Development and application of an objective staffing calculator for antimicrobial stewardship programs in the Veterans Health Administration

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Purpose. The development and validation of a staffing calculator and its use in creating staffing guidance for antimicrobial stewardship programs (ASPs) in Veterans Health Administration (VHA) facilities are described.

Methods. The Tools and Resources Work Group of the Antimicrobial Stewardship Task Force and PBM Clinical Pharmacy Practice Office of the Department of Veterans Affairs developed, tested, and validated a staffing calculator to track patient care and ASP management activities needed to maintain a comprehensive ASP. Time spent on activities was based on time-in-motion tracking studies and input from experienced antimicrobial stewards. The staffing calculator was validated across VHA facilities of varying sizes and complexities to determine the number of needed clinical pharmacist full-time equivalents (FTEs) to implement and maintain ASPs per 100 occupied beds.

Results. A total of 12 facilities completed the staffing calculator for 1 calendar week. The median number of occupied beds was 226. Most facilities had at least 100 occupied beds, and 6 of the 12 were considered high complexity facilities. The median calculated FTE personnel requirement was 2.62, or 1.01 per 100 occupied beds. The majority of FTE time (70%) was spent on patient care activities and 30% on program management activities, including infectious diseases or ASP rounds. The final recommendations indicated that in order to implement and manage a robust ASP, a pharmacist FTE investment of 1.0 per 100 occupied beds would be needed.

Conclusion. A staffing calculator to account for the time needed to implement ASP activities and provide staffing guidance across a large healthcare system was validated.

Keywords: antimicrobial stewardship, clinical pharmacists, infectious diseases, pharmacists, staffing, workload

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Increasing antimicrobial resistance is a global threat, and, with a dwindling antibiotic pipeline, alternative methods to control or delay the emergence of resistance are critical. It has been estimated that up to 50% of antibiotics used in the hospital are used inappropriately or unnecessarily.[1,2] Antibiotic stewardship is defined as the use of coordinated interventions designed to improve and measure the appropriate use of antibiotic agents by promoting the selection of the optimal drug regimen, including dosing, duration of therapy, and route of administration.[3] In March 2015, the National Action Plan for Combating Antibiotic-Resistant Bacteria was released.[4] Two of the plan's objectives are for acute care facilities to implement antibiotic stewardship programs (ASPs) by 2020 and to reduce inappropriate antibiotic use by 50% in the outpatient setting and 20% in inpatients. In addition,

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the Joint Commission has released standards for an ASP to be a component of accreditation, and the Centers for Medicare and Medicaid Services (CMS) has proposed a standard that would require hospitals to have policies and to demonstrate evidence of an active and hospitalwide ASP. Although several organizations, such as the Centers for Disease Control and Prevention and the Infectious Diseases Society of America (IDSA), recommend ensuring dedicated protected time for ASP implementation, the ideal level of staffing support needed to implement comprehensive ASPs is not known. Clinical pharmacists, ideally with training in infectious diseases (ID), have been identified as core members of an antimicrobial stewardship team.[5]

To address this widespread issue, the National Antimicrobial Stewardship Task Force (ASTF) has been in place in the Veterans Health Administration (VHA) since 2011 in order to promote and facilitate the development of ASPs across VHA facilities. Activities of the ASTF include communication, monthly webinars, and the creation of sample business plans, policies, educational slide sets, and pamphlets that facilities can use or adapt. In 2014, VHA Directive 1031 was approved, requiring all VHA acute care facilities to have an ASP, with dedicated physician and pharmacist champions; have an ASHP policy; and report annually on the ASP's activities.[6] Several ASTF policies and initiatives for facilities to electively use or adapt for local use had been developed, outlining important ASP activities such as i.v.-to-oral therapy conversion, avoidance of dual anaerobic therapy, and de-escalation of drugs active against methicillin-resistant *Staphylococcus aureus* (MRSA) and broad-spectrum gram-negative therapy. The Tools and Resources Work Group was tasked with developing and validating a flexible calculator that used local data to estimate personnel resources (clinical pharmacy specialists and physicians) needed in full-time equivalents (FTEs). The validation data were used to develop general staffing guidance based on facility size. This work group consisted of clinical pharmacy specialists and physicians with extensive experience in ID and ASPs.

KEY POINTS

- Antimicrobial stewardship is considered a cornerstone of improving patient safety and minimizing antibiotic resistance and *Clostridium difficile* and is required for facility accreditation.
- Pharmacists are core members of the antimicrobial stewardship program, but the appropriate level of staffing to implement a strong program is unclear.
- An objective staffing calculator can estimate staffing needs based on the volume of antibiotic orders, and program management activities and can be used to prioritize which activities to implement.

This article describes the development and validation of a staffing calculator and its use in creating staffing guidance for ASPs in VHA facilities.

Methods

The ASTF Tools Work Group partnered with the Clinical Pharmacy Practice Office (CPPO) of VHA Pharmacy Benefits Management to develop the staffing calculator. CPPO is a national program office dedicated to promoting, standardizing, and expanding clinical pharmacy services across VHA. It has developed successful staffing models for other areas of clinical pharmacy practice and thus provided technical expertise on methodologies and validation.

The initial calls for the work group were to develop a list of expected ASP activities for hospitalized or long-term-care patients for inclusion in the calculator. Patient care activities such as restriction, prospective audit and feedback, and ASP or ID rounds were included. These activities were derived from published ASP guidelines and literature as well as specific ASTF policy initiatives (i.e., i.v.-to-oral therapy conversion, avoidance of dual-anaerobe therapy, anti-MRSA de-escalation, broad-spectrum gram-negative de-escalation, and outpatient parenteral therapy consultations). The calculator also captured ASP management activities, such as antibiotic-use tracking, committee time and preparation, projects related to antimicrobial use, and education (Tables 1 and 2). Once the activities were determined, the work group assigned a time value to each activity, using time-in-motion studies for common activities and expert opinion for the others. The time-in-motion studies were completed by postgraduate year 2 (PGY2) ID pharmacy residents and clinical pharmacy specialists who tracked the time spent reviewing patients for specific interventions. The means were calculated to provide the time per review for each activity. The majority of patient activities ranged from 10 to 15 minutes in duration, but some required up to 60 minutes per patient. Time per patient included both screening and the intervention, if indicated. The final list of patient care interventions and the associated times included in the calculator can be found in Table 1.

For patients who met criteria for more than a single intervention at a time (e.g., de-escalation of drugs active against MRSA, de-escalation of broad-spectrum gram-negative therapy), the time for the primary intervention was estimated, with an add-on value (10 minutes) assigned for the second activity to minimize inflating time results with multiple interventions. For program management, time was estimated as hours per month spent on these activities, including ASP activities related to committees, projects, development of clinical guidance and administra-

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tive tasks, and didactic education for healthcare providers (Table 2). Experiential teaching was not included in the calculator because it was not felt to be directly related to the activities of the ASP.

A 0.2 full-time equivalent (FTE) personnel leave factor to account for various types of leave (vacation or sick leave) was discussed but ultimately not included in the final results. Program management time was converted into hours per week and ultimately to total FTEs and FTEs normalized to each 100 occupied beds (based on the average daily census of acute care units and VHA onsite nursing home units). This was done to account for differences in workload related to facility size. The decision to include nursing home units was based on the fact that many are connected to the acute care medical center; therefore, antibiotic use in these units is likely to be important as part of a comprehensive ASP. The final calculator was then discussed and approved by the Tools and Resources Work Group for validation.

A total of 15 VHA facilities with robust or developing ASPs were invited to participate in the data validation. Of these, 13 agreed to participate, though 1 site was excluded as an ongoing ASP project did not allow for accurate validation. Initial calls were made to the validation sites to discuss the use of the calculator, definitions of clinical activities, and how to complete reviews in the calculator in a reproducible fashion. The sites did not have to regularly complete all reviews in the calculator but were required to enter data as if all patients meeting criteria for review would be included as part of the validation process. As the intent was to provide robust but accurate estimates of FTE support needed for specific types of intervention, the importance of accurate accounting was reinforced.

For the validation process itself, the sites collected data for 1 workweek (Monday through Friday) in June 2014. Sites tracked the average daily census and the numbers of patients meeting criteria for review for the patient care activities and estimated the time spent per month on programmatic activities. The work group chair and members were available to answer questions during the validation process.

Table 1. ASP Patient Activities and Time Spent per Patient Review[a]

Activity	Time per Activity per Patient (min)
Review of restricted or nonformulary antimicrobial	20
I.V.-to-oral switch	10
Avoidance of dual anaerobic therapy	10
De-escalation of therapy against methicillin-resistant *Staphylococcus aureus*	15
De-escalation of broad-spectrum gram-negative antibiotics	15
Review of positive blood or other culture for appropriate therapy	20
Review of therapy for appropriate duration	15
Pharmacokinetics and therapeutic drug monitoring	15
Review of patients with *Clostridium difficile* infection and intervention to minimize antibiotics and acid-suppressive therapy	15
Outpatient parenteral antibiotic therapy consultation	30
Outpatient parenteral therapy follow-up or other clinic (not HIV or hepatitis C clinic)	15
Drug–drug interaction review	15
Coordination of care with outside hospital	60
Review of surgical prophylaxis	15
Consultation for patient review and recommendations	20

[a]ASP = antimicrobial stewardship program.

Table 2. Program Management Activities[a]

Activity	Examples
Committee time and preparation	Antibiotic subcommittee (chair or member), pharmacy and therapeutics committee, residency advisory committees, infection control committee, national or regional VA committees
Education	Lectures on ASP to physicians or other healthcare providers or patients
Projects	Quality-improvement projects, medication-use evaluations, ASP-related research projects
Other longitudinal activities	Ad hoc work groups, ASP outcome tracking (antibiotic use or other outcomes), development of clinical pathways, computerized order sets or menus, template ASP notes
Administrative activities	E-mail and nonpatient care–related phone calls, paperwork

[a]VA = Department of Veterans Affairs, ASP = antimicrobial stewardship program.

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Table 3. Characteristics of Validation Sites

Facility No.	Complexity[a]	Average Daily Patient Census	Teaching Facility
1	1a	418	Yes[b]
2	1a	385	Yes[b]
3	1a	300	Yes
4	1a	290	Yes[b]
5	1a	280	Yes[b]
6	1a	213	Yes
7	1b	240	Yes[b]
8	1b	200	Yes
9	1b	146	Yes
10	1b	120	Yes
11	1c	182	Yes
12	2	72	No

[a]The Facility Complexity Model classifies Veterans Health Administration facilities as level 1a, 1b, 1c, 2, or 3. Level 1a facilities are the most complex; level 3 facilities are the least complex. The model is reviewed and updated every 3 years.
[b]Sites with postgraduate year 2 infectious diseases pharmacy residency programs.

Table 4. ASTF ASP Staffing Calculator Validation Results[a]

Variable	Total FTE	FTE per 100 Occupied Beds
Median (IQR)	2.68 (1.82–3.41)	1.1 (1.0–1.47)
Patient care reviews	1.85	0.82
Program management activities[b]	0.83	0.27

[a]ASTF = Antimicrobial Stewardship Task Force, ASP = antimicrobial stewardship program, FTE = full-time equivalent, IQR = interquartile range.
[b]Includes rounds and preparation for rounds.

Results

Characteristics of the 12 validation sites are shown in Table 3. Within VHA, facilities are categorized according to complexity level, determined on the basis of the characteristics of the patient population, clinical services offered, educational and research missions, and administrative complexity. Facilities are classified into 3 levels, with level 1 representing the most complex facilities, level 2 moderately complex facilities, and level 3 the least complex facilities. Level 1 is further subdivided into categories 1a–1c. Half of the sites were large, complex facilities (1a), and the other 6 were of moderate or low complexity (1b, 1c, or 2). The number of occupied beds ranged from 72 to 418 with a median census of 227 patients. The majority were teaching facilities for physicians and pharmacists, and 5 of the 12 sites had PGY2 ID pharmacy residency programs. All facilities had some pharmacist FTEs dedicated to ASP or ID activities, but none had more than 1.0 dedicated pharmacist FTE at the time of data validation.

The median total pharmacist FTEs calculated per facility was 2.68 (interquartile range [IQR], 1.82–3.41). When normalized to census, median needs were 1.1 pharmacist FTEs per 100 occupied beds (IQR, 1.0–1.47). As there was significant variability, results were also calculated after exclusion of high and low outliers, with identical results. Table 4 shows the overall results from the ASTF staffing calculator validation.

Breaking down the components of FTEs in the validation, 70% of FTEs was spent on patient care activities and 30% on program management activities, including ID or ASP rounds. For the patient care activities, the majority of time was spent on audits and feedback, with i.v.-to-oral therapy conversion (14%) and de-escalation of anti-MRSA (22%) or broad-spectrum gram-negative agents (23%) accounting for over 50% of all reviews. Restriction or prior authorization (10%), review of positive cultures (9%), and therapeutic drug monitoring (6%) were also common activities. The remaining 16% included formal consultations for antibiotic advice (4%), reductions in the duration of therapy (2%), and other patient care reviews not included above (10%). Overall, a median of 221 patients per week met the criteria for review. Rounds with the ASP/ID service (including preparation for rounds) and projects were the largest components of the program management activities (Table 5). Patient care activities accounted for a higher percentage of time for facilities with more than 200 beds (mean, 77%) versus facilities with no more than 200 beds (62%).

Based on the validation results, guidance was approved by the ASTF and presented at a national ASTF webinar in 2015. The final recommendations indicated that in order to implement and manage a robust ASP, a pharmacist FTE investment of 1.0 per 100 occupied beds would be needed, ideally with the FTE having experience in ID or ASPs. Although not included in this report, ASTF guidance also recommended a physician FTE investment of 0.25 per 100 occupied beds, ideally with training in ID. As very few VHA facilities have dedicated physician time for ASPs, the activities to be performed by physicians were not clear. For all facilities, including

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smaller ones, it was suggested that a minimum of 0.5 pharmacist FTEs and 0.25 physician FTEs should be allotted for program development and support, as this time would be relatively fixed regardless of facility size. The ASTF staffing guidance for ASPs could be used as general guidance for FTE support, but a simplified calculator based on the original was also created and made available to VHA facilities to calculate staffing needs based on local data for resource requests. Facilities were also encouraged to use the calculator to prioritize which interventions could be managed with existing ASP and ID pharmacist staff.

Table 5. Estimated Time and FTEs Required for ASP Management Activities[a]

Activity	Hours per Week	FTEs
ID/ASP rounds	13.2	0.33
Committee time and preparation	3.2	0.08
Education, quality-improvement projects, development of clinical pathways, order sets, note templates	5.6	0.14
Other administrative responsibilities (e-mail, scheduling, ASP outcomes tracking and annual evaluation)	5.0	0.125
Total	27.0	0.68

[a]FTE = full-time equivalent, ASP = antimicrobial stewardship program, ID = infectious diseases.

Discussion

Antimicrobial stewardship programs are important to help reduce inappropriate antibiotic use, rates of *Clostridium difficile* infection, antibiotic resistance, and adverse events; however, it is unclear which components and activities should be included as well as the level of staffing support needed to accomplish such reductions. A Cochrane review found a preauthorization strategy more effective than prospective audit and feedback for reducing antibiotic use and *C. difficile* infection, though staffing and time spent on activities were not examined.[7] Although the optimal level of staffing needed to influence ASP outcomes is unknown, there are some data to support a relationship between ASP resources and antibiotic consumption.[8] In contrast, data from the University HealthSystem Consortium did not find an association between an antimicrobial resource score (personnel and automated surveillance software) and antimicrobial usage, but only 21% of facilities had more than 1 FTE, and surveillance software was more highly weighted than pharmacist resources.[9] A lack of adequate personnel has been identified as a primary barrier to the implementation of effective ASPs.[10,11]

A survey of 522 physicians in the Emerging Infections Network of IDSA found that only 13% of sites had more than 1 ASP pharmacist FTE, and 24% had no dedicated FTE personnel support.[11] To compensate for inadequate dedicated ASP pharmacists to review all patients, many facilities assign ASP activities to other pharmacists. However, a comparison study using a model with a dedicated ID pharmacist showed that this may be a more effective approach, particularly for therapy modification after the receipt of laboratory test results.[12] This may be due to the specific skills and experience of a pharmacist with training in ID or ASPs or competing priorities when pharmacists are responsible for many different activities in addition to ASPs. Historically, most hospitals implement an ASP by either hiring a single ID/ASP pharmacist or assigning the ASP as an additional duty for an existing employee.

In a formal VHA survey of ASP activities by the Healthcare Analysis and Information Group, 89% of 140 VHA facilities reported having an antimicrobial stewardship team in 2015 versus 38% in 2012. Additional pharmacist FTE resources were added in 46 facilities between the 2012 and 2015 surveys, including 40 new FTEs for pharmacists. In addition, 96% of facilities had an identified pharmacy champion, with 78% of those facilities identifying their champion as having specific training in ASP or ID. Still, only 44% of the 125 facilities responding had 0.5 or more pharmacist FTEs dedicated to ASPs.[13,14]

Limitations of this study include the lack of generalizability to smaller facilities and those with less-experienced staff, as these sites were underrepresented. Variability in prescribing across hospitals is also an important consideration, and this has been demonstrated within VHA.[15] High-use facilities may require more resources for their size but have the greatest potential for reductions over time. Although time-in-motion studies were performed to identify the time needed for patient reviews, there is likely considerable variability in actual practice, based on factors such as the training and experience of the person performing the reviews, patient complexity, and other responsibilities assigned to ASP personnel. As the focus of the ASTF was on hospitalized patients, the calculator does not account for ASP activities to be implemented in outpatients, though a similar methodology of tracking time could be followed. In addition, due to the lack of adequate FTE support for ASP activities, many facilities employed inpatient clinical pharmacists who performed ASP activities in addition to other clinical duties. Our model does not account for who is completing the activity but rather accounts for the time needed for the activity. Still, most administrators and pharmacy

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directors are unaware of the time required to perform day-to-day ASP reviews and program management activities. Adequate staffing is likely to be more important given recent mandates from the Joint Commission to not only implement ASPs but also present outcomes of the programs.

The advantage of our staffing calculator is that it provides an accurate and validated estimate of the FTE support needed to implement specific ASP activities, regardless of whether they are performed by the ASP pharmacist or assigned to other pharmacists across the facility. It also is flexible and can be useful when preparing resource management requests for personnel or estimating what interventions can be implemented based on the level of FTE support available. Activities already being performed by clinical pharmacists could be eliminated from the calculation. Future research should aim to identify the specific activities (e.g., de-escalation, reduction of duration of therapy, preauthorization) most closely linked to ASP outcomes. Within VHA, estimates of the time needed to perform outpatient ASP activities will need to be addressed.

Conclusion

A staffing calculator to account for the time needed to implement ASP activities and provide staffing guidance across a large healthcare system was validated.

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