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Performance of Infectious Diseases Specialists, Hospitalists, and Other Internal Medicine Physicians in Antimicrobial Case-Based Scenarios: Potential Impact of Antimicrobial Stewardship Programs at 16 VA Medical Centers

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Abstract:

Objective:

As part of a project to implement antimicrobial dashboards at select facilities, we assessed physician attitudes and knowledge regarding antibiotic prescribing.

Design:

An online survey explored attitudes toward antimicrobial use and assessed respondents' management of four clinical scenarios: cellulitis, community-acquired pneumonia, non-catheter-associated asymptomatic bacteriuria, and catheter-associated asymptomatic bacteriuria.

Setting:

Sixteen VA medical centers in 2017.

Participants:

Physicians working in inpatient settings specializing in infectious diseases (ID), hospital medicine, and non-ID/hospitalist internal medicine.

Methods:

Scenario responses were scored by assigning +1 for answers most consistent with guidelines, 0 for less-guideline-concordant but acceptable answers and -1 for guideline-discordant answers. Scores were normalized to 100% guideline-concordant to 100% guideline-discordant across all questions within a scenario, and mean scores were calculated across respondents by specialty; differences in mean score per scenario were tested using ANOVA.

Results:

One-hundred-thirty-nine physicians completed the survey (19 ID physicians, 62 hospitalists, 58 other internists). Attitudes were similar across the three groups. There was a significant

difference in cellulitis scenario scores (concordance: ID 76%, hospitalists 58%, other internists 52%, p=0.0087). Scores were numerically but not significantly different across groups for community-acquired pneumonia (concordance: ID 75%, hospitalists 60%, other internists 56%, p=0.0914) and for either of the asymptomatic bacteriuria scenarios (concordance: ID 65%, hospitalists 55%, other internists 40%, p=0.322 (non-catheter-associated); ID 27% concordant, hospitalists 8% discordant, other internists 13% discordant, p=0.12 (catheter-associated).

Conclusions:

Significant differences in performance on management of cellulitis and low overall performance on asymptomatic bacteriuria point to these conditions as being potentially high-yield targets for stewardship interventions.

Introduction:

The goal of antimicrobial stewardship is to promote proper antimicrobial therapy to improve not only the care of the patient at hand, including reducing or preventing complications such as *Clostridioides difficile*-associated colitis, but also to preserve antimicrobial treatment options on an individual and population level in the future through reduction of antimicrobial resistance.[1,2] The Veterans Health Administration (VHA) has made a concerted effort to increase antimicrobial stewardship implementation over the past decade, starting with the charter of the VA Antimicrobial Stewardship Task Force in 2011 and a nationwide directive in 2014 that all VA facilities implement antimicrobial stewardship programs (ASPs),[3] with much of the initial focus being on inpatient care. While reductions in inpatient antimicrobial use have resulted,[3] strategies are evolving regarding the involvement and education of inpatient providers who may have differing training backgrounds, clinical experiences and familiarity with antimicrobial stewardship principles. As part of a project implementing antimicrobial dashboards designed to provide feedback to antimicrobial stewards at select VA facilities nationwide, we assessed attitudes, knowledge, and prescribing practices with regard to antimicrobial use and stewardship among different groups of physicians who typically provide inpatient care at VA facilities.

Methods:

The Cognitive Support Informatics for Antimicrobial Stewardship project enrolled eight university-affiliated VA sites across the nation to participate in implementation of electronic antimicrobial dashboards that allow for inter- and intra-facility comparisons of antimicrobial utilization across common inpatient conditions (skin-soft tissue infection, pneumonia, and urinary tract infection) over the time frame of a typical hospital admission.[4] To assess facility-

level physician knowledge of appropriate antibiotic use, we administered an electronic survey via REDCAP (www.project-redcap.org) to physicians who attend on inpatient medical services at all eight intervention sites along with eight control sites matched by complexity and geographic location during October-December of 2017. The full survey instrument is included in the Supplemental Materials. We contacted medical leadership at each participating facility to provide rosters of physicians who had attended on the inpatient acute general medicine service during the prior year and invited those physicians to participate in the survey anonymously via email. One pre-notification email, one invitation with a survey link, and one reminder email to initial non-respondents were sent over the course of 30 days. No incentives were provided for participation. The first portion of the survey collected information regarding physicians' VA appointments, practice characteristics, attitudes toward antimicrobial use, and antibiotic prescribing practices. Questions asking about agreement with certain statements used Likert scales that were converted into numerical scores for analysis (1: Strongly Disagree; 2: Disagree; 3: Neutral; 4: Agree; 5: Strongly agree). The second part of the survey explored how respondents would manage four clinical scenarios: cellulitis, community-acquired pneumonia (CAP), non-catheter-associated asymptomatic bacteriuria (NC-ASB), and catheter-associated asymptomatic bacteriuria (C-ASB). A final part of the survey addressed availability and use of antibiotic prescribing resources.

For each scenario, responses were scored by assigning +1 for answers most concordant with Infectious Diseases Society of America guidelines at the time ("correct"),[2,5–7] 0 for less concordant but acceptable answers (or no answer given), and -1 for guideline-discordant answers ("incorrect"). Guidelines were interpreted with an eye towards antimicrobial stewardship and practicality. One generalist (P.A.G.) and two infectious diseases physicians (C.J.G. and M.B.G.)

collectively assigned a value to each answer to each sub-question *a priori* with free-text responses analyzed *post hoc* independent of knowledge of the type of practitioner giving the answer. For questions that allowed for multiple answers, 0 points were assigned when a less guideline-concordant answer was combined with a guideline-concordant answer, and -1 point was assigned when a guideline-discordant answer was combined with either a guideline-concordant or less guideline-concordant answer. Scores were then compiled across all questions within each scenario and normalized to 100% concordant (all "correct") to 100% discordant (all "incorrect"). Mean scores were calculated across respondents who self-identified as belonging to one of three categories: infectious diseases (ID) specialists, hospitalists, and other internists (general internal medicine and non-ID internal medicine subspecialists). For each question within a scenario, we tabulated percentages of responses based on total number of survey participants in each physician category rather than the number in each category that responded to the individual question. Statistical significance of differences between groups was evaluated via Kruskal-Wallis Rank Sum test, Pearson's Chi-squared test, and F-test where appropriate. This study was approved by the Veterans Health Administration Central Institutional Review Board.

Results:

Practice characteristics and antimicrobial attitudes, prescribing practices, and resource utilization:

A total of 467 physicians who attended on inpatient wards from all sites were contacted regarding participation in the survey; 159 answered at least one question (19 ID physicians, 71 hospitalists, and 69 other internists). 140 respondents answered up to the first scenario (30.4% overall response rate): 19 ID physicians, 62 hospitalists, 58 other internists, and one respondent

who did not identify a specialty. This respondent was excluded, leaving 139 respondents to be analyzed. Of the 58 non-ID, non-hospitalist "other" internist respondents, 43 (74.1%) identified as generalists, 3 as rheumatologists, 3 as nephrologists, 2 as geriatricians, 2 as endocrinologists, 2 as pulmonologists, 2 as oncologists, and 1 as an endocrinologist and rheumatologist. No remarkable differences were seen between physician characteristics at intervention and control sites for any portion of the survey (data not shown). Practice characteristics and attitudes toward antimicrobial use are shown in Table 1. Significant differences were found in proportion of time in clinical care ($p=0.023$) and in inpatient care ($p<0.001$), with hospitalists having the highest proportions. Attitudes toward antimicrobial use were largely similar across the 3 groups, though ID physicians more frequently felt that antibiotics were overused by clinicians at their facility ($p=0.002$) and less likely felt that the harm of antibiotic overuse in livestock is exaggerated ($p=0.001$). Most physicians (94/139, 67.6%) felt that antimicrobial stewardship programs were of at least moderate benefit to patient care at their institution, and most (108/139, 77.7%) were satisfied or very satisfied with the assistance they have received from their facility regarding antibiotic prescribing over the prior year. Answers regarding antibiotic prescribing practices and resource utilization among provider groups are shown in Supplemental Table 1. ID physicians were significantly more confident of their optimal use of antibiotics in the inpatient setting ($p<0.001$) and less likely to believe they may be overprescribing antibiotics in the inpatient setting ($p=0.019$). ID physicians relied more on antibiograms ($p=0.017$) than hospitalists and other internists in making antibiotic prescribing decisions. Numerically, they tended to rely less on electronic health record (EHR) templates ($p=0.144$) and local infectious diseases online resources ($p=0.181$) than the other two groups, but these differences were not statistically significant. Hospitalists and other internists frequently noted that they would find feedback on

prescribing practices to be extremely or very helpful (82.3% hospitalists, 72.4% other internists, 52.6% of ID physicians, p=0.033), and hospitalists frequently noted that additional education or guidance on antibiotic prescribing would be extremely or very helpful (74.2% hospitalists, 46.6% other internists and 26.3% of ID physicians, p<0.001). While non-ID respondents infrequently noted that their facility provided any new general guidance for antibiotic prescribing for skin-soft tissue infection, pneumonia, and urinary tract infection across different timepoints of a typical hospital course, they frequently noted that the guidelines, when present, did impact their antibiotic prescribing practices (Supplemental Table 2). Among non-ID physicians, guidance regarding tailoring antibiotic courses after 3 days impacted antibiotic prescribing practices for pneumonia (97.1%) significantly more frequently as compared to skin and soft tissue infection (80%) and urinary tract infection (90%) (p=0.0079); no significant differences across these conditions were observed for guidance regarding initial choice and completion of an antibiotic course.

Clinical scenario performance:

Clinical scenario scores are summarized in Table 2, with full descriptions of each scenario and all responses tabulated in Supplemental Table 3. Scenario 1 describes a case of simple spreading cellulitis of the lower extremity with blood cultures on admission that turn positive for group A streptococcus. There was a significant difference in scores on this scenario (ID physicians 76% concordant, hospitalists 58% concordant, other internists 52% concordant, p=0.0087), driven mostly by differences in appropriately classifying the clinical condition as cellulitis alone (p=0.019). Scenario 2 describes a case of community-acquired pneumonia where high-quality respiratory cultures grow *Streptococcus pneumoniae*. Scores were numerically but not significantly different across specialties for this scenario (ID 75% concordant, hospitalists

60% concordant, other internists 56% concordant, p=0.0914), though ID physicians were significantly more likely to select appropriate oral antimicrobial therapy on day 3 (p=0.006). Scenarios 3 and 4 presented cases of asymptomatic bacteriuria (in a non-catheterized patient in Scenario 3 and a catheterized patient in Scenario 4) where there were two questions each: what is the clinical presentation (guideline-concordant answer: asymptomatic bacteriuria) and what is the antibiotic treatment (guideline-concordant answer: none). All specialties (including infectious diseases) did poorly on both scenarios, with ID physicians answering 65% concordant, hospitalists 55% concordant, and other internists 40% concordant (p=0.322) on Scenario 3, and ID physicians answering 27% concordant, hospitalists 8% discordant, and other internists 13% discordant (p=0.12) on Scenario 4. Other internists were more likely to incorrectly select an antibiotic in Scenario 3 (p=0.034).

Physicians were asked after each scenario what resources they would most likely use in management of the case at hand. General medical resources (such as UpToDate or a medical textbook) were most frequently selected, though pre-specified guidance from the facility and information/input from an inpatient ward pharmacist were also commonly selected (Supplemental Table 4). After each scenario, physicians were asked about their confidence in making antibiotic prescribing decisions for the patient in the scenario without the use of those resources. ID physicians were significantly more confident in all scenarios, particularly for Scenario 1 (cellulitis) (84.2% “very confident” vs. 27.4% for hospitalists and 39.7% for other internists (p<0.001)) (Supplemental Table 5), but confidence did not correlate with performance (data not shown).

Finally, we examined whether non-ID physicians’ awareness of new guidance within the prior 12 months from their facilities’ ID division or antimicrobial stewardship team on the initial

choice, tailoring, and completion of an antibiotic course was associated with their performance on the clinical scenarios. While no significant associations were seen for hospitalists, other internists' overall awareness of this guidance was associated with higher performance across all scenarios (p=0.011), driven mostly by awareness of guidance regarding management of pneumonia (p=0.001) (data not shown).

Discussion:

We found significant differences in survey responses between ID physicians, hospitalists, and generalists on how to manage infectious conditions that are commonly seen in the practice of inpatient internal medicine and are frequently targets for antimicrobial stewardship interventions. Most notably, the low overall scores in management of asymptomatic bacteriuria (both non-catheter-associated and catheter-associated) point to the difficulties inherent in recognizing and/or avoiding antimicrobial treatment for this situation and the need for education and interventions in this domain that target all physicians who practice inpatient internal medicine, even ID physicians. Implementation of algorithm-based peer feedback has been shown to be successful in this regard.[8] A knowledge gap between ID physicians and other specialties on the management of cellulitis also points to opportunities for developing stewardship interventions targeted at non-ID physicians and focusing on the management of skin and soft tissue disease. All specialties scored highest on the community-acquired pneumonia scenario, but opportunities exist for improvement in this domain as well. As with cellulitis, de-escalation of antimicrobial therapy when culture data returns and the patient is improved clinically was a particular weak point where interventions can be focused.

Specialties likely differ in terms of how they can best be targeted by stewardship interventions. A recent study of inpatient services at an academic medical center demonstrated that generalist-led services prescribed more broad-spectrum therapy than hospitalist-led services.[9] In our survey, hospitalists and other internists tended to rely less on antibiograms than ID physicians in their clinical practice. While hospitalists and other internists tended to rely more on EHR templates and local infectious diseases online resources, overall reliance on these modalities was low. This illustrates an antimicrobial stewardship principle that occurs frequently in the literature: educational or informational resources make an impact when accompanied by patient-level antimicrobial stewardship team intervention.[10–14] More involvement of antimicrobial stewardship teams in provider-facing activities such as audit and feedback and in-person presence on rounds ("handshake stewardship") may be particularly high-yield.[2,15–19] Physicians in our survey highlighted online general medical resources such as UpToDate (Wolters Kluwer) as most frequently referenced when making antibiotic prescribing decisions; antimicrobial stewards should routinely ensure that these resources reinforce antimicrobial prescribing principles at their facilities. Hospitalists and other internists particularly noted a desire for more feedback on prescribing practices, signifying awareness of their knowledge gaps and interest in improving upon them. Other internists seemed particularly influenced by guidance on antimicrobial prescription for pneumonia, particularly when tailoring therapy around hospital day 3.

Our study is subject to several limitations. A low number of ID physician respondents significantly limits our ability to make inferences on the ID community at-large. Overall response rate was also relatively low. The survey was lengthy: not all respondents answered all questions, and there may be a bias towards those who had more available time, altruism, or

interest in the subject. While clinical scenarios can be effective in demonstrating physician proficiency independent of patient case mix and other factors that may influence patient care-related metrics,[20] our scenarios may have been worded in a way that was less clear or not fully representative of real-life circumstances. For example, we noted in the community-acquired pneumonia case that the patient presented "from home" but did not give details that further suggested community vs. healthcare-associated acquisition. Factors such as this may have influenced respondents to invoke underlying biases and experience that may not truly reflect antibiotic prescribing expertise. Finally, the small number of questions pertaining to management of asymptomatic bacteriuria increases variance in our estimate of provider understanding of its management. However, the overall detailed information we received on antimicrobial prescribing practices should serve as a useful roadmap for stewards who are trying to best balance the attitude, knowledge, and practice differences of the practitioners at their facility in planning antimicrobial stewardship interventions.

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342 **Table 1: Practice characteristics and attitudes toward antimicrobial use among survey**

343 **respondents (by specialty)**

	ID (n=19)	**Hospitalists (n=62)**	**Other Internists (n=58)**
Demographics:			
Age (years): 25 or under, n (%)	0 (0%)	0 (0%)	0 (0%)
26-35, n (%)	5 (26.3%)	17 (27.4%)	11 (19%)
36-45, n (%)	5 (26.3%)	25 (40.3%)	16 (27.6%)
46-55, n (%)	3 (15.8%)	10 (16.1%)	12 (20.7%)
56-65, n (%)	2 (10.5%)	4 (6.5%)	9 (15.5%)
Over 65, n (%)	3 (15.8%)	0 (0%)	1 (1.7%)
No answer, n (%)	1 (5.3%)	6 (9.7%)	9 (15.5%)
Sex: Male, n (%)	14 (73.7%)	30 (48.4%)	27 (46.6%)
Female, n (%)	3 (15.8%)	27 (43.5%)	22 (37.9%)
Practice Characteristics:			
Years since completing clinical training, median (range)	6 (1-46)	7 (0-34)	13 (0-38)
Years practicing within VA, median (range)	6 (1.5-46)	5 (0.5-23)	7 (0.5-38)
Full-time practice at VA, n (%)	14 (73.7%)	45 (72.6%)	46 (79.3%)
% time spent in clinical care, median (range)*	50 (15-100)	65 (0-100)	50 (0-100)
% clinical time spent on inpatient care, median	75 (33-100)	100 (0-100)	40 (2-100)

(range)**			
Attitudes toward antimicrobial use: Likert 1-5:† mean (standard deviation)			
Antibiotics are overused nationally	4.74 (0.45)	4.63 (0.48)	4.44 (0.66)
Antibiotics are overused by clinicians at my facility*	4.32 (0.67)	3.63 (0.73)	3.72 (0.77)
Better use of antibiotics will reduce problems with antibiotic-resistant organisms	4.63 (0.50)	4.53 (0.59)	4.60 (0.53)
Strong knowledge of antibiotics is important in my medical career	4.84 (0.37)	4.74 (0.44)	4.55 (0.57)
Prescribing broad spectrum antibiotics when equally effective narrower-spectrum antibiotics are available increases antibiotic resistance	4.53 (0.61)	4.56 (0.64)	4.59 (0.56)
Hand washing/cleaning practices are not utilized to the recommended extent at my facility	3.37 (1.30)	2.73 (1.16)	2.59 (1.08)
Inappropriate use of antibiotics can harm patients	4.84 (0.37)	4.72 (0.49)	4.62 (0.53)
The harm of antibiotic overuse in livestock is exaggerated*	1.37 (0.50)	1.87 (0.82)	2.16 (0.81)
The harm of antibiotic overuse in humans is exaggerated	1.58 (0.77)	1.58 (0.76)	1.81 (0.85)
At your facility, how much of an obstacle or benefit are antimicrobial stewardship programs to good patient care?			
Considerable benefit	6 (31.6%)	24 (38.7%)	22 (37.9%)
Moderate benefit	9 (47.4%)	20 (32.3%)	13 (22.4%)
Others	4 (21%)	18 (29%)	23 (39.7%)
What is your overall satisfaction with the assistance you have received from your facility			

regarding antibiotic prescribing for your inpatients over the past 12 months?			
Very satisfied	8 (42.1%)	26 (41.9%)	23 (39.7%)
Satisfied	8 (42.1%)	22 (35.5%)	21 (36.2%)
Others	3 (15.8%)	14 (22.6%)	14 (24.1%)

*: p <0.05

**: p <0.001

†: 1: Strongly Disagree; 2: Disagree; 3: Neutral; 4: Agree; 5: Strongly agree

348 **Table 2: Summary of clinical scenario scores by practice type**

	Average points		
	ID (n=19)	**Hospitalists (n=62)**	**Other Internists (n=58)**
Scenario 1: Simple cellulitis			
Syndrome classification*	+1.0	+0.65	+0.69
Initial antibiotic choice	+0.53	+0.21	+0.34
De-escalation antibiotic choice	+0.84	+0.65	+0.45
Discharge antibiotic choice	+0.84	+0.71	+0.52
Treatment duration	+0.58%	+0.68	+0.60
SCENARIO 1 TOTAL POINTS (p-value 0.0087 by F-test)*	+3.8 (76% CONCORDANT)	+2.9 (58% CONCORDANT)	+2.6 (52% CONCORDANT)
Scenario 2: Community-acquired pneumonia			
Syndrome classification	+0.74	+0.61	+0.69
Initial antibiotic choice	+0.58	+0.56	+0.52
De-escalation antibiotic choice*	+0.74	+0.34	+0.33
Treatment duration	+0.90	+0.89	+0.69
SCENARIO 2 TOTAL POINTS (p-value 0.091 by F-test)	3.0 (75% CONCORDANT)	2.4 (60% CONCORD-ANT)	2.23 (56% CONCORD-ANT)
Scenario 3: Asymptomatic bacteriuria (non-catheter-associated)			
Syndrome classification	+0.63	+0.56	+0.41
Antibiotic choice*	+0.63	+0.52	+0.34
SCENARIO 3 TOTAL POINTS (p-value 0.322 by F-test)	1.3 (65% CONCORDANT)	1.1 (55% CONCORDANT)	0.8 (40% CONCORDANT)
Scenario 4: Asymptomatic bacteriuria (catheter-associated)			

Syndrome classification	0	-0.18	-0.21
Antibiotic choice	+0.53	+0.016	-0.052
SCENARIO 4 TOTAL POINTS (p-value 0.12 by F-test)*	0.53 (27% CONCORDANT)	-0.16 (8% DISCORDANT)	-0.26 (13% DISCORDANT)

*: $p < 0.05$