A Survey of Knowledge, Attitudes, and Beliefs of House Staff Physicians From Various Specialties Concerning Antimicrobial Use and Resistance

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**Background:** Examination of knowledge, attitudes, and beliefs of house staff physicians will be important in developing interventions to improve antimicrobial use and prevent resistance.

**Methods:** A 75-item survey was distributed to house staff physicians on nonpediatric services in a university teaching hospital. Knowledge was assessed with a 10-question quiz.

**Results:** The survey was completed by 179 (67%) of 269 house staff physicians on 5 specialties. Outside and inside the intensive care unit, 21% and 25% of respondents, respectively, reported that they were using antibiotics optimally. Surgeons were significantly more likely than other physicians to report that they were regularly seeking input into antimicrobial selections (P<.001). Of the 170 physicians who completed the survey, 88% agreed antibiotics are overused in general and 72% also agreed this was the case at their institution (r=0.56; P<.05); 96% agreed that hospitals in general face serious problems with antibiotic resistance and 93% agreed that their hospital faces these same problems (r=0.57; P<.05); 97% agreed that better use of antibiotics would reduce resistance; 32% stated that they had not had formal teaching on antimicrobial agents in the last year (medicine residents reported significantly more formal teaching than others [P=.001]); and 90% wanted more education about antimicrobials and 67% wanted more feedback on antimicrobial selections. The mean antimicrobial quiz score was 28%, with medicine residents scoring significantly higher than others (P=.04). Upper-level residents did not perform better than interns.

**Conclusions:** This survey (1) revealed that house staff are aware of the importance of antimicrobial resistance and believe better antimicrobial use will help this problem and (2) demonstrated differences between specialties with respect to antimicrobial use and knowledge. House staff at our hospital have suboptimal knowledge about antimicrobials, and this knowledge did not increase appreciably over the course of their training. Antimicrobial education is needed and is likely to be well received by house staff physicians in academic centers but may be more effective if it is tailored to specific specialties.

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**THERE IS WIDESPREAD AGREEMENT** that the growing problem of antimicrobial resistance is an important challenge to health care. Data from the Centers for Disease Control and Prevention’s (CDC’s) National Nosocomial Infection Surveillance (NNIS) System indicate that not only have the rates of bacterial resistance risen steadily over the past decade but that this resistance is no longer a phenomenon limited to the intensive care unit (ICU) setting.1 It has been demonstrated that a great deal of antimicrobial use is either unnecessary or inappropriate2-7 and that decreasing this use is effective in curtailing resistance.8-12 These facts have prompted many to call for improvements in antimicrobial prescribing practices13-16 and have led to the creation of position statements and guidelines from national infectious disease (ID) organizations.17 More recently, the CDC has included several measures pertaining to improved antimicrobial use in its “Campaign to Prevent Antimicrobial Resistance in Health-Care Settings.”18

Because changes in antimicrobial prescribing patterns will necessitate changes in physician behavior, it is important to better understand what physicians know about antimicrobial agents, how they acquire and maintain that knowledge, and what factors influence their prescribing of antimicrobials. As is the case with other campaigns targeting physician behavior, a better understanding of these underlying factors will permit the development of more effec-
survey. The survey included a detachable consent cover page, which facilitated tracking. Every 2 weeks for 4 weeks, surveys were resent to those who had not returned them. On receipt of the survey, the consent page was removed and kept separately from the survey, which prevented matching respondents to surveys and ensured complete confidentiality.

STATISTICAL METHODS

All data were analyzed with STATA software (STATA Inc, College Station, Tex). Descriptive analyses included means for continuous variables and percentages for categorical data. We tested for differences among the various specialties and years of training using a χ² test for normally distributed data or a Kruskal-Wallis test for nonnormally distributed data. For assessing the relationship between responses to various Likert-scale items, we used a Pearson correlation coefficient. For the Likert items, we analyzed the data using the 5-point scale and, after collapsing the response options into agree, neutral, and disagree categories.

RESULTS

DEMOGRAPHICS

Of 269 house staff members, 179 (67%) completed the survey. The response rate was highest among medicine residents, with 86 (83%) of 104 returning the survey, compared with 23 (64%) of 36 emergency medicine residents, 15 (50%) of 30 Ob/Gyn residents, 40 (48%) of 84 surgery residents, and 5 (33%) of 15 neurology residents. Of the respondents, 32% were in the first year of residency, 23% in the second year, 31% in the third year, and 13% were beyond the third year of training. In addition, 79% reported that they planned a career doing primary clinical work, and 83% reported rotating in ICUs. Because of the small sample size, results for neurology were not included in the specialty-specific sections and since only 2 Ob/Gyn residents reported rotating in ICUs, their results were not included in ICU-specific analyses.
ANTIMICROBIAL USE

Outside of the ICU, emergency medicine house staff reported prescribing antimicrobials significantly more frequently than others, with 78% of emergency medicine respondents prescribing them more than once a day compared with 33% of Ob/Gyn residents, 25% of surgery residents, and 20% of medicine residents (P<.001). However, there were no differences between specialties with respect to the reported frequency of antimicrobial use while working in the ICU setting, where 70% of medicine, 64% of surgery, and 83% of emergency medicine residents reported prescribing antimicrobials more than once a day.

Both outside and inside the ICU, surgery house staff were significantly more likely than others to seek input on their antimicrobial selections from either more senior residents or attending physicians (Table 1). Likewise, on both non-ICU and ICU rotations, first-year residents were significantly more likely than upper-level residents to consult with other physicians about antimicrobial decisions (Table 1).

Overall, only 21% of those surveyed felt very confident that they were using antimicrobials optimally outside of the ICU, and 25% believed that they were using them optimally in the ICU setting, with no significant differences among the specialties. Upper-level residents were significantly more likely than first-year residents to feel very confident in their antimicrobial use both outside and inside the ICU (P=.03 outside the ICU; P=.02 inside the ICU) (Figure 1). Furthermore, respondents who reported that they were seeking input into their antibiotic choices more often were significantly more confident in their antimicrobial use (P=.02 for those who sought input from senior residents; P=.01 for those who sought input from attending physicians). Overall, 34% of respondents indicated that they received useful feedback on their antimicrobial decisions, and 67% stated that wanted more feedback.

ATTITUDES ABOUT RESISTANCE AND ANTIMICROBIAL USE

Of the respondents, 88% agreed that antimicrobials are overused in general and 72% agreed that they are also overused at their own hospital (r=0.56; P<.05); 96% agreed that hospitals overall face serious problems with antimicrobial resistance and 93% agreed that their hospital faced the same problem (r=0.57; P<.05); and 88% of respondents also agreed that overall issues of resistance should be considered when prescribing antimicrobials for an individual patient.

In addition, 97% of those surveyed agreed that better use of antimicrobials would help decrease resistance. With respect to various antimicrobial stewardship interventions, 82% believed that management programs were more of an aid than an obstacle to good patient care, 77% believed that locally developed guidelines for antimicrobial use would be more useful than national ones, and 38% agreed that requiring prior approval made them less likely to use certain antimicrobials.

Finally, there was a significant difference in terms of the perceived influence that pharmaceutical representatives have on antimicrobial prescribing, with 20% of respondents reporting that these interactions influenced their own antimicrobial selections, while 45% believed that these interactions influenced the decisions of others (P=.002).

ANTIMICROBIAL EDUCATION

Of the respondents, 22% stated they had not had any formal education on antimicrobials in the last year, including teaching on ward rounds. For those who reported some formal education, 62% stated that they had received this education at a grand rounds lecture, 50% at a formal lecture on ward rounds, 46% at another on-campus lecture, and 39% at a pharmaceutical company-sponsored lecture; 90% of respondents stated that they wanted more antimicrobial education.

The number of formal teaching sessions in the past year for each respondent was summed to calculate a “teaching exposure score.” Medicine residents had a significantly higher mean score of 5.5 compared with 2.2 for surgery, 2.7 for emergency medicine, and 2.8 for Ob/Gyn (P=.001) (Figure 2), but the teaching exposure scores for first-year residents did not differ significantly from that of upper-level residents (3.9 vs 4.1).

The utility of various sources of antimicrobial continuing education and information is summarized in Table 2. Overall, The Sanford Guide to Antimicrobial Therapy25 and ID colleagues were rated as the most useful with pharmaceutical representatives being the least useful. Respondents were significantly more likely to find interactions with ID colleagues useful compared with interactions with non-ID attending physicians (P<.001). The only interspecialty difference in these sources was that emergency medicine residents were less likely than other residents to find interactions with other house staff to be useful (P=.04).

ANTIMICROBIAL KNOWLEDGE

The average scores on the antimicrobial quiz included with the survey were 37% on the basic questions, 15%
on the advanced questions, and 28% overall (range, 0%-80%). Medicine residents had a significantly higher mean score of 31% compared with 27% for surgery and 25% for emergency medicine and Ob/Gyn (P = .04, medicine vs others). There were no significant differences between the specialties when scores were compared for basic and advanced questions (Figure 3). Furthermore, there were no significant differences among the scores for various years of training, either overall or on basic or advanced questions.

There was no particular information source whose use was correlated with greater knowledge (as reflected in higher quiz scores), nor was exposure to any particular teaching venue. Further, individual respondents who had teaching scores above the mean were not more likely to score above average on the antimicrobial quiz.

Upper-level residents who agreed that antimicrobial resistance was a problem at Johns Hopkins Hospital were significantly more likely to score above average on the quiz (P = .04). When stratified by specialty, emergency medicine, and Ob/Gyn residents who stated that pharmaceutical representatives did not influence their antimicrobial choices were significantly more likely to score above average (P = .04). Finally, in the specialty-stratified analysis, there was a trend for medicine residents who did not think that antimicrobials were overused at Johns Hopkins Hospital to score below average (P = .08).

Those who reported they were very confident in their antimicrobial use, either inside or outside the ICU, were not more likely to score above average on the quiz, nor were those who believed that a knowledge of antimicrobials would be important to their careers. Outside of the ICU, there was a trend for those who used antimicrobials more frequently to score higher on the quiz (P = .08), but this trend was not seen in the ICU. Conversely, there was a trend toward a higher quiz score (P = .08) for respondents who were more likely to report seeking input into antimicrobial choices from a more senior colleague in the ICU, while this trend was not seen outside of the ICU.

It has been demonstrated that physicians will not alter their management practices unless they are both aware of and in agreement with the changes that are being proposed.19,26 Thus, a better understanding of what physicians know and believe about issues of antimicrobial use and resistance can enhance the effectiveness of interventions targeted at improving in-hospital antimicrobial use, such as CDC’s Campaign to Prevent Antimicrobial Resistance in Health-Care Settings19 among hospitalized adults. Previous surveys have addressed these issues among outpatient attending physicians in internal medicine,21 family practice,21 or pediatrics.22,23 Only 1 recent survey focused on those who care for inpatients and included some house staff.24 Understanding the knowledge, attitudes, and beliefs of resident physicians is crucial to efforts to reduce inpatient antimicrobial resistance, since house staff prescribe a substantial portion of these agents in teaching hospitals, where problems of antimicrobial resistance are most severe. Furthermore, since problems of antimicrobial resistance are not limited by specialty, a better understanding of the practices of all specialties is also essential. To our knowledge, our survey was the first to focus exclusively on house staff and to include physicians in surgery, emergency medicine, Ob/Gyn, and neurology.

Overall, we found that house staff are very aware of the problem of antimicrobial resistance, both at a na-
tional and local level, with no significant interspecialty variation in this awareness. These results differed from those of Wester et al., in which 87% of respondents agreed that resistance was a problem nationally but only 55% believed that their own hospital faced the problem. Furthermore, we found that 97% of house staff at our institution believed that better antimicrobial use would help address the issue of resistance, compared with 66% in the study by Wester et al. The recent introduction of an antimicrobial stewardship program and long-standing antimicrobial prior approval program may have contributed to these differences by lending credence to the seriousness of the problem of antimicrobial resistance and to the efficacy of better antimicrobial use as a solution. The differences may also be explained by the fact that the study by Wester et al. encompassed multiple hospitals with varying degrees of resistance issues. Our findings are also somewhat different from those of Metlay et al., who indicated that there is a tension between the social concerns of antimicrobial resistance and the physician's desire to prescribe broader agents for an individual patient, since 88% of residents believed that overall issues of resistance should be considered when prescribing therapy for an individual patient.

The importance of including specialties other than internal medicine when evaluating antimicrobial knowledge and practices is demonstrated in the relative frequencies with which nonmedical residents reported using antimicrobials. Indeed, medicine residents were the least likely of the surveyed groups to report prescribing antimicrobials more than once a day, while emergency medicine residents reported prescribing antibiotics more often. However, this difference may simply reflect the fact that the emergency medicine residents see more patients and thus have more opportunities to prescribe antimicrobials. Our survey also demonstrated important differences between the services with respect to how often they sought input into their antimicrobial decisions, with surgical residents being significantly more likely than all other groups to report seeking input into antimicrobial choices from more senior physicians. Such interspecialty differences can be important in planning interventional approaches. For example, interventions that focus on upper-level residents and count on a “trickle-down” effect are likely to be much more effective on surgical services than others. Though some have raised concern that antimicrobial management interventions, such as the use of antibiotic guidelines and prior approval programs, may have the unintended consequences of hindering optimal patient care and 1 study found restrictions to be burdensome to physicians, we found that 82% of our house staff believed that such programs were actually more of an aid than an obstacle to good patient care. However, to be optimally effective, these interventions will likely need to be individually developed by each institution, since 77% of our respondents indicated that locally developed guidelines would be more useful than national ones.

Overall antimicrobial knowledge, reflected by the scores on the quiz, was much lower than expected, and thus for evaluation, the quiz was divided into basic and advanced questions with the thought that some of the questions may have been too difficult. The fact that the average score on even the basic questions was only 37% suggests that antimicrobial education was suboptimal among our house staff, rather than the quiz being too difficult. This surprisingly low knowledge base may account for how infrequently house staff expressed high confidence in their ability to use antimicrobials optimally outside and inside of the ICU (25% and 21%, respectively). Although house staff appear to have limited continuing education about antimicrobial use, they appear very interested in learning more and improving their usage patterns, with 67% stating that they wanted more feedback on their antimicrobial decisions.

The apparent lack of continuing antimicrobial education was also supported by the findings that upper-level residents did not score significantly higher than first-year residents and that a third of respondents stated that they had had no formal teaching on antimicrobials in the past year. That medicine residents, who had the highest overall teaching score as a group, also had a significantly higher mean quiz score suggests that when education does occur it is effective. Whether the higher quiz score reflects the increased exposure to formal teaching or is a result of some other aspect of internal medicine training is not known.

We also found that upper-level residents who believed that antimicrobial resistance was a problem at our hospital were more likely to score above average on the quiz. This suggests that either those who believe in the seriousness of the problem of resistance are more likely to try and learn more about optimal antimicrobial use or that education increases awareness of the problem of antimicrobial resistance or both. Either explanation lends credence to the importance and effectiveness of continuing education about antimicrobial resistance and appropriate antimicrobial use.

This study found that house staff use a wide variety of resources to learn about antimicrobials, but those rated as being most useful were other house staff physicians, ID physicians, and The Sanford Guide to Antimicrobial Therapy. Since 96% of respondents rated ID colleagues as a useful source of information, our results suggest that a continued emphasis from ID physicians about the importance of antimicrobial resistance and optimal antimicrobial use is warranted. Our findings also indicate that house staff physicians continue to rely heavily on each other for antimicrobial teaching, which will enhance the efficacy of educational efforts focused at house staff, since they will not only learn themselves but teach others as well. The fact that 71% of respondents reported that non-ID attending physicians were a useful source of continuing education on antimicrobials argues for ongoing educational efforts directed at this audience. Overall, no specific resource was associated with a higher knowledge score, but this may simply reflect the fact that almost all house staff found the same sources of information useful.

Because our survey was conducted at only 1 institution, the results must be generalized with caution. However, the overall agreement among our house staff about the problems posed by antimicrobial resistance was relatively similar to that reported in previous studies. Wester et al., who indicated that there is a tension between the social concerns of antimicrobial resistance and the physician's desire to prescribe broader agents for an individual patient, since 88% of residents believed that overall issues of resistance should be considered when prescribing therapy for an individual patient.
et al\textsuperscript{14} reported that individual experience with antimicrobial resistance was the strongest predictor of physician attitudes toward problems of antimicrobial resistance. Given, the relatively high incidence of resistance at our institution, few of our physicians have not encountered infections with resistant organisms, particularly in the ICU. Thus, we believe that the results of our survey may be reproducible in hospitals that face significant resistance issues. Another potential limitation of any survey is the tendency of respondents to give socially desirable answers instead of revealing their true opinions. We tried to minimize this problem by assuring respondents complete confidentiality and believe that certain findings of the survey support its validity. For example, a third of those surveyed stated they had had no formal teaching on antimicrobials in the past year, even though this would not be considered a desirable answer. Further, the interspecialty variations on several items suggest that the answers on the survey were a true reflection of practice. Finally, there is the problem of designing a quiz that accurately assesses knowledge. We attempted to design an accurate quiz by having it designed by an expert in IDs with extensive experience writing questions for national residency examinations and then reviewed by ID fellows and an ID-trained pharmacist. However, the quiz did not undergo formal statistical evaluation to ensure its validity.

House staff physicians at our hospital are well aware of the problems posed by antimicrobial resistance and believe that efforts to optimize this use can help address these problems. Our survey found some important variations in the practices of different specialties, which may help in the design of more targeted interventions. Future surveys on antimicrobial use should also include nonspecialized physicians. Overall, educational efforts appear to be inadequate, since antimicrobial knowledge was not higher among upper-level residents than among first-year residents. Our results suggest that such education would be well received, with 90% of house staff wanting more teaching about antimicrobials. Ongoing educational efforts about optimal antimicrobial use, such as the CDC's Campaign to Prevent Antimicrobial Resistance in Health-Care Settings,\textsuperscript{16} will be important measures in helping stem the tide of antimicrobial resistance.

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