Antibiotic Resistance

A Survey of Physician Perceptions

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Background: Antibiotic resistance is caused partly by excessive antibiotic prescribing, yet little is known about prescribers’ views on this problem.

Methods: We surveyed 490 internal medicine physicians at 4 Chicago-area hospitals to assess their attitudes about the importance of antibiotic resistance, knowledge of its prevalence, self-reported experience with antibiotic resistance, beliefs about its causes, and attitudes about interventions designed to address the problem.

Results: The response rate was 87% (424 of 490 physicians). Antibiotic resistance was perceived as a very important national problem by 87% of the respondents, but only 55% rated the problem as very important at their own hospitals. Nearly all physicians (97%) believed that widespread and inappropriate antibiotic use were important causes of resistance. Yet, only 60% favored restricting use of broad-spectrum antibiotics, although this percentage varied by hospital and physician group.

Conclusions: Although most physicians view antibiotic resistance as a serious national problem, perceptions about its local importance, its causes, and possible solutions vary more widely. Disparities in physician knowledge, beliefs, and attitudes may compromise efforts to improve antibiotic prescribing and infection control practices.

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The recognition that antibiotic resistance is caused in part by excessive antibiotic prescribing has prompted calls for reform, yet the optimal methods for addressing this problem remain obscure. Because such reform is likely to require fundamental changes in physicians' behavior, a better understanding of physicians' perceptions of antibiotic resistance is essential. In general, physicians are likely to alter their practice patterns only when their knowledge, beliefs, attitudes, and skills are aligned with the ends (a reduction in antibiotic resistance) and the means to achieve them.

Most surveys regarding antibiotic resistance have focused on patients’ and physicians’ perceptions of antibiotic prescribing for respiratory tract infections in the outpatient setting, with an emphasis on patient demands and expectations. Little is known, however, about how physicians perceive the problem of antibiotic resistance—and efforts to control it—in the inpatient setting.

We surveyed internal medicine physicians at 4 hospitals to measure their knowledge, beliefs, and attitudes regarding antibiotic resistance, with the goal of using the information to design and implement more effective antibiotic control interventions.

Participants and Methods

We conducted a cross-sectional survey of all eligible physicians at 4 Chicago-area hospitals during April and May 1999 using a self-administered questionnaire. The 4 hospitals were selected because they were geographically local and shared professional affiliations, yet varied greatly in mission, level of care, and prevalence of antibiotic resistance. The 4 hospitals included the following: (1) a large, urban, public teaching hospital with a relatively low prevalence of antibiotic resistance (Cook County Hospital); (2) a large, private, university-based teaching hospital with an intermediate prevalence of antibiotic resistance (Rush–Presbyterian–St Luke’s Medical Center); (3) a small, public, community hospital with a low prevalence of antibiotic resistance (Providence Hospital); and (4) a large, public, long-term care hospital with a high prevalence of antibiotic resistance (Oak Forest Hospital).

Physicians eligible for the survey included all internal medicine residents and all internal medicine attending physicians at the 4 institutions (excluding cardiologists and neurologists) who cared for a minimum of 60 inpatients during the preceding calendar year. We did not sur-
The survey defined antibiotic resistance as being present if the bacterial pathogen in question demonstrated in vitro resistance to the first-line antibiotic of choice as recommended by current textbooks or guides. Antibiograms, when mentioned, refer to pocket-sized cards listing in table format the most recent hospital-specific antibiotic resistance rates for important bug-drug combinations.

SURVEY INSTRUMENT

The 94-item self-administered questionnaire collected information on physicians' perceived importance of the problem of antibiotic resistance, their knowledge of the local hospital prevalence of antibiotic resistance, their self-reported experience with antibiotic resistance and its complications, their beliefs about the causes of antibiotic resistance, and their attitudes on current and potential interventions designed to address the problem. Data were also collected on hospital affiliation, level of training, subspecialty, and duration of clinical practice. Copies of the survey instrument are available from one of us (A.T.E.). Most questions about beliefs and attitudes used 5- to 7-point Likert-style response options, from strongly disagree to strongly agree, or other graded response options, such as a 7-point scale from unimportant to extremely important. To assess knowledge of the prevalence of antibiotic resistance, physicians were asked to estimate the prevalence of resistance at their hospital—

from 0% to 100%—for 7 specific bug-drug combinations. Recent rates of resistance were obtained from antibiograms published internally by each hospital's antibiotic and infection control committee. Based on a review of the literature and on local focus groups, we amassed a list of 19 possible causes of antibiotic resistance and 15 possible interventions for respondents to evaluate. Each possible intervention was rated on a 5-point scale for effectiveness, from definitely ineffective to definitely effective, and on a 5-point scale for desirability, from definitely more harmful than good to definitely more good than harm. Because the results of the 2 scales (effectiveness and desirability) are nearly identical, only the results for effectiveness are reported. Physicians were also given the opportunity to identify and rate other causes and interventions that were not among the options listed.

SURVEY ADMINISTRATION

After the institutional review boards at each institution had approved the study, we distributed the questionnaires during a 2-month period in 1999 using a unique identifying number linking the questionnaire to individual respondents. Questionnaires not returned within 2 weeks triggered telephone call reminders and the delivery of up to 2 additional questionnaires. Before data entry, we physically removed the identifying numbers on questionnaires and destroyed the roster linking numbers to physician names. Therefore, although the data were not collected anonymously, we guaranteed complete confidentiality to each respondent.

STATISTICAL METHODS

Our goal was an 80% response rate, which would require 392 respondents among the 490 eligible physicians. To simplify reporting results, we collapsed most 5- to 7-point response options into 3, such as agree/uncertain/disagree, unimportant/neutral/important, and ineffective/unused/effective. There were no important differences when the analyses were conducted using the full response scales and the collapsed scales.

Descriptive univariate analyses included means and SDs for normally distributed continuous data, percentages for categorical data, and quartiles for ordinal or nonnormal continuous data. We tested for differences among the 4 hospitals and among 4 physician groups (residents, general internal medicine attending physicians, infectious disease attending physicians, and other internal medicine subspecialty attending physicians) using an analysis of variance if the data were normally distributed and if the data met the assumption of equal variances (Levene test). Otherwise, we used the equivalent nonparametric test, such as the Mann-Whitney test, the Kruskal-Wallis test, or logistic regression. For examining the relationships among knowledge, beliefs, and attitudes, we used Pearson product moment or Spearman rank correlation coefficients and multivariable linear and logistic regression. We analyzed all data using Statistical Product and Service Solutions software, versions 8 and 9 (SPSS Inc, Chicago). All reported P values are 2-tailed. We made no adjustments for multiple comparisons, but we considered P<.01 as statistically significant.

RESULTS

Among the 490 eligible physicians, 429 returned questionnaires, of which 424 (87%) were complete and evaluable. The sample included 243 internal medicine residents, 114 general internal medicine attending physicians, 21 infectious disease subspecialists, and 46 other internal medicine subspecialists (Table 1).

IMPOR TANCE OF THE PROBLEM OF ANTIBIOTIC RESISTANCE

Most respondents (87%) perceived antibiotic resistance to be a very important national problem. Even more (91%) thought it would be a very important national problem 10 years from now. These attitudes did not differ across hospitals, specialty, or level of training.

However, there was significant variability among physicians' attitudes regarding the problem of antibiotic resistance in their own clinical practices (Figure 1). The proportion of physicians who rated the local problem of antibiotic resistance as very important ranged from 49% at the county hospital to 94% at the long-term care hospital (P=.01). Nearly all infectious disease attending physicians (90%) ranked the local problem of antibiotic resistance as very important, compared with only 53% of non–infectious disease respondents (P=.004). There were no differences between residents and attending physicians (Figure 1). In a multivariable linear model, physicians' attitudes about the local problem of antibiotic resistance were best predicted by their previous experiences with resistance (r=0.25; P<.001), whereas all other variables in the model were insignificant (training status, subspecialty, hospital, and knowledge of local resistance).

KNOWLEDGE OF THE PREVALENCE OF ANTIBIOTIC RESISTANCE

The prevalence of antibiotic resistance for 7 bug-drug combinations is shown for each hospital in Table 1. The accuracy of physicians' estimates of these prevalences is depicted in Figure 2.
Most physicians tended to underestimate the prevalence of antibiotic resistance at their own institution, except for those bug-drug combinations for which only overestimation was possible—vancomycin-resistant Staphylococcus aureus and high-level (minimum inhibitory concentration, \(2.0 \mu g/mL\)) penicillin-resistant Streptococcus pneumoniae, which had actual rates of 0, with one exception (Figure 2). As expected, infectious disease physicians estimated antibiotic resistance rates more accurately and with much less variation.

**EXPERIENCE WITH ANTIBIOTIC RESISTANCE AND ITS COMPLICATIONS**

Infectious disease physicians reported that, on average, 32% of the infected inpatients they cared for had antibiotic-resistant infections, similar to the mean percentage reported by critical care physicians (34%), but twice the rate reported by general internal medicine physicians (16%) \((P<.001)\). There were significant differences in physicians’ experiences with antibiotic-resistant infections that paralleled the true variation in the prevalence of antibiotic resistance across hospitals (Spearman \(\rho=0.55, P<.001\)).

Although the reported prevalence of in vitro resistance to the standard, recommended, first-line antibiotic of choice (our definition of “antibiotic resistance”) ranged from 11% to 44% across the 4 hospitals, the reported resistance to the initial antibiotics actually prescribed was lower (10%) and nearly the same for all physician groups and hospitals.

**CAUSES OF ANTIBIOTIC RESISTANCE**

Nearly all physicians (97%) believed that widespread and inappropriate use of antibiotics were important general causes of antibiotic resistance, while use of antibiotics for self-limited nonbacterial infections and use of antibiotics with a broader-than-necessary spectrum were most often considered very important specific causes (Table 2). Poor hand washing was identified as a very important cause by only 45% of respondents, although with greater frequency at the 2 nonteaching hospitals (71% and 82%) than at the 2 teaching hospitals (38% and 45%) \((P=.006)\).

The factors most frequently identified as unimportant or minimally important were lack of antibiotic restrictions, poor access to prescribing guidelines, drug company promotions, excessive antibiotic use in livestock, and antibiotic use for an inappropriately long duration.

**INTERVENTIONS**

Although most physicians cited widespread antibiotic use as a very important cause of antibiotic resistance, reducing use of antibiotics was considered an effective remedy by only 66% (Table 3). However, almost all infectious disease physicians (20 of 21 physicians) supported the effectiveness of this general approach \((P=.02)\).
The most favored interventions were those that provided information and did not restrict physicians’ behavior, such as providing current antibiograms and institution-specific antibiotic prescribing guidelines and conducting grand rounds on antibiotic prescribing and antibiotic resistance (Figure 3).

At the 2 hospitals with established restrictions on antibiotic use (county and community hospitals), only 11% of residents, 29% of community hospital attending physicians, and 39% of public hospital attending physicians favored increasing the scope of restrictions. In contrast, increasing restrictions was favored by more than 50% of the physicians at the other 2 hospitals, where there are few restrictions (Figure 4).

Figure 1. Physicians’ perceptions of the importance of the problem of antibiotic resistance in their clinical practices. Physicians’ responses are collapsed into 3 groups: extremely important or very important (very important), moderately important or somewhat important (moderately important), and minimally important or unimportant (unimportant). Responses differed by hospital (Kruskal-Wallis test, P=.001) and physician group (Kruskal-Wallis test, P=.004). Numbers in parentheses indicate the number of physicians: ID attendings, infectious disease subspecialists; and non-ID attendings, general internal medicine attending physicians and internal medicine physicians who specialize in areas other than IDs.

Figure 2. Box plots of the differences between physician estimates of antibiotic resistance and true hospital prevalence for 7 bug-drug combinations (surveillance year, 1999). The boxes represent physicians between the 25th and 75th percentiles; white lines within the boxes, medians. Whiskers extend a length of 1.5 times the interquartile range or to the most extreme value, whichever is shortest. The 3 physician groups differed significantly for some of the bug-drug combinations (multivariate analysis of variance, Wilks \( \Lambda =0.77, P<.001 \)), in particular, for Escherichia coli and the combination of ampicillin and sulbactam and for Streptococcus pneumoniae and penicillin (\( P<.001 \) for both). For Klebsiella pneumoniae and ceftazidime, the median estimate was an underestimate of the true prevalence by 9 percentage points, whereas the middle half of physicians (represented by the box) ranged from an underestimate of 12 percentage points to an overestimate of 4 percentage points. However, there were some physicians who underestimated the problem by nearly 30 percentage points. Non-ID specialists indicated internal medicine physicians who specialize in areas other than infectious diseases; ID specialists, those who specialize in IDs; and MIC, minimum inhibitory concentration.

Figure 4. Our survey demonstrates that internal medicine physicians are aware of and concerned about antibiotic resistance in the inpatient setting. However, their perceptions about its importance, its causes, and potential solutions are often contradictory and at variance with available medical evidence.

Although 87% of our sample viewed resistance as a very important national problem—demonstrating awareness of an ecologic problem that poses risks to patients—only 55% believed that antibiotic resistance was a very important problem in their own hospitals, sug-
spondents, yet reducing antibiotic use was believed effective in ameliorating resistance by only 66%. This discrepancy may be due to a lack of awareness of the effectiveness of this strategy in inpatient \textsuperscript{17-20} and outpatient \textsuperscript{21,22} settings or to skepticism about the feasibility of reducing antibiotic use in actual practice.

The tepid endorsement of poor hand hygiene as a contributor to antibiotic resistance may reflect a similar lack of awareness of the effectiveness of this simple, yet underused, practice.\textsuperscript{23-26} Dispelling such misconceptions is a prerequisite for effectively combating resistance.

Agreement with a general strategy of reducing inappropriate antibiotic use does not guarantee acceptance of the specific means of accomplishing the goal. Consistent with the findings of Murray et al.\textsuperscript{14} the internists we surveyed preferred interventions that promote voluntary changes in prescribing behavior, such as dissemination of guidelines, antibiograms, and educational conferences. Guidelines, in particular, have the additional advantage of offering prescribing support to those physicians who are insecure about optimal antibiotic use.\textsuperscript{27}

Although physician education has a generally poor track record in changing physician behavior,\textsuperscript{28} a multifaceted approach can be successful.\textsuperscript{29} The likelihood of success is further enhanced if the educational message is delivered at the time of prescribing,\textsuperscript{30} which is easiest to implement in the context of computerized physician order entry.\textsuperscript{31,32} Because sophisticated informational interventions such as these conform more closely to physicians’ preferences, they may meet with greater acceptance and, possibly, more sustained effectiveness.

There was much less support in our survey for interventions that compel compliance by requiring prior approval for antibiotic use or limiting formulary antibiotic choices, perhaps because they restrict physician au-

### Table 2. Physician Ratings of the Importance of Possible Causes of Antibiotic Resistance\textsuperscript{*}

<table>
<thead>
<tr>
<th>Cause of Antibiotic Resistance</th>
<th>Unimportant or Minimally Important</th>
<th>Somewhat or Moderately Important</th>
<th>Very or Extremely Important</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use of antibiotics for self-limited nonbacterial infections</td>
<td>3</td>
<td>22</td>
<td>75</td>
</tr>
<tr>
<td>Use of antibiotics with a broader-than-necessary spectrum</td>
<td>2</td>
<td>25</td>
<td>73</td>
</tr>
<tr>
<td>Use of antibiotics for shorter than standard duration</td>
<td>15</td>
<td>31</td>
<td>54</td>
</tr>
<tr>
<td>Patient expectations</td>
<td>9</td>
<td>45</td>
<td>46</td>
</tr>
<tr>
<td>Poor hand washing</td>
<td>16</td>
<td>40</td>
<td>45</td>
</tr>
<tr>
<td>Poor access to local antibiograms</td>
<td>10</td>
<td>45</td>
<td>44</td>
</tr>
<tr>
<td>Lack of knowledge about antibiotic prescribing</td>
<td>9</td>
<td>48</td>
<td>43</td>
</tr>
<tr>
<td>Use of antibiotics for self-limited bacterial infections</td>
<td>9</td>
<td>51</td>
<td>40</td>
</tr>
<tr>
<td>Empirical antibiotic therapy</td>
<td>6</td>
<td>56</td>
<td>38</td>
</tr>
<tr>
<td>Mutational and evolutionary microbial changes</td>
<td>10</td>
<td>53</td>
<td>37</td>
</tr>
<tr>
<td>Lack of prescription guidelines</td>
<td>15</td>
<td>49</td>
<td>36</td>
</tr>
<tr>
<td>Pharmaceutical company influence</td>
<td>19</td>
<td>46</td>
<td>35</td>
</tr>
<tr>
<td>Lack of restrictions on antibiotics</td>
<td>17</td>
<td>51</td>
<td>32</td>
</tr>
<tr>
<td>Excessive antibiotic use in livestock</td>
<td>20</td>
<td>49</td>
<td>31</td>
</tr>
<tr>
<td>Use of antibiotics for longer than standard duration</td>
<td>22</td>
<td>48</td>
<td>30</td>
</tr>
<tr>
<td>Poor access to prescribing guidelines</td>
<td>20</td>
<td>52</td>
<td>28</td>
</tr>
</tbody>
</table>

\textsuperscript{*}Data are given as percentage of physicians (N = 424). Percentages may not total 100 because of rounding.

### Table 3. Physician Ratings of the Effectiveness of Potential Interventions for Antibiotic Resistance\textsuperscript{*}

<table>
<thead>
<tr>
<th>Type of Intervention</th>
<th>Probably or Definitely Ineffective</th>
<th>Unsure</th>
<th>Probably or Definitely Effective</th>
</tr>
</thead>
<tbody>
<tr>
<td>General approach</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improve physicians’ knowledge of antibiotic use</td>
<td>2</td>
<td>3</td>
<td>94</td>
</tr>
<tr>
<td>Reduce antibiotic use</td>
<td>11</td>
<td>23</td>
<td>66</td>
</tr>
<tr>
<td>Informational interventions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Institution-specific guidelines for antibiotic use</td>
<td>1</td>
<td>8</td>
<td>91</td>
</tr>
<tr>
<td>Institution-specific antibiograms</td>
<td>3</td>
<td>8</td>
<td>90</td>
</tr>
<tr>
<td>Grand rounds on appropriate prescribing</td>
<td>4</td>
<td>6</td>
<td>90</td>
</tr>
<tr>
<td>Grand rounds on antibiotic resistance</td>
<td>6</td>
<td>8</td>
<td>86</td>
</tr>
<tr>
<td>Restrictive interventions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Require infectious disease subspecialist approval for restricted antibiotics</td>
<td>20</td>
<td>21</td>
<td>60</td>
</tr>
<tr>
<td>Restrict more antibiotics</td>
<td>35</td>
<td>27</td>
<td>38</td>
</tr>
<tr>
<td>Require an antibiotic order form</td>
<td>37</td>
<td>36</td>
<td>27</td>
</tr>
<tr>
<td>Limit interactions with drug company representatives</td>
<td>40</td>
<td>34</td>
<td>25</td>
</tr>
</tbody>
</table>

\textsuperscript{*}Data are given as percentage of physicians (N = 424). Percentages may not total 100 because of rounding.
have little effect on antibiotic resistance, while causing study of physicianscretion in empirical antibiotic prescribing. Therefore, our the greater volume of antibiotic use and the greater distance have focused on the outpatient setting because of the inpatient setting provides complementary information. In summary, the physicians we surveyed were aware of antibiotic resistance as a national problem and recognized the causal role of excessive antibiotic use. At the same time, however, there was substantial ambivalence about the importance of antibiotic resistance in the physicians’ own hospitals, the effectiveness of reducing antibiotic consumption in combating resistance, and the importance of poor hand hygiene as a contributor to resistance. These contradictory perspectives present challenges that must be overcome if we are to successfully address the mounting problem of antibiotic resistance.

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The contents of this study are solely the responsibility of the authors and do not necessarily represent the official views of the Centers for Disease Control and Prevention.

Figure 3. Physicians’ beliefs about the effectiveness of informational interventions. Among the 5 response options, we collapsed definitely effective and probably effective (effective) and definitely ineffective and probably ineffective (ineffective). There was 1 physician from the public hospital and 1 from the university hospital (1 resident and 1 non-ID physician, respectively) who believed informational interventions would be ineffective. Responses differed among the 3 physician groups (Kruskal-Wallis test, $P<.001$), but did not differ significantly among the 4 hospitals (Kruskal-Wallis test, $P=.40$). Numbers in parentheses indicate the number of physicians; ID attendings, infectious disease subspecialists; and non-ID attendings, general internal medicine attending physicians and internal medicine physicians who specialize in areas other than infectious diseases.

Figure 4. Physicians’ beliefs about the effectiveness of restricting more antibiotics. Among the 5 response options, we collapsed definitely effective and probably effective (effective) and definitely ineffective and probably ineffective (ineffective). Responses differed among the 4 hospitals and among the 3 physician groups (Kruskal-Wallis test, $P<.001$ for both). Numbers in parentheses indicate the number of physicians; ID attendings, infectious disease subspecialists; and non-ID attendings, general internal medicine attending physicians and internal medicine physicians who specialize in areas other than infectious diseases.

tomy and complicate antibiotic ordering. Indeed, although prior approval programs can effectively reduce use of targeted antibiotics, they may promote a shift in antibiotic use rather than a reduction in antibiotic resistance, while causing resentment among prescribing physicians.

Previous surveys about antibiotic use and resistance have focused on the outpatient setting because of the greater volume of antibiotic use and the greater discretion in empirical antibiotic prescribing. Therefore, our study of physicians’ attitudes about antibiotic resistance in the inpatient setting provides complementary information. Our overall response rate was high (87%), but we surveyed physicians in only 4 hospitals and did not include all relevant specialties (surgery, pediatrics, family practice, and emergency medicine). And, as with most surveys, it is possible that respondents gave socially desirable answers. To minimize this potential bias, we introduced our survey in a neutral manner, emphasized the dearth of prior research and the appropriateness of disparate views, and assured complete respondent confidentiality. Finally, questions about personal experience are subject to recall bias. Several findings, however, support the questionnaire’s validity: the spectrum of physicians’ reported experiences with antibiotics varied appropriately (twice as common among infectious disease specialists) and physicians’ perceived experiences with antibiotic resistance correlated with objectively measured levels of antibiotic resistance at each hospital.
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