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ORIGINAL ARTICLE

Characteristics of Antimicrobial Stewardship Programs at Veterans Affairs Hospitals: Results of a Nationwide Survey

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BACKGROUND. Antimicrobial stewardship programs (ASPs) are variably implemented.

OBJECTIVE. To characterize variations of antimicrobial stewardship structure and practices across all inpatient Veterans Affairs facilities in 2012 and correlate key characteristics with antimicrobial usage.

DESIGN. A web-based survey regarding stewardship activities was administered to each facility's designated contact. Bivariate associations between facility characteristics and inpatient antimicrobial use during 2012 were determined.

SETTING. Total of 130 Veterans Affairs facilities with inpatient services.

RESULTS. Of 130 responding facilities, 29 (22%) had a formal policy establishing an ASP, and 12 (9%) had an approved ASP business plan. Antimicrobial stewardship teams were present in 49 facilities (38%); 34 teams included a clinical pharmacist with formal infectious diseases (ID) training. Stewardship activities varied across facilities, including development of yearly antibiograms (122 [94%]), formulary restrictions (120 [92%]), stop orders for antimicrobial duration (98 [75%]), and written clinical pathways for specific conditions (96 [74%]). Decreased antimicrobial usage was associated with having at least 1 full-time ID physician ($P = .03$), an ID fellowship program ($P = .003$), and a clinical pharmacist with formal ID training ($P = .006$) as well as frequency of systematic patient-level reviews of antimicrobial use ($P = .01$) and having a policy to address antimicrobial use in the context of *Clostridium difficile* infection ($P = .01$). Stop orders for antimicrobial duration were associated with increased use ($P = .03$).

CONCLUSIONS. ASP-related activities varied considerably. Decreased antibiotic use appeared related to ID presence and certain select practices. Further statistical assessments may help optimize antimicrobial practices.

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Widespread antimicrobial use and the inexorable rise of bacterial resistance constitute a global crisis.[1,2] Approximately 30%–50% of inpatient antimicrobial use is inappropriate, needlessly contributing to increased adverse events, most notably *Clostridium difficile*–associated colitis,[3] and escalating healthcare costs.[4–6]

The US Centers for Disease Control and Prevention and professional societies[7] have strongly recommended that hospitals implement antimicrobial stewardship programs (ASPs) to promote appropriate antimicrobial prescribing.[6] More recently, the White House established a national plan to combat antimicrobial resistance through antimicrobial stewardship (AS).[8] Broadly, ASPs seek to optimize antimicrobial use to maximize therapeutic success, improve patient outcomes, and minimize costs.[5,6,9–12] Effective ASPs should include a multidisciplinary team of healthcare providers to implement evidence-based practice through education, decision support, antimicrobial restrictions, and other interventions. ASPs should also engage in data collection and reporting to guide their activities, as well as support audit and feedback interventions.[5,6,13–15]

There is increasing evidence that ASPs improve antimicrobial use outcomes. In a systematic review, Kaki et al[16] in 2011 found that ASPs were associated with reduced antimicrobial use, total antimicrobial cost, and average duration of

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therapy. Similarly, a meta-analysis by Davey et al[17] of clinical trials across all types of health care facilities for 1980–2009 concluded that ASPs have resulted in a 34%–43% reduction in antimicrobial prescribing. However, few studies have reported reductions in adverse events and even fewer have reported decreases in resistance; comprehensive assessments of patient outcomes are lacking.[18]

Little evidence is available about how ASP structures and processes relate to effective AS, and there is a lack of specificity of these structures and processes given the wide range of implementation strategies. The science guiding AS is largely based on uncoordinated, single-site trials that focus on process measures,[19–25] leaving gaps in evidence that would identify highly effective components and processes for implementation. For example, audit and feedback have often been cited as an effective strategy,[26] yet their targets and implementation strategies remain unclear. Furthermore, the framework for interpreting audit and feedback reports remains underdeveloped, leaving recommendations largely unactionable. Systematic study of ASPs is relatively new and definitions of appropriate antimicrobial use and ASP components continue to evolve. Therefore, it is a priority to identify effective strategies, and the factors that impact the implementation of those strategies, for modifying inappropriate antimicrobial prescribing behaviors.[27] Our study objective was to better characterize variations of existing AS structural aspects and practices across a nationwide healthcare system and explore associations of these characteristics with antimicrobial use. The findings will lend insight into common elements of AS structure and processes.

METHODS

Setting

The Veterans Affairs (VA) healthcare system is the largest integrated system in the United States, offering both inpatient and outpatient services as well as long-term care. It is a leader in implementing multicenter quality improvement projects, such as system-wide initiatives to reduce hospital transmission of methicillin-resistant *Staphylococcus aureus* and to promote human immunodeficiency virus testing.[28,29] Even so, there are considerable, as yet unexplored, variations in the patterns and magnitude of antimicrobial use across individual facilities.

In 2011, VA chartered the National VA Antimicrobial Stewardship Task Force to guide its effort to optimize antimicrobial use and enhance patient safety.[30] This task force, serving as a national resource in ASP development and expansion, understood that many VA facilities had implemented ASPs that were tailored to local needs and criteria. As such, ASP implementation was not uniform and stewardship-related activities varied widely. To better characterize these efforts, the National VA Antimicrobial Stewardship Task Force, after performing a nationwide AS inventory in 2011, completed a more detailed survey in 2012 with the assistance of the VA Healthcare Analysis and Information Group (HAIG).

Survey Design

The nationwide survey was developed by HAIG, composed of 6 individuals whose expertise and experience spanned administration, research, physician patient care, and infectious diseases (ID) clinical pharmacy specialist. The survey was pilot-tested on a representative sample of facilities with different complexity levels (ie, degrees of specialty services offered) and from diverse geographical regions (ie, Veterans Integrated Service Networks).

Data Sources

Data collection occurred from November 2 through December 5, 2012. Using the Inquisite survey software (Allegiance Software), HAIG distributed the web-based survey to each Veterans Integrated Service Network director and chief medical officer for dissemination to each facility in their network. All 130 facilities providing inpatient treatment received a request to complete the survey. Respondents included chiefs of staff, medicine, ID, and pharmacy. The survey gathered facility-level data on ASP makeup, AS-related staffing, support, resources, and restrictions.

Antimicrobial utilization data were extracted from the Veterans Informatics and Computing Infrastructure for the same calendar year as the HAIG survey implementation (2012). Antimicrobial use, expressed as the number of acute care antimicrobial days per 1,000 patient-days present for each facility, was calculated according to the National Healthcare Safety Network's definitions, published by the Antimicrobial Use and Resistance Option Centers in the Centers for Disease Control and Prevention. An antimicrobial day was counted for each unique antimicrobial given to a patient in a calendar day. For example, if a patient was given 2 unique antimicrobials in a single day, regardless of doses, then 2 antimicrobial days were counted. Similarly, if 2 patients were each given 1 unique antimicrobial then 2 antimicrobial days were counted. Antimicrobial use was denominated by days present, which counted any partial day spent in a location for which antimicrobial use was measured. Acute care included all intensive care unit, medicine, surgery, neurology, and medical specialty beds. Antimicrobial use was aggregated at a facility-level.

Analysis

Frequency statistics were computed, generating count and percentages for each survey item to describe facility characteristics related to AS. Drawing from the Donabedian model relating structure and process to outcomes,[31,32] we selected question elements that described factors in these domains (Figure 1). Facility structure would facilitate the work and resources needed to carry out AS activities. Structural

components also influence facility capacity to respond to institutional demands and implement change. Processes fit the structure to ensure the uptake and execution of AS activities.

To estimate associations between select facility characteristics and facility-level antimicrobial use, we conducted bivariate analyses, using appropriate *t*-statistics. Among these, we included survey questions with responses that were amenable to representation as simple binary variables (comparing present versus not present) and that had sufficient counts and variability to allow interpretation. We examined antimicrobial use in the context of 5 structural components and 14 process measures. Structural components were formal policy establishing ASP, presence of AS team, facility offering internal inpatient ID consultation, presence of at least 1 full-time attending ID physician, and facility having an ID fellowship program. Examples of the process measures were as follows: AS clinical pharmacist had ID training, restriction on antimicrobial use, policy promoting substitution of oral for parenteral antimicrobials, policy for de-escalation of antimicrobials, policy for intervention on antimicrobial usage in context of *C. difficile* infection, automatic ID consults for certain conditions, automatic stop orders for antimicrobial duration, written clinical pathways/guidelines for specific conditions and duration, electronic antimicrobial order form(s), frequency of systematic review for de-escalation, timely review of blood cultures to assure appropriate therapy, group or provider-specific feedback on antimicrobial use patterns, and educational programs for prudent antimicrobial use. All statistical analyses were conducted using Stata, version 11 (StataCorp).

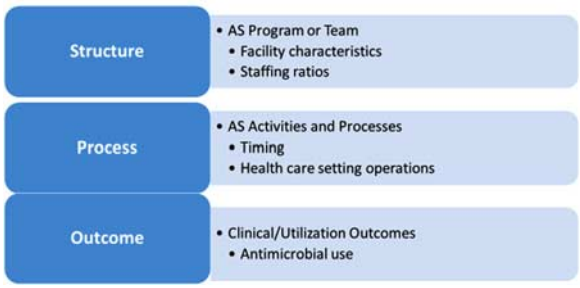

FIGURE 1. Antimicrobial stewardship (AS) activities categorized by the Donabedian model.

RESULTS

All 130 VA facilities that offer both acute and long-term inpatient services responded to the survey (response rate, 100%). Overall, the mean operating bed size in acute care was 81 and that for long-term care was 117. The mean number of full-time ID providers was 1.9. Figure 2 presents the geographic distribution of the VA facilities.

Table 1 presents findings, categorized into structural and process domains, that describe critical organizational factors facilitating AS activities.

ASP and Structure

Among the 130 VA facilities, 29 (22%) had a formal written policy establishing an ASP; another 55 (42%) had one in development. Of facilities with a formal written ASP policy, the policy had been in place for less than a year in 11 (38%), between 1 and 4 years in 13 (45%), and 5 or more years in 5 (17%). Among the 101 (78%) without a written policy, 57 (56%) reportedly had an informal policy. Approved business plans for ASPs were present in 12 (9%) facilities, with an additional 29 (22%) developing one.

Forty-nine VA facilities (38%) reported having an AS team, which was defined as "a multi-disciplinary group that is

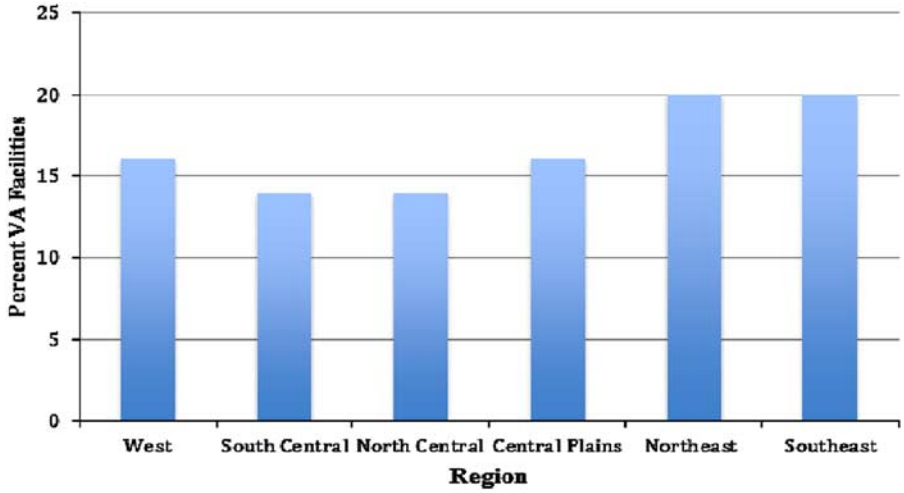

FIGURE 2. Geographic distribution of 130 Veterans Affairs (VA) facilities with inpatient services.

TABLE 1. Antimicrobial Stewardship (AS) Characteristics at 130 Veterans Affairs Facilities

Domain	Facility factor	Count	(%)
ASP/AS team structure			
ASP establishment	Formal policy for ASP established	29	22%
	Formal policy for ASP in development	55	42%
	Informal ASP policy	57	44%
	Business plan for ASP approved	12	9%
	Business plan for ASP in development	29	22%
AS team	Facility had AS team	49	38%
	ID physician was part of AS team	45/49	92%
	Clinical pharmacist/clinical pharmacy specialist was part of AS team	49/49	100%
	Clinical pharmacist/clinical pharmacy specialist had ID training	34/49	69%
	AS team functions under the authority of pharmacy & therapeutics committee	23/49	47%
	AS team functions under the authority of chief of ID	30/49	61%
ID attending/consultation availability	Facility offered internal inpatient ID consultation	103	79%
	Facility had at least 1 full- or part-time attending ID physician	104	80%
	Facility had at least 1 full-time attending ID physician	78	60%
	ID physicians attended on medical ward teams	89	68%
Training programs	Pharmacy residency program	102	78%
	ID pharmacy residency program	12	9%
	ID fellowship program	68	52%
	Internal medicine residency program	95	73%
Pharmacy service availability	Clinical pharmacist assigned to acute care teams	118	91%
AS activities and processes			
Antimicrobial restrictions and policies	Any restriction of antimicrobial use	120	92%
	Policy to promote substitution of oral for parenteral antimicrobials	34	26%
	Policy for de-escalation of antimicrobials	19	15%
	Policy for intervention on antimicrobial usage in context of CDI	25	19%
	Automatic ID consults for certain conditions	36	28%
	Automatic stop orders for antimicrobial duration	98	75%
Antimicrobial guidelines	Written clinical pathways/guidelines for specific conditions	96	74%
	Guidelines for antimicrobial duration	47	36%
	Electronic antimicrobial order form(s) for any specific antimicrobial	55	42%
Interventions	Systematic review for de-escalation (always or usually)	39	30%
	Timely review of blood cultures to assure appropriate therapy	56	43%
	Outpatient parenteral antimicrobial therapy program	85	65%
Feedback	Yearly updated antibiograms reported and disseminated	122	94%
	Group or provider-specific feedback on antimicrobial use patterns	55	42%
Monitoring of AS effectiveness	Measurement of antimicrobial utilization and outcomes	84	65%
	Reports on clinical outcomes related to antimicrobial use	71	55%
	Medication use evaluation for any antimicrobial performed in prior 2 years	61	47%
Education	Educational programs for prudent antimicrobial use	94	72%
	Email alerts provided updated information on principles of antimicrobial use	51	39%
	Newsletters provided updated information on principles of antimicrobial use	37	28%
	Pharmacy alerts provided updated information on principles of antimicrobial use	48	37%
Community engagement	Participation in AS collaborative within geographic region	13	10%

NOTE. ASP, AS program; CDI, *Clostridium difficile* infection; ID, infectious diseases.

composed of at least a physician and clinical pharmacist/clinical pharmacy specialist (CP/CPS) who routinely meet (daily or several times a week) to discuss patient-specific and/or facility-specific AS components," with 19 (39%) of the 49 having had a team in place for more than 3 years. Of the 49 facilities with AS teams, 46 (94%) of the AS teams worked or consulted in the acute medical/surgical setting, 25 (51%) in the outpatient setting, 33 (67%) in the community living center, and 24 (49%) in the dialysis centers. An ID physician was on the team at 45 (92%) of these 49 facilities and a clinical pharmacist/clinical pharmacy specialist participated in all cases. Among 49 clinical pharmacists/clinical pharmacy specialists, 34 (69%) had formal ID training and in 41 teams (84%), a clinical pharmacist/clinical pharmacy specialist oversaw the day-to-day operations.

One hundred four facilities (80%) had at least 1 full- or part-time ID attending physician. ID physicians attended on

medical ward teams in 89 facilities (68%). One hundred three VA facilities (79%) offered internal VA inpatient ID consultation. Of the 27 (21%) that did not offer inpatient consultation, facilities relied on various combinations of personnel to handle ID issues: 20 (74%) of these reported using an ID physician at another VA facility, 10 (37%) used a non-VA external ID physician, and 9 (33%) used clinical pharmacists.

Ninety-five facilities (73%) had internal medicine residencies, and 68 (52%) had ID fellowships. Pharmacy residency programs were common (102 [78%]), though only 12 (9%) had an ID pharmacy residency program.

AS Processes

A number of facilities had processes in place to facilitate the use of evidence-based AS practices. Guidelines for antimicrobial duration were present in 47 (36%), most frequently distributed via the electronic medical record. Ninety-eight facilities (75%) had automatic stop orders in place for antimicrobial duration. Thirty-four facilities (24%) had a written policy to promote intravenous to oral antimicrobial conversion and another 51 (50%) had an informal policy to do so. Nineteen facilities (15%) had a policy for antimicrobial de-escalation.

Many facilities had processes and policies targeting specific organisms or conditions. Formulary restrictions to limit the use of specific antimicrobial agents were reported in 120 VA facilities (92%). Ninety-six facilities (74%) had written clinical pathways for specific conditions (eg, healthcare-associated or community-acquired pneumonia, upper respiratory tract infection, urinary tract infection, CDI), and 36 (28%) reported that they required automatic ID consults for certain conditions, most often for *Staphylococcus aureus* bacteremia. Fifty-five facilities (42%) provided order forms for specific agents in the electronic medical record; of those 55 facilities, 41 (75%) provided order forms for vancomycin. Twenty-five facilities (19%) had a policy for intervention limiting the use of non–*C. difficile*–directed antimicrobial exposure in patients with CDI.

In terms of outreach, 122 (94%) generated and disseminated yearly antibiograms, through various media such as facility intranet (96 [79%]), pocket card reference (56 [46%]), or at the charting location (12 [10%]), but only 55 (42%) provided group or provider-specific feedback on antimicrobial use patterns. The most utilized method of feedback delivery was through verbal presentation (71 [55%]); data regarding the frequency or nature of these communications were not captured. Finally, 39 (30%) reported that the AS team always or usually systematically reviewed antimicrobial de-escalation, and 56 (43%) reported timely review of blood cultures.

As for self-evaluation of AS activities, 71 facilities (55%) generated reports based on clinical outcomes related to antimicrobial use, at monthly (33 [46%] of 71 facilities) or quarterly (23 [32%] of 71 facilities) intervals. Analysis of antimicrobial susceptibilities independent of the facility antibiograms, such as tracking specific drug-resistant pathogens, was the most common measurement of antimicrobial utilization and outcomes (44 [34%]). Thirty-seven facilities (29%) tracked antimicrobial utilization density such as days of therapy or defined daily doses; an equivalent number of facilities tracked antimicrobial expenditures. AS personnel at 61 facilities (47%) reported completing a structured medication use evaluation for antimicrobial(s) in the last 2 years.

Educational programs to promote prudent antimicrobial use were common (94 [72%]). Many facilities provided up-to-date information on the principles of antimicrobial use via email (51 [39%]) and pharmacy alerts (48 [37%]). Participation in regional stewardship collaboratives was uncommon (13 [10%]).

Characteristics Associated With Antimicrobial Use

Table 2 presents bivariate findings between organizational characteristics and facility-level antimicrobial use among all VA patients in 2012.

Five factors were significantly associated with decreased inpatient antimicrobial use. Structurally, we found that the presence of an ID fellowship program was associated with a 9% reduction ($P = .003$); having at least 1 full-time ID attending was associated with a 2% decrease ($P = .03$) in antimicrobial use. The presence of a clinical pharmacist with ID training as part of the AS team was associated with a 10% decrease in use ($P = .006$). In terms of process, each increase in the ordinal score pertaining to systematic patient-level review of antimicrobial use was associated with a 3% decrease ($P = .01$) whereas having a policy to review antimicrobial use in the setting of CDI was associated with a 9% decrease in antimicrobial use ($P = .01$). On the other hand, automatic stop orders for antimicrobial duration were associated with a 7% increase in use ($P = .03$).

DISCUSSION

The HAIG Stewardship Survey provided a cross-sectional, baseline view of AS activities across the VA system. Although the presence of formal ASPs was not uniform, there were a number of AS-focused practices that had been adopted across the system. Some were almost universal, such as formulary restrictions on antimicrobial use and disseminating yearly antibiograms. Others were less so, but approximately two-thirds of the facilities had inpatient ID consultations, written clinical pathway/guidelines for specific conditions, pharmacy residency programs, automatic stop orders for antimicrobial duration, clinical pharmacists overseeing day-to-day stewardship operations, use of the electronic medical record to facilitate AS activities, educational programs for prudent antimicrobial use, inpatient attending service on medical ward teams covered by ID staff, urgent approval for restricted antimicrobials via phone consultation, and

TABLE 2. Bivariate Associations Between Antimicrobial Use and Select Organizational Characteristics in Study of Antimicrobial Stewardship (AS) Characteristics at 130 Veterans Affairs Facilities

Facility factor	Estimate (change in antibiotic use)	*P* value
ASP establishment		
Formal policy for AS established	−0.02	.33
Facility had AS team	−0.06	.06
ID attending/consultation availability		
Facility had at least 1 full-time attending ID physician	−0.02	.03
Presence of ID fellowship program	−0.09	.003
Pharmacy service availability		
Clinical pharmacist/clinical pharmacy specialist had ID training	−0.10	.006
Antimicrobial restrictions and policies		
Any restriction on antimicrobial use	−0.04	.56
Policy to promote substitution of oral for parenteral antimicrobials	0.004	.90
Policy for de-escalation of antimicrobials	−0.05	.22
Policy for intervention on antimicrobial usage in context of CDI	−0.09	.01
Automatic ID consults for certain conditions	−0.05	.15
Automatic stop orders for antimicrobial duration	0.07	.03
Antimicrobial guidelines		
Written clinical pathways/guidelines for specific conditions	0.03	.39
Guidelines for antimicrobial duration	0.01	.75
Number of electronic antimicrobial order form(s) for any specific antimicrobial	−0.01	.10
Interventions		
Frequency of systematic review for de-escalation (each increase in ordinal score from 0 to 4)	−0.03	.01
Timely review of blood cultures to assure appropriate therapy	−0.01	.73
Group or provider-specific feedback on antimicrobial use patterns	0.03	.32
Education		
Educational programs for prudent antimicrobial use	−0.04	.28
Facility offered internal inpatient ID consultation	−0.04	.35

NOTE. ASP, AS program; CDI, *Clostridium difficile* infection; ID, infectious diseases.

measurement of antimicrobial use and outcomes. These common components showed that AS activities within the VA were, for the most part, consistent with those core elements of hospital ASPs identified by the Centers for Disease Control and Prevention, including (1) leadership commitment with human, financial, and information technology resources; (2) accountability with a single leader responsible for outcomes; (3) a pharmacy leader; (4) antibiotic use tracking; (5) regular reporting on antibiotic use and resistance; and (6) specific improvement interventions such as education.[33] On the other hand, less frequent AS activities, where fewer than half of the facilities had such in place, included having a medication use evaluation on antimicrobial(s), processes for timely review of positive blood cultures, group or provider-specific feedback on antimicrobial usage, systematic review of patient-level antimicrobial usage, and a policy to limit antimicrobial usage in patients diagnosed with CDI. These findings demonstrate gaps for improvement.[33,34]

Our findings, which are consistent with those reported by recent studies that specified AS components, enhance prior work with a more comprehensive examination of AS components across a healthcare system. For example, in developing an AS score, Pakyz et al[35] studied 44 academic medical centers and classified AS components into 2 categories to determine their relationships to antimicrobial usage: resources (eg, ASP personnel and automated surveillance software) and strategies (eg, preauthorization, audit with intervention and feedback, education, guidelines and clinical pathways, parenteral to oral therapy programs, de-escalation of therapy, antimicrobial order forms, and dose optimization). In studies published in 2014, Kullar and Goff[36] examined specific information technology tools while Wagner et al[12] focused on audit and feedback, guideline implementation, and decision support for antimicrobial use. Beyond the United States, France has mandated ASPs and by 2008, 98% of the hospitals in a sample of 84 had implemented formularies, antibiotic committees, surgical prophylaxis guidelines, and monitored antibiotic use.[37] Eighty-five perecent of these hospitals had antibiotic advisors. On the other hand, Dumartin's group[37–39] reported that pharmacist time dedicated to antibiotic management, restrictive dispensation using stop-orders, computerized tools, continuing education, and audits were components that remained underused. Components identified as playing a role in AS were similar to those reported in the HAIG survey and the extent to which these structure and processes have been implemented within the VA was comparable with that in other

studies.[37–39] However, each of these studies addressed only a few components and none is as comprehensive as the HAIG survey in examining ASP components.

It is not clear from the current medical literature exactly which ASP components and activities are the most effective in promoting appropriate antimicrobial use. Nevertheless, a recent analysis of ASP resources and activities within a consortium of US academic hospitals suggested that the number of strategies used by an ASP may be more predictive of reductions in targeted antimicrobial use than the total amount of resources available to the ASP.[35] In our exploratory bivariate analyses, the presence of ID-trained personnel was associated with decreased antimicrobial use. Having mechanisms to systematically review opportunities for antimicrobial de-escalation was also associated with decreased use. The finding that antimicrobial stop orders were associated with increased antimicrobial use was puzzling. Facilities that have relied on this tool may need to reassess this process to ensure appropriate default duration. We are conducting further multivariate analyses to better elucidate how various factors may potentially affect different antibiotic resource outcomes. Moreover, we will examine the effect of specific AS policies implemented compared with that of the number of AS policies implemented on these outcomes.

Our study has limitations that warrant discussion. First, the survey was within the VA and this may limit generalizability. Moreover, patient populations were likely to vary across VA hospitals as well. Second, we did not have a systematic method to validate accuracy or completeness of responses; thus there may be unmeasured biases. Third, the study was cross-sectional, reflecting data illustrating the AS landscape in 2012, and may not capture how the AS environment is changing over time. Although a follow-up survey is planned, data collection would not commence until 2016. Fourth, our statistical analysis was more descriptive in nature and oriented to assessing the presence of foundational AS elements; a more robust and nuanced analytic model, using broader antimicrobial use metrics, is forthcoming. Additionally, interpretation of significant associations observed remains limited because of study design and the various levels of care and types of setting (eg, ambulatory, long-term) may further confound the results. More research is necessary to discover whether they represent causal or even reproducible relationships. Finally, reduction in aggregated antimicrobial use does not necessarily indicate "appropriate use" and further analyses will be required to assess use.

In summary, the HAIG nationwide survey across VA yielded initial data on the comprehensiveness of AS policies, personnel, and resources. The survey was timely, as it presaged the White House's National Action Plan to Combat Antibiotic-Resistant Bacteria that specifies the establishment of ASPs in all acute care hospitals.[8] Although a follow-up survey is anticipated in the near future, the present survey indicates important variations at baseline. More robust assessments using an implementation framework may better elucidate which AS components to prioritize for optimizing antimicrobial use and combating resistance.[40]

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