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 (Provident 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-
survey cardiologists and neurologists because we believed they pre-
scribe antibiotics much less often.

The survey defined antibiotic resistance as being present
if the bacterial pathogen in question demonstrated in vitro re-
sistance to the first-line antibiotic of choice as recommended
by current textbooks or guides.13,14 Antibiograms, when men-
tioned, refer to pocket-sized cards listing in table format
the most recent hospital-specific antibiotic resistance rates for im-
portant bug-drug combinations.

SURVEY INSTRUMENT

The 94-item self-administered questionnaire collected infor-
mation on physicians’ perceived importance of the problem
of antibiotic resistance, their knowledge of the local hospital
prevalence of antibiotic resistance, their self-reported experi-
ence with antibiotic resistance and its complications, their
beliefs about the causes of antibiotic resistance, and their atti-
tudes on current and potential interventions designed to
address the problem. Data were also collected on hospital
affiliation, level of training, subspecialty, and duration of cli-
nical 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 knowl-
dge 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. Re-
cent rates of resistance were obtained from antibiograms pub-
lished internally by each hospital’s antibiotic and infection control
committee. Based on a review of the literature and on local fo-
cus groups, we amassed a list of 19 possible causes of antibi-
otic 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 harm than good to definitely more good than harm. Be-
cause the results of the 2 scales (effectiveness and desirability)
are nearly identical, only the results for effectiveness are re-
ported. 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 link-
ing the questionnaire to individual respondents. Question-
naires not returned within 2 weeks triggered telephone call re-
minders and the delivery of up to 2 additional questionnaires.
Before data entry, we physically removed the identifying num-
bers on questionnaires and destroyed the roster linking num-
bers to physician names. Therefore, although the data were not
collected anonymously, we guaranteed complete confidential-
ity to each respondent.

STATISTICAL METHODS

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

Descriptive univariate analyses included means and SDs
for normally distributed continuous data, percentages for cat-
egorical data, and quartiles for ordinal or nonnormal contin-
uous data. We tested for differences among the 4 hospitals and
among 4 physician groups (residents, general internal medi-
cine attending physicians, infectious disease attending physi-
cians, and other internal medicine subspecialty attending phy-
sicians) using an analysis of variance if the data were normally
distributed and if the data met the assumption of equal vari-
ances (Levene test). Otherwise, we used the equivalent non-
parametric 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 prod-
uct moment or Spearman rank correlation coefficients and mul-
tivariable linear and logistic regression. We analyzed all data
using Statistical Product and Service Solutions software, ver-
sions 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.

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

IMPORTANCE OF THE PROBLEM
OF ANTIBIOTIC RESISTANCE

Most respondents (87%) agreed that antibiotic resistance
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 propor-
tion of physicians who rated the local prob-
lem 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 prob-
lem 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 insignifi-
cant (training status, subspecialty, hospital, and knowl-
gedge 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
prevalence of antibiotic resistance for 7 bug-drug
combinations is shown for each hospital in Table 1.
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, \( \geq 2.0 \mu g/mL \)) 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 \((P = .02)\).

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**Table 1. Characteristics of Participating Physicians and Hospitals**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Public Hospital</th>
<th>University Hospital</th>
<th>Community Hospital</th>
<th>Long-term Care Hospital</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residents</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of respondents</td>
<td>143</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>243</td>
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<tr>
<td>Response, %</td>
<td>91</td>
<td>84</td>
<td>. .</td>
<td>. .</td>
<td>88</td>
</tr>
<tr>
<td>Attending physicians</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General internal medicine</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of respondents</td>
<td>61</td>
<td>31</td>
<td>8</td>
<td>14</td>
<td>114</td>
</tr>
<tr>
<td>Response, %</td>
<td>92</td>
<td>82</td>
<td>72</td>
<td>93</td>
<td>88</td>
</tr>
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<td>Infectious disease subspecialty</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>No. of respondents</td>
<td>11</td>
<td>7</td>
<td>2</td>
<td>1</td>
<td>21</td>
</tr>
<tr>
<td>Response, %</td>
<td>92</td>
<td>88</td>
<td>100</td>
<td>100</td>
<td>91</td>
</tr>
<tr>
<td>Other subspecialty</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of respondents</td>
<td>19</td>
<td>21</td>
<td>4</td>
<td>2</td>
<td>46</td>
</tr>
<tr>
<td>Response, %</td>
<td>70</td>
<td>81</td>
<td>80</td>
<td>100</td>
<td>77</td>
</tr>
<tr>
<td>Total respondents</td>
<td>234/283 (89)</td>
<td>159/191 (83)</td>
<td>14/18 (78)</td>
<td>17/18 (94)</td>
<td>424/490 (87)</td>
</tr>
<tr>
<td>Attending physician clinical experience, median (25th-75th percentile), y</td>
<td>11 (6-18)</td>
<td>15 (8-21)</td>
<td>11 (9-12)</td>
<td>12 (9-18)</td>
<td>12 (7-19)</td>
</tr>
<tr>
<td>Prevalence of antibiotic-resistant pathogens, %†‡</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><em>Escherichia coli</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Ampicillin-sulbactam</td>
<td>50</td>
<td>41</td>
<td>48</td>
<td>35</td>
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<tr>
<td>Trimethoprim-sulfamethoxazole</td>
<td>27</td>
<td>20</td>
<td>16</td>
<td>48</td>
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</tr>
<tr>
<td>Ciprofloxacin</td>
<td>4</td>
<td>11</td>
<td>2</td>
<td>37</td>
<td>. . . . . .</td>
</tr>
<tr>
<td><em>Staphylococcus aureus</em> and methicillin sodium</td>
<td>28</td>
<td>46</td>
<td>32</td>
<td>83</td>
<td>. . . . . .</td>
</tr>
<tr>
<td>Klebsiella pneumoniae and ceftazidime</td>
<td>11</td>
<td>17</td>
<td>4</td>
<td>76</td>
<td>. . . . . .</td>
</tr>
<tr>
<td>Streptococcus pneumoniae and penicillin (MIC, &gt;2.0 µg/mL)</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>. . . . . .</td>
</tr>
</tbody>
</table>

*MIC indicates minimum inhibitory concentration; ellipses, data not applicable.

†Data are given as total number of respondents/total number eligible (percentage). There was no difference in response rates between residents and attending physicians.

‡The prevalence of vancomycin-resistant *S aureus* was 0 at all hospitals.
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).

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, suggesting that many respondents see the risks as more theoretical than concrete, possibly weakening the impetus for behavior change. These findings are consistent with those of Paluck and colleagues, who found that only 77% of British Columbia family practitioners agreed that widespread antibiotic use was a notable factor in their own communities.

There was also wide variation in physicians’ knowledge of the prevalence of antimicrobial resistance at their own hospitals, despite the availability of antibiograms at each. Perceived prevalence, however, was only weakly correlated with physicians’ perceived importance of resistance in their own hospitals. This suggests that educational interventions or antibiograms that correct physicians’ underestimates of the prevalence of resistance may not translate into a heightened concern for the problem. Because personal experience with antibiotic resistance was a stronger predictor of perceptions about importance, it raises the possibility that case vignettes illustrating the harmful effects of antibiotic resistance may improve the effectiveness of interventions.

Another apparent contradiction in our survey results is the perceived role of antibiotic use as a cause of resistance and as a target for interventions. Widespread antibiotic use and inappropriate use were believed to be important general causes of resistance by 97% of the respondents.
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.

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

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

\*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 a 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.

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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