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## How Far We've Come, How Far We Have to Go: a Review of Advances in Antimicrobial Stewardship in the Veterans Health Administration

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### Abstract

**Purpose of review**—This review highlights several of the successes in antimicrobial stewardship seen in the largest integrated healthcare system in the USA, the Veterans Health Administration.

**Recent findings**—Since deploying antimicrobial stewardship programs on a national scale in the Veterans Health Administration, decreases in overall antimicrobial use and *Clostridioides difficile* infections have been observed. Concurrent infection prevention initiatives have also contributed to these improvements in the Veterans Health Administration.

**Summary**—By embracing multidisciplinary stewardship teams, focusing on education and research in the field of antimicrobial stewardship, and leveraging the vast data available within the national system, the Veterans Health Administration has made substantial advances in antimicrobial stewardship.

### Keywords

Antimicrobial stewardship; Veterans Health Administration; Multidisciplinary; *Clostridioides difficile* infections

### Introduction

In the face of growing antimicrobial resistance and scarce novel antibiotic production, antimicrobial stewardship programs (ASPs) have become urgently essential to guide

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Compliance with Ethical Standards

Conflict of Interest

Aditi Ramakrishnan declares no conflict of interest.

Payal K. Patel declares no conflict of interest.

Human and Animal Rights and Informed Consent

All reported studies/experiments with human or animal subjects performed by the authors have been previously published and complied with all applicable ethical standards (including the Helsinki declaration and its amendments, institutional/national research committee standards, and international/national/institutional guidelines).

appropriate antibiotic use [1, 2]. Since policy change has led to the mandate of ASPs in acute care hospitals and long-term care facilities, healthcare systems have been left to navigate how to best integrate antimicrobial stewardship into existing organizations [3–5]. Local variation, such as unique antibiograms or patient populations, can significantly shape individual ASPs. Given this variation, large healthcare systems encounter a significant challenge in implementation of stewardship across various clinical settings [6].

The Veterans Health Administration (VHA) is a healthcare system which has demonstrated a successful response to this challenge of implementing overarching stewardship policies and programs while allowing local centers to develop customized paths to achieving stewardship goals. The VHA is the largest integrated federal healthcare system in the United States (US), consisting of more than 1700 sites of care that serve approximately 8 million individuals [7]. These centers comprise acute care hospitals, outpatient clinics, long-term care facilities (LTCFs), and rehabilitation centers [1,7]. This system has pioneered development, implementation, and optimization of ASPs throughout its diverse medical centers.

The VHA has established the success of its ASPs through demonstrating significant decrease in overall antibiotic use and in *Clostridioides difficile* infection (CDI) rates over the years. These goals were achieved through implementing programs preceding national changes in policy, championing ASP practices, embracing the multidisciplinary nature of effective stewardship, engaging in collaborative evaluation of stewardship efforts, and pioneering big data research which has captured important factors shaping local ASP variation. Despite being a massive and complex federal system, the organization of antimicrobial stewardship within the VHA has engendered flexibility in local ASP processes, leading to mutual shared goals and numerous successes within antimicrobial stewardship [2, 8].

### **VHA antimicrobial stewardship policies through the years**

The VHA established antimicrobial stewardship requirements preceding national policy developed by the Centers for Medicare and Medicaid Services and The Joint Commission, illustrating how stewardship could be implemented in a large integrated healthcare setting [9]. Beginning in 2010, the VHA developed the VHA Antimicrobial Stewardship Initiative to provide national guidance and resources for the development of ASPs at local VHA medical centers [1]. In 2014, the VHA announced that all VHA medical facilities were required to appoint local stewardship champions and to develop and annually evaluate ASPs, which was an unprecedented policy among national large healthcare systems at the time [1, 10, 11]. By 2015, 92% of VHA facilities had developed written stewardship policies [1].

In this timeframe, the VHA launched another policy known as the VHA Multidrug-Resistant Organism Prevention Initiative, which was a complementary national program established to prevent CDI [1,7]. Since these initiatives were established, overall inpatient antimicrobial use decreased by 12% between 2011 and 2015, CDI rates in VHA acute care centers and LTCFs declined, and readmission and mortality rates decreased significantly [1]. Following in the VHA's footsteps, the Joint Commission and Centers for Medicare and Medicaid developed similar ASP requirements for acute care centers nationally [7].

More recently, the VHA has implemented the National Action Plan for Combatting Antibiotic-Resistant Bacteria, a policy encouraging optimized antimicrobial use to achieve a 20% reduction in inpatient antibiotic use and a 50% reduction in outpatient antibiotic use by 2020 [1, 2]. These policies and subsequent results indicate that the VHA has been adept in pioneering successful antimicrobial stewardship policies which have influenced national policy as well.

Structures which allow for variation in paths to achieve unified goals are key to implementation of successful antimicrobial stewardship. One example of this was the development of regional stewardship collaboratives within the VHA system in 2019 focusing on antimicrobial stewardship. The VHA is divided into 21 Veterans Integrated Service Networks (VISNs) which facilitate communication and programming within individual VISNs. One of the initial goals of the regional stewardship collaboratives was to disseminate methods of reducing fluoroquinolone use, which has been a common goal of stewardship programs internationally [12, 13]. Similar structures have been employed to deliver successful antimicrobial stewardship across the country, such as the Atrium Health system [4].

### **Embracing multidisciplinary stewardship teams**

In 2011, the VHA established the National Antimicrobial Stewardship Task Force (ASTF) to help guide implementation and development of ASPs across VHA facilities. The group consists of approximately 250 field stewardship champions representing diverse disciplines including clinical pharmacists and infectious diseases (ID) physicians [1, 2]. The ASTF has developed and disseminated high-impact educational programs, tools such as sample business plans and educational slide sets, and resources for creating and improving local VHA ASPs. The group also maintains a highly active email listserv through which stewards share resources and algorithms and troubleshoot common problems.

In order to ensure appropriate training and staffing, the 2014 VHA Directive 1031, which required all VHA acute care facilities to have an ASP, specified that these programs should feature dedicated physician and pharmacist champions [2]. The Centers for Disease Control (CDC) Core elements reflect that physician and pharmacist involvement can lead to a more effective program [14••]. The VHA has been the largest system to implement this form of multidisciplinary ASP. Clinical pharmacists, particularly with training in ID, have emerged as core members of antimicrobial stewardship efforts in the VHA locally, regionally, and nationally. More recently, in 2018, the VHA developed recommendations encouraging a more multidisciplinary composition of stewardship teams to include non-ID pharmacists, hospitalists, and nursing staff [15]. The CDC Core elements have also been updated to more clearly reflect that physician and pharmacist co-leadership may be an ideal way to achieve accountability, and the 2019 National Healthcare Safety Network Annual Hospital Survey indicated that 59% of hospitals had physician and pharmacist co-leadership [16•].

Regarding the strength of multidisciplinary stewardship with specialty training in the VHA, Graber et al. [8] identified in a survey of ASP at 130 VHA facilities that presence of pharmacists and/or physicians with formal ID training was associated with improved antimicrobial utilization. A recent survey of clinicians, nurses, and nursing assistants at four

VHA medical centers regarding knowledge and behavioral approaches to asymptomatic bacteriuria identified consistent knowledge gaps, as well as different cognitive biases and views on safety climate unique to each group [17]. This study also highlights the value of multidisciplinary teams for stewardship efforts in both the clinical and research realms.

### **Infectious disease and stewardship-focused medical education in the VHA system**

The VHA has also demonstrated leadership in providing stewardship training for medical students, residents, pharmacists, and ID fellows (Fig. 1). The VHA also offers 13-s-year ID residency positions and two fellowships for pharmacist trainees, playing an important role in stewardship education. In 2017, 43,565 medical residents, 24,683 medical students, 463 fellows, and 849 dental residents and students rotated through the VHA system in 1 year ([https://www.va.gov/OAA/GME\\_default.asp](https://www.va.gov/OAA/GME_default.asp)). Interventions involving multidisciplinary teams and antimicrobial stewardship rounding have featured critical evaluation of antibiotic prescribing at discharge and of inpatient antibiotic prescribing [18, 19]. We have both experienced the benefits of multidisciplinary rounding on the ID consult service at various VHA hospitals which incorporate multiple aspects of stewardship into ID training.

### **The strength of VHA collaborative research**

Given that the VHA is a large integrated healthcare system, the strengths of the research produced are due to the degree of collaboration, sheer amount and ease of access to data, and ability to capture geographic and medical context variation. Such interdisciplinary collaboration can be observed in various fields within VHA health services research. For example, regarding pain management research, one VHA three-site study examined and developed a screening tool for pain management incorporating patient perspectives [20]. The strength of collaborative research has also surfaced in the field of infection control, with several successes including development of optimal hand hygiene bundles and contact isolation protocols to reduce MRSA transmission [20].

As an example of collaborative stewardship research, the ASTF Tools and Resources Work Group partnered with the Clinical Pharmacy Practice Office of VA Pharmacy Benefits Management to develop a staffing calculator which applied national data to determine the ideal pharmacist staffing ratio to maintain ASPs [2]. This helped to guide ASP staffing policies across VHA facilities [2]. As another illustration of research partnerships, since 2014, the ASTF has collaborated with the Pharmacy Benefits Management Center for Medication Safety to rigorously evaluate antimicrobial prescribing for various infections [21]. While this was historically done by manual review of the electronic health record (EHR), more recently, VHA researchers have developed and evaluated a tool facilitating electronic review of the EHR and creating the potential for more adept review of data useful for ASPs [21].

The ASTF and VHA Healthcare Analysis and Informatics Group jointly administered a survey of characteristics of ASPs at 130 VHA acute care facilities in 2012 and again in 2015 [1]. Factors associated with favorable changes in antimicrobial utilization included presence of postgraduate physician/pharmacy training programs, number of antimicrobial-specific order sets, frequency of systematic de-escalation review, presence of pharmacists and/or ID

attendings on acute care ward teams, and formal ID training of the lead ASP pharmacist [8]. This data has helped researchers connect specific stewardship interventions with antimicrobial use patterns in order to outline key characteristics of high-quality ASPs [8].

### Strengths of VHA data and its applications

The VHA is a leader in national research partly due to the sheer amount of data available with potential applications. VHA researchers have leveraged the VHA Corporate Data Warehouse to analyze the effectiveness and outcomes of ASPs [15]. Antimicrobial use is integral to measure in order to improve stewardship efforts, but is difficult to quantify and define given diversity of clinical situations, subjectivity when it comes to defining “appropriate antimicrobial use,” lack of a systematic method of measuring national antibiotic consumption, among other factors [22, 23]. The VHA developed the VHA Directive 1031 which in part requires VHA hospitals with more than 30 beds to report antimicrobial use data to the CDC’s National Healthcare Safety Network Antimicrobial Use Option [24]. Through this initiative, the VHA is the first large cohort to report national antimicrobial use data, which will help elucidate how best to measure this metric, particularly in the context of varying characteristics, and how to apply it to future work.

Regarding the application of big data, Goto et al. [25] conducted a retrospective review of national microbiology and patient data between 2003 and 2013 from the VHA delineating non-susceptibility trends of community-acquired and healthcare-associated gram-negative bacteremia. Through the analysis of 47,746 cases of gram-negative bacteremia over an 11-year period in the VHA system, this study showcases the strength of access to and application of integrated longitudinal big data in the VHA system.

As previously discussed, Graber et al. [8] highlight that the variability of ASPs across VHA facilities and the ability to access this data facilitated identification of specific facility elements and their association with ASP effectiveness, thus showcasing the application of big data to improving ASP research and implementation.

### ASP success stories in the VHA

**Decline in CDI rates**—The VHA Multidrug-Resistant Organism Prevention Initiative was a complementary national program established in 2012 to prevent CDI. This program consisted of a bundled approach to infection control and environmental management practices. Since the program’s establishment, along with implementation of the VHA Antimicrobial Stewardship Initiative, CDI rates have significantly decreased in VHA acute care centers and LTCFs [26, 27]. One analysis demonstrated that quarterly pooled standardized infection ratios decreased 15% by the final quarter between 2012 and 2015 in acute care centers [26].

In 2014, the VHA launched a national initiative to decrease CDI rates in VHA LTCFs. The CDI prevention bundle consisted of environmental management, hand hygiene, and contact precautions for CDI [28]. Prior to this initiative, a 24month analysis revealed CDI rates across VHA LTCFs were comparable to non-VHA LTCFs nationally [27]. Following a 2015 campaign which reinforced the original CDI prevention bundle, along with prolonged

contact isolation and antimicrobial stewardship efforts, no significant changes in infection prevention behaviors nor antimicrobial prescribing practices were identified at 6 VHA LTCFs [28].

These findings illustrate the difficulty of implementing successful CDI prevention bundles in the context of LTCFs due to LTCF-specific challenges, such as difficulty maintaining protracted isolation for CDI patients and competing priorities inhibiting aspects of the bundle's efforts. This study highlighted, however, the unique ability of VHA research to leverage national electronic microbiology and antimicrobial administration data in order to evaluate infection control and stewardship practices in LTCFs.

**Decline in antimicrobial use**—Following the establishment of the VHA Antimicrobial Stewardship Initiative, between 2008 and 2015, overall inpatient antimicrobial use significantly decreased by 12%, particularly after implementation of the initiative in late 2010 [1]. Specifically, use of antimicrobials targeting gram-negative pathogens, such as carbapenems, declined following initiative implementation [1]. Between 2007 and 2015, fluoroquinolone use decreased as well, from 18 to 13%, though this was not found to be significant. As previously noted, VHA regional collaboratives have also focused on reducing fluoroquinolone prescribing.

In addition to achieving an overall decrease in antimicrobial use, VHA antimicrobial stewardship researchers have also developed innovative methods to reduce antimicrobial utilization and to more easily facilitate inter-facility comparison of antibiotic use. Graber et al. [29] describe an electronic interactive graphic tool communicating in-depth antimicrobial use which facilitated the ability for comparison of antibiotic utilization between VHA facilities of similar complexity. Pre-post analysis (2014–2016 vs. 2016–2018) revealed significant decrease in total antimicrobial use, anti-MRSA antimicrobial use, and antipseudomonal antimicrobial use in the 8 VHA facilities where the tool was implemented compared with nonintervention sites. Qualitative data collected from this study revealed that monthly comparison data spurred VHA stewards to develop de-escalation interventions such as antibiotic timeout programs, order sets, antibiograms to assist with non-fluoroquinolone selection for UTI treatment, and use of the data to engage various stakeholders.

**Advances in stewardship of outpatient prescribing**—Inappropriate antibiotic prescribing in the ambulatory setting has created a significant challenge for antimicrobial stewardship efforts. This is mirrored in one systematic review, which also highlighted various barriers to appropriate antimicrobial prescribing and key interventions associated with successful outpatient stewardship [30]. A 12-month retrospective review of antibiotic prescriptions by 76 primary care physicians in the VHA Pittsburgh Health System revealed antibiotics were not indicated in 49.7% of cases and that 76% of reviewed prescriptions were inappropriate [31]. Ciprofloxacin and azithromycin were most likely to be prescribed inappropriately. This was the first study, per the authors, to comprehensively review unnecessary and guideline-discordant antibiotic prescribing in the ambulatory setting, highlighting VHA research contributions to stewardship literature in this context.



In an effort to reduce outpatient fluoroquinolone use, the VHA Portland Healthcare System implemented a patient safety initiative which was in the form of a mandatory fluoroquinolone order checklist in the EHR [32]. Retrospective pre-post analysis of this intervention among the 10 outpatient facilities revealed a significant initial decrease in outpatient weekly fluoroquinolone prescriptions, though this was not sustained. The authors posit that potentially this initiative could lead to a sustained decrease in fluoroquinolone use if coupled with ongoing education or performance feedback and audit.

Regarding a different aspect of fluoroquinolone use, a retrospective cohort study of fluoroquinolone prescribing at hospital discharge among 122 VHA medical centers between 2014 and 2016 found that prescribing practices were more often associated with absence of a fluoroquinolone restriction stewardship strategy [33]. Of post-discharge fluoroquinolone prescriptions, 41% were deemed inappropriate. This study again showcases the ease of access to robust data in the VHA system and the continued need for rigorous outpatient antimicrobial stewardship, particularly regarding fluoroquinolone use.

**Telehealth applications to stewardship efforts**—One of the challenges in dissemination of antimicrobial stewardship practices is a paucity of physicians and pharmacists trained in ID, particularly in rural areas. Forty percent of VHA medical centers reported not having a full-time ID physician on staff [34]. In response to this, the VHA developed the Specialty Care Access Network Extension for Community Healthcare Outcomes (SCAN-ECHO), a telemedicine program creating access to specialty care for small and rural hospitals [34]. While this has been widely used for various specialties, VHA facilities are beginning to employ this program to improve stewardship efforts.

One example of this is a pilot study of a telehealth antimicrobial stewardship model implemented in two rural VHA medical centers in 2016 [34]. This model consisted of a weekly videoconference covering cases and antimicrobial stewardship-related education. The on-site team, like many rural hospitals, did not have access to an in-house infectious disease-trained specialist, so an offsite infectious disease physician provided video stewardship support weekly [35]. Stewardship recommendations were accepted most of the time (73% and 65% of the time at the two sites). Qualitative interviews revealed that providers valued the multidisciplinary nature of the teams and perceived that their stewardship efforts and patient care improved through participating in the program.

## Conclusions

As the largest integrated federal healthcare system, the VHA has demonstrated insight in development of innovative antimicrobial stewardship policies and remarkable leadership in its ability to implement ASPs throughout the nation. This review elucidates that the key to achieving implementation of ASPs in all VHA acute care facilities lies in the VHA's ability to nurture local flexibility and customized paths towards the common goal of improving antimicrobial stewardship nationally. To this end, the VHA has pioneered multidisciplinary teamwork, stewardship-focused big data research, educational initiatives, and innovative methods such as telehealth applications in order to reduce inappropriate antimicrobial use

and complications such as CDI. In doing so, the VHA has advanced the field of antimicrobial stewardship and serves as a leading example for other health systems.

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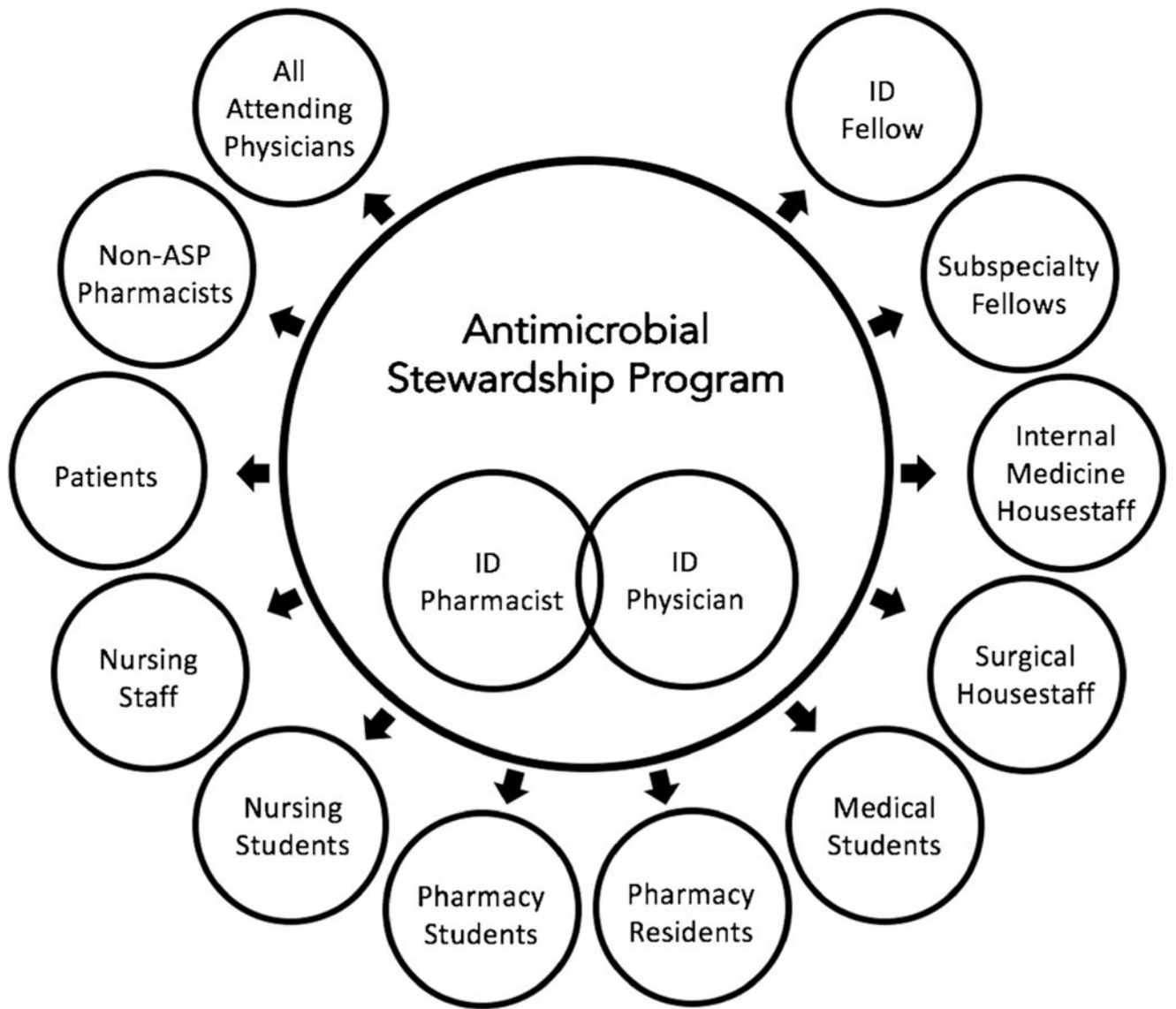
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**Fig. 1.** Reach of antimicrobial stewardship education in the Veterans Health Administration.