How Nova Scotia general practitioners choose antibiotics for the empirical treatment of community-acquired pneumonia

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OBJECTIVE: To gain an understanding of how physicians in general practice choose antibiotics for the empirical treatment of community-acquired pneumonia (CAP).
DESIGN: Questionnaire with three sample cases of CAP and a knowledge assessment (mailed to half of the physicians).
POPULATION STUDIED: Nova Scotia family physicians.
RESULTS: One hundred and eighty-four of the 841 (21.9%) physicians who were mailed a questionnaire responded. A knowledge assessment showed satisfactory knowledge except in two areas – an overestimation of the prevalence of penicillin-resistant *Streptococcus pneumoniae* in Nova Scotia and the view that ciprofloxacin was an effective antibiotic for the treatment of CAP (42% of physicians). As the complexity of the case increased, there was decreasing consensus regarding the choice of antibiotic therapy and a decline in prescribing according to guidelines for the treatment of CAP. Also, as the complexity of the cases increased, it became increasingly difficult to discern a decision-making strategy. For the simplest case – a 17-year-old male with presumed *Mycoplasma pneumoniae* pneumonia – physician factors (age, family practice training), desire to target specific pathogens, and concern with resistance and side effects affected the choice of antibiotic. However, for the most complex case – a 45-year-old female with severe pneumonia – familiarity with such a case was the only significant factor and led to treatment with a combination of antibiotics designed to treat both typical and atypical pathogens.
CONCLUSIONS: For uncomplicated cases of CAP, physician factors, desire to treat specific pathogens and concern with resistance affect the choice of antibiotic therapy. For complex cases, familiarity with such cases was the only factor that influenced choice of antibiotic therapy.

Key Words: *Antibiotics; Community-acquired pneumonia; Decision-making; Empirical treatment; General practitioners*

Critères de sélection du traitement empirique contre la pneumonie extrahospitalière chez les omnipraticiens néo-écossais

OBJECTIF : Comprendre comment les omnipraticiens choisissent les antibiotiques pour le traitement empirique de la pneumonie extrahospitalière.
MODÈLE : Questionnaire portant sur trois cas types de pneumonie extrahospitalière et évaluation des connaissances (expédié à la moitié des médecins).

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POPULATION ÉTUDIÉE : Médecins de famille de la Nouvelle-Écosse.
RÉSULTATS : Cent quatre-vingt-quatre médecins sur 841 (21,9 %) à qui on a posté le questionnaire ont répondu. L'évaluation des connaissances a montré un degré de connaissances satisfaisant, sauf dans deux domaines, soit une surestimation de la prévalence des souches de *Streptococcus pneumoniæ* pénicillino-résistantes en Nouvelle-Écosse et la perception que la ciprofloxacine est un antibiotique efficace pour le traitement de la pneumonie extrahospitalière (42 % des médecins). À mesure que les cas devenaient plus complexes, on notait une baisse du consensus en ce qui a trait au choix de l'antibiothérapie et une baisse des ordonnances correspondant aux directives thérapeutiques pour le traitement de la pneumonie extrahospitalière. En outre, à mesure que les cas devenaient plus complexes, il devenait plus difficile de discerner une stratégie décisionnelle. Pour le cas le plus simple, un jeune homme de 17 ans, présumé atteint d'une pneumonie à *Mycoplasma pneumoniæ*. Les facteurs liés au médecin (âge, formation en médecine familiale), le ciblage d'organismes pathogènes spécifiques et l'inquiétude à l'endroit du phénomène de la résistance et des effets secondaires ont influé sur le choix de l'antibiotique. Par contre, dans le cas le plus complexe, soit celui d'une femme de 45 ans atteinte de pneumonie grave, le degré de connaissances a été le seul facteur significatif à avoir mené à un traitement d'antibiothérapie associative conçu pour traiter les organismes pathogènes typiques et atypiques.
CONCLUSION : Pour les cas de pneumonie extrahospitalière non compliqués, les facteurs liés au médecin, le ciblage des agents pathogènes spécifiques et l'inquiétude soulevée par le phénomène de résistance ont influé sur le choix de l'antibiothérapie. Dans les cas complexes, le degré de connaissance a été le seul facteur à influer sur le choix de l'antibiothérapie.

Community-acquired pneumonia (CAP) is one of the most commonly diagnosed infectious diseases in North America, and is a cause of significant morbidity and mortality. Proper treatment depends on targeting antibiotic therapy towards the responsible pathogen. In 50% of cases, however, the specific pathogen cannot be detected (1). In those cases where treatment must be empirical, antibiotic choice is based on clinical and demographic 'cues' provided by the patient. Interpretation of these cues is influenced by the context in which the physician is practising and by the physician's decision-making process. It is important that this decision-making process be better understood, because it has been estimated that as many as 30% of preventable deaths from pneumonia are due to improper choice of antibiotics (2).

Earlier studies revealed only a vague picture of how physicians choose antibiotics for the treatment of pneumonia. Lilja's survey (3) of 180 Dutch general practitioners concluded that physicians are most concerned with the 'curing' effect of the antibiotics that they choose for treating pneumococcal pneumonia, and express more concern about cost than side effects. Hepler et al (4) concluded that physicians tend to base empirical choice of antibiotics on "instrumentalities", ie, beliefs regarding the relationship between treatment and outcome. Hueston and Schiaffino (5) found that for patients with CAP, internists were more likely than family physicians to prescribe broader spectrum antibiotics, and both groups prescribed broader spectrum agents for older patients. A previous study found that infectious disease specialists show decreasing consensus regarding the choice of antibiotic therapy as the severity of the pneumonia increases, with choice of therapy becoming increasingly dependent on physician characteristics such as age and province of practice (6).

To understand better the process by which physicians choose antibiotics when treating CAP empirically, a survey of Nova Scotia general practitioners was undertaken. The survey was designed to answer three specific questions. First, what antibiotics are chosen by general practitioners when treating CAP empirically? Second, how do those choices compare with the choices made by Canadian infectious disease specialists and with the recommendations of published guidelines? Third, what factors influence or correlate with the antibiotic chosen by the general practitioner for treating CAP empirically?

PATIENTS AND METHODS

A total of 841 questionnaires were mailed during April and May 1997 to general practitioners registered with the Medical Society of Nova Scotia. Respondents were asked to provide the following demographic information: age; sex; medical school attended; graduation year; whether they had family practice training; whether they had specialty training, and if so what kind; whether their practice was solo or group, and rural or urban; whether they had hospital admitting privileges; the number of pneumonia cases seen in the previous two months; the average number of prescriptions written per day; and the average percentage of prescriptions written for antibiotics.

Respondents were then presented with three hypothetical cases of CAP in which a definite pathogen was not known. These cases were based on the three types of patients described by the Canadian Consensus Guidelines for the Empirical Treatment of CAP {**12**}. The first case involved a 17-year-old, previously healthy patient with a nonsevere clinical presentation. The second scenario concerned a 66-year-old male with a long smoking history and a nonsevere clinical presentation. The third scenario was based on a 45-year-old, previously healthy woman with a severe clinical presentation. The actual case presentations are provided in Appendix 1.

For each case, respondents were asked whether they treated such patients frequently, occasionally, rarely or never. These responses were coded numerically with "never" equalling 1 and "frequently" equalling 4, thereby creating a 'familiarity index' for each case. Respondents were then asked to name the antibiotic therapy that they would most likely use to initiate treatment and to explain their choice by assigning values to a series of Likert scales. The Likert scales assessed decision-making variables that previous studies had found to be important in the choice of antibiotic for the empirical treatment of CAP (see Appendix A).

An additional section was attached to one-half of the questionnaires. This section contained questions designed to as-

TABLE 1
Characteristics of physicians who completed case-based questionnaires regarding antibiotic choice to treat community-acquired pneumonia (n=184)

Characteristic	Questionnaire respondents
Sex	
Male	117 (63.6%)
Female	67 (36.4%)
Mean age of respondent (years SD)	42.8 8.6
Mean number of years since graduation (± SD)	16.6 8.6
Medical school attended	
Dalhousie	130 (71.8%)
Other Canadian medical school	36 (19.9%)
Non-Canadian medical school	15 (8.3%)
Respondents with family practice training	100 (54.95%)
Respondents with specialty training	27 (17.3%)
Size of practice	
Solo	55 (30.4%)
Group	126 (69.6%)
Population density of practice area	
Rural	62 (53.9%)
Urban	53 (46.1%)
Respondents with hospital admitting privileges	130 (73.4%)
Mean number pneumonia patients seen in past two months (SD)	7.7 7.7
Mean number prescriptions written per day (± SD)	21.1 17.8
Percentage of prescriptions written for antibiotics	
Less than 10%	15 (8.3%)
10% to 14%	43 (23.8%)
15% to 29%	65 (35.9%)
30% to 49%	40 (22.1%)
50% to 70%	16 (8.8%)
More than 70%	2 (1.1%)

TABLE 2
Answers to knowledge-testing questions on case-based questionnaires regarding antibiotic choice to treat community acquired pneumonia (n=71)

A. "What antibiotic is most effective in treating..."	
Chlamydia pneumoniae	
Macrolide	40 (57.1%)
Tetracycline	20 (28.6%)
Doxycycline	8 (11.4%)
Metronidazole	2 (2.9%)
Legionella pneumoniae	
Macrolide	59 (88.0%)
Tetracycline	4 (6.0%)
Other	4 (6.0%)
Mycoplasma pneumoniae	
Macrolide	66 (94.3%)
Tetracycline	4 (5.7%)
Staphylococcus aureus	
Cloxacillin	29 (42.%)
Amoxicillin/clavulinic acid	9 (13.%)
Second generation cephalosporin	7 (10.1%)
Amoxicillin	5 (7.2%)
Penicillin	4 (5.8%)
Macrolide	2 (2.9%)
Other	13 (18.8%)
Streptococcus pneumoniae	
Penicillin	40 (56.3%)
Amoxicillin/clavulinic acid	5 (7.0%)
Amoxicillin	5 (7.0%)
Ampicillin	5 (7.0%)
Second generation cephalosporin	4 (5.6%)
Macrolide	4 (5.6%)
Other	8 (11.3%)
B. Respondents able to name three macrolides	54 (76.1%)
C. "Is ciprofloxacin an effective antibiotic in the treatment of community-acquired pneumonia?"	
No	38 (57.6%)
Yes	28 (42.4%)
D. "What percentage of *Streptococcus pneumonia*e isolates in your area are resistant to penicillin?"	
0% to 1%	9 (22%)
2% to 5%	3 (7.3%)
6% to 10%	8 (19.5%)
11% to 20%	8 (19.5%)
More than 20%	13 (31.7%)

sess the respondent's base knowledge of microbiology and antibiotics. The section was included in only one-half of the surveys to determine whether its presence would affect the response rate. Respondents were asked the following: the most likely pathogen for each of the three cases presented; the antibiotic of choice for treating *Chlamydia pneumoniae*, *Haemophilus influenzae, Legionella pneumophilia, Mycoplasma pneumoniae, Staphylococcus aureus* and *Streptococcus pneumoniae*; the names of three macrolides, and which of the three, if any, would be most effective; whether ciprofloxacin would be an appropriate drug for treating CAP; and what percentage of local *S pneumoniae* isolates are resistant to penicillin. Respondents were also asked how many cases of Legionnaires disease, and *M pneumoniae*, *C pneumoniae* and *S pneumoniae* infection that they had treated in the past year.

Statistical analysis: Statistical analysis of the questionnaires was accomplished using the software application StatView (SAS Institute Inc, United States). Antibiotics were grouped into classes, such as macrolides, penicillins (including ampicillin, amoxicillin and amoxicillin/clavulinic acid), and first, second or third generation cephalosporins.

For discrete variables, a ^{2} analysis was employed. For continuous variables, a one-factor ANOVA was used. For analysis of the values assigned to the decision-making variables, a two-factor, repeated-measures ANOVA was used. If significant interaction was found between the antibiotic choice and the decision-making variables, a one-factor ANOVA was undertaken for each of the decision-making variables individually. When a one-factor ANOVA of a decision-making variable was significant, antibiotic classes were compared with one another for that variable using Fisher's test of least significant difference (7).

TABLE 3
Factors found to be significant correlates with respondent choice of antibiotic for case 1 – A 17-year-old, previously healthy patient with nonsevere clinical presentation

	Macrolide	Penicillin	Other	P
Family practice training	59 (39.1%)	15 (71.4%)	8 (66.7%)	0.001
Mean age (years)	41.3	48.7	50.8	0.0001
Mean graduation year	1982	1974	1973	0.000
Mean weights assigned to Likert scales				
Desire to target specific pathogen	4.540	4.381	3.917	0.028
Concern with antimicrobial resistance	2.940	2.000	3.667	0.000
Desire to minimize side effects	2.940	3.952	3.833	0.000
Two most common pathogens targeted (number of respondents)	MP (90), SP (54)	SP (14), MP (3)	SP (5), MP (3)	NA

MP Mycoplasma pneumoniae; *NA Not applicable; SP* Streptococcus pneumoniae

In cases where respondents stated that they were attempting to target specific pathogens, additional analyses were conducted. The most commonly targeted pathogens were compared qualitatively across the different antibiotic classes, and the mean number of pathogens targeted (among respondents who targeted pathogens) was calculated for each antibiotic class. These mean number of pathogens targeted by each antibiotic class was then compared using a one-factor ANOVA (7).

In summary, an attempt was made to correlate a respondent's antibiotic choice in three ways: with physician demographics (eg, medical school attended); with physician decision-making strategy (ie, the weights assigned to the decision-making variables); and with the types and number of pathogens towards which respondents directed treatment.

RESULTS

A total of 184 of the 841 (21.9%) case-based questionnaires were returned. The characteristics of the survey respondents are shown in Table 1. Seventy-one of the returned questionnaires contained answers to knowledge-testing questions; the responses to these questions are summarized in Table 2. Two questions were answered poorly. Almost one-half, 42%, felt that ciprofloxacin was an effective antibiotic for the treatment of CAP, and the prevalence of penicillin-resistant *S pneumoniae* in Nova Scotia was overestimated.

Case 1 – 17-year-old male with no comorbidity and a nonsevere clinical presentation: Respondents assigned an average familiarity index of 2.8 to this case. The most commonly chosen antibiotic was a macrolide (82%), followed by a penicillin (11%). Seven per cent of respondents chose an antibiotic therapy that did not fall into any particular class.

The demographic factors that correlated significantly with antibiotic choice were the presence or absence of family practice training, the respondent's age and the number of years since graduation (Table 3). Respondents who chose a macrolide tended to be younger and to have graduated more recently, and were less likely to have family practice training than respondents who chose other antibiotic classes. Correlation approaching significance was found with medical school attended, and solo versus group practitioners; respondents who graduated from Canadian medical schools from other provinces (than Nova Scotia) and respondents who worked in group practices were more likely to choose a macrolide for this case. No significant correlation was found with the remaining demographic factors (physician sex, specialty training, rural versus urban practice, hospital admitting privileges, number of pneumonia cases seen in previous two months, number of prescriptions written per day, percentage of prescriptions written for antibiotics or familiarity with the case).

Significant interaction was found between the weights assigned to the various decision-making variables and the antibiotic chosen; that is, there were apparent differences in decision-making strategy for choosing an antibiotic. A series of one-factor ANOVAs was then conducted for each of the decision-making variables, and the following were found to be significant correlates of antibiotic choice: a desire to target a specific pathogen (P=0.287); concern with antibiotic resistance (P=0.000); and concern with side effects (P=0.000). Respondents who chose a macrolide attached more importance to targeting specific pathogens but were less concerned with side effects than other respondents, while respondents who chose a penicillin were the least concerned with the issue of antibiotic resistance.

One hundred and twenty-five of the 184 respondents (68%) named specific pathogens that they were targeting. These respondents named an average of 1.56 pathogens, with no significant correlation between number of pathogens named and the antibiotic therapy chosen. Qualitatively, it appeared that most doctors suspected either a mycoplasmal or streptococcal infection, although respondents who chose a macrolide appeared to be more confident of a mycoplasmal infection.

Case 2 – 66-year-old male with comorbidity and non-severe clinical presentation: Respondents assigned an average familiarity index of 3.1 to this case. The most commonly chosen type of antibiotic was a second generation cephalosporin (34%), followed by a penicillin (28%), a macrolide (15%), and trimethoprim/sulphamethoxazole (TMP/SMX) (11%). A further 11% of respondents chose an antibiotic therapy that did not fall into any particular class.

No demographic predictors of antibiotic choice could be identified for this case. There was, however, interaction between antibiotic choice and the decision-making variables (Table 4). A series of one-factor ANOVAs was then conducted for each of the decision-making variables, and the following

TABLE 4
Factors found to be significant correlates with respondent choice of antibiotic for case 2 – A 66-year-old male with comorbidity and nonsevere clinical presentation

	2nd generation cephalosporin	Penicillin	Macrolide	TMP/SMX	Other	P
Mean weights assigned to Likert scales*						
Concern with patient's health	4.238	3.750	4.370	4.286	4.000	0.014
Concern with smoking history	4.365	3.615	4.148	4.381	4.048	0.000
Concern with resistance	3.714	2.846	3.704	3.524	2.952	0.000
Experience with similar cases	4.206	3.635	4.222	4.143	4.000	0.01
Concern with cost-effectiveness	3.222	3.750	3.556	4.238	3.333	0.000
Mean number of pathogens targeted	1.667	1.367	2.25	1.583	1.167	0.030
Two most common pathogens targeted (number of respondents)	SP (30), HI (22)	SP (28), HI (8)	SP (10), HI (6)	SP (11), MP (5)	SP (6), HI (5)	NA

HI Haemophilus influenzae*; MP* Mycoplasma pneumoniae*; NA Not applicable; SP* Streptococcus pneumoniae*; TMP/SMX Trimethoprim/sulphamethoxazole*

TABLE 5
Factors found to be significant correlates of respondent choice of antibiotic for case 3 – A 45-year-old woman with no comorbidity and severe clinical presentation

	2nd generation cephalosporin	3rd generation cephalosporin	2nd generation cephalosporin and macrolide	Macrolide	3rd generation cephalosporin and macrolide	Other	P
Familiarity index	1.882	1.903	2.037	1.8	2.077	1.591	0.03
Top two pathogens targeted (number of respondents)	SP (13), LP (2)	SP (6), SA (4)	SP (11), LP (6)	MP (5), SP (3), LP (3)	MP (5), HI (3)	SP (19), MP (8)	NA

HI Haemophilus influenzae*; LP* Legionella pneumophilia*; MP* Mycoplasma pneumoniae*; NA Not applicable; SA* Staphylococcus aureus*; SP* Streptococcus pneumoniae

were found to be significant correlates of antibiotic choice: concern with the patient's general health (P=0.014); concern with the patient's smoking history (P=0.000); concern with the possibility of resistance (P=0.000); experience with similar cases (P=0.013); and concern with cost-effectiveness (P=0.000). Respondents who chose a penicillin were less concerned with the patient's health and smoking status and with the issue of resistance, and were less likely to base their choice of antibiotic on experience. However, they attached greater importance to cost effectiveness than respondents who chose a second generation cephalosporin. Respondents who chose TMP/SMX also attached more importance to cost effectiveness than respondents who chose either a second generation cephalosporin or a macrolide.

No significant differences were found for the other decision-making variables (patient age, results of Gram stain, published guidelines, desire to target a specific pathogen, concern with side effects, peer preference or other factors).

Ninety-six of the 184 respondents (52%) named specific pathogens that they were treating. These respondents named an average of 1.60 pathogens, with significant correlation found between number of pathogens targeted and antibiotic therapy chosen. Respondents who chose a macrolide tended to name the most pathogens, while respondents who chose either a penicillin or an antibiotic that fell into no particular class named the fewest (P=0.030). While the number of pathogens targeted varied with the antibiotic chosen, there seemed to be general consensus among respondents that *S pneumoniae* was the most likely pathogen, followed by *H influenzae*.

Case 3 – 45-year-old woman with no comorbidity and a severe clinical presentation: Respondents assigned an average familiarity index of 1.8 to this case. The most common antibiotic choice was a second generation cephalosporin (20%), followed by a third generation cephalosporin (18%),a second generation cephalosporin with a macrolide (16%), macrolide alone (12%) and a third generation cephalosporin with macrolide (8%). Twenty-eight per cent of respondents chose an antibiotic therapy that did not fall into any particular class.

No demographic predictors of antibiotic choice could be found for this case beyond respondent familiarity with similar patients (Table 5). Respondents who expressed the greatest degree of familiarity with this type of case tended to choose a second or third generation cephalosporin combined with a macrolide, whereas those who were least familiar chose an antibiotic that did not fall into any particular class of therapy (P=0.030).

Seventy-six of the 184 respondents (41%) named specific pathogens against which they were targeting their antibiotic choice. These respondents named an average of 2.17 pathogens, with no significant correlation between the number of pathogens named and the antibiotic therapy chosen.

DISCUSSION

The aim of the present study was to undertake a descriptive analysis of how physicians choose antibiotics for a specific disease process (CAP). We found that Nova Scotia general practitioners knew the antibiotics of choice for the treatment of *C pneumoniae*, *M pneumoniae* and *L pneumophila*. Surprisingly, less than half knew that cloxacillin was the antibiotic of

choice for the treatment of *S aureus* pneumonia and 42% felt ciprofloxacin was an effective agent for the treatment of CAP. The latter conclusion probably reflects the common use of ciprofloxacin and a deficit in knowledge that it is ineffective against *P pneumoniae*, the most common cause of CAP. The inadequate knowledge about rates of penicillin-resistant *S pneumoniae* in Nova Scotia reflects the fact that this information is not readily available to Nova Scotia general practitioners. Previous studies that have attempted to model physician drug choice have resulted in the 'lens' model and the 'drug-expectancy-value' model. In the 'lens' model (8), physicians are assumed to read a series of cues from a clinical situation (for example, the patient's age), assign relative values to those cues, and then weigh the cues against one another in order to arrive at a clinical impression. In the 'drugexpectancy-value model', developed by Segal and Hepler (9), a physician chooses a drug by considering various "instrumentalities" associated with that drug, for example, the drug's cost, assigning values to those instrumentalities based on their probability and relative importance, in this way choosing the drug that has the highest net value. Both models draw upon a cognitivist decision-making assumption; that is, they assume that impressions and decisions are constructed rationally. Some authors have proposed that the decision-making strategy itself changes in response to the complexity of the task at hand (10). Others have argued that decision-making is primarily behavioural, based upon conditioned responses derived from previous experiences, such as the medical school attended (11). In the present study, both behaviourist (ie, physician demographics) and cognitive factors (ie, decision-making variables) were explored for their relevance to the respondent's choice of antibiotic. Furthermore, the decision-making variables that were measured by the Likert scale consisted of both clinical cues (eg, chest x-ray) and issues regarding drug instrumentality (eg, likelihood of encountering antibiotic resistance). As was expected, physician demographics, the clinical cues provided in each of the cases and issues surrounding the properties of the antibiotics themselves, all had some influence on the physician's choice of antibiotic (Table 6).

One advantage of using written cases to study prescribing behaviour is that it allows for a controlled comparison between different groups of physicians. The three cases of CAP used in this study were also used in a previous study of Canadian infectious disease specialists (6); thus, a comparison between 'generalist' and 'specialist' opinion is possible. For case1 (17-year-old male, previously healthy), a macrolide was the most popular choice of both Nova Scotia general practitioners (82%) and Canadian infectious disease specialists (75%). For case 2 (66-year-old male with smoking history), however, the general practitioners were more likely to choose a second generation cephalosporin (34%) than a penicillin (26%), while the opposite was true for the infectious disease specialists (25% and 41%, respectively). For case 3 (45-year-old female, severely ill), there was little agreement between the two groups. Nova Scotia general practitioners chose, in descending order, a second generation cephalosporin (20%), a third generation cephalosporin (18%), a second generation cephalosporin with macrolide (16%), a macrolide alone (12%) or a third generation cephalosporin with a macrolide (8%). Canadian infectious disease specialists were more likely to choose a combination therapy, opting for a third generation cephalosporin with a macrolide (43%), a second generation cephalosporin with a macrolide (18%) or triple therapy of a third generation cephalosporin with a macrolide and another antibiotic (13%). If the guidelines of the Canadian Community Acquired Pneumonia Consensus Group (12) are applied to these three cases, the recommended therapy for case 1 would be a macrolide; for case 2, a second generation cephalosporin; and for case 3, a second or third generation cephalosporin with a macrolide with or without rifampin (12).

TABLE 6
Correlates of antibiotic choice: Summary of results

Correlates of antibiotic chosen	Case 1	Case 2	Case 3
Demographic factors	Yes	No	No
Decision-making strategy	Yes	Yes	No
Type of pathogens targeted	Yes	No	Yes

When the three cases of CAP are ranked in order of increasing complexity (case 1 case 2 case 3), a number of trends can be observed. First, as case complexity increased there was decreasing consensus regarding the choice of antibiotic among both general practitioners and infectious disease specialists. Second, there was decreasing agreement between the two groups. Third, general practitioners became less and less likely to prescribe in accordance with published guidelines. Fourth, the number of general practitioners who targeted their therapy against a specific pathogen decreased. Finally, for the general practitioners who did target specific pathogens, the average number of pathogens targeted increased.

There is no one 'correct' choice of antibiotic for any of the three cases. However, it can be assumed that the best choice of antibiotic will be the one recommended by both the practice guidelines and expert opinion. If one accepts this assumption, the results of the present study suggest that while general practitioners manage straightforward cases of CAP appropriately, they are less comfortable treating more seriously ill patients.

When the three cases were ranked in order of decreasing familiarity to the general practitioners surveyed (case 2 case 1 case 3), another trend emerged: it became increasingly difficult to discern a decision-making strategy. For case 2, differences in antibiotic choice correlated with five decision-making variables, and there was little debate about which pathogens were most likely. For case 1, only three decision-making variables were of importance in predicting antibiotic choice, while physician demographics (eg, age, graduation year, family practice training) assumed greater importance. In addition, there was decreasing consensus about which pathogens were most likely the cause. Finally, for case 3, differences in antibiotic choice did not correlate with any decision-making variables, and the only demographic factor that could predict antibiotic choice was overall familiarity with the type of patient

described. There was very little agreement regarding which pathogens should be targeted.

It is interesting to note that although familiarity with case 3 was a predictor of antibiotic choice for that particular case, the number of pneumonia patients treated in the previous two months did not predict antibiotic choice for any of the three cases. Similarly, when each respondent had their familiarity indexes for each case averaged into a measure of their 'overall familiarity' with pneumonia, this, too failed to predict which antibiotics they would choose for any of the three cases. That is, overall familiarity with pneumonia did not predict physician choice of antibiotics for any of the three cases. It could be concluded that mild, moderate and severe cases of CAP are best thought of as three discrete clinical entities that the general practitioner must become familiar with separately.

Another notable finding was that, for all three cases, respondent choice of antibiotic was not predicted by the weight given to laboratory investigations (ie, chest x-ray and Gram stain), patient age or peer preference. It is difficult to interpret this finding, however, because the weights assigned to these variables were sometimes high; the average weight assigned to the results of the Gram stain, for example, was 4.011 of a possible five. There are several explanations for this. It may be that these variables truly do not influence antibiotic choice; previous studies suggest that microbiological diagnosis only rarely influences the clinical management of pneumonia (13) and often does not prompt physicians to change their initial, empirical choice of antibiotic therapy (14).

Alternatively, the seeming irrelevance of certain variables to the drug-choosing process might be the result of flaws in study design. The importance of some variables (for example, peer preference) may not have been appreciated consciously by respondents, and by grouping antibiotics into classes such as 'macrolides', important differences between specific antibiotics, such as erythromycin and azithromycin, could have been masked. Such flaws in study design may explain the apparent irrelevance of patient age to the drug choice process, a finding that contradicts earlier studies of antibiotic choice for CAP (5).

Earlier studies of general practitioners have concluded that the more appropriate or 'rational' prescriber tended to be younger and more recently graduated from medical school, to have received more years of postgraduate training, to be working in a group practice setting and to prescribe fewer drugs per patient visit (15-17). The reasoning underlying these conclusions has since been criticized (18), and a more recent study of New Zealand general practitioners observed that neither practitioner nor practice-related factors could explain more than 3% of the observed variance in antibiotic choice (19). The present study also found few physician or practice characteristics that could predict antibiotic choice. Younger and more recent graduates did prescribe more in accordance with guidelines for case 1. Surprisingly, physicians with more postgraduate training (ie, family practice training) were less likely to prescribe according to guidelines for case 1. Respondents who reported frequent prescribing or who prescribed a high proportion of antibiotics did not appear to prescribe different types of antibiotics for any of the three cases. There was occasionally a correlation approaching significance (results not shown) between the antibiotic chosen and the respondent's type of practice (solo versus group and urban versus rural) and medical school attended (Dalhousie University versus other Canadian schools versus non-Canadian schools).

The responses given to the knowledge-testing questions demonstrate a good understanding of the microbiology relevant to the choice of antibiotics for CAP. It is notable, however, that while 56% of respondents chose penicillin as being the most effective treatment for *S pneumoniae*, another 34% of respondents chose extended spectrum penicillins or cephalosporins. It is also noteworthy that 42% of respondents considered ciprofloxacin to be an effective treatment for CAP.

Also, one-half of the respondents also grossly overestimated the frequency of penicillin-resistant streptococcus isolates in Nova Scotia, which recent audits have put at 7.9% of isolates (20). Only one isolate of *S pneumoniae* intermediately resistant to penicillin has been found, from an adult with pneumonia in Nova Scotia (TJ Marrie, unpublished observations). In all likelihood, respondents were extrapolating from international data when the penicillin resistance rates were given in their responses.

Overall, the results of this study provide some insight into the prescribing variation observed in the treatment of CAP. The results of the study should also guide education programs.

As noted, there are several potential design flaws in this study, some of which are inherent to any survey that uses written simulations to study physician behaviour (21).

REFERENCES

1. Niederman MS. Empirical therapy of community-acquired pneumonia. Semin Respir Infect 1994;9:192-8.
2. Dubois RW, Brook RH. Preventable deaths: who, how often and why. Ann Intern Med 1988;109:582-9.
3. Lilja J. How physicians choose their drugs. Soc Sci Med 1976;10:363-5.
4. Hepler CD, Clyne KE, Donta ST. Rationales expressed by empiric antibiotic prescribers. Am J Hosp Pharm 1982;39:1647-55.
5. Hueston WJ, Schiaffino MA. Antibiotic choice and patient outcomes in community-acquired pneumonia. J Am Board Fam Pract 1994;7:95-9.
6. Pendergrast J, Marrie T. Reasons for choice of antibiotic for the empiric treatment of community-acquired pneumonia by Canadian infectious disease physicians. Can J Infect Dis 1999;10:337-45.
7. Ott L. An Introduction to Statistical Methods and Data Analysis, 3rd edn. Boston: PWS-Kent Publishing Company, 1988.
8. Kirwan JR, Chaput de Saintonge DM, Joyce CR. Clinical Judgement Analysis. Q J Med 1990;76:935-49.
9. Segal R, Hepler CD. Prescribers' beliefs and values as predictors of drug choices. Am J Hosp Pharm 1982;39:1891-7.
10. Chinburapa V, Larson LN, Brucks M, Draugalis J, Bootman JL, Puto CP. Physician prescribing decisions: the effects of situational involvement and task complexity on information acquisition and decision-making. Soc Sci Med 1993;36:1473-82.
11. Denig P, Haaijer-Ruskamp FM, Wesseling H, Versluis A. Towards understanding treatment preferences of hospital physicians. Soc Sci Med 1993;36:915-24.
12. Mandell LA, Niderman MS and The Canadian Community Acquired Pneumonia Consensus Conference Group. Antimicrobial treatment of community acquired pneumonia in adults: a conference report. Can J Infect Dis 1993;4:25-8.
13. Woodhead MA, Arrowsmith J, Chamberlain-Webber R, Wooding S, Williams I. The value of routine microbial investigation in community-acquired pneumonia. Respir Med 1991;85:313-7.

Appendix 1

CASE 1. Your patient is a 17-year-old male with fever and nonproductive cough. Chest radiograph reveals a right middle lobe alveolar opacity. The remainder of the history and physician examination is noncontributory, and no sputum is available for culture.

To explain your choice of antibiotic therapy, please assign a number of 1 to 5 to each of the following statements, with 1 meaning "totally disagree" and 5 meaning "totally agree"

"I CHOSE THE ABOVE ANTIBIOTIC THERAPY BECAUSE..."

a) the patient is 17-years-old	1 2 3 4 5
b) this antibiotic is appropriate, considering the patient's general health state	1 2 3 4 5
c) of the results of the chest x-ray	1 2 3 4 5
d) I followed a set of published guidelines for the treatment of pneumonia	1 2 3 4 5
e) my antibiotic will treat the most likely pathogenic organism(s); if you were attempting to cover for specific organism(s), please specify which ones	1 2 3 4 5
f) I was concerned that the pathogen might be resistant to alternative antibiotic choices	1 2 3 4 5
g) I have found by experience that this antibiotic therapy is effective for these kinds of cases	1 2 3 4 5
h) I wanted to minimize side effects	1 2 3 4 5
i) my choice of antibiotic therapy is also preferred by my peers and/or co-workers	1 2 3 4 5
j) I wanted to choose a cost-effective medication	1 2 3 4 5
k) of other factors (please describe)	1 2 3 4 5

CASE 2. Your patient is a 66-year-old male, 40 pack-a-year history of smoking. He presents with fever and chills of two days' duration. He has a cough that is productive of purulent sputum, which on Gram stain shows many white blood cells and Gram-positive diplococci. The remainder of the history and physical exam is noncontributory.

To explain your choice of antibiotic therapy, please assign a number of 1 to 5 to each of the following statements, with 1 meaning "totally disagree" and 5 meaning "totally agree"

"I CHOSE THE ABOVE ANTIBIOTIC THERAPY BECAUSE..."

a) the patient is 66-years-old	
b) this antibiotic is appropriate, considering the patient's general health state	1 2 3 4 5
c) the patient is a smoker	1 2 3 4 5
d) of the results of the Gram stain	1 2 3 4 5
e) I followed a set of published guidelines for the treatment of pneumonia	1 2 3 4 5
f) my antibiotic will treat the most likely pathogenic organism(s); if you were attempting to cover for specific organism(s), please specify which ones	1 2 3 4 5
g) I was concerned that the pathogen might be resistant to alternative antibiotic choices	1 2 3 4 5
h) I have found by experience that this antibiotic therapy is effective for these kinds of cases	1 2 3 4 5
i) I wanted to minimize side effects	1 2 3 4 5
j) my choice of antibiotic therapy is also preferred by my peers and/or co-workers	1 2 3 4 5
k) wanted to choose a cost-effective medication	1 2 3 4 5
l) of other factors (please describe)	1 2 3 4 5

CASE 3. You are on call at your local hospital's emergency room. A 45-year-old, previously healthy female is brought in by friends because of fever, cough and progressive shortness of breath over a four-day period. Her cough is nonproductive, and on chest x-ray she has bilateral lobar pneumonia. Her PO_2 is 45 mmHg while breathing room air, her pulse rate is 120 beats/min, respiratory rate 32 breaths/min, and temperature of 39.5°C. Shortly after admission her blood pressure drops to 90/60 mmHg from 110/70 mmHg.

To explain your choice of antibiotic therapy, please assign a number of 1 to 5 to each of the following statements, with 1 meaning "totally disagree" and 5 meaning "totally agree"

"I CHOSE THE ABOVE ANTIBIOTIC THERAPY BECAUSE..."

a) the patient is 45-years-old	1 2 3 4 5
b) this antibiotic is appropriate, considering the patient's general health state	1 2 3 4 5
c) of the results of the chest x-ray	1 2 3 4 5
d) I followed a set of published guidelines for the treatment of pneumonia	1 2 3 4 5
e) my antibiotic will treat the most likely pathogenic organism(s); if you were attempting to cover for specific organism(s), please specify which ones	1 2 3 4 5
f) I was concerned that the pathogen might be resistant to alternative antibiotic choices	1 2 3 4 5
g) I have found by experience that this antibiotic therapy is effective for these kinds of cases	1 2 3 4 5
h) I wanted to minimize side effects	1 2 3 4 5
i) my choice of antibiotic therapy is also preferred by my peers and/or co-workers	1 2 3 4 5
j) I wanted to choose a cost-effective medication	1 2 3 4 5
k) of other factors (please describe)	1 2 3 4 5

14. Granato PA. The impact of same-day tests versus traditional overnight testing. Diagn Microbiol Infect Dis 1993;16:237-43.
15. Becker MH, Stolley PD, Lasagna L, McEvilla JD, Sloane LM. Characteristics and attitudes of physicians associated with the prescribing of chloramphenicol. HSMHA Health Rep 1971;86:993-1003.
16. Stolley PD, Becker MH, Lasagna L, McEvilla JD, Sloane LM. The relationship between physician characteristics and prescribing appropriateness. Med Care 1972;10:17-28.
17. Haayer F. Rational prescribing and sources of information. SocSci Med 1982;16:2017-23.
18. Bradley CP. Decision making and prescribing patterns – A literature review. Fam Pract 1991;8:276-87.
19. Davis PB, Yee RL, Millar J. Accounting for medical variation: the case of prescribing activity in a New Zealand practice sample. Soc Sci Med 1994;39:367-74.
20. Davidson RJ, Low DE, Canadian Bacterial Surveillance Network. A cross-Canada surveillance of antimicrobial resistance in respiratory tract pathogens. Can J Infect Dis 1999;10:128-33.
21. Jones TV, Gerrity MS, Earp J. Written case simulations: do they predict physicians' behaviour? J Clin Epidemiol 1990;43:805-15.

CLINICAL VIGNETTE

Hemoptysis and fever post-transplant: Diagnosis?

Marc G Romney MD

A 28 year-old man was admitted to the hematology unit of a tertiary care hospital following an episode of hemoptysis and fever 170 days after an allogeneic bone marrow transplant. On admission, his temperature was 39.4°C. The patient was thoroughly investigated for sepsis, and started on intravenous ciprofloxacin and ceftazidime. Total white blood count was 1.5×10^9/L, with hemoglobin 85 mg/L and platelets 14×10^9/L. A chest x-ray was performed and provisionally reported as normal. During the months before admission, the patient's transplant was complicated by graft-versus-host disease and renal impairment. A recent episode of abdominal pain was diagnosed as cytomegalovirus enteritis, for which he received intravenous ganciclovir 450 mg daily for 14 days.

On review of the patient's chest x-ray, a faint nodule in the right upper lobe was discerned, which in retrospect had been present for two weeks. A computed tomographic scan of the patient's chest was performed, showing the lesion to be more obvious (Figure 1). Amphotericin B was started for a presumed invasive fungal infection.

After 72 h incubation, a blood culture from the original septic work-up yielded growth of a bacterial species.

What is the diagnosis?

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Figure 1) *Computed tomography scan of the chest, showing a cavitary lesion in the lung on the right side*

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