates, educators, communicators, influencers, facilitators, and operational coordinators of care (Edwards et al., 2011; Olans et al., 2015; Olans et al., 2015; Toska & Geitona, 2015; Wentzel, van Velsen et al., 2014). Aside from leveraging the depth and breadth of the nursing discipline, there is also a pragmatic aspect as the number of infectious disease physicians continues to decrease, nurses can help disseminate information to fill the antimicrobial knowledge gap (Chandrasekar, Havlichek, & Johnson, 2014). Nurses comprise the largest clinical discipline, especially when compared to physicians and pharmacists (American Association of Colleges of Nursing, 2011; Olans et al., 2015), thus, traditional ASPs comprised solely of infectious disease experts limits the reach stewardship. Community hospitals, critical access, long-term care, and ambulatory environments have limited resources and access to infectious disease physicians and pharmacists. Conversely, staff nurses have a consistent presence across the care continuum but lack resources to participate meaningfully in ASPs.

The national attention on nurse participation in ASP, highlights the current need to help nurses achieve and enhance skills related to antimicrobial management. Sym et al. (2007) examined nurse practitioner programs and identified that even though this clinical group is a frequent prescriber of antibiotics, they receive fewer than 10 hours of training on antimicrobial therapy in their education programs. Equating those findings with registered nurse programs,

often infection prevention practices are embedded in standard nursing courses, therefore, the duration and quality of education provided to staff nurses is limited, despite their fundamental role in stewardship (Olans et al., 2015).

Increased patient and health system complexity has created a need for clinical specialization. The advent of specialty teams and service lines has had the unintended consequence of disempowering nursing from traditionally held responsibilities. It is possible that focused education about ASP may energize nurses to optimize ASP interventions within their clinical practice (Edwards et al., 2011; Olans et al., 2015; Olans et al., 2015). In order to do so, we need research to determine how nurses' in varied practice locations best receive and process information about ASP. Wentzel et al. (2016) identified that particularly in an academic setting, where many ASPs are situated, nurses preferred interfacing and accessing human information sources compared to electronic applications. While it may be possible for specialty teams to interface and play a pivotal role in antimicrobial practices in academic health centers it is less likely to occur in other settings. It is essential that alternative information mediums be identified and developed to support nurses when infectious disease experts are lacking.

The absence of a nursing presence in ASP literature may signify that staff nurses and other professionals might not recognize nursing functions related to antibiotic stewardship as tangible contributions to ASPs (Edwards et al., 2011; Olans et al., 2015; Olans et al., 2015). It is also noteworthy that nurses have a knowledge gap when it comes to their role as stewards. The distribution of knowledge between nursing, medical, and pharmacy disciplines on AMR is uneven which can lead to a disparate understanding or communication among clinical teams (Abera et al., 2014; McGregor et al., 2015). Overlooking nurses as ASP allies has the potential to have a negative effect on team communication and planning, and possibly patient outcomes.

The imbalance of knowledge can impede nurses' ability to identify antimicrobial management issues, escalate patient safety concerns to their medical partners, and sculpt antibiotic plans to ensure clear interpretation from providers to patients (Charani et al., 2013; Olans et al., 2015).

Beyond the necessary skills to optimize antimicrobial therapy, developing a stewardship workforce includes leveraging principles of patient safety science to utilize a systems thinking approach to understand organizational infrastructure and the manner in which individuals interact with each other within the confines of the organizational structure. This mindset considers how highly specialized teams operationalize safety behaviors (e.g. supporting a questioning attitude and respecting diversity in knowledge or expertise) to make decisions about antimicrobial management. Practicing with a mindset rooted in safety science and using safety behaviors, individuals are open to a more complex and comprehensive view of the clinical situations, thereby allowing for better informed decision-making. For staff nurses to be empowered as stewards, tactical skill development and education are important, but efforts to strengthen inter-professional collaboration within the ASP architecture is essential.

This search was limited to 13 qualitative and quantitative methodologies describing the ASP role of staff nurses practicing in acute care settings. International literature was included, but nurses may have different clinical responsibilities depending on country practice requirements; therefore, their scope may reflect unique cultural considerations and possibly challenge generalizability of findings. The limited interventional research and breadth of study populations make comparisons between the articles subject to inference by reviewers. Variation in stewardship programs and outcome data adds another layer of heterogeneity when attempting to quantify nursing participation and impact on ASP success. Nonetheless, given the novelty of

the topic, we could have expanded the search to include non-peer review sources such as conference proceedings.

Conclusion

As AMR threats intensify, health policy leaders recognize that staff nurses add range and robustness to stewardship, despite limited research on their role or impact. Importantly, they have identified for antimicrobial management interventions to continue achieving and sustaining improvement momentum, we must strengthen skills to produce interdisciplinary partners. Concerted efforts to empower a nursing presence in ASP is crucial. The paucity in literature regarding their participation in formalized stewardship programming revealed through this review reflect a prime opportunity to examine the role of staff nurses in ASP. Future study includes exploring their integration into stewardship infrastructure and quantifying the effect of staff nurse participation on health outcomes.

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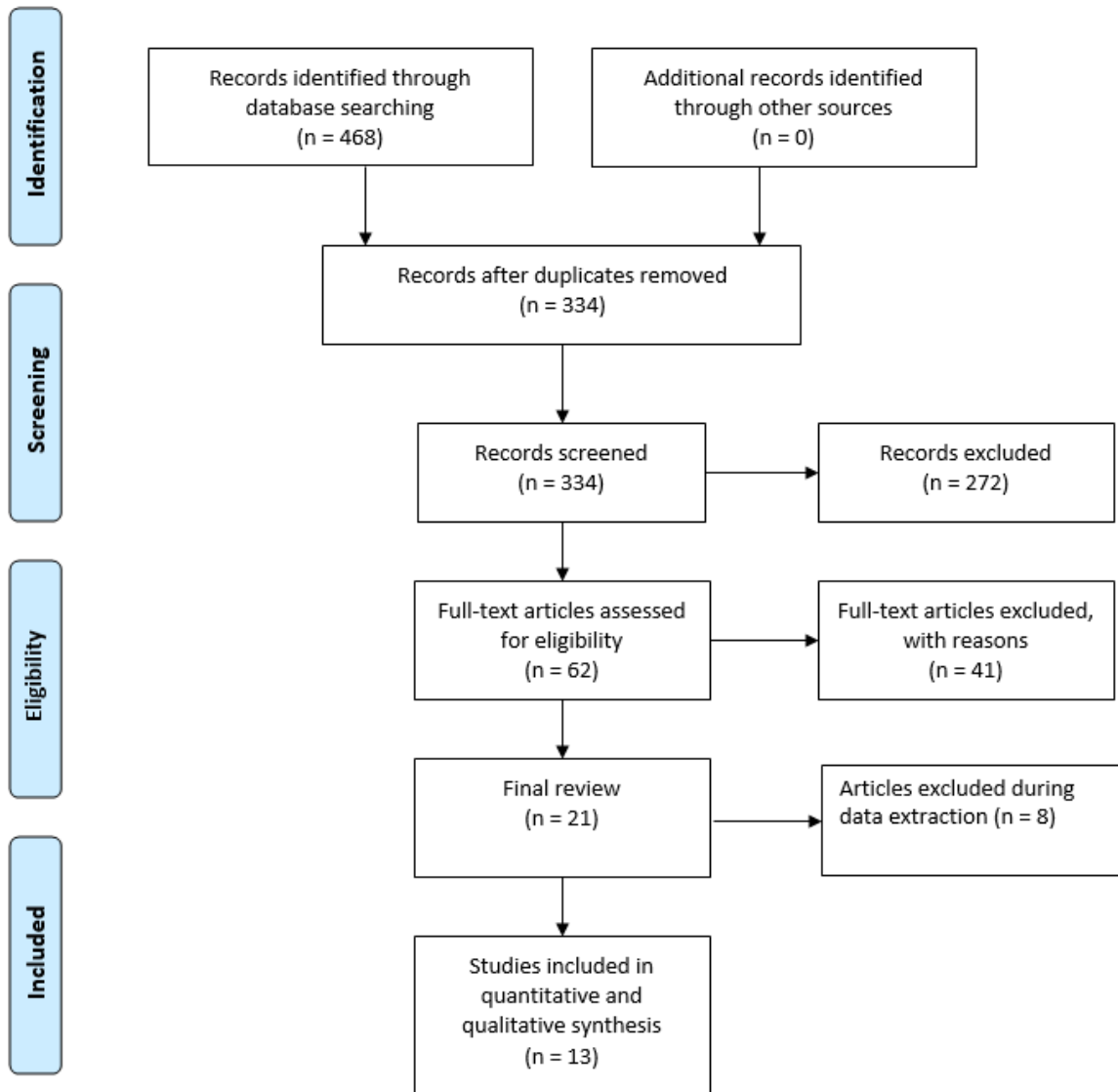
Figure 1

Periodical databases and terms used for search

Pubmed	CINAHL	Scopus
<p>PubMed Search: ("Anti-Infective Agents"[Mesh] OR anti-infective OR anti-bacterial OR antimicrobial* OR antibiotic*) AND (stewardship OR "Practice Patterns, Physicians"[Mesh] OR "prescribing practices" OR "restriction policies") AND nurs*</p>	<p>(MH "Antibiotics+") OR "antibiotic" OR (MH "Drug Resistance, Microbial") OR (MH "Antiinfective Agents") OR "antimicrobial", "stewardship" OR (MH "Prescribing Patterns") OR "prescribing patterns", (MH "Public Policy") OR (MH "Hospital Policies") OR (MH "Health Policy") OR "restriction policy" OR (MH "Policy Making") OR (MH "Health Policy Studies"), "nurse" OR (MH "Nurses+") OR "nursing" OR (MH "Nurse Administrators") OR (MH "Students, Nursing, Graduate") OR (MH "Students, Nursing, Doctoral") OR (MH "Schools, Nursing")</p>	<p>TITLE-ABS-KEY (antibiotics OR antimicrobial OR antibiotic) AND TITLE-ABS-KEY (nurse OR nurses OR nursing) AND TITLE-ABS-KEY (stewardship)</p>

Figure 2

Flowchart of selection process



From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *PLoS Med* 6(7): e1000097. doi:10.1371/journal.pmed1000097

Table 1

Study Description with Essential Findings

Author	Aim, setting and sample	Methods of data collection	Review Theme	Key findings	Methodology
Wentzel et al. (2016)	Examined nurse satisfaction with Antibiotic Information Application (AIA) Dutch 1000-bed teaching hospital, 62 nurses working on 2 units	Self-developed pre and post implementation questionnaire and scenario tests	Knowledge and Information Needs and Patient Safety	Significant results for: unobtrusiveness (2.8 to 3.7; $p = .000$); relevance (3.6 to 4.1; $p = .002$); user friendliness (2.9 to 3.3; $p = .000$); and speed (2.4 to 3.7; $p = .000$)	Quantitative
Cotta et al. (2015)	Explored organizational barriers to ASP implementation Large, private Australian hospital, 17 participants	Focus group discussion	Patient Safety	<ul style="list-style-type: none"> • Peers impact prescribing practices • Identified other disciplines aside from prescribers should participation in stewardship 	Qualitative
Hamilton et al. (2015)	Piloted an ASP flowchart within non-ASP hospitals 4 United States hospitals ranging in bed size from 150 to 398; 2 in NC, MA, NJ.	Research Electronic Data Capture used to manage optional survey	Patient Safety	<ul style="list-style-type: none"> • 25% of survey participants used nurses to initiate with housestaff completing the flowchart • 94.7% (n = 18) providers completed survey • 3 minute median completion time 	Quantitative

McGregor et al. (2015)	<p>Evaluated staff nurses and midwives understanding of ASP from 14 National Health Service regions in Scotland</p> <p>901 respondents with 855 completing an online survey and 46 additional interviews. 54.8% worked in acute care; 79.2% with more than 10 years clinical experience</p>	Self-developed questionnaire	Knowledge and Information Needs	<ul style="list-style-type: none"> • 36.8% (n = 189) thought nurse role included appropriate antimicrobial use • 26.3% (n = 109) identified workload as a stewardship challenge • 15.4% (n = 64) reported difficulty maintaining current knowledge • 42% (n = 183) perceived need of further support to be stewards 	Quantitative
Murni et al. (2015)	<p>Evaluated effectiveness of an interdisciplinary infection control program</p> <p>Large, pediatric referral hospital in Indonesia with 1020 patients in each period</p>	National Healthcare Safety Network Surveillance data	Knowledge and Information Needs	<ul style="list-style-type: none"> • Central line catheter use declined from 2.9% (36/1227) to 1.4% (20/1419), $p = .007$ • Risk of ventilator-associated pneumonia decreased from 28.1% (34/121) to 3.6% (5/138), RR = 0.13, 95% CI [0.05 to 0.31] • Risk of urinary catheter decreased from 20.6% (40/194) to 4.9% (8/164), RR = 0.24, 95% CI [0.11 to 0.49] 	Quantitative

Toska & Geitona (2015)	<p>Evaluated knowledge and perceptions of antimicrobial resistance and prescribing among pediatric nurses</p> <p>3 of 4 pediatric hospitals and 33/59 pediatric departments in hospitals in Greece participated</p> <p>301 nurses participated, 94% university educated, mean years of experience 13.8</p>	Self-developed questionnaire	Knowledge and Information Needs	<ul style="list-style-type: none"> • Nurses with university degrees had higher perception of AMR in their hospital OR = 3.62, 95% CI [1.058-12.396], $p = .040$ • Specialized hospitals correlated with higher perception of antimicrobial duration as AMR cause, OR = 2.93, 95% CI[1.175-7.305], $p = .021$ 	Quantitative
Olans, R.D., Nicholas, Hanley, & DeMaria (2015)	<p>Examined understanding of antimicrobial therapy and identified knowledge gaps among staff nurses and educators.</p> <p>10 nurse educators</p> <p>180-bed, two campus community hospital in Boston, MA with established ASP</p>	Focus group discussion with optional survey for staff nurses	Knowledge and Information Needs and Patient Safety	<p>Revealed paucity in literature. Six themes revealed for nurse inclusion in ASP</p> <ul style="list-style-type: none"> • Obtaining cultures • Interpreting microbiology results • De-escalating antibiotics • Recognizing colonization and infection • Assessing for infection • Developing a questioning attitude 	Mixed Methods
Abera, Kibret, & Mulu (2014)	<p>Interdisciplinary evaluation of AMR knowledge and beliefs</p>	Self-developed questionnaire	Knowledge and Information Needs	<ul style="list-style-type: none"> • 68.5% (n = 144) of nurses indicated they have not received current information on 	Quantitative

13 hospitals in Amhara Region,
Ethiopia

385 total participants comprised of
175 physicians and 210 nurses

antimicrobial resistance
compared to 13.5% (n
= 5) and 29.7% (n =
41) of senior physicians
and general
practitioners,
respectively.

- 40.4% (n = 85) of
nurses perceived drug
resistant tuberculosis
more prevalent in
hospitals than
physicians 4.1% (n =
7), $p = .001$
- 9.3% (n = 36) of nurse
and physicians have
ASP training

Cotta et
al. (2014)

Attitudinal survey on AMR,
antimicrobial use, and
interdisciplinary ASP practices

490-bed private Australian hospital;
331 respondents; 105 nurses

Self-developed
questionnaire

Knowledge and
Information
Needs

Identified discipline-
dependent responses:

- surgeon/anesthesiologis
ts (22% , 26%
respectively, $p < .001$)
perceive AMR
affecting patients
compared to 45% in
nursing and physicians
- 62% of respondents
consider AMR a
problem but only 45%
perceive AMR of issue

Quantitative

	Wentzel, van Velsen, et al. (2014)	Designed an Antibiotic Information Application to support nursing involvement in ASP Dutch 1000-bed teaching hospital; 5 staff nurses in first focus group and 4 staff nurses in second focus group	Focus groups	Knowledge and Information Needs and Patient Safety	<p>in their hospital ($p < .001$)</p> <ul style="list-style-type: none"> Used participatory development approach Nurses revealed a need to reconcile disparate data sources to support antimicrobial management, streamlining relevant resources, and patient information on one interface 	Qualitative
	Wentzel, de Jong, et al. (2014)	Developed and examined use of nurse Antibiotic Information Application (AIA) Dutch 1000-bed teaching hospital; 17 nurses to use the AIA; 17 nurses to utilize existing information formats	Semi-structured interviews and log data analysis	Knowledge and Information Needs and Patient Safety	<ul style="list-style-type: none"> Used persuasive system design to analyze: task support, dialogue support, perceived credibility, social support, unobtrusiveness, perceived persuasiveness, perceived effort, perceived effectiveness, and use continuance AIA utilized on average 5.21 (SD 3.09) times per day 	Qualitative

Gillespie et al. (2013)	<p>Measured the impact of nursing specific education on antibiotic use and effect on clinical practice.</p> <p>2 hospitals in large Australian system; 79 nurses participated</p>	Survey	Knowledge and Information Needs and Patient Safety	<ul style="list-style-type: none"> • 11% bounce percentage reflecting a low rate of leave after entering AIA • May help nurses develop statement for physician communication • Significant change in understanding of AMR development 59% 95% CI [48.7-68.7] to 79% [69.2-88], $p < .003$ • Prior to intervention, questioned antibiotic order 71% [62.1-80.0] to 91% [86.6-98.2], $p < .001$ 	Quantitative
Charani et al. (2013)	<p>Studied antimicrobial prescribing attitudes, barriers to prescribing recommendations and factors that influence prescribing.</p> <p>4 hospitals of the Imperial College Healthcare National Health Service Trust in the United Kingdom.</p> <p>39/80 healthcare professionals with routine patient contact: 10 doctors, 10 pharmacists, 18 staff nurses, 1 midwife.</p>	Semi-structured interviews	Patient Safety	<ul style="list-style-type: none"> • Three themes emerged: decision-making autonomy, policy limitations, and culture of hierarchy • Healthcare disciplines are hesitant to question peers even when knowledge exists • Nurses rely on policy to guide practice 	Qualitative

CHAPTER THREE

INTEGRATING STAFF NURSES IN ANTIBIOTIC STEWARDSHIP: OPPORTUNITIES AND BARRIERS

Monsees, E., Popejoy, L., Jackson, M. A., Lee, B., & Goldman, J. (2018). Integrating staff nurses in antibiotic stewardship: Opportunities and barriers. *American Journal of Infection Control*, 46(7), 737-742. doi:10.1016/j.ajic.2018.03.028

Abstract

Nursing has been called for greater participation in antibiotic stewardship and while many of the functions that are integral to successful stewardship are within the scope of bedside nurses, data evaluating nursing engagement in stewardship are limited. Nurses' roles and confidence in engaging in stewardship practices were identified by conducting a survey of pediatric staff nurses employed at a 354-bed freestanding children's hospital with a well-established prospective audit and feedback stewardship program. An investigator-developed online survey was utilized to assess 10 identified practices that fall within the responsibility of inpatient nurses and contribute to the stewardship process. One hundred eighty nurses participated in the study. Nurses were highly confident assessing for an adverse drug reaction history, obtaining cultures prior to antibiotics, and participating in patient education. They were less confident in reviewing microbiology results to determine antibiotic appropriateness. Clinical practice and hospital culture influenced perceptions of the nursing role in stewardship. Reported barriers to stewarding included: nurses not included in rounds, interdisciplinary power differentials and nursing input not actively sought. Barriers to nurse engagement were identified

and could be addressed by improving education in microbiology and principles of antibiotic use along with more consistent inclusion of nurses in bedside rounds while also cultivating an environment where nurse contribution is actively sought.

It has been more than two decades since the Infectious Disease Society of America (IDSA) sounded an alert regarding the need for antibiotic stewardship to stop or slow the development of bacterial resistance (Shlaes et al., 1997). In 2007, IDSA issued guidelines to promote development of stewardship teams with a primary goal to optimize clinical outcomes, while decreasing the rates of *Clostridium difficile*, antimicrobial toxicity, and the emergence of resistance (Dellit et al., 2007). The policy statement that followed, endorsed by IDSA, the Society for Hospital Epidemiology and the Pediatric Infectious Disease Society (PIDS), outlined recommendations to monitor interventions and promote education and research regarding antibiotic use in the United States (PIDS, 2012).

As regulatory and accrediting agencies began to adopt policies related to antibiotic stewardship, IDSA reiterated the need for all healthcare systems to commit to stewardship programs that align with the Centers for Disease Control and Prevention's (CDC) Core Elements (Barlam et al., 2016). The critical roles of infectious disease professionals, including infectious disease physicians, infectious disease pharmacists, clinical microbiologists and infection preventionists were emphasized, and it was recommended that antibiotic stewardship programs (ASP) utilize team-based systems to optimize care and reduce adverse events associated with antibiotic misuse. As the body of evidence increased, there was a call for greater participation by the entire health care team in stewardship programs, including nurses (CDC, 2014; Edwards, Drumright, Kiernan, & Holmes, 2011; Ladenheim, Rosembert, Hallam, & Micallef, 2013; Manning, 2016; Olans, Olans, & DeMaria, 2015).

The inclusion of nurses as members of the ASP team has been endorsed by the CDC, the American Nurses Association, American Academy of Nursing, the National Institute of Nursing Research and accrediting agencies (Edwards et al., 2011; Ladenheim et al., 2013; Manning,

2016; Olans et al., 2015). A better understanding of how nurses perceive their role in stewardship is needed. Currently there is a paucity of information specific to practices facilitating nursing engagement as stewards (Monsees, Goldman, & Popejoy, 2017). Herein we report the results of a pediatric nurse antibiotic stewardship survey to identify staff nurses' perceptions and performance confidence of their stewardship role, as well as barriers to nursing stewardship engagement.

Methods

Setting

This single-centered, cross-sectional survey study describes how inpatient staff nurses perceive their role and confidence to perform an identified set of nursing practices that support stewardship processes. The study was undertaken in a 354-bed freestanding, Midwestern pediatric hospital, which, since 2008, has an ASP utilizing prospective audit and feedback method to help providers tailor and optimize therapies. With over 26,000 reviews of antibiotic treatment, this program is led by a dedicated team of infectious disease physicians and pharmacists who interface daily with antimicrobial prescribers on each unit.

Survey Design

The investigator-developed online survey was modeled after an article published by Olans et al. (2015) which listed nursing activities that support the stewardship process. There were 16 practices in the original list. Using a consensus approach, 10 practices that commonly fall within the responsibility of hospital nurses were selected as practices of interest for the stewardship team. These 10 practices were: obtaining cultures prior to antibiotic administration, performing a 48-hour time out, assessing for adverse drug reactions, reviewing culture results, identifying wrong antibiotic doses, notifying the provider of wrong antibiotic doses, assessing for

potential adverse events, transitioning antibiotics from IV to PO, limiting antibiotic exposure to prevent *Clostridium difficile* infections, and educating patients on appropriate antibiotic use. The survey included a total of 31 items, 20 of which were 10 pairs of role and confidence assessments about nursing practices that support the stewardship process. The remaining questions included free text, demographic, and contextual questions about engagement and antibiotic stewardship. The survey was pilot tested for semantic clarity and face validity with 6 nurses working within the Pediatric Intensive Care Unit, oncology unit, and float pool. The survey utilized a 5-point Likert scale with 1 (strongly disagree) to 5 (strongly agree) to assess role and confidence for each of the 10 practices. The investigators added a category of “I don’t know” based on staff feedback. The survey included the following basic information for respondents: (a) number of years since completion of formalized clinical training; (b) description of their current role; (c) number of years worked at current facility; (d) primary unit; and (e) routine clinical shift. The study was reviewed and approved by the hospital Institutional Review Board.

Study Participants

A total of 1098 direct-care registered nurses, representing 11 diverse clinical units, were invited to participate in a web-based survey using the Research Electronic Data Capture (REDCap) application (Harris et al., 2009). The survey was open for one month and began with dissemination via email by the Chief Nursing Officer, with two subsequent reminder emails to participate.

Analysis

Of the 10 nursing stewardship practices, each practice was associated with parallel role and confidence questions. To examine the association between role and confidence in

performing stewardship practices, the 10 role and 10 confidence questions were averaged separately to create two composite scores for a ratio comparison. Pearson's correlation was used to determine the relationship between the total role score and total confidence score. Next, a series of pairwise chi-square tests was completed using each of the 10 role questions with their respective confidence question. For example, if nurses positively perceived their role to transition medications from intravenous to oral therapy, the investigators examined the performance confidence for that practice. "Don't know" selections were treated as missing data. If more than one unit was selected then the respondent was assigned to a "greater than two units" category. Frequency statistics were computed for antibiotic stewardship questions exploring process aspects, such as time to receiving antibiotics in suspected sepsis patients and three contextual questions on nurse engagement. All quantitative analyses were completed using SAS software (version 9.4, SAS Institute Inc., Cary, NC).

Participants had the opportunity to elaborate on their role in stewardship and to define their perception of stewardship barriers using free text comments. These free text comments were categorized by a study team member (EM). The research team then reviewed categories and related constructs for consensus regarding analytic decisions. Stewardship barriers were then organized by clinical unit and type and number of years of nursing experience to explicate variations in unit and experience-based responses. Potential activities associated with the nurse stewardship role were categorized separately. This analysis was completed using Microsoft Office Professional Plus 13.

Results

Respondents

A total of 180 nurses completed the survey (response rate of 16.4%), with all levels of nursing experience represented (Table 2). Seventy-nine (43.8%) were recent nursing graduates and 38 (21.1%) had graduated more than 15 years ago. The majority have practiced at the hospital less than 5 years. More than 50% of respondents worked in an intensive care unit or on the hematology/oncology unit and 46 (25.6%) identified working on two or more units.

Beliefs and Attitudes

The majority of respondents ($n = 125$, 69.4%) either agreed or strongly agreed that they knew what the term “antibiotic stewardship” meant (Table 3). However, nurses who have worked less than 5 years at the hospital were least familiar with the term antibiotic stewardship (21.6% disagree or strongly disagree) compared to nurses with more than 15 years of practice (6.9% disagree or strongly disagree). The majority wanted to be more involved in the stewardship process and 97 (54%) perceived they were already functioning as stewards (Table 3).

Free Text Results

Of the 180 survey participants, 17 (9%) elected to provide comments in the free text fields. Barriers were condensed into the following categories: education, compliance, hospital culture, and clinical practice. Nurses articulated that lack of knowledge (education), not following procedures consistently (compliance), poor collaboration, communication and disrespect between disciplines (culture), and variability in accepted practices or process organization (practice) were all barriers to being stewards.

Specifically, nurses noted their role in ASP was not well-defined. Nurses suggested their active participation in ASP would be improved if they were consistently present in rounds and had a formal role to play so that nurse input related to antibiotic decision-making was routinely

solicited. Figure 3 demonstrates nurse reported barriers to stewarding varied by years of practice since graduation. More recent graduates indicated lack of education as a barrier to participation in antibiotic stewardship, while more experienced nurses noted their role in medication safety shifted when technology and processes changed. For example, when unit-based pharmacists and automated electronic medical record calculation of medication doses occurred, their practice changed. As one respondent reported, "...nurses could be more active in double checking appropriate doses of antibiotics - I think as we have moved to electronic resources (LexiComp), the PICU as a culture has moved away from checking doses. It used to be that every nurse had a drug book and was expected to look up every drug prior to giving it, in order to review dosing and the class of drug/reason for giving it. Now, it seems that we just accept whatever is on the MAR, expecting that either the calculation functions of the orders or pharmacy will flag any inappropriate dosages." Such a statement suggests subtle changes in the medication administration process also had an effect on how nurses interacted with the systems of double checks and their perceived their responsibility in the process.

In terms of unit-based experience, nurses on surgical units and in the Intensive Care Nursery indicated that the hospital culture constrained their role. For example, one nurse explained, "I feel very strongly about my antibiotic stewardship here but am continually frustrated by the providers' [poor] response when I find that dosage hasn't been adjusted for weight or the timing of administration is incorrect. They brush off my concerns and it's very frustrating." Nurses in other specialized units identified lack of education in stewardship as a limiting factor. All units indicated that practices limited their involvement in the stewardship process (Figure 4).

Discussion

Despite the formal endorsement in 2017 by the American Nurses Association (ANA) and the CDC to engage direct care nurses in antibiotic stewardship, limited data exists on how they view their role as partners in stewardship efforts (ANA & CDC, 2017). This study identified several important factors related to nurses and stewardship: 1) nurses perceive they have a role in stewardship, 2) enhanced education for nurses as related to antibiotics may be important as the role of nurses as stewards continues to evolve, and 3) clinical practice and hospital culture influence nursing perceptions of their role in antibiotic stewardship.

The nurse respondents represent a varied scope of service in terms of years of experience and in the unit where they were primarily based. Most of the surveyed nurses indicated familiarity with the term “antibiotic stewardship,” especially those with more than 15 years of experience. The respondents were most confident in obtaining cultures prior to antibiotics, assessing histories of reactions, and educating patients. Nurses reported they were least confident in evaluating microbiology results for antibiotic appropriateness and in performing 48-hour antibiotic time outs. These may be areas of practice to focus additional education and training, especially in non-acute care settings where nurses drive patient care work flow and serve as frontline stewards.

The study showed that nurses are highly confident performing multiple aspects of care and medication safety; however, their engagement differed depending on the clinical unit where they worked. The comments added some clarification of this finding. Of those who commented, 50% of nurses on surgical units and nearly 50% in the Intensive Care Nursery reported hospital culture as a barrier to their participation in antibiotic stewardship. These results suggest that to facilitate nurse involvement in antibiotic stewardship, a change in hospital culture may be needed. Stewardship leaders may need to explore how nurses can be meaningfully included in

work flow design and consider team-based resources, knowledge and attitudes toward nurse inclusion.

Many nurses in specialty units indicated that they lack education in basic microbiology and in the principles of antibiotic use and stewardship. Nurse practitioners have less than 10 hours of training in antibiotic stewardship, and nurses in training most likely receive even less (Olans, Nicholas, Hanley, & DeMaria, 2015; Sym, Brennan, Hart, & Larson, 2007). Similar to the guidance details found in the ANA-CDC White Paper, a stronger emphasis needs to be placed on developing curriculums related to antibiotic use and stewardship for nurses in training, as well as for those already in clinical practice (ANA & CDC, 2017). Nurses provide moment to moment care of patients and are responsible for completing the tasks that support stewardship processes, which is why in settings where infectious disease experts are lacking or in facilities that do not have formalized stewardship programs, emphasis on appropriate antibiotic use is essential for developing the next generation of nurse stewards.

It is critical to create an environment where nurse engagement is encouraged and input is solicited. Changes within the healthcare system shape nursing practice and suggest resources intended to support clinical care may have unintended consequences. As one of the nurses reported, the availability of pharmacy or electronic resources has influenced the medication roles typically held by nurses and may have reduced nurses' vigilance in double-checking that medications are correct in terms of the correct drug, at the correct time, given the in the correct route, in the correct dose, for the correct person (Institute for Healthcare Improvement, 2017). Technology may have inadvertently made nurses too comfortable in believing that the medications are correct and disconnected nurses from being stewards. Similarly, Edwards et al. (2011) cautioned even the semantics of antibiotic prescribing eliminates "nursing from the

decision-making process,” as prescribing connotes the practice of physicians and pharmacists. Therefore, stewardship leaders need to be observant to subtle changes in practices and sensitive to processes that may reflect unintentional barriers to nurse involvement.

The vast majority of survey respondents want to be engaged in stewardship and could identify skill sets where they have a high degree of confidence. As nurse integration continues to unfold, multiple opportunities to enhance nurse participation include improving education in microbiology and principles of antibiotic use, and in cultivating an environment where nurse contribution is actively sought. This may include changing the hospital-based culture in acceptance of nurse input and defining such roles. In looking forward, there are additional areas where nurses can support appropriate antibiotic use, including reconciling an immunization history or in managing and preventing infections from medical devices.

This study was conducted in a pediatric, academic center with access to infectious disease physicians and an established stewardship team, which may limit generalizability. While the response rate was slightly low, a wide array of nurses from different clinical settings participated. The survey demonstrated direct care nurses perceived certain practices that support stewardship are both within their scope of responsibility and ability to perform, but it did not measure their knowledge or competence in performing such activities.

Antibiotics are a shared “community resource” (Spellberg et al., 2016, p. 1229). This is a fitting description because direct care nurses are now being recognized as the newest members of the stewardship community, and national leaders have invited them to be a visible part of stewardship processes. Though the impact of that work is currently understudied, nurses are well-positioned to be part of the solution to preserve and promote the value of appropriate

antibiotic use; however, there are multiple barriers that must be addressed before widespread nurse engagement becomes the norm.

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Figure 3

Barriers to Steward by Experience

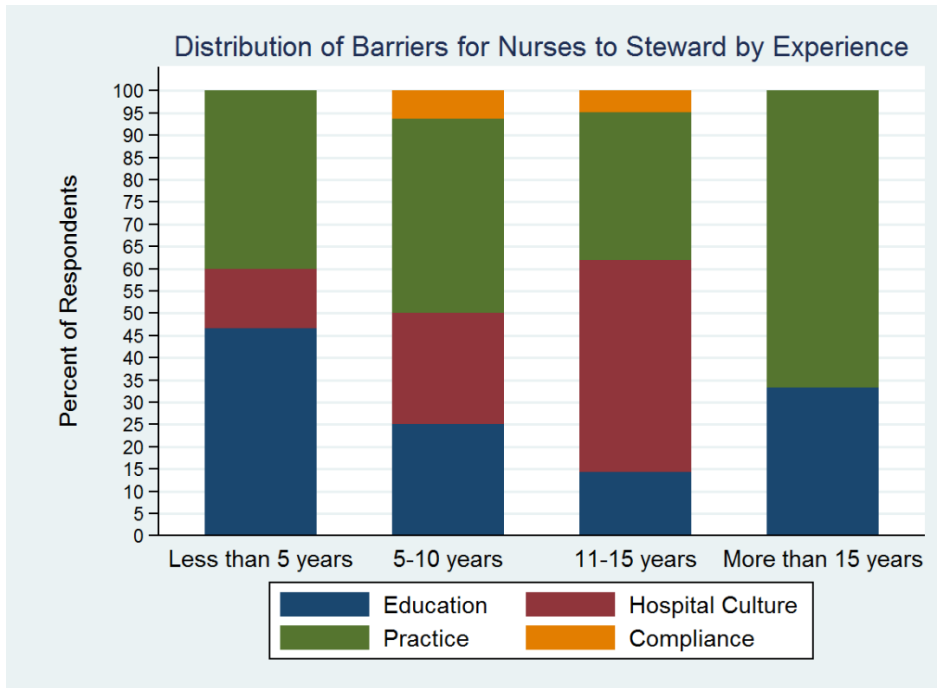


Figure 4

Barriers to Steward by Unit

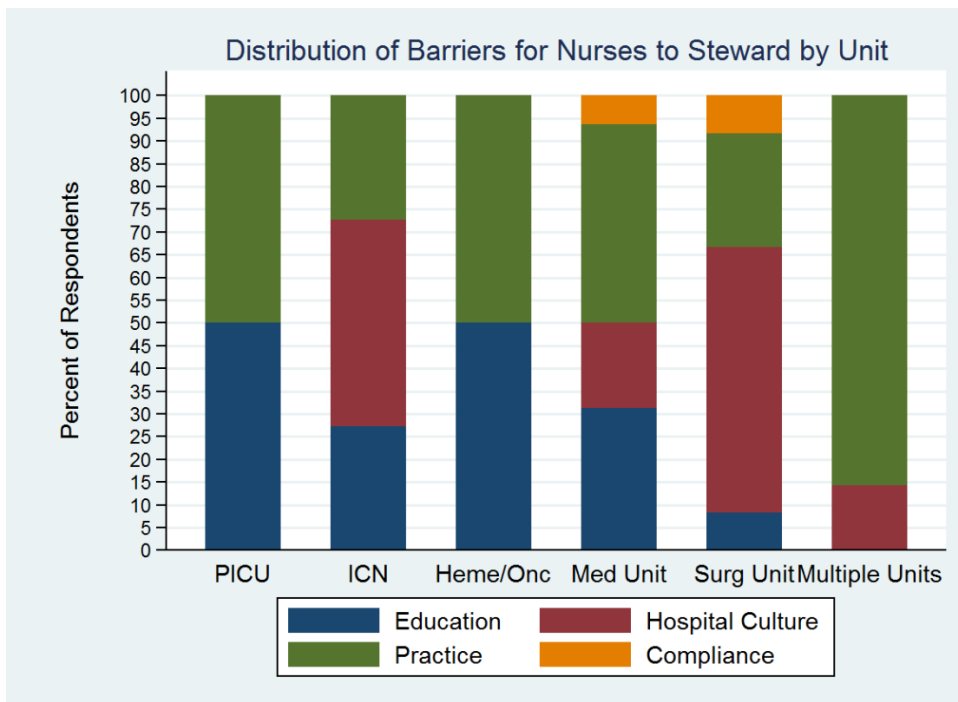


Table 2

Respondent Characteristics

	Respondents (N = 180)	Percent
Time since graduating from nursing school		
Less than 1 year ago	17	9.4%
1-5 years ago	62	34.4%
6-10 years ago	39	21.7%
11-15 years ago	24	13.3%
More than 15 years ago	38	21.1%
I have worked at the hospital		
Less than 5 years	88	48.9%
5-10 years	37	20.6%
11-15 years	26	14.4%
More than 15 years	29	16.1%
My primary role as a nurse is		
Staff nurse	154	86.0%
Educator	8	4.5%
RN manager/director	6	3.4%
Other	11	6.2%
Patient unit where I mainly work		
ICN	30	16.7%
PICU	50	27.8%
Hematology/Oncology	15	8.3%
Medical	30	16.7%
Surgical	5	2.8%
Specialty	4	2.2%
Two or more units	46	25.6%

Table 3

Beliefs and Attitudes Towards Antibiotic Stewardship

	Respondents (N = 180)		Percent
<hr/>			
I know what antibiotic stewardship means			
Strongly disagree	5		2.8%
Disagree	23		12.8%
Neither agree nor disagree	27		15.0%
Agree	89		49.4%
Strongly agree	36		20.0%
I perceive that staff nurses on my unit function as antibiotic stewards			
Strongly disagree	4		2.2%
Disagree	15		8.3%
Neither agree nor disagree	64		35.6%
Agree	82		45.6%
Strongly agree	15		8.3%
Staff Nurses need to be involved in antibiotic stewardship			
Disagree	6		3.3%
Neither agree nor disagree	46		25.6%
Agree	98		54.4%
Strongly agree	30		16.7%
<hr/>			

Table 4

Beliefs Regarding the Role and Performance Confidence

	<u>Importance of my role</u>		<u>Confidence</u>	
	<u>Respondents (N = 180)</u>	<u>Percent</u>	<u>Respondents (N = 180)</u>	<u>Percent</u>
Assuring cultures are obtained				
Strongly disagree	1	0.6%	1	0.6%
Disagree	1	0.6%	4	2.2%
Neutral	0	0.0%	7	3.9%
Agree	41	22.8%	52	28.9%
Strongly agree	137	76.1%	116	64.4%
Evaluating continued antibiotic use and performing 48-hour time outs				
Strongly disagree	2	1.2%	16	9.1%
Disagree	21	12.4%	47	26.9%
Neutral	46	27.2%	42	24.0%
Agree	62	36.7%	50	28.6%
Strongly agree	38	22.5%	20	11.4%
Assessing for a history of adverse drug reactions				
Strongly disagree	2	1.1%	1	0.6%
Disagree	3	1.7%	4	2.2%
Neutral	2	1.1%	6	3.4%
Agree	40	22.2%	56	31.3%
Strongly agree	133	73.9%	112	62.6%

Reviewing microbiology results to antibiotic orders

Strongly disagree	11	6.3%	19	10.6%
Disagree	34	19.3%	59	32.8%
Neutral	32	18.2%	36	20.0%
Agree	60	34.1%	44	24.4%
Strongly agree	39	22.2%	22	12.2%

Identifying a wrong antibiotic dose

Strongly disagree	2	1.1%	17	9.6%
Disagree	2	1.1%	38	21.4%
Neutral	15	8.4%	23	12.9%
Agree	58	32.4%	63	35.4%
Strongly agree	102	57.0%	37	20.8%

54

Notifying the provider of a wrong antibiotic dose

Strongly disagree	1	0.6%	9	5.1%
Disagree	5	2.8%	13	7.3%
Neutral	7	4.0%	12	6.7%
Agree	50	28.3%	50	28.1%
Strongly agree	114	64.4%	94	52.8%

Assessing for potential adverse events associated with antibiotics

Strongly disagree	0	0.0%	15	8.3%
Disagree	1	0.6%	24	13.3%
Neutral	3	1.7%	9	5.0%
Agree	48	26.8%	77	42.8%
Strongly agree	127	71.0%	55	30.6%

Collaborating with providers about IV/PO transitions

Strongly disagree	1	0.6%	18	10.1%
Disagree	6	3.4%	14	7.9%
Neutral	14	7.9%	19	10.7%
Agree	72	40.5%	75	42.1%
Strongly agree	85	47.8%	52	29.2%

Educating patients/families about the importance of taking antibiotics

Strongly disagree	2	1.1%	3	1.7%
Disagree	3	1.7%	4	2.3%
Neutral	7	3.9%	9	5.1%
Agree	50	28.1%	60	33.7%
Strongly agree	116	65.2%	102	57.3%

Understanding the relationship between antibiotics and C. difficile

Strongly disagree	5	2.8%	5	2.8%
Disagree	11	6.2%	23	12.9%
Neutral	25	14.1%	15	8.4%
Agree	70	39.6%	67	37.6%
Strongly agree	66	37.3%	68	38.2%

CHAPTER FOUR

METHOD

The following research proposal is modified from the version submitted for funding through the Society for Healthcare Epidemiology of America Epidemiology (EPI) Competition. The proposal was not selected for funding.

Specific Aims

The Centers for Disease Control and Prevention (CDC) estimates that 20-50% of antimicrobial use is unnecessary, contributing to approximately 2 million infections caused by antimicrobial resistant bacteria in the U.S. alone (Slayton et al., 2015). Effective interdisciplinary collaboration in antimicrobial stewardship programs has been suggested by health leaders as a way to accelerate progress towards reducing the emergence of resistant organisms and the associated clinical complications that arise from multidrug resistant bacteria (CDC, 2014). Staff nurses perform practices that are essential to decision-making about antimicrobial prescribing, which influence the implementation of stewardship processes to optimize antimicrobial therapy (Monsees, Goldman, & Popejoy, 2017). There is emerging literature describing how relationships between medical and nursing teams influence antimicrobial prescribing (Broom, Broom, Kirby, & Scambler, 2017; Charani et al., 2013). Despite the national call to enroll nurses as stewards, there is no literature on how staff nurses perceive their role as supporting the stewardship process and how patient safety culture influences their stewardship understanding and confidence. There is a need to determine staff nurses' understanding and confidence in performing nursing practices that impact the stewardship activities of the healthcare team and the influence of an organization's patient safety culture on nurses' engagement in stewardship practices.

The purpose of this study is to describe acute care nurses' clinical practices that support stewardship processes, their perceived confidence to perform those practices, and the influence of culture on performance confidence. First, we will survey nurses on antimicrobial stewardship practices using an investigator-developed survey to assess staff nurses' understanding of practices that impact the stewardship process and evaluate their confidence in performing those practices both within and across hospitals. Second, we will examine the association between staff nurse participation in antimicrobial stewardship and Agency for Healthcare Research and Quality (AHRQ) developed organizational patient safety culture questions on communication practices and team interaction.

Specific Aim 1:

Determine nursing practices that are associated with antimicrobial stewardship processes and nurses' perceived confidence in performing those practices.

Research question 1. What nursing practices do nurses' associate with antimicrobial stewardship?

Research question 2. How confident are nurses in performing practices that support antimicrobial stewardship?

Research question 3. How do distributions in nursing practice and confidence vary by facility?

Specific Aim 2:

Explore the relationship between nurses' understanding and perceived confidence in performing practices that impact antimicrobial stewardship and patient safety culture.

Research question 1. What is the relationship between nurses' perceived antimicrobial stewardship practices and their facility's patient safety culture?

Research question 2. What is the relationship between nurses' perceived confidence in performing antimicrobial stewardship practices and their facility's patient safety culture?

Research question 3. How do distributions in nursing practice and confidence vary by facility?

Nurses have a key role in assuring the progression of the antimicrobial stewardship process as they are the largest clinical discipline in healthcare (American Nurses Association [ANA], 2018). The results from this study will be used to establish a baseline for nursing stewardship performance by broadly describing practices nurses' associate with the stewardship process, nurses' perceived performance confidence, and the influence of patient safety culture on stewardship. Furthermore, there is potential for the survey to be used as a baseline readiness inventory as facilities begin to formally integrate staff nurses into stewardship programming. Understanding more about the practices associated with stewardship process, confidence in performing the practices, and organizational patient safety culture will inform what we know about the staff nurses' role in antimicrobial stewardship practices in different hospital settings, and potentially inform exploration in other settings like long term care where staff nurses drive patient care workflow.

Research Strategy

Background

Antimicrobial Stewardship Programs (ASP) are designed to improve antibiotic use, and to address concerns around rising bacterial resistance rates and enhance the quality and safety of clinical care (CDC, 2014). The most common stewardship interventions currently in use are prior authorization of certain antimicrobials and prospective audit and feedback. Literature suggests that ASPs led by infectious disease physicians and pharmacists with specialized training have

been influential in decreasing unnecessary antimicrobial prescribing, enhancing appropriate use, decreasing cost, and influencing patient outcomes in acute care settings (Barlam et al., 2016). Recently, attention has expanded to improving antimicrobial management and better outcomes for patients receiving care in critical access hospitals and long-term care facilities, which are settings where infectious disease specialists are not readily available (CDC, 2014). The one clinician constantly present in the organizations described are nurses.

Rationale

Strategies designed to enhance patient safety such as ASPs, require multifaceted and interdisciplinary approaches, however staff nurses have not traditionally been involved in interventions designed to support ASPs (Barlam et al., 2016). There is currently no consensus about which practices comprise effective stewarding of antimicrobial therapies, and little is known about how to formally integrate nurses into the antimicrobial stewardship process. As part of their daily work, staff nurses perform practices that influence antimicrobial decisions, thus have a role to play in the stewardship process towards optimizing therapy. To date, nurses have been underutilized in ASPs and their integral role in activities directly related to antimicrobial optimization such as obtaining cultures, antimicrobial administration, and patient education have been overlooked as key areas for implementing stewardship strategies.

Clinical Practices Performed by Staff Nurses that Support Antimicrobial Stewardship Processes

The ANA (2018) reports there are over 3.6 million registered nurses practicing in the United States, which represents the largest cadre of healthcare professionals practicing in all care settings. A comprehensive review of the literature found a limited number of articles addressing the role of staff nurses in advancing stewardship processes (Monsees et al., 2017). This paucity

of literature supports the need to examine staff nurse practices that support antimicrobial decision-making in the stewardship process. Consensus on the exact practices that comprise effective stewarding of antimicrobial therapies has not been reached but the following practices have been identified as potential practices for staff nurse involvement: (a) conducting an antibiotic “time out” with the interdisciplinary team; (b) recognizing and documenting allergies specific to medication, type of reaction, and severity; (c) transitioning intravenous antibiotic therapy to the oral route; (d) obtaining diagnostic tests such as blood cultures prior to antimicrobial therapy; (e) reviewing microbiology culture results and comparing susceptibilities to antimicrobial orders to determine appropriateness; (f) identifying wrong antimicrobial doses and notifying providers; and (g) providing patient education in antimicrobial management during hospitalization and at discharge (Olans, Olans, & DeMaria, 2016).

Theoretical Framework

The questions in the survey are intended to evaluate perceptions of staff nurses regarding their understanding of nursing practices that support antimicrobial stewardship processes and whether they have the confidence to perform those practices. Additionally, by examining the association between nurse practices, confidence, and organizational patient safety culture, we will develop an understanding about how staff nurses perceive unit-based organizational culture by exploring communication practices and team interactions. Guided by our theoretical framework, complex adaptive systems (CAS), this systems-level lens on staff interaction will inform organizational learning about the healthcare system, such as, how information is exchanged, the quality of the connections, and the interrelationships among teams (Anderson et al., 2013).

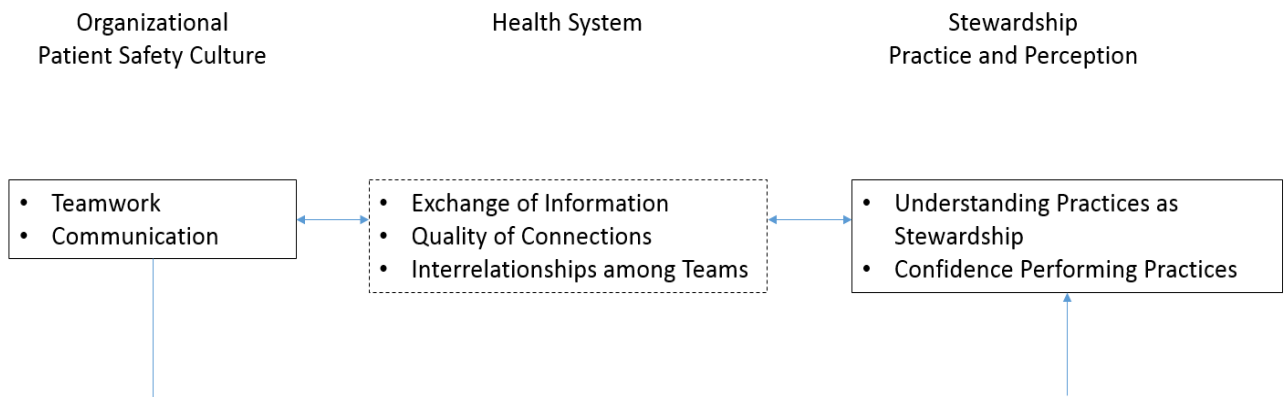
Complex adaptive systems are defined as an interconnected system comprised of individual agents with the freedom to behave in an unpredictable manner whose actions influence or change the behaviors of other agents (Plsek, 2001). Complexity science explores how various independent agents and service interactions impact interdisciplinary approaches (Paley, 2007). Though no consensus exists on defined aspects of CAS, the interdisciplinary theory seeks to discover how individual agents learn, interact, self-organize, and systems evolve (Anderson & McDaniel, 2008).

Modeled from Anderson et al. (2003), Figure 5, illustrates that organizational patient safety culture, particularly teamwork and communication, are hypothesized to influence nurse perceptions on the antimicrobial stewardship process. The concepts of CAS, particularly, self-organization, is used to describe how new behaviors and practices emerge (Anderson, Issel, & McDaniel, 2003). Antimicrobial stewardship is an interactive, dynamic process within the healthcare system. Complexity science is a framework by which we can describe how staff nurses understand their role in the stewardship process and how teams interface to exchange antimicrobial information.

Figure 5

Safety, System, and Stewardship Practice

Nursing Antimicrobial Stewardship Practice



Pilot Study Informing Broader Survey Dissemination

Currently, no validated surveys exist to assess staff nurse understanding of and confidence in performing antimicrobial stewardship practices. This research team has conducted a pilot study in a pediatric academic medical facility and identified a relationship between staff nurse perceptions on their antimicrobial stewardship role and their confidence performing practices that support stewardship processes. Modeled from the Olans et al. publication (2015) our self-developed web-based survey was designed to identify nursing practices that support the stewardship process in 11 clinical units within a pediatric hospital. The 31-question survey with optional comments that was Likert-scaled 1-5 to assess agreement asked participants about 10 distinct nursing practices associated with antimicrobial stewardship. The survey development process included rewording questions for semantic clarity and testing for face validity with staff nurses from the Pediatric Intensive Care Unit, float pool, and oncology. The survey was revised to reduce respondent burden and only included critical stewardship constructs. For example, Olans et al. includes implementing transmission-based precautions as a nursing function we

removed it as it primarily serves as an infection prevention practice rather than a stewardship practice. Then, the survey was distributed to inpatient nurses participating in the 11 clinical units. Demographics were stratified by the staff nurses' unit, years of experience, and years of practice at the hospital.

Frequency statistics were computed for antibiotic stewardship questions exploring role and confidence. The response rate was 16.4% ($n = 180$) and revealed nurses perceived they had an important role in stewardship, with 98.9% ($n = 178$) of nurses identifying it was important they assured that cultures are obtained prior to initiating antibiotics and 96.1% ($n = 173$) thought it was important to assess for a history of an adverse drug reaction. Nurses were confident obtaining cultures (93.3%, $n = 168$), notifying providers of dosing errors (80.9%, $n = 144$), assessing for adverse drug reactions (73.4%, $n = 132$), and participating in patient education (91%, $n = 162$) (Monsees et. al., 2017). They were less confident in interpreting microbiology results to determine antibiotic appropriateness (38%, $n = 176$).

Free text comments were analyzed and grouped into broad safety themes of hospital culture, practice, compliance, and education. Barriers to nursing participation in ASP reflected potential problems with unit culture including nursing not included in rounds and their input not recognized or actively sought. Staff nurses clearly identified that the 10 nursing practices supporting stewardship as being within their scope of practice; however, we were unable to ascertain whether staff nurses recognized and understood those practices as impacting decisions about antimicrobial use in the stewardship process and findings are not generalizable beyond this single pediatric academic center.

Significance

The continued progression of stewardship cannot not be accomplished without leveraging the largest clinical discipline, staff nurses. Therefore, this study is timely; it will assess acute care staff nurses' understanding of practices that contribute to the stewardship process, their confidence in performing those practices, and identify the influence of their organization's patient safety culture on these practices. The results from this study will be used to develop interventions guiding effective stewardship strategies for staff nurses as well as to develop a baseline of nursing practices and performance, thus contributing to our understanding on how to develop strategies that optimize nursing's unique expertise, and measure nursing contributions to stewardship efforts across the health care continuum. Moreover, to our knowledge no study has linked unit culture to practices staff nurses perform to support stewardship processes. While organizational support has been recommended for developing a foundation for stewardship programming, there is no literature on how organizational patient safety culture supports or inhibits nursing inclusion in stewardship. Furthermore, this survey has implications beyond acute care and can be adapted for use in other health care organizations that intensively employ nurses as the primary clinician such as critical access hospitals and long term care facilities.

Approach

Design

This descriptive, cross-sectional study used an investigator-developed web-based survey to determine staff nurses' understanding of current practices that support stewardship processes, their perceived confidence to perform those practices, and the influence of culture on their practices.

Setting

We recruited nine acute care hospitals, 7 of which were part of two larger health systems. These Missouri-based hospitals ranged in size from 42 to 562 beds comprising academic and community settings serving adult and pediatric populations with clinically disparate units. Each site coordinator collaborated with the PI to provide information on hospital-specific features which are summarized features below:

- **Hospital A** is a 392-bed full service hospital located in Columbia, Mo. It is a regional referral center located in the center of the state, affiliated with a large health system. The hospital provides progressive health care programs, services and technology to residents in 25 mid-Missouri counties. Hospital A has been named the top hospital in mid-Missouri by U.S. News & World Report from 2015-2018 and is designated as a Magnet® Hospital for Nursing Excellence by the American Nurses Credentialing Center.
- **Hospital B** comprises 5 hospitals within a university system, 3 of which were selected for this study as they have inpatient acute care services. Serving patients from 114 counties, approximately 6,000 health care professionals (including physicians and nurses) practice within the large academic medical system. The primary acute care site, Hospital Ba, with 310 inpatient beds, is the only Level 1 trauma center and helicopter service in central Missouri. This hospital has a seven-story Critical Care Tower, Level 1 stroke center and remains the only burn center within the region. Hospital Bb has 143 beds with 40 pediatric medical/surgical beds, 18-bed pediatric intensive care unit (PICU), 51-bed Level III neonatal intensive care unit, 12 labor and delivery rooms. Over 30 pediatric specialties clinical services are represented and the facility also includes emergency and surgical services targeting this unique patient population. Hospital Bc contains 42 inpatient beds and a freestanding orthopedic surgical center. Presently, this facility has 9

operating rooms as well as a host of services to address and consolidate orthopedic care in one location.

- **Hospital C** is a stand-alone, not-for-profit health care facility, located in Kansas City with 451-beds and more than 3,000 employees, over 1,100 of whom are nurses and 520 physicians. Its centers of excellence and range of services include Level III neonatal intensive care, adult acute and critical care, Level II trauma services and home health services.
- **Hospital D** is a not-for-profit, faith-based health system which includes 16 hospitals and has one of the nation's top cardiology and heart surgery programs as well as a nationally-ranked stroke reversal program. Four hospitals within this large system were selected for their representation throughout the Kansas City community: Hospital Da, Hospital Db, Hospital Dc, and Hospital Dd. The flagship, Hospital Da is a 562 bed facility has more than 60 medical specialties represented and has received numerous national recognitions including the Magnet® Hospital for Nursing Excellence and *U.S. News & World Report* which recognizes Hospital Da as among the top 5% performing hospitals. In addition to community services, this site is also the primary teaching hospital for the University of Missouri-Kansas City School of Medicine. The other three metropolitan hospitals comprised in this study include, a) Hospital Db, a 203-bed facility with a Level IIIa neonatal intensive care unit, b) Hospital Dc, a 160-bed facility with 24-hour emergency services and a Level II neonatal intensive care unit, and c) Hospital Dd, a 125-bed facility with emergency services and a Level IIIa neonatal intensive care unit.

This study examined nurse responses from clinically disparate units: intensive care, hematology/oncology, medical-surgical units, telemetry, and designated units with specialty patients.

Sample

A convenience sample of 4282 acute care staff nurses included on hospital email distribution lists were invited to participate in this one-time electronic survey with two reminder emails. Based on hospital distribution lists, the individual facility response rates were based on the following denominators: Hospital A 428, Hospital Ba 792, Hospital Bb 313, Hospital Bc 43, Hospital C 822, Hospital Da 950, Hospital 558 Db, Hospital Dc 117, and Hospital Dd 266. Of the larger hospital systems, Health System B had a total of 1148 possible respondents with Health System D comprising 1891 potential nurse participants. Considering our previous participation rate of 16% during the pilot survey, we anticipated a response rate of 685 nurses.

Inclusion criteria. Individuals eligible for participation:

- (a) Staff nurses and who are responsible for administration of antibiotics on inpatient units
- (b) Staff nurses who lead inpatient clinical operations

Exclusion criteria. Individuals disqualified from participation:

- (a) Non-nursing disciplines, including medical residents and APRNs

Instrument

Measured 10 previously tested stewardship practices using a 5-point Likert scale from strongly disagree to strongly agree. To reduce respondent confusion, nursing confidence questions followed a similar pattern, with the 5-point Likert scale ranging from not confident to very confident. A subset of AHRQ patient safety culture questions reflecting communication practices and team interaction used a 5-point Likert scale from never to always. Additional

questions were included to add to our understanding of how nurses perceive their participation, knowledge, and general role as antibiotic stewards. Examples of question domains and responses are in **Error! Reference source not found.**

Table 5

Survey Constructs

General Stewardship	Examples of Topics Include:
Participation Status	<ul style="list-style-type: none"> • I participate as an antibiotic steward • Nursing leaders encourage my involvement in antibiotic discussions • Prescribers encourage my involvement in antibiotic discussions • Select strategies that best engage nurses in antibiotic stewardship • Select barriers that impact ability to act as antibiotic stewards
Stewardship Purpose	Which statement best describes the purpose of antibiotic stewardship?
Stewardship Knowledge	I am knowledgeable about antibiotic stewardship
Stewardship Role	I think nurses have an important role in the antibiotic stewardship process
<hr/>	
Nursing Practices (NP) and Confidence (C)	
Allergy History	Assessing for a history of an adverse drug reaction (NP, C)
Timeliness of Cultures	Assuring that cultures (i.e. urine, blood, etc.) are obtained before antibiotics are initiated (NP, C)
Microbiology Results	Reviewing preliminary microbiology culture results and comparing susceptibilities to antimicrobial orders to determine appropriateness (NP, C)
Antibiotic “Time Out”	Reviewing the antibiotic treatment to determine whether the patient’s infection responds to the selected antimicrobial, is on the correct dose and route, spectrum, and duration (NP, C)
Identification of Adverse Events	Similar to allergy history, assessing the development of potential adverse events based on antimicrobial use (NP, C)

Documentation of Adverse Events	Recording detailed signs and symptoms of reactions (NP)
Transition of IV to PO	Assessing the ability to change intravenous antimicrobials to oral therapy (NP, C)
Patient Education	Educating patients about taking antibiotics correctly to reduce possible side effects (NP, C)
Device Management	Providing catheter care (i.e. urinary or central line) using evidence-based procedures to prevent infections (NP)
Drug Therapeutics	Drawing drug levels (e.g. peaks and troughs) (NP)
Identification of Wrong Dose	Identifying a wrong antibiotic dose (C)
Provider Communication	Notifying the provider of a wrong antibiotic dose prior to giving the medication (C)
<i>Clostridium difficile</i> acquisition	Understanding the relationship between antimicrobial use and <i>Clostridium difficile</i> risk (C)

Patient Safety Culture

AHRQ Teamwork Within Units	In this unit, people treat each other with respect
AHRQ Teamwork Across Units	Hospital units do not coordinate well with each other
AHRQ Teamwork Across Units	There is good cooperation among hospital units that need to work together
AHRQ Teamwork Across Units	It is often unpleasant to work with staff from other hospital units
AHRQ Teamwork Across Units	Hospital units work well together to provide the best care for patients
AHRQ Communication Openness	Staff will freely speak up if they see something related to antibiotic use that may negatively affect patient care
AHRQ Communication Openness	Staff feel free to question the decisions or actions of those with more authority

AHRQ Communication
Openness

Staff are afraid to ask questions when something does not seem
right

Data Collection

Procedures

Prior to the deploying the survey, we collaborated with nurses in one of the acute care facilities to review the survey questions to establish face and content validity. This was accomplished through a think aloud process with approximately 10 adult nurses at Hospital Da and 10 pediatric nurses at Children's Mercy. The survey was reworked for semantic consistency. One of the major changes included clarifying the Likert scale. When presented to the nurses, some questions were reverse-coded. The nurses recommended modifying the scale to "not confident to very confident" thus removing unnecessary confusion caused by the negatively worded questions. Nurses suggested including a demographic question by day, night and weekend option, which was added to the instrument. Likewise, nurses recommended adding a question about whether participants primarily interface with medical or surgical services, as these groups perceived a difference in potential responses. Nurses also requested educational levels be added to distinguish differences between responses from associate's degree or diploma nurses from those with baccalaureate or master's degrees. Phrases like antibiotic "optimization" were replaced and simplified to describe stewardship purpose. Nurses in both groups articulated their support for the various engagement and barriers responses. Redundant questions like "I am familiar with the term 'antibiotic stewardship'" were removed in favor of a question like "I am knowledgeable about antibiotic stewardship." Candid discussions ensued about including the question "I participate as antibiotic steward" at the beginning and end of the survey to examine if after the nursing practices were introduced participants favorably changed their responses. Additionally, the practice of transitioning antibiotics from IV to PO produced a thoughtful dialog as nurses some interpreted "reviewing preliminary culture results and comparing susceptibilities

to antibiotic order” as two distinct practices. These comments were considered and retained as antibiotic appropriateness comprises the review of results is dependent upon comparison of orders and susceptibilities. Different survey iterations included modifying the AHRQ teamwork and communication questions to focus on antimicrobial use. After a number of discussions, the AHRQ questions were retained in their original format.

Following survey testing, the PI contacted Nursing and Infection Prevention and Control Directors to confirm their willingness to participate. During each contact the PI discussed study purpose, reviewed the survey content, the informed consent process, the anticipated survey timeline, distribution needs, and any internal facility approvals that were required. Once the University of Missouri Health Sciences IRB approval was secured, the PI then collaborated with hospital leadership from each setting to designate a site coordinator to manage email correspondence between the PI and site. This coordinator was responsible for managing the distribution lists, addressing logistical or IRB concerns, and interfacing with the Chief Nursing Officer to deploy the survey within their respective institutions and sending follow-up reminders. Letters of support were attained. Data about distribution lists, exact number of nursing staff queried was also obtained.

The survey was administered via the Research Electronic Data Capture (REDCap) and results were stored in the REDCap database. Appendix A is a copy of the stewardship survey with participant instructions embedded into the beginning of the REDCap tool. To enhance survey participation, nurses were recruited by the Chief Nursing Officer or the site coordinators three times two weeks apart via electronic reminder emails. Nursing distribution lists may include unit secretaries or other non-clinical personnel, therefore, recipients were asked if they are a RN or LPN upon survey launch. If they selected “no” they were thanked for their time and

automatically removed from the survey. Those who selected “yes” were allowed to proceed after they addressed the mandatory location fields. Additional informed consent language was provided and consent was implied should the respondent elect to complete the survey. Staff could end the survey at any time. The PI prompted the site coordinators two weeks after the initial recruitment message (Appendix B) was provided to send the first reminder email. One week following the first reminder, the PI again prompted site coordinators for the second and final reminder notice. Examples of those email communications are provided in Appendix C.

Data Management

Unit and facility data were collected; no personally identifiable information e.g. name or date of birth was collected. All data generated from the survey was exported from REDCap into the Statistical Package for the Social Sciences (SPSS), Dedoose, and Windows version 25.0 for analyses.

Data Analyses

Specific Aim 1:

Determine nursing practices that are associated with antimicrobial stewardship processes and nurses’ perceived confidence in performing those practices.

Research question 1. What nursing practices do nurses’ associate with antimicrobial stewardship?

Research question 2. How confident are nurses in performing practices that support antimicrobial stewardship?

Research question 3. How do distributions in nursing practice and confidence vary by facility?

Based on a preliminary review of the number of staff nurses, we anticipated having 16% of eligible participants (at least 685 nurses) respond to the survey invitation. Descriptive statistics were used to describe the demographics of our sample population, including years since formalized clinical training, education, current role, licensure, years at the participating hospital, certification and/or traveler status and clinical unit. To examine the association between overall practice, performance confidence, and safety culture, the respective questions were summed to create three composite scores. We then examined the relationship of selected respondent demographic characteristics with the composite scores of the nursing practice, confidence, and safety culture questions and examined responses by facility. As Likert-scaled items are rarely normally distributed, differences in distributions between the total practice score and the total confidence score were determined using Spearman correlation to determine the relationship. The distribution of the practice and confidence composite scores across demographic characteristics were calculated, with either parametric (ANOVA) or non-parametric (Kruskal-Wallis) tests used to determine statistically significant differences. A *p* value less than or equal to 0.05 was considered statistically significant. We used pairwise deletion to preserve data that is lost with list wise deletion.

Specific Aim 2:

Explore the relationship between nurses' understanding and perceived confidence in performing practices that impact antimicrobial stewardship, and patient safety culture.

Research question 1. What is the relationship between nurses' perceived antimicrobial stewardship practices and their facility's patient safety culture?

Research question 2. What is the relationship between nurses' perceived confidence in performing antimicrobial stewardship practices and their facility's patient safety culture?

Research question 3. How do distributions in nursing practice and confidence vary by facility?

We examined the overall distributions of select clinical and demographic characteristics, using descriptive statistics. No demographic data was collected aside from years since and type of formalized clinical training, current role, licensure, years at the participating hospital, practice unit, certification, and traveler status. The statistics were calculated for each variable, practice and confidence, including means, standard deviations and actual ranges of responses. Proportions were calculated for all responses. In addition, 2-sample difference in proportion tests and χ^2 tests were performed to identify significant differences in response rates with p values less than or equal to 0.05 being considered statistically significant. We analyzed the composite scores for practice, confidence and safety culture questions and then examined individual responses by clinical unit (intensive care, hematology/oncology, intermediate care, medical/surgical, multiple units, and other) and years from graduation (less than 1 year ago, 1-5 years ago, 6-10 years ago, 11-15 years ago, and >15 years ago) to determine if clinical unit and experience are important moderators for perceptions on organizational patient safety culture. We selected Spearman's correlation for this analysis for bivariate associations due to ordinal nature of the data. Subsequent statistical testing was conducted using analysis of variance (ANOVA) and non-parametric (Kruskal-Wallis) tests to evaluate differences by clinical units and years of clinical experience. Open text responses were analyzed for content and group by similar themes. Dedoose was used for analysis and data was triangulated to inform understanding of the quantitative results.

Institutional Review Board (IRB) Review and Informed Consent

After securing facility interest and letters of support, the PI spoke with nursing leadership to identify site coordinators or individuals who were responsible for assuring their facility IRB process. For example, as part of a large health system, Hospital A obtains IRB approval through a university system. After discussions with the IRB officiant at Hospital A, it was determined that approval through the University of Missouri Health Sciences IRB was sufficient. All other sites also elected to use the University of Missouri Health Sciences IRB approval, no reliance agreements were needed. The PI did assist the site coordinator at Hospital C in completing facility documentation to attain exempt status at that location. Approvals were largely granted as no harm to the study participants was anticipated in the development of nor during the testing of the survey when evaluating for semantic clarity, nor in the actual deployment. Perceptions of staff nurse understanding, confidence, and organizational patient safety culture may be subject to social desirability bias. Strategies used to mitigate this bias included phrasing questions and the introduction to demonstrate that we welcome answers that are honest and actually represent their perceptions. The study may be modified or discontinued at any time by the IRB, the Sponsoring facility, the OHRP, the FDA or other Government agencies as part of their duties to ensure that research subjects are protected.

Anticipated Difficulties in Conducting the Study

Conducting an electronic survey presented some recruitment challenges especially during the summer months when patient census is typically lower and staff take vacation. Analyzing different acute care facilities increased sampling potential, however, the complexity of comparing results across distinctly different clinical populations presented difficulties interpreting findings. For example, specialty services often have a dedicated group of providers and staff nurses. The relationship and how they communicate with one another is culturally

different than other services. Likewise, our pilot study occurred in a facility with a well-established ASP, whereas, the other facilities queried are just developing their ASP so initial pilot findings on nurse confidence may not be reproduced at outside institutions given their organizational attributes. To enhance external validity, we included adult centers and non-academic centers where specialty services are limited.

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CHAPTER FIVE

BEDSIDE NURSE STEWARDSHIP: RECOGNITION, CONFIDENCE, & ORGANIZATIONAL FACTORS ACROSS NINE HOSPITALS

*As the primary author, my colleagues and I plan to submit for publication to Infection Control
and Hospital Epidemiology*

Abstract

Effective interdisciplinary collaboration in antimicrobial programs has been suggested by health leaders as a way to advance and expand the progression of stewardship efforts. Bedside nurses perform practices that are essential to antimicrobial decision-making, which influences optimization of therapy. Nurses work in teams organizing moment-to-moment care for patient. Their role gives them unique insight into team relations and the complexities of the healthcare system. here is a national call to engage nurses as stewards, but there is no literature on what practices nurses associate with the process of stewardship and how patient safety culture influences their stewardship understanding and confidence. Using an investigator-developed online survey, 558 nurses practicing in 9 acute care hospitals ranging in size from 42 to 562 beds in 2 different metropolitan areas participated in the study. Composite scores for practice, confidence, and safety were developed and correlated. Analysis of variance (ANOVA) with Tukey HSD post-hoc tests and non-parametric (Kruskal-Wallis) tests with Bonferroni adjusted p-values for multiple comparisons were used to evaluate differences by clinical unit and years of clinical experience. A significant positive association was found between nurses' beliefs about nursing practices that contribute to the antibiotic stewardship process and their perceived confidence to perform. Nurses identified they have a professional role in stewardship process, yet subtle changes within the health care system combined with organizational patient safety

culture inhibited their stewardship involvement. The study details factors that may inform the inclusion of nurses in stewardship programming efforts and areas for further inquiry.

Infectious disease physicians and pharmacists with specialized training have been influential in decreasing unnecessary antibiotic prescribing, enhancing appropriate use, decreasing cost, and influencing patient outcomes in acute care settings (Barlam et al., 2016). However, recent shifts in stewardship programming are moving from predominately relying on infectious disease experts to primarily ensure the safe use of antimicrobial therapies to shared interdisciplinary models. The call for collaboration continues to become more pronounced as regulatory and accrediting agencies support the adoption of Centers for Disease Control and Prevention (CDC) Core Elements, which are a series of sustainable and reformative team-based stewardship strategies that draw upon the collective knowledge of the entire health care team to optimize therapies and improve clinical outcomes (CDC, 2014).

Behavior and organizational culture play central roles in expanding the breadth and scope of stewardship teams (Castro-Sánchez & Holmes, 2015; Lorencatto, Charani, Sevdalis, Tarrant, & Davey, 2018; Szymczak & Newland, 2018; van Buul et al., 2014). The Agency for Healthcare Research and Quality (AHRQ) has recognized the importance of culture and has integrated team-based approaches and behavioral modifications within their Safety Program for Improving Antibiotic Use so all members of the healthcare team are supported and empowered as change agents (AHRQ, 2017). As interdisciplinary team-based stewardship interventions and the application of patient safety principles on improving patient outcomes gains traction in the literature the role of nurses in this process will need to be explicated.

Given the pivotal role of nurses in medication safety and their presence as the largest discipline in and across the health care continuum, nurses have a key role in assuring the progression of the antibiotic stewardship processes (American Nurses Association [ANA] & Centers for Disease Control & Prevention, 2017). As part of their daily work, staff nurses

perform practices that influence antibiotic decisions, thus are integral to the collective process towards therapy optimization (Manning, 2016; Manning, Septimus, Dodds Ashley, Cosgrove, Fakih, Schweon,...& Moody, J., 2018; Monsees, Goldman, & Popejoy, 2017; Olans et al., 2016). Nurses generally work in teams, they build relationships with other disciplines and patients, and they have a unique understanding of the complexities of the healthcare system because of their role as a knowledge broker (Broom et al., 2016). Yet, little is known about how patient safety culture influences the stewardship perspectives of bedside nurses, though early work has suggested organizational culture as a performance barrier (Monsees, Popejoy, Jackson, Lee, & Goldman, 2018). In this manuscript we report the findings of a study describing nurses' antibiotic stewardship clinical practices and associated processes, their perceived confidence to perform those practices, and the latent influence of organizational patient safety culture on nurse stewardship.

Methods

Design and Setting

This multi-site, cross-sectional study used survey methodology to describe how staff nurses practicing in acute, inpatient care recognize and perceive their confidence performing nursing activities that support the process of stewarding antibiotics, and the potential role of organization culture as a factor. Participating hospitals ranged in size from 42 to 562 beds and were located in different metropolitan regions of the same state that has a senate bill requiring the implementation of stewardship programs. Hospital A is full service Magnet®-designated regional referral center and community partner of a large academic healthcare system. Health System B is an academic health system with 5 hospitals and regional affiliations of which 3 were selected for this study as they have inpatient acute care services. One hospital is a Level I

Trauma center, the second is a women's and children's hospital, and the third is an orthopedic hospital. Hospital C is freestanding, not-for-profit healthcare facility. Health System D is a not-for-profit, faith-based system comprised of 16 hospitals of which four hospitals located in different sections of a large metropolitan Midwestern city participated. Two of all the participating of the hospitals have received Magnet® recognition for nursing excellence.

Survey design

An investigator-developed online survey was modified following the completion of a pilot study with previously reported result. Nursing practices were selected from approaches previously described in the literature (ANA & CDC, 2017; Olans et al., 2016). To ensure semantic clarity, questions were adjusted during two separate sessions with 20 practicing registered nurses from an adult and pediatric facility using a face validity and a think aloud technique. Additional demographic questions were included based on their feedback, such as hours of routine clinical shift, highest level of formalized clinical training, and further specification between medical and surgical services. In total, the survey comprised 50 questions inclusive of a demographic section. Organizational factors, such as teamwork and communication were explored using questions from the Hospital Survey on Patient Safety Culture from AHRQ (AHRQ, 2018).

Ten nursing practices and ten confidence questions were developed to assess nurses' recognition of nursing practices that support the stewardship process and their confidence performing those practices. Practice and confidence questions were measured using a 5-point Likert scale from strongly disagree (1) to strongly agree (5). The AHRQ patient safety culture questions on teamwork were similarly represented with the communication openness questions utilizing a 5-point Likert scale from never to always. Additional questions were included to

bolster understanding of how nurses perceive their participation, knowledge, and general role as antibiotic stewards. Respondents were also asked to identify strategies to enhance nurse engagement and any barriers impacting their capacity as stewards. A table entitled, Survey Constructs, are available as supplementary material. Respondent demographics included: (1) number of years since graduation from nursing school, (2) number of years worked as a nurse at the current hospital, (3) type of clinical population (e.g. pediatrics) and type of clinical unit (e.g. intensive care unit), (4) type of clinical service (e.g. medical or surgical), (5) clinical shift worked, (6) description of current role, (7) highest educational level, (8) certification in professional practice, and (9) whether they are currently working as a traveler nurse for that hospital. The study was reviewed and approved by the University of Missouri health sciences institutional review board. Given the exempt status, all sites elected to use the University of Missouri-Columbia's approval, no reliance agreements were required.

Study participants. A total of 4282 direct care registered nurses (RN) and licensed practical nurses (LPN) were asked to participate in the optional, anonymous, Web-based survey using the Research Electronic Data Capture (REDCap) application (Harris et al., 2009). In 5 of the 9 hospitals, the Chief Nursing Officer formally invited participation through a recruitment email, which included the informed consent process and a link to the online survey. To minimize non-nursing participation, as distribution lists may include administrative personnel, recipients were required to answer whether they are a RN or LPN upon survey launch. Seven selected “no” and were thanked for their time and automatically removed from the survey. Those who selected “yes” were allowed to proceed after they addressed the mandatory hospital location fields. Twenty-nine participants accessed the survey, but no information was provided, so the surveys were removed. Participation implied informed consent and respondents were

allowed to stop the survey at any time. Data was collected for 1 month with 2 subsequent reminder emails to participate.

Analysis. To examine the association between nursing practice, confidence, and safety culture, the 10 practice questions, 10 confidence questions, and 8 safety culture questions were summed separately to create three composite scores. Statistics were calculated for each variable, including means, standard deviation and actual ranges of responses. Spearman correlation was used to determine the relationship between nurse perceptions of practices that contribute to the stewardship process and their perceived confidence to perform in total and by facility. Proportions were calculated for all demographic variables (e.g. years worked at hospital, level of education, etc.). The 2-sample difference in proportions tests and χ^2 were performed to identify significant differences in responses with p values less than or equal to 0.05 being statistically significant. We examined individual responses for possible relationships between each practice, confidence and safety questions. Next, we examined those responses by clinical unit (intensive care, hematology/oncology, intermediate care, medical/surgical, multiple units, and other) and by years from formalized education (less than 1 year ago, 1-5 years ago, 6-10 years ago, 11-15 years ago, and >15 years ago) to determine if clinical unit and experience are important moderators for perceptions on organizational patient safety culture. Analysis of variance (ANOVA) with Tukey HSD post-hoc tests and non-parametric (Kruskal-Wallis) tests with Bonferroni adjusted p -values for multiple comparisons were used to evaluate differences by clinical unit and years of clinical experience. We used pairwise deletion to preserve data that would be lost with a list wise deletion. SPSS 25.0 was used to complete all quantitative analysis.

Since free-text comments provided insight on nurse engagement in the pilot survey, a field was included within this survey to invite nurses to expound on their role or potential

engagement strategies. The principal investigator (E.M.) and study advisor (L.P.) categorized comments by content looking for similar words or concepts. Grouped text was then further categorized by positive team interactions that contribute to stewardship and barriers to stewardship. The majority of nurses reported on barriers to their role as stewards, therefore, these data were then linked to facility and respondent characteristics (unit and years of experience) to identify contextual elements that aided in interpretation of results. Initial comment organization and analysis was performed using Microsoft Office Professional Plus 13 (Microsoft, Redmond, WA) followed by Dedoose 8.0.35, a web application for managing, analyzing, and presenting qualitative and mixed method research data (2018) by SocioCultural Research Consultants, LLC in Los Angeles, CA.

Results

Respondents

A total of 558 nurses completed the survey (response rate 13%). Respondents represented inpatient nurses practicing in a variety of clinical settings, including stand-alone community hospitals and two health systems (Table 6). The highest number of respondents were nurses who graduated within 1-5 years ($n = 190$, 34.1%), with the second highest category representing nurses with more than 15 years of experience ($n = 176$, $n = 31.5\%$). More than half of the nurses have practiced at their respective facility less than 5 years ($n = 308$, 55.2%) with more than 50% working during the day (0700-1900). Four hundred and eighty five (86.9%) primarily work with adults. Nurses practicing in the intensive care unit represented 27.4% ($n = 153$) of the population. The majority of respondents were RNs ($n = 528$, 94.6%) and 368 ($n = 65.9\%$) had obtained a baccalaureate degree. Nearly one-third of nurses ($n = 197$) held a

professional certification in their professional practice. Only 3.6% ($n = 20$) worked as traveler nurses.

Role Perceptions and Nurse Participation

Most respondents agreed that nurses have an important role in the antibiotic stewardship process ($n = 408$, 73%), despite the fact only 43.1% agreed they are knowledgeable about antibiotic stewardship ($n = 241$). Thirty-one percent ($n = 176$) reported the purpose of antibiotic stewardship programs is to reduce antibiotic resistance. In order to gauge if their perception of themselves as stewards changed as a result of completing the survey, nurses were asked if they participate as stewards at the beginning and then again at the end of the survey. A total of 49.7% ($n = 267$) had the same response, whereas 10.8% ($n = 58$) changed their response by two or more degrees (e.g. agreed at the beginning to strongly disagree at the end). More than 60% ($n = 335$) agreed they participate as a steward at the beginning of the survey, and 56% ($n = 302$) agreed that they participate as a steward at the end of the survey. When asked whether nurses perceived support from their nursing leaders or physician colleagues, nursing leaders ($n = 241$, 43%) and prescribers ($n = 153$, 27.4%) encouraged their involvement in antibiotic decisions less than half the time.

Practice and Confidence. Facility-aggregated results of the Spearman's rho correlation indicated there was a significant positive association between nurses' beliefs about nursing practices that contribute to the antibiotic stewardship process and their perceived confidence to perform $r_s = .454$, $p < .001$ (Table 7). Nursing practice and safety culture were weakly correlated $r_s = .161$, $p < .001$. Facility results evaluated separately showed minimal variation in each of the composite scores (Table 8). Therefore, the remaining analyses were conducted using either aggregated total scores or were stratified by the individual questions comprising the composite

scores. Results for each survey question were examined for correlation to practices and confidence (Supplement 1).

Years of Experience. A significant difference between years since graduation was not found for practice [$F(4,513) = 0.274, p = 0.895$] or safety composites [$F(4, 530) = 0.807, p = 0.521$], however, confidence composite did significantly differ by experience [$F(4, 509) = 3.575, p = 0.007$]. Tukey's HSD post hoc test was conducted to determine pairwise differences. Nurses who graduated more than 15 years ago were significantly more confident when compared to nurses who graduated less than 1 year ago ($M_{\text{difference}} = 3.89477, SE = 1.19445, p = 0.010$). When examining individual questions, nurses who have been in practice 15 years or more were significantly more likely than nurses with 1-5 years of experience to attribute taking an allergy history to the stewardship process ($p = 0.025$). Nurses with less than 1 year of experience were significantly less confident in assuring that cultures are obtained before antibiotics than all other experience levels ($p < 0.001$). Nurses with less than 1 year of experience and those with 1 to 5 years of experience were significantly less confident than those with 15 years or more of experience for: (a) assessing for a history of an adverse drug reaction ($p = 0.049, p = 0.023$), (b) reviewing preliminary microbiology results and comparing susceptibilities ($p = 0.011, p < 0.001$), and (c) notifying a provider of a wrong antibiotic dose ($p = 0.011, p = 0.017$). Nurses with 15 or more years of experience were significantly more confident than all other groups in identifying a wrong antibiotic dose ($p < 0.001$). No significant differences were identified by experience level and responses to safety questions.

Clinical Unit. Nurses practicing in medical/surgical ($p = 0.003$) and other ($p < 0.001$) units recognized that taking an allergy history contributes to the stewardship process significantly more than ICU respondents. Nurses working in all other units were more confident

in educating patients about taking antibiotics correctly than the ICUs ($p = 0.05$). Nurses working in medical/surgical units were more confident than ICUs, in assuring that cultures are obtained prior to antibiotic administration ($p = 0.038$). Intermediate care ($p = 0.008$) and other units ($p = 0.024$) were more confident in assessing for a history of an adverse drug reaction than ICUs and other units ($p = 0.001$) were also more confident in identifying a wrong antibiotic dose than intermediate units. Under the safety constructs on teamwork and communication, all other units had a significantly more positive response compared to intermediate units in that they perceive hospital units to work well together to provide the best care for patients ($p = 0.042$). More specifically, medical/surgical units were more positive about hospital units working well with each other ($p = 0.001$).

Nurse Participation. Nurses identified the top engagement strategies as formal educational offerings, empowerment techniques to enhance communication, and soliciting nurse input in antibiotic use discussions (Table 9). Whereas nurses expressed a desire to participate in stewardship processes, a lack of knowledge, workplace culture, and poorly defined roles limited their ability to steward (Table 10). Just 10% of nurses ($n = 56$) identified no barriers to stewarding, but less than 5% ($n = 27$) had the perception that they do not function as stewards.

Free-text Results. In addition to asking nurses to identify the top strategies and barriers to their participation, we also included a free-text field to allow nurses to elaborate about their role. Ninety-one nurses (16%) opted to provide comments about their general stewardship role or suggestions for stewardship engagement. Twenty-three comments specifically included requests for formal education, treatment indications, and practice algorithms to enhance their stewardship knowledge and build confidence to raise questions to providers. Seven nurses voiced positive comments with five attributing their engagement to positive teamwork within

their units and that “having the PharmD on the unit has really expanded [stewardship] collaboration.” Since all other comments referenced factors complicating nurses’ ability to participate as stewards, those barriers were condensed into three categories: organizational factors, knowledge gaps, and communication. Table 11 and Table 12 demonstrate the distribution of those barriers by experience, and clinical unit.

Nurses identified that the primary barrier to their ability to steward were organizational factors ($n = 43$). Several subthemes were noted and are listed in order of frequency: (a) dichotomized roles ($n = 24$), (b) competing demands ($n = 7$), (c) inadequate governance ($n = 6$), (d) disrespect of contribution ($n = 3$) and (e) poor work processes ($n = 3$). For example, under dichotomized roles, one nurse stated, “Nurses are rarely informed on why a medication is being used versus another antibiotic. Usually you just see a change in the MAR [Medication Administration Record] and just go with it.”

Thirty-five nurses identified knowledge gap as a barrier. Most of the comments indicated how education impeded their participation and that more education was necessary “to feel more confident in identifying errors in ax [sic] therapy.” Thirteen nurses had not previously heard the term antibiotic stewardship.

Poor communication was represented in 21 comments with seven nurses reporting they identified a lack of voice, or were not invited to be part of antibiotic discussions. Twelve nurses reported interdisciplinary planning as a barrier to their involvement and 2 indicated problems occurring with the night shift. Given the informative nature of the comments, representative quotes for organizational factors and communication are displayed in Table 13.

Discussion

In her work on antibiotic stewardship and communication, medical sociologist, Julia Szymczak, PhD, has described “human behavior is a result of internal process but also as a result of relationship between the individual and their environment. To understand that behavior, we need to understand the relationship” (Szymczak, 2018). The role of nurse stewards is gaining momentum, though little is known about how organizational culture influences their participation. This study identified factors that may help to inform stewardship programming efforts and areas for further exploration. First, nurses identified they have a professional role in stewardship process and want to participate in discussions. Second, when nurses perceived their practices contributed to the stewardship process, performance confidence was heightened. Finally, subtle changes within the health care system combined with organizational patient safety culture inhibited nurses’ stewardship involvement.

The majority of nurses indicated they have an important role in stewardship, but that a lack of education contributes to unclear responsibilities. Stewardship is defined as “the optimal selection, dosage, and duration of antimicrobial treatment that results in the best clinical outcome for the treatment or prevention of infection with minimal toxicity to the patient and minimal impact on subsequent resistance” (Gerding, 2001, p. 403). Despite the focus being on the optimization of therapies, from the nurse comments and their responses on the purpose of stewardship, it appears stewardship is viewed as a global issue focusing on improving resistance, rather than a collection of local strategies used to directly improve appropriate antibiotic use and prevent adverse patient events. While education is necessary to bolster capacity, it may be of utility to distinguish differences between role and ownership. We found nurses want to participate, but are vague about where they can intervene or can meaningfully contribute as owners in the medication process and antibiotic stewardship has different connotations (e.g.

stewardship viewed as a prescribing issue) to bedside nurses.

A few nurses commented that stewardship was viewed as a distinct task or an additional undertaking, rather than a series of practices performed by different disciplines enveloped within the larger context of medication safety. These comments have a similar tenor to the unspoken cultural rules often described in the social and behavioral sciences as “prescribing etiquette,” defined as a shifting in social professional roles (Charani et al., 2013; Fleming, Bradley, Cullinan, & Byrne, 2014; Lorencatto et al., 2018). In Table 13, under dichotomized roles, nurses comments indicates stewardship was perceived as a prescribing issue and their role was being confined to the administration process, which may result in an unwillingness to interfere with antibiotic decisions. One nurse viewed his/her role of questioning physician orders as a practice beyond his/her professional scope with another nurse echoing the process of going with whatever is ordered in the MAR. Curiously, this sub-segmentation of work is not generally seen in the medication administration process where nurses are responsible for knowing the actions and indications of all administered medications as well as the monitoring parameters medication safety (Durham, 2015). For example, nurses check potassium levels or apical heart rates prior to administering furosemide or digoxin, respectively (Durham, 2015). For antibiotics, this would entail reviewing susceptibilities to ensure appropriate treatment, yet nurses in our study reported the ownership of those activities as being out scope. Several factors may contribute to perceptions that stewardship is a prescriber’s function.

First, in our study and in other related publications, nurses have revealed that their stewardship education is limited (Carter et al., 2018; Manning, & Pogorzelska-Maziarz, 2018) (Monsees et al., 2017). Carter et al. (2018) reported that not only is stewardship information absent in baccalaureate nursing curriculums, but varying educational requirements following

post-licensure leaves education incumbent upon the individual nurse. When learning occurs within the clinical workplace, the variability in antibiotic prescribing based on discipline preferences makes it challenging for nurses to establish pattern recognition and intervene when something appears different than expected.

Second, the variability in prescribing orders coupled with nurse stewardship knowledge debt suggests nurses are deferential to those with antibiotic-specific expertise, which may supersede traditional duties and drug checks held by nursing. Nurses reported trusting the system (e.g. MAR) or deferring to providers or pharmacists to ensure medications are correct. Nurses also reported that they did not feel as though they had the right to question physicians. Instead of applying the collective experiences and practices from providers, pharmacists, and nurses to ensure safe antibiotic use, nurses viewed the process of stewardship as distinct tasks “doctors order, nurses hang” or as explicit spheres of responsibility by different disciplines (e.g. drug evaluation vs. administration) (Weick, 2015).

Third, stewardship is a specialty service to help clinicians optimize treatments. Edwards et al. (2011) referred to stewardship practices as “antimicrobial management” rather than “prescribing” and that perhaps this semantical differentiation may be clearer to nurses. This critical insight is applicable to the findings in this study, which revealed nurses perceive they have a professional responsibility to steward yet they currently view their ownership in the antibiotic process differently than other medications. Thus stewardship leaders should consider the effect of language on medication role and where opportunities exist for crafting messages in “nursing speak” (Hou, Cybulski, Kraemer, Vyas, & Condoluci, 2018). In many ways, antimicrobial stewardship parallels the trajectory of the infection prevention field. As a highly specialized and technical group of individuals, improvement strategies were originally viewed as

the sole responsibility of the infection preventionist. Through rebranding and recalibrating communication, these concerted efforts have positioned infection prevention as a team sport where frontline clinical staff are empowered as practice owners and leaders (Murphy et al., 2012).

Nurses have suggested improved communication as a strategy to enhance participation, this approach may help to mitigate a perceived knowledge debt and problems identified in workplace culture. Learning has been described as a social act, flourishing through interaction and communication openness (Edmondson, 2003; Provost, Lanham, Leykum, McDaniel, & Pugh, 2015). Thus, team-based interactions invite informed decision-making, interprofessional collaboration through respective interaction, and provides a comprehensive view of what is occurring with the patient (Monsees et al., 2017). It also allows them to draw on the collective wisdom of their clinical partners. Examples of this has been identified in the infection prevention literature where organizational characteristics influence the adoption socio-adaptive behaviors to improve clinical practice (Meddings et al., 2017; Saint, Howell, & Krein, 2010). Structured conversation or framing instances empowered nurses to speak up and stop the placement of central lines when sterility breaches were identified (Pronovost, 2008; Pronovost et al., 2017) and these interactive approaches suggest utility for nurse integration into stewardship initiatives too (Raybardhan, 2017).

The majority of nurses correctly recognized nursing practices contribute to the process of stewarding antibiotic therapies. These favorable results were also identified in several nurse comments demonstrating deep understanding of how stewardship influences patient care. These views suggest when nursing is engaged in antibiotic discussions and given the confidence to participate, they can be powerful collaborators and knowledge brokers (Broom et al., 2017). It

also reflects an opportunity for nursing to own and leverage their expertise for building teams and strong systems when considering their role in medication safety.

Several limitations are noted. First, the intention of this study was to describe nursing perceptions, the investigator-developed survey was not tested for psychometric soundness. Should the instrument move beyond a descriptive tool to an instrument measuring stewardship behavior and knowledge, formal reliability and validity testing should be performed. Second, to reduce respondent burden, the PI selected only 8 of the 42 AHRQ hospital survey on patient safety culture questions to associate organizational culture with stewardship practice and confidence. These data provide a glimpse of organizational features, such as teamwork and communication, but the limited number of questions likely impacted the ability to fully associate patient safety culture with stewardship practice and confidence. Free-text comments revealed substantive issues and organizational contextual factors that can provide a platform for further study and gives credence to evaluating the system and organizational culture in which teams operate prior to rushing the development of an intervention (Lorenatto et al., 2018).

Conclusion

As the stewardship movement continues to surge throughout healthcare facilities, these survey results serve as a guide to initiate understanding into how acute care, bedside nurses want to be included in antibiotic stewardship. When nurses perceive their practices as contributing to the stewardship process, they were more confident in their performance. Workplace culture was a factor that negatively impacted the ability to steward. There is a need to enhance interactional approaches and team communication through the use of sociobehavioral strategies. Opportunities to strengthen the messaging of stewardship, as shared responsibility under the umbrella of medication safety may be of utility. Moreover, these qualitative findings will be

used to inform and design novel team-based stewardship interventions that encourage cognitive diversity in clinical expertise through interdisciplinary learning and rounds.

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Table 6

Respondent Characteristics

	Respondents	Percent
Facility (<i>n</i> = 558)		
Hospital A – Community Hospital	51	9.1
Hospital B – Academic Health System	197	35.3
Hospital C – Community Hospital	71	12.7
Hospital D – Health System	239	42.8
Highest level of education (<i>n</i> = 548)		
LPN-Diploma/Certificate	1	0.2
LPN-Associate degree	2	0.4
RN-Diploma	12	2.2
RN-Associate degree	124	22.2
RN-Baccalaureate degree	368	65.9
Master's degree	35	6.3
Other	6	1.1
Experience (<i>n</i> = 550)		
<1 year	42	7.5
1-5 years ago	190	34.1
6-10 years ago	91	16.3
11-15 years ago	51	9.1
> than 15 years ago	176	31.5
Time worked in this hospital (<i>n</i> = 549)		
<5 years	308	55.2
5-10 years	99	17.7
11-15 years	46	8.2
More than 15 years	96	17.2
Assigned Unit (<i>n</i> = 545)		
Intensive Care	153	27.4
Hematology/Oncology	19	3.4
Intermediate Care (step-down)	101	18.1
Medical/Surgical	128	22.9
Multiple units/No specific	28	5
Other	116	20.8
Primary Shift (<i>n</i> = 549)		
Nights (1900-0700)	167	29.9
Days (0700-1900)	300	53.8
Weekend Option Nights (1900-0700)	27	4.8
Weekend Option Days (0700-1900)	30	5.4

Table 7

Composite Correlations

		Confidence Composite	Safety Composite
Practice Composite	ρ	.45**	.16**
	N	491	506
Confidence Composite	ρ	.	0.18**
	N	.	505

ρ Spearman rank order correlation

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Table 8

Practice, Confidence, Safety Composite by Facility

Participating Facility	Practice Composite	Confidence Composite	Correlation by Practice & Confidence	Safety Composite
<i>Hospital A</i>	44.81 ($n = 48$)	40.12 ($n = 50$)	.66**	30.42 ($n = 50$)
<i>Health System B</i>	44.50 ($n = 184$)	39.95 ($n = 182$)	.49**	29.83 ($n = 193$)
Hospital Ba	44.63 ($n = 129$)	40.04 ($n = 126$)	.56**	29.89 ($n = 134$)
Hospital Bb	44.18 ($n = 50$)	39.98 ($n = 48$)	.32*	30.04 ($n = 50$)
Hospital Bc	44.33 ($n = 3$)	38.20 ($n = 5$)	.	27.17 ($n = 6$)
<i>Hospital C</i>	44.24 ($n = 66$)	38.82 ($n = 67$)	.35**	29.88 ($n = 69$)
<i>Health System D</i>	44.41 ($n = 225$)	38.81 ($n = 220$)	.41**	30.32 ($n = 225$)
Hospital Da	43.62 ($n = 106$)	38.24 ($n = 105$)	.42**	30.07 ($n = 108$)
Hospital Db	45.57 ($n = 77$)	39.20 ($n = 76$)	.36**	31.01 ($n = 77$)
Hospital Dc	47.40 ($n = 15$)	42.64 ($n = 11$)	0.22	27.92 ($n = 13$)
Hospital Dd	42.54 ($n = 26$)	38.27 ($n = 26$)	.56**	30.44 ($n = 25$)

Range of scores summed from 10 to 50

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Table 9

Best Strategies for Nurse Engagement

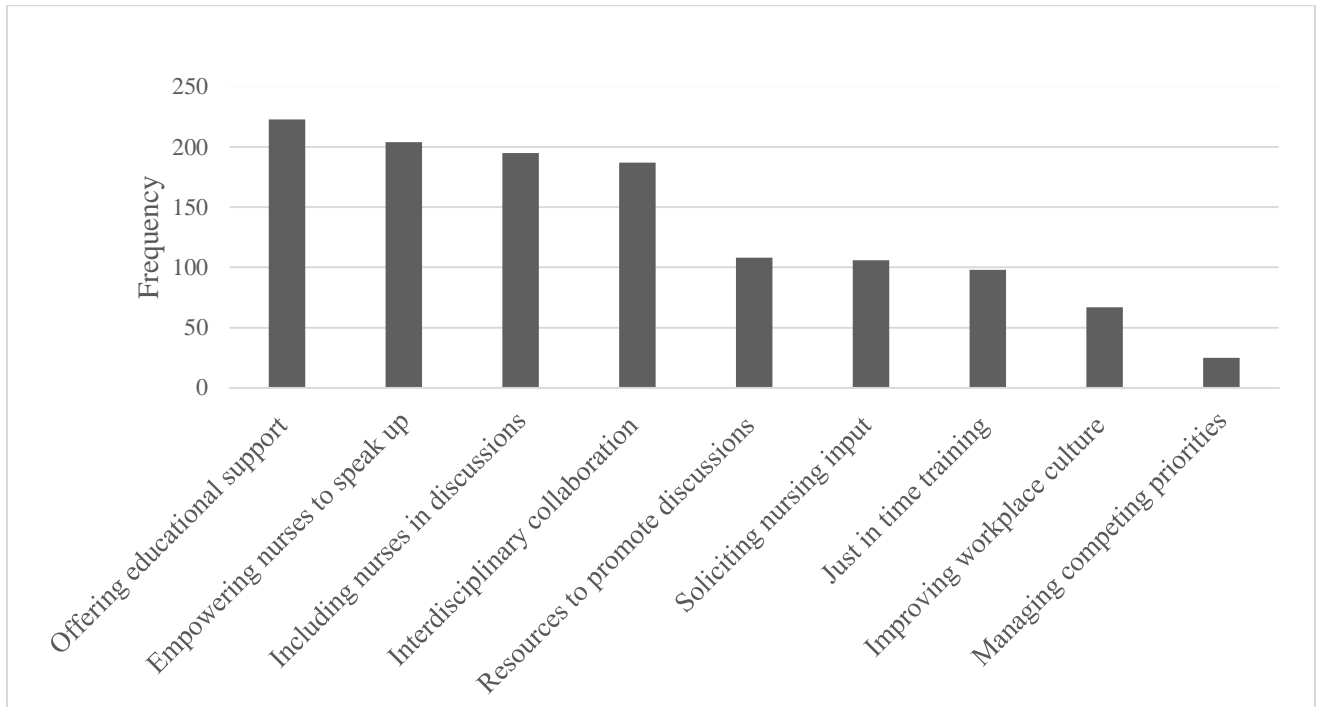


Table 10

Barriers to Stewarding

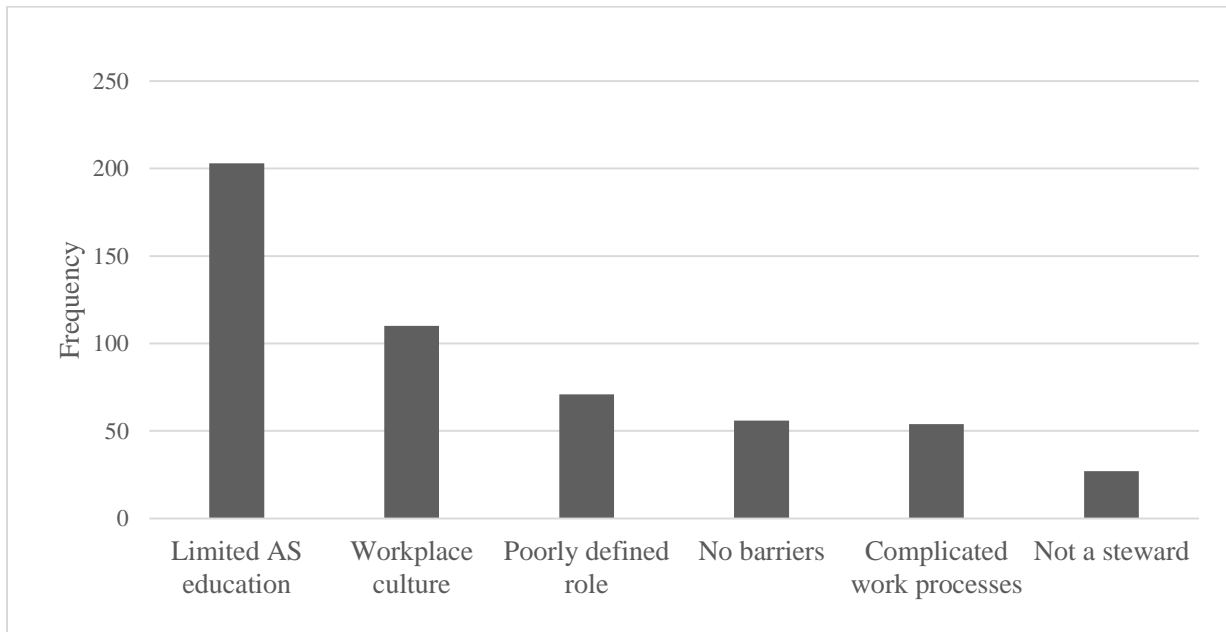


Table 11

Barrier Themes by Clinical Unit

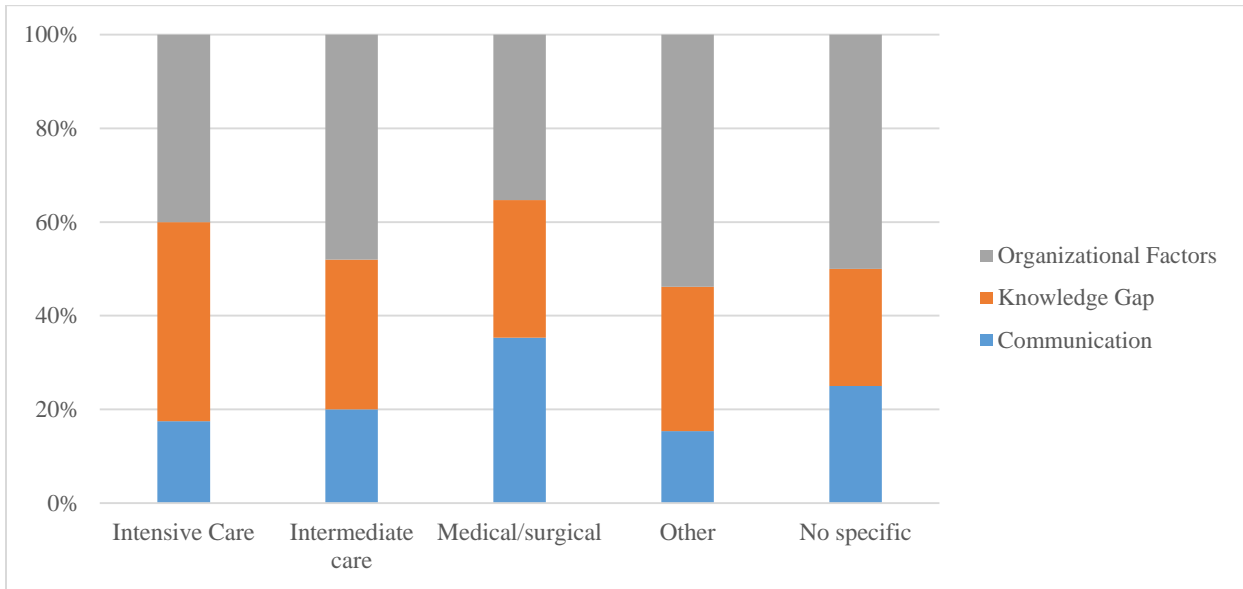


Table 12

Barrier Themes by Experience

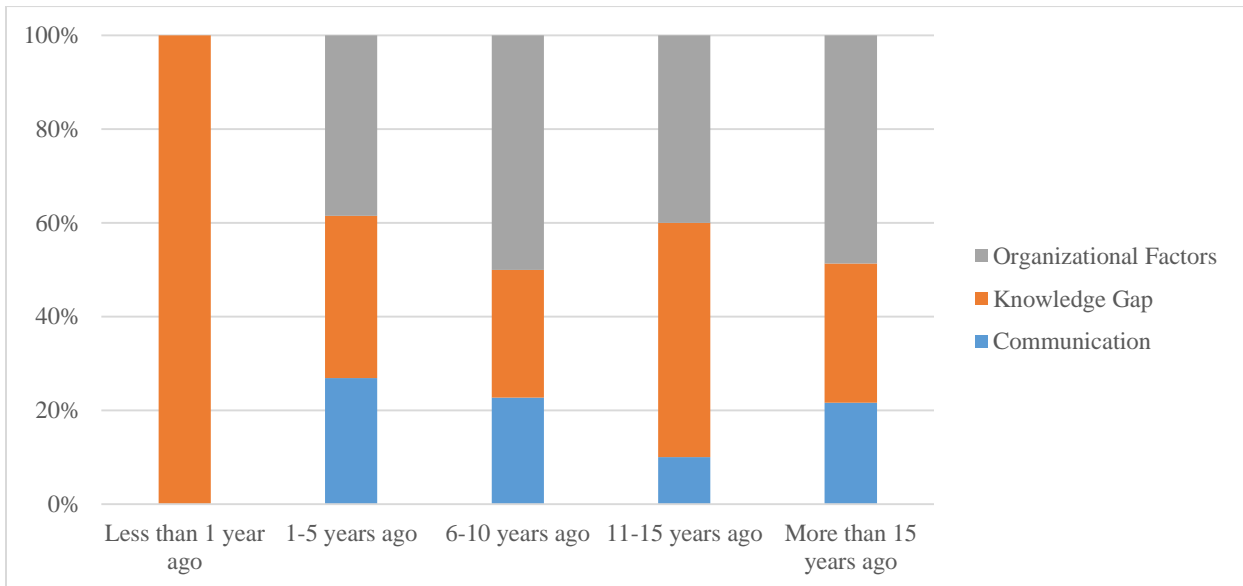


Table 13

Representative Quotes and Participant Characteristics by Organizational Factors and Communication

	Subtheme	Representative Quote	Experience	Clinical Unit	Location
107 Communication	Interdisciplinary Planning	I would like for the physicians to discuss with nurses about continued IV's especially when patients are admitted on two-three IV ABT's at the same time. This can result in MDRO/C-Diff and other complications.	11-15 years	Medical/Surgical	Hospital D
	Night Shift	Providers should be asking staff that work at night to have input into antibiotic treatment and therapy. In addition, often night nurses are not provided the tools to have proper IV access such as with midlines to keep patients free from phlebitis when high-strength antibiotics are started. This often delays antibiotic treatment in a timely manner (ie: after loading dose, maintenance [sic] dose is received late).	1-5 years	Medical/Surgical	Hospital B
	Lack of Voice	...in our unit nursing does not have any input on antibiotics prescribed, effectiveness, evaluation, start and stop times or any thing [sic] else. In my unit prescribing information is left to providers.	6-10 years	ICU	Hospital D
Organizational Factors	Competing Demands	...too many patients with too complicated history to be able to do everything that needs to be done	> 15 years	Medical/Surgical	Hospital B
	Disrespect of Contribution	It has been said that nurses do not have any clinical judgment and for that reason I never feel like my opinion matters. It feels like we are just the medication deliverers and should just do what the orders say and go home.	1-5 years	Medical/Surgical	Hospital D
	Inadequate Governance	...keeps changing along with the doctors [sic] preference, then add pharmacy who has opinions different from [the] doctor.”	11-15 years	Maternal Care	Hospital C

Poor Work Processes	...blood cultures often ordered when pt [patient] arrives to the floor after first dose antibiotics given; seems like a redundant practice.	11-15 years	Intermediate Care	Hospital B
Dichotomized Roles	...some of these [survey] questions are confusing to me because in a lot of situations it is not my place to question a physician's antibiotic orders. I do not have the amount of education they do in this area. I find it unfair to expect RNs to do this. Educating patients and other tasks regarding administration of antibiotics is within our scope. Perhaps it is the pharmacists who need to be involved more than RNs in checking physician antibiotic orders (although I believe they already do, and do a good job in my experience).	5-10 years	Other (Telemetry)	Hospital D

Supplement 1

Survey Constructs

General Stewardship	Examples of Topics Include:
Participation Status	<ul style="list-style-type: none">• I participate as an antibiotic steward• Nursing leaders encourage my involvement in antibiotic discussions• Prescribers encourage my involvement in antibiotic discussions• Select strategies that best engage nurses in antibiotic stewardship• Select barriers that impact ability to act as antibiotic stewards
Stewardship Purpose	Which statement best describes the purpose of antibiotic stewardship?
Stewardship Knowledge	I am knowledgeable about antibiotic stewardship
Stewardship Role	I think nurses have an important role in the antibiotic stewardship process
Nursing Practices (NP) and Confidence (C)	
Allergy History	Assessing for a history of an adverse drug reaction (NP, C)
Timeliness of Cultures	Assuring that cultures (i.e. urine, blood, etc.) are obtained before antibiotics are initiated (NP, C)
Microbiology Results	Reviewing preliminary microbiology culture results and comparing susceptibilities to antimicrobial orders to determine appropriateness (NP, C)
Antibiotic “Time Out”	Reviewing the antibiotic treatment to determine whether the patient’s infection responds to the selected antimicrobial, is on the correct dose and route, spectrum, and duration (NP, C)
Identification of Adverse Events	Similar to allergy history, assessing the development of potential adverse events based on antimicrobial use (NP, C)
Documentation of Adverse Events	Recording detailed signs and symptoms of reactions (NP)
Transition of IV to PO	Assessing the ability to change intravenous antimicrobials to oral therapy (NP, C)

Patient Education	Educating patients about taking antibiotics correctly to reduce possible side effects (NP, C)
Device Management	Providing catheter care (i.e. urinary or central line) using evidence-based procedures to prevent infections (NP)
Drug Therapeutics	Drawing drug levels (e.g. peaks and troughs) (NP)
Identification of Wrong Dose	Identifying a wrong antibiotic dose (C)
Provider Communication	Notifying the provider of a wrong antibiotic dose prior to giving the medication (C)
<i>Clostridium difficile</i> acquisition	Understanding the relationship between antimicrobial use and <i>Clostridium difficile</i> risk (C)

Patient Safety Culture

AHRQ Teamwork Within Units	In this unit, people treat each other with respect
AHRQ Teamwork Across Units	Hospital units do not coordinate well with each other
AHRQ Teamwork Across Units	There is good cooperation among hospital units that need to work together
AHRQ Teamwork Across Units	It is often unpleasant to work with staff from other hospital units
AHRQ Teamwork Across Units	Hospital units work well together to provide the best care for patients
AHRQ Communication Openness	Staff will freely speak up if they see something related to antibiotic use that may negatively affect patient care
AHRQ Communication Openness	Staff feel free to question the decisions or actions of those with more authority
AHRQ Communication Openness	Staff are afraid to ask questions when something does not seem right

Supplement 2

Correlation between Nursing Practice and Confidence

		Nursing Confidence										
		Culture collection	Antibiotic need	Allergy history	Micro biology results	Wrong doses	Notifying wrong dose	Signs of reactions	IV to PO	Family education	Antibiotics & C. difficile	
III	Allergy history	ρ	0.05	.09*	.33**	.10*	.18**	.16**	.25**	.22**	.22**	.16**
		N	549	548	549	549	549	547	548	546	545	544
	Culture collection	ρ	.31**	.15**	0.08	.11*	-0.01	0.04	0.07	.12**	.17**	.13**
		N	544	543	544	544	545	542	543	541	540	539
	Microbiology results	ρ	.21**	.34**	.16**	.47**	.26**	.25**	.13**	.24**	.12**	.17**
		N	545	544	545	545	545	543	544	542	541	540
	Antibiotic need	ρ	.15**	.36**	.11**	.37**	.24**	.24**	0.08	.27**	.10*	.17**
		N	549	548	549	549	549	547	548	546	545	544
	Antibiotic adverse events	ρ	0.08	.12**	.35**	0.07	.12**	.12**	.35**	.15**	.21**	.18**
		N	546	545	546	546	546	544	545	543	543	541
	Signs of reactions	ρ	0.07	.18**	.32**	.09*	.13**	.17**	.34**	.17**	.26**	.17**
		N	546	545	546	546	546	544	545	543	542	541
	IV to PO	ρ	.16**	.32**	.20**	.30**	.19**	.20**	.20**	.41**	.18**	.21**
		N	545	544	545	545	545	543	544	542	541	540
	Family education	ρ	.10*	.19**	.28**	.14**	.15**	.19**	.23**	.21**	.38**	.28**
		N	541	540	541	541	541	539	540	538	537	537
Catheter care	ρ	.10*	0.05	.23**	0.04	0.07	0.04	.25**	.12**	.25**	.26**	
	N	546	545	546	546	546	544	545	543	542	541	
Drug levels	ρ	.16**	.19**	.24**	.13**	.12**	.11*	.26**	.22**	.22**	.21**	
	N	547	546	547	547	547	545	546	544	543	542	

** . Correlation is significant at the 0.01 level (2-tailed).

* . Correlation is significant at the 0.05 level (2-tailed).

CHAPTER 6

CONCLUSION

Antibiotic misuse contributes to bacterial resistance by causing agents to lose effectiveness as the bacteria adapts to exposure with mechanisms rendering therapy ineffective (Spellberg, Srinivasan, & Chambers, 2016). While mitigating resistance through appropriate use is one of the key goals of an Antimicrobial Stewardship Program (ASPs), often the more immediate effects of antibiotic misuse and exposure include related complications, such as *Clostridioides difficile* infections and adverse drug reactions (Centers for Disease Control and Prevention [CDC], 2013). Recent publications have also associated antibiotic use with obesity, inflammatory bowel disease, and juvenile idiopathic arthritis; representing another spectrum of how antibiotics when used inappropriately can have significant patient safety implications (Bailey et al., 2014; Goldman & Jackson, 2015; Horton et al., 2015; Kronman, Zaoutis, Haynes, Feng, & Coffin, 2012; Saari, Virta, Sankilampi, Dunkel, & Saxen, 2015). Finally, antibiotic misuse is direct burden on healthcare expenditure, not only in terms of unnecessary or redundant use, but also in avoidable costs associated from complications (Barlam et al., 2016; Beck et al., 2017).

Interdisciplinary collaboration in ASPs has been endorsed in practice and policy to slow the emergence of antimicrobial resistance, improve the aforementioned patient outcomes, and add programmatic breadth (CDC, 2014; Centers for Medicare & Medicaid Services, 2016; National Quality Forum, 2016; Perspectives, 2016; The White House, 2015). Recognizing the original scope and function of ASPs were predicated on refining the acute care provider's prescribing privileges, direct care nurses have been overlooked in interventions designed to support stewardship. Nurses with direct care responsibility are gaining recognition for their

contributions as stewards due to the nature of their work but also because they are present in settings where infectious disease experts are lacking.

Dissertation Overview and Findings

This dissertation study focused acute care nurses' perceptions, confidence, and influence of patient safety culture on their behavior to steward which was developed based on findings from the integrative review of the literature. As noted in Chapter 2, I identified a dearth of literature on nursing role and that organizational culture appeared to shape their limited stewardship involvement. These findings substantiated the need for a single-center survey on nurse perceptions of stewardship practices and performance confidence (Chapter 3). Again, the theme of organizational culture surfaced when nurses reported that as a barrier to their participation. Chapter 4 is the research plan detailing how data would be collected across 9 different hospital sites to achieve the following specific aims: 1) determine practices that are associated with antimicrobial stewardship processes and nurses' perceived confidence in performing those practices, and 2) to explore the relationship between nurses' understanding and perceived confidence in performing practices that impact antimicrobial stewardship and patient safety. This study spanned a number of hospitals, and facility-level data was analyzed for variation between facilities.

Approach

A cross-sectional study using an investigator-developed instrument that was tested in an earlier study described in Chapter 2 and refined a second time prior to use in this study. Quantitative data was collected on selected nursing confidence and practices that have been associated with the process of antimicrobial stewardship. Questions related to teamwork and communication were included with permission from the Agency for Healthcare Research and

Quality (AHRQ) Hospital Survey on Patient Safety because earlier results indicated that organization culture may inhibit nurse involvement in stewardship. One qualitative question was included to allow nurses to elaborate on their role and any enablers or barriers to their stewardship engagement. Data were analyzed using SPSS, Dedoose, and Excel software.

Major Findings

Quantitative analysis demonstrated the majority of nurses agreed they have a role in the antimicrobial stewardship process ($n = 408, 73\%$), despite a limited stewardship knowledge ($n = 241, 43.1\%$). A moderate association $r_s = .454, p < .001$ was found between the perceived nursing practices that contribute to the stewardship process and the confidence to perform. Safety was weakly correlated $r_s = .161, p < .001$ with nursing practice. Minimal variation was identified by facility, therefore responses to individual practice, confidence, and safety questions were examined by experience and clinical unit. As expected, nurses with more experience were more confident in performing a number of clinical practices related to stewardship. Interestingly, intensive care units score lower in certain nursing practices, such as taking allergy history and educating patients and were also less confident in identifying a wrong antibiotic dose. This finding was different than those found in a recent survey of health system infection prevention managers that indicated critical care nurses may be more likely to be involved in certain stewardship activities (Manning & Pogorzelska-Maziarz, 2018).

While the safety data yielded limited statistically significant results, the qualitative responses produced from the free text field added robustness and depth to overall study. Despite their reported desire to be involved in stewardship, nurses revealed a number of performance barriers to their practice. Not surprising, nurses reported a lack of stewardship education, which is consistent with other studies exploring this issue including my first study (Carter et al., 2018;

Greendyke et al., 2018; Monsees, 2017). Similar to the pilot study, organizational culture was perceived as an impediment to stewarding that unfolded in a number of ways: a) dichotomized roles, (b) competing demands, (c) inadequate governance), (d) disrespect of contribution, and (e) poor work processes. Though communication is also traditionally considered an organizational factor, given the number of responses ($n = 21$), comments were analyzed and grouped separately.

Discussion

To my knowledge, this is the largest multi-site study on nursing stewardship practices. The strengths of the study include the representation of nurses practicing in diverse types of hospitals (e.g. academic vs. community) in different health systems situated in two distinct metropolitan settings of varying size. Given the representative sample, the findings may demonstrate how nurses, as a profession, perceive their stewardship practice. Additionally, this is the first study to introduce the concept of organizational culture as a factor influencing nurse behavior to steward. Stewardship is recognized as highly complex set of behaviors and the benefit of social and behavioral sciences are gaining traction in the literature as pathway to improve prescribing, however, this attention is mainly focused on prescribers and pharmacists (Lorenatto, Charani, Sevdalis, Tarrant, & Davey, 2018; van Buul et al., 2014). This study attempts to unveil the need for a systems' thinking approach, especially when facilities are considering nurse stewardship engagement strategies and that is critical to analyze the subtle changes in work processes and explore the interactions between teams that may influence participation or limit the overarching message that everyone is a steward.

Findings from the study highlighted a number of system issues that bear further attention. First, nurses viewed antibiotic work processes as distinct and separate tasks from the overall act of medication safety. This may be attributed to the direction of stewardship language to

prescribers which focus on order refinement, rather than a collection of shared processes to ensure optimal medication administration (Edwards, Drumright, Kiernan, & Holmes, 2011). A number of nurse comments described this division of labor as, “doctors order, nurses hang” or “doctors manage micro and select antibiotics. Not nurses role.” Similarly, Fleming et al. (2014) describes this sub-segmentation of work as “social professional/role identify” or a set of behaviors demonstrated in social or work setting. Like the nurses in our survey, Fleming et al. (2014) provides an excerpt from a qualitative stewardship study on a reported performance barrier “the role of the pharmacist is primary to screen for drug interactions and provide medicines information rather than influencing the antibiotic prescribing process.” These divisions of roles and accepted cultural rules reflect an unspoken “prescribing etiquette” which appears to create a practice of noninterference within the specifics of prescribing (Charani et al., 2013; Lorencatto et al., 2018). Systems thinking takes habits and patterns into account as humans naturally seek shortcuts to automate regularly performed tasks, however, if each member of the care team has a separatist lens, it raises the larger concern, who is actually responsible for medication safety?

Second, the advent of specialized infectious disease teams in acute care settings may have had the unintended consequence of disempowering nursing or fostering disconnectedness from traditionally held nurse responsibilities in antibiotic management (Edwards et al., 2011; Monsees, 2017). The lack of self-efficacy in antibiotic safety suggests a bigger cultural issue (Vaughn et al., 2018) than simply deferring to those with recognized and advanced antimicrobial knowledge, rather the mental process of “going with it” may have dampened the application of professional knowledge and nursing actions and indications of medication administration. Reacquainting links between clinical practices (e.g. evaluating microbiology susceptibilities for

drug bug mismatch) with function attribution to stewardship process (e.g. ensures correct therapy) are needed. These fissures in practice demonstrate that efforts towards team-based interventions that support interdisciplinary learning will be necessary to boost collaboration and reduce role ambiguity by delineating how everyone is responsible for antibiotic management.

Third, nurse inclusion is important and timely, but we know very little about how to effectively engage nurses as antibiotic stewards. Practice recommendations are asking bedside nurses, a group that has not been formally engaged and underutilized to bring their clinical expertise to existing stewardship relationships without exploring how these disciplines function and communicate on antibiotic safety. Furthermore, it is concerning that in our study, the majority of nurses indicated a lack of support by both their nursing leaders and physician counterparts.

In response, operational and administrative leadership will need to be active in triaging competing initiatives so antibiotic safety is prioritized as a facility goal and provide time for education and resource development to facilitate the inclusion of nurses into stewardship processes (American Nurses Association [ANA] & CDC, 2017). Leaders must work with frontline staff to strengthen strategies for communicative and interactional approaches so all members of the healthcare team are supported and empowered as change agents and practice owners. Examining system design will be essential so practice modifications are not incumbent on a particular individual or discipline, rather a demonstration of shared beliefs that everyone is accountable for safe antibiotic use.

Limitations are present in the current study. To reduce respondent burden, the PI selected only 8 of the 42 Agency for Healthcare Research and Quality Hospital Survey on Patient Safety questions to associate organizational culture with stewardship practice and confidence. While

the selected safety culture domains theoretically-related to ASP, such as teamwork and communication, provide a snapshot of organizational behavior, they should not represent a facility's overall patient safety culture. The free text comments revealed early contextual factors influencing nurse behavior to steward that require further exploration. For example, the analysis on the division of labor during antibiotic delivery and how it fits into the larger practice of medication safety does provide a glimpse of where education, role clarification, or practice considerations are needed, but future work should use a qualitative approach for in-depth analysis.

Implications for Practice

The prospect of another discipline actively entering the fight against antimicrobial misuse is attractive, however, it is generally understood that modifying prescribing practices and implementing changes are challenging and multifactorial (Charani, Castro-Sanchez, & Holmes, 2014; Charani et al., 2013; Klein et al., 2017). A recent Cochrane review of 221 studies confirms current stewardship strategies improve use and reduce duration of hospitalization (Davey et al., 2017), however, the authors reason that additional studies are not necessary to further establish effect, rather new work should focus on behavioral change techniques and address limitations with existing stewardship approaches (Davey et al., 2017; Lorencatto et al., 2018). This call to involve the expertise of disciplines in the behavioral and social sciences aligns with the recent promotions for a broader reach for stewardship and the focus of this dissertation work (ANA & CDC, 2017; Manning, 2016; Manning, Septimus, Dodds Ashley, Cosgrove, Fakhri, ... & Moody, 2018).

Applying Behavioral and Complexity Science to Guide ASP

First, complexity science offers insight as to why formally, structured programs or processes have failed despite being well-designed (Cooper & Geyer, 2008). When complexity science is applied to stewardship, current ASP structure might be regarded as having a reductionist approach, such as, the restriction of select antibiotics, by individual infectious disease experts. Recalling that a key finding of the Cochrane review was to address the limitations and understand the uncertainties in current stewardship models (well-designed as they are) and this recommendation aligns with the experiences of the infection prevention profession (Davey et al., 2017; Lorencatto et al., 2018). Infection prevention has evolved over 40 years from initially relying on specialty-trained individuals (a reductionist model) to facilitating ownership and accountability by frontline stakeholders to make significant reductions in healthcare-associated infections. At present, ASP is comprised of highly specialized individuals, focused on prescribing, but with the increasing accrediting requirements and regulations coupled with the growing science promoting interdisciplinary partnerships, programs are in transition. I posit that the natural output from the increased attention on interprofessional engagement and service expansion will result in more fully integrated stewardship models within healthcare systems which moves from strictly clinical services to core players in the patient safety movement. To achieve this, applying concepts from complexity and behavioral sciences are needed.

Research is demonstrating how the continued progression of stewardship relies on the emergence of new participants and behaviors through learning and interconnectivity and an understanding of factors that influence engagement. A few examples sensitive to the behavioral considerations of stewardship may be useful for exploring nurse participation. Two experiential methods that show promising results for stewardship engagement include, the Dutch Unique

Method for Antimicrobial Stewardship Participatory Intervention Study used a participatory action research model comprised of interdisciplinary professionals (including nurses) to make statistically significant improvements in appropriate antimicrobial selection from 64.1% to 77.4% (+13.3%, RR 1.17, 95% CI, 1.04-1.27) (Sikkens et al., 2017; van Buul et al., 2014). Lorencatto et al. (2018) suggests applying a theory-driven, systematic approach to antimicrobial interventions using the Capacity, Opportunity, and Motivation (COM-B) model with Theoretical Domains which are a synthesis of 33 behavior change theories (Michie, van Stralen, & West, 2011).

Second, complexity science can provide powerful insight into how to design ASP research to explain the impact of unit-specific phenomenon on overall practice and how people self-organize to complete their work. The practical approaches to behavioral change suggested by Lorencatto et al. (2018) and Sikkens et al. (2017) align nicely with complexity science, which was the overarching framework used to guide this dissertation. Within complexity science, complex adaptive systems (CAS) are defined as an interconnected system comprised of individual agents with the freedom to behave in an unpredictable manner whose actions influence or change the behaviors of other agents (Chaffee & McNeill, 2007; Plsek, 2001). Using a similar approach as Chaffee and McNeill (2007), the following stewardship example illustrates characteristics to demonstrate a series of individual CAS. Infectious Disease physicians or pharmacists either assist in the restriction of medications (*simple rules*) or provide feedback to an array of providers to optimize antibiotic therapies (*context, co-evolution*). To reinforce program initiatives, they may seek out informal leaders distinguished by their clinical expertise to champion stewardship principles (*attractors*). Nurses witnessing the exchange of information between infectious disease specialists and primary physicians may assume new responsibilities

(*self-organization, adaptable*) and begin to question providers about medication duration or route (*emergent behavior*). These small changes in practice are unpredictable. Without coaching they could devolve or in the right environment they might promote further adaption stimulating a large system response to stewardship (*nonlinearity*).

When applied to the final study included in this dissertation, nurses reported they do not have ownership in the prescribing or evaluation of antibiotic therapy. Complexity science can provide a different way to look at long standing problems such as provider nurse relationships, and the influence of power on behavior (McDaniel, Lanham, & Anderson, 2009). Like behavioral science, complexity science also focuses on exploring the interconnections within the system prior to intervening with a solution. As Lorencatto et al. (2018) implied, one would not prescribe an antibiotic without first assessing symptoms and select an effective treatment based on the diagnosis. Thus, developing a checklist may be appropriate for a simple problem (e.g. stopping unnecessary antibiotics at 48 hours) and inappropriate for a complex one, like improving how interprofessional teams communicate and determining who is actually responsible for stewarding antimicrobials (Plsek, 2001). The limitation of using complexity science in ASP is that the constructs are difficult to operationalize and measure (McDaniel et al., 2009). Thus, as learned in this dissertation, complexity science may be better applied as an explanatory framework with behavioral change theories guiding the development of an intervention (Davey et al., 2017; Lorencatto et al., 2018).

In closing, it is encouraging that nurse stewardship engagement is receiving attention in the literature and in policy, and as we learn from complexity and behavioral scientists, “understanding how different clinical teams operate and what demands they must face given available resources, is key to designing ASPs that not only target drivers of individual behavior

change, but also address the underlying sociocultural factors that shape behavior (Lorenatto et al., 2018, p.2616).” Moving forward, science produced by sociologists and behavioral scientists have shown applicability to stewardship, particularly how organizational factors influence behavior and suggest approaches that could be valuable to inform and guide future research on nurse integration (Charani, Castro-Sanchez, & Holmes, 2014; Charani et al., 2013; Davey et al., 2017; Davey, Peden, Charani, Marwick, & Michie, 2015; Lorenatto et al., 2018; Szymczak & Newland, 2018). Despite the recent push to expand nurse participation, authors affirm stewardship inventions should not be rushed, rather time should be allocated to develop a “behavioral diagnosis” which consider influencers of interest and system features in the broader social and environmental context (Lorenatto et al., 2018). Therefore, as revealed in this dissertation, to advance the progression of stewardship, behavioral facilitators and barriers need further exploration so all members of the care team are mutually responsible for the judicious and safe use of antimicrobials.

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APPENDIX

Appendix A

ASP – RN Survey

Confidential

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ASP RN Survey

Antibiotic Stewardship Programs (ASP) are designed to improve antibiotic use, to address concerns around rising bacterial resistance rates and enhance the quality and safety of clinical care (Centers for Disease Control and Prevention [CDC], 2015). Literature suggests that ASPs led by infectious disease physicians and pharmacists with specialized training have been influential in decreasing unnecessary antibiotic prescribing, enhancing appropriate use, decreasing cost, and influencing patient outcomes in acute care settings.

This survey is intended to help us understand how nurses' view their role in antibiotic stewardship.

Your completion of this survey and submission of your responses implies your informed consent to participate in this research study.

Please complete the survey below. Thank you!

A. [This first section will help us understand your role as a nurse related to the antibiotic stewardship process.

1. I am familiar with the term "antibiotic stewardship."
 Yes
 No

2. I participate as an antibiotic steward.
 Strongly Disagree
 Disagree
 Neutral
 Agree
 Strongly Agree

3. Which statement best describes the purpose of antibiotic stewardship? Select one.
 Optimizing antibiotic therapies
 Minimizing toxicity from antibiotic therapies
 Improving the quality of care
 Improving infection rates
 Reducing treatment failures
 Increasing the frequency of correct prescribing
 Increasing the frequency of correct prophylaxis
 Reducing antibiotic resistance
 Saving hospitals money
 Reducing adverse events from antibiotic therapies
 Restricting antibiotic use
 Providing feedback on antibiotic use

4. I am knowledgeable about antibiotic stewardship.
 Strongly Disagree
 Disagree
 Neutral
 Agree
 Strongly Agree

5. I think nurses have an important role in the antibiotic stewardship process.
 Strongly Disagree
 Disagree
 Neutral
 Agree
 Strongly Agree

B. Select a response that reflects your beliefs about nursing practices that contribute to the antibiotic stewardship process. Please choose from: 'Does not contribute', 'Rarely contributes', 'Neutral', 'Sometimes contributes' or 'Strongly contributes'

	Does not contribute	Rarely contributes	Neutral	Sometimes contributes	Strongly contributes
Taking an allergy history	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Obtaining cultures before starting antibiotics	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Reviewing preliminary microbiology culture results and comparing susceptibilities to antibiotic orders to determine antibiotic appropriateness	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Evaluating antibiotic treatment to see if it's still necessary	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Assessing for antibiotic adverse events	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Recording detailed signs and symptoms of reactions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Transitioning antibiotics from IV to PO	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Educating patients about taking antibiotics correctly to reduce possible side effects	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Provides catheter care (i.e. urinary or central line) using evidence based procedures to prevent infections	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Drawing drug levels (e.g. peaks and troughs)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

C. The next series of questions focuses on your confidence level relative to antibiotic stewardship related to your role as a nurse. Select a response that reflects your confidence with each practice. Please choose from '1' for not confident to '5' for very confident.

I am confident:

	1 Not confident	2	3	4	5 Very confident
Assuring that cultures (i.e. urine, blood, etc.) are obtained before antibiotics are initiated	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Evaluating the need for continued antibiotic use to see if the treatment is still necessary (e.g. 48 hour time out)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Assessing for a history of an adverse drug reaction	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Reviewing preliminary microbiology culture results and comparing susceptibilities to antibiotic orders to determine antibiotic appropriateness	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Identifying a wrong antibiotic dose	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Notifying the provider of a wrong antibiotic dose prior to giving the medication	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Assessing for potential adverse events associated with antibiotic use	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Collaborating with providers about transitioning antibiotic route from IV to PO	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Educating patients and/or families about the importance of taking antibiotics correctly to reduce bacterial resistance and expected side effects	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Understanding of the relationship between antibiotic use and acquiring C. difficile	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

D. The next series of questions focuses on your hospital "unit" where you spend most of your time or provide most of your clinical services. Select a response that reflects your agreement with each statement. Please choose from 'Strongly disagree', 'Disagree', 'Neutral', 'Agree', and 'Strongly agree'

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
In this unit, people treat each other with respect	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hospital units do not coordinate well with each other	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
There is good cooperation among hospital units that need to work together	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
It is often unpleasant to work with staff from other hospital units	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hospital units work well together to provide the best care for patients	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Staff will freely speak up they see something related to antibiotic use that may negatively affect patient care	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Staff feel free to question the decisions or actions of those with more authority	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Staff are afraid to ask questions when something doesn't seem right	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

E. This last section will help us understand your participation as a nurse in antibiotic stewardship.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Nursing leaders encourage my involvement in antibiotic discussions.	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Providers encourage my involvement in antibiotic discussions.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I participate as an antibiotic steward.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Select two strategies that reflect the best way to engage nurses in antibiotic stewardship?

- Empowering nurses to speak up to providers when they have a concern
- Providing nursing input about patient care observations to the healthcare team.
- Including nurses in healthcare team discussions
- Enhancing interdisciplinary collaboration between providers and nurses
- Offering formal information and education support to nurses
- Managing priorities within the unit
- Improving organizational workplace culture to support nurse involvement.
- Providing just in time training (e.g. informal conversations about antibiotic use during stewardship rounds)
- Developing clinical algorithms or resources to promote discussions with the healthcare team.

Select the top barrier that most impacts your ability to act as an antibiotic steward?

- Organizational workplace culture (e.g. hierarchy, poor communication)
- Limited stewardship education
- Complicated work processes
- Poorly defined role and responsibilities
- Other
- No Barriers
- I do not consider myself an antibiotic steward

Is there anything else you would like to tell us about the nurse's role or how to engage nurses in antibiotic stewardship?

F. Demographics Section. Please review your role and clinical experience at this hospital.

1. I graduated from nursing school:
 - Less than 1 year ago
 - 1-5 years ago
 - 6-10 years ago
 - 11-15 years ago
 - More than 15 years ago
2. I have worked as a nurse at this hospital:
 - Less than 5 years
 - 5-10 years
 - 11-15 years
 - More than 15 years
3. I mainly work with:
 - Adults
 - Pediatrics
 - Neonates
4. I mainly work in the following type of patient unit. Select ONE patient unit.
 - Intensive Care
 - Hematology/Oncology
 - Intermediate care (step-down)
 - Medical/surgical
 - Many different hospital units/No specific
5. When considering your primary patient population, which type of service do you think of?
 - Surgical
 - Medical

-
6. I mainly work:
- Nights
 - Days
 - Evenings
-
7. Which of the following best describes your title?
- RN
 - LPN
 - Nurse Educator
 - Nurse Manager/Director
 - Other
-
8. Which of the following best describes your highest educational program? I have a:
- LPN - Diploma/Certificate
 - LPN - Associate degree
 - RN - Diploma
 - RN - Associate degree
 - RN - Baccalaureate degree
 - Masters degree
 - Other
-
9. I have a certification in my professional practice? (e.g CPN; CCRN-E)
- Yes
 - No
-

If you would be willing to participate in a test-retest reliability of this instrument, please enter the first two letters of your mothers first name and then the last 4 digits of your phone number (no spaces e.g. em1234) so we can match results. Thank you!

Appendix B

Recruitment

Will you please be part of helping to understand how nurses' view their role in using antibiotic appropriately? Your responses can assist in the development of strategies to address antibiotic misuse.

As a registered or licensed practical nurse, you are being asked to participate in a research study. The goal of this research study is to help us understand how nurses' view their role in antibiotic stewardship. There are no right or wrong answers.

There are specific antibiotic stewardship questions and demographic questions. The survey, accessed by the following link, will take about 10 minutes to complete. You may elect to quit the survey at any time. The responses from all surveys will be reported in group and your individual responses cannot be identified and will remain confidential.

Your completion of this survey and submission of your responses implies your informed consent to participate in this research study. There will be no way for the study team to know who participates or to match your identifying information to your responses. The survey does not provide the study team with your computer address.

The study team is not aware of any risks to you in taking this survey. There are no direct benefits to you for participating. Your participation will contribute to the knowledge base about nurse's perceptions of role and abilities to function as antibiotic stewards. Your responses are appreciated.

Participation in this survey is voluntary. You will suffer no negative consequences if you choose not to take the survey or choose not to complete it once you have begun the survey. If you experience discomfort from the survey you can stop the survey at any time.

We know how busy your practice is on a daily basis, so we appreciate your time to participate in this survey!

Appendix C

Sample Reminder Message

Dear Colleagues.

You received an e-mail message asking for your assistance in understanding the nurse's role in Antimicrobial Stewardship by completing a REDCap survey. This message has gone to everyone in the selected sample population. Since no personal data is retained, we are unable to identify whether or not you have already completed the survey. If you have completed the survey, we thank you!

If you have not had a chance to take the survey yet, there is still time! This survey should take less than 10 minutes to complete.

Your completion of this survey and submission of your responses implies your informed consent to participate in this research study. There will be no way for the study team to know who participates or to match your identifying information to your responses. The survey does not provide the study team with your computer address.

Participation in this survey is voluntary. You will suffer no negative consequences if you choose not to take the survey or choose not to complete it once you have begun the survey. If you experience discomfort from the survey you can stop the survey at any time.

Please access the survey using this REDCap link: <https://showmeportal.missouri.edu/redcap/surveys/?s=8LFW8YAKND>

Thank you for your assistance in advancing antibiotic stewardship knowledge!

Mary

If you have questions about the survey, please contact the Principal Investigator:

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VITA

Elizabeth Ann Monsees is master's prepared nurse and Jonas Nurse Leaders Scholar with nearly 20 years of clinical and operational experience in infection prevention and control. She has lead hospital-wide committees specifically aimed at the reduction of device associated infections and was an author on the 2016 APIC *Guide for Preventing Central Line-Associated Bloodstream Infections*. She has developed and delivered educational curriculums locally, nationally, and internationally. As a Fellow of APIC, she established the first Advanced Practice Workshop designed to enhance the skills of experienced infection preventionists; the course has continued to serve APIC membership. She currently is the Chair of the APIC Nominating and Awards Committee. She has also published book chapters on quality methodology and patient safety science in two textbooks, *The APIC Text of Infection Control and Epidemiology*, 4th edition and *APIC: Fundamental Statistics & Epidemiology in Infection Prevention* and has developed a new chapter on antimicrobial stewardship for *The APIC Text of Infection Control and Epidemiology* that is in press. Next year she will serve on the Society for Healthcare Epidemiology of America Research Committee. Elizabeth works as the Antibiotic Stewardship Program Manager at Children's Mercy Hospital in Kansas City.