What Factors Influence Physicians' Decisions to Switch from Intravenous to Oral Antibiotics for Community-acquired Pneumonia?

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OBJECTIVE: **One of the major factors influencing length of stay for patients with community-acquired pneumonia is the timing of conversion from intravenous to oral antibiotics. We measured physician attitudes and beliefs about the antibiotic switch decision and assessed physician characteristics associated with practice beliefs.**

DESIGN: **Written survey assessing attitudes about the antibiotic conversion decision.**

SETTING: **Seven teaching and non-teaching hospitals in Pittsburgh, Pa.**

PARTICIPANTS: **Three hundred forty-five generalist and specialist attending physicians who manage pneumonia in 7 hospitals.**

MEASUREMENTS AND RESULTS: **Factors rated as ''very important'' to the antibiotic conversion decision were: absence of suppurative infection (93%), ability to maintain oral intake (79%), respiratory rate at baseline (64%), no positive blood cultures (63%), normal temperature (62%), oxygenation at baseline (55%), and mental status at baseline (50%). The median thresholds at which physicians believed a typical patient could be converted to oral therapy were: temperature $\leq$100°F (37.8°C), respiratory rate $\leq$20 breaths/minute, heart rate $\leq$100 beats/minute, systolic blood pressure $\geq$100 mm Hg, and room air oxygen saturation $\geq$90%. Fifty-eight percent of physicians felt that ''patients should be afebrile for 24 hours before conversion to oral antibiotics,'' and 19% said, ''patients should receive a standard duration of intravenous antibiotics.'' In univariate analyses, pulmonary and infectious diseases physicians were the most predisposed towards early conversion to oral antibiotics, and other medical specialists were the least predisposed, with generalists being intermediate ($P < .019$). In multivariate analyses, practice beliefs were associated with age, inpatient care activities, attitudes about guidelines, and agreeableness on a personality inventory scale.**

CONCLUSIONS: **Physicians believed that patients could be switched to oral antibiotics once vital signs and mental status had stabilized and oral intake was possible. However, there was considerable variation in several antibiotic practice beliefs. Guidelines and pathways to streamline antibiotic therapy should include educational strategies to address some of these differences in attitudes.**

KEY WORDS: **antibiotic therapy; streamlining; pneumonia; physician attitudes.**
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Each year in the United States, there are 1.2 million hospitalizations for community-acquired pneumonia at an estimated cost of 9 billion dollars.[1,2] Previous studies have found wide variations in hospital length of stay in pneumonia[3,4] that are not explained by differences in patient case mix or disease severity.[5,6] These data suggest that variation in physician practices or hospital policies may be important determinants of length of stay.

One of the major management decisions influencing length of stay in pneumonia is the timing of conversion from intravenous to oral antibiotics. While most patients are usually discharged 1 day after switching to oral therapy, there is considerable variability in the overall duration of parenteral therapy.[7] In a 4-hospital cohort study, we found that patients received a median of 6 days of intravenous antibiotics, even though the median time to clinical stability was three days.[7] When surveyed about their management practices, 15% of the treating physicians reported that patients remained in the hospital, despite being clinically stable, to complete a "standard" duration of intravenous antibiotics.[8]

In response to these apparent inefficiencies in care, many practice guidelines and clinical pathways for patients hospitalized with community-acquired pneumonia recommend early conversion to oral antibiotics once patients are clinically stable as a way to decrease length of stay without compromising outcomes.[9–11] Streamlining antibiotic therapy may also have important quality-of-care benefits by minimizing the risk of line infection and sepsis, decreasing patient deconditioning, and expediting recovery at home.

However, the success of efforts to promote the timely switch to oral antibiotic therapy may depend on the extent to which they are consonant with physicians' underlying attitudes and beliefs. Therefore, we administered a written survey on pneumonia management practices to help understand how physicians decide when patients should be switched to oral therapy. Our study has 2 goals: 1) to examine physician attitudes and beliefs about the antibiotic conversion decision, and 2) to assess physician characteristics underlying variation in attitudes about

antibiotic conversion. We were particularly interested in whether physician age, specialty training, or other physician characteristics were associated with beliefs about treatment.

METHODS

Study Sites and Participants

Seven hospitals in Pittsburgh, Pa, participated in the study (1 university medical center, 3 community teaching hospitals, and 3 community nonteaching hospitals). We surveyed all general internal medicine, general practice, family practice, geriatrics, community medicine, pulmonary medicine, or infectious diseases physicians at each site. We also surveyed other internal medicine specialists who had 2 or more pneumonia admissions in 1996 as identified by hospital administrative databases (DRGs 79, 80, 89, and 90). For the 27% of physicians with privileges at more than 1 study hospital, their primary hospital affiliation was defined as the site that they had the most pneumonia admissions in 1996.

Survey Content

The survey had 4 sections. The first section collected information on physician practice characteristics including direct inpatient care hours, other job activities (teaching, administration, and research), percent of time spent on inpatient care, annual pneumonia caseload, percent income from salary, journal reading habits, quality assurance and continuing medical education activities, and job satisfaction. Psychosocial characteristics included risk avoidance (assessed with 3 items from the Jackson Personality Inventory),[12] and 2 personality traits—agreeableness and intellectualism—from the Goldberg Personality Scale.[13] Attitudes about practice guidelines in general were assessed with a previously published 9-item instrument.[14] Information regarding physician age, gender, years in practice and specialty was obtained from the study site hospitals and the Pennsylvania Medical Society.

The second section asked physicians to rate the importance of 14 clinical factors identified in a previous study as important to the hospital discharge decision in pneumonia.[8] These factors included vital signs, oral intake status, mental status, and test results (white count, microbiology reports, and x-ray findings). Respondents rated each factor as not important, somewhat important, or very important to the antibiotic conversion decision. To establish numerical vital sign cut points, physicians were asked to specify in writing the threshold at which they would consider a typical patient hospitalized with community-acquired pneumonia appropriate for conversion from intravenous to oral antibiotics. The last section asked respondents to state their level of agreement with three commonly held attitudes about the conversion decision using a 5-point Likert scale (1, strongly disagree to 5, strongly agree).

The questionnaire was pilot-tested with 24 physicians for wording clarity and coverage of critical domains. Physician addresses were verified by telephone and questionnaires were mailed to 621 eligible participants in January 1998. Nonresponders received a replacement survey and a reminder telephone call. Local opinion leaders personally distributed a third questionnaire to those who did not respond to the second mailing.

Variable Definitions and Analytical Methods

We categorized physicians into 3 specialty groups: generalists, pulmonary and infectious diseases specialists ("pneumonia" specialists), and other medical specialists. We defined "generalists" as those practicing in general internal medicine, general practice, family practice, community medicine, and geriatrics. Those in medical specialties other than pulmonary medicine or infectious diseases were classified "other specialists". Hospital size was defined as small (<200 beds), medium (200–500 beds), and large (>500 beds).

To assess the relationship between physician characteristics and practice beliefs, we constructed a pneumonia practice summary score as our main dependent variable based on the mean rating of the responses to 5 items indicating a predisposition to early conversion to oral antibiotics. The 5 items were the: 1) need to be afebrile for 24 hours prior to conversion to oral antibiotics; 2) need for a standard duration of intravenous antibiotics to treat pneumonia; 3) appropriate temperature threshold for conversion to oral antibiotic therapy; 4) importance of a normalized white blood cell count for antibiotic conversion; and 5) importance of the radiographic resolution of the pulmonary infiltrate for antibiotic conversion. Individual items comprising the summary practice score were rescaled from 0 (most) to 1 (least) predisposed to early conversion. We had complete data for all 5 items for 308 physicians. Thirty-four respondents had incomplete information on 1 or 2 items. A summary mean was calculated for all respondents who answered at least 3 of the 5 individual items. The summary scores were normally distributed and ranged from 0.08 to 0.96, with a mean and standard deviation of 0.48 ± 0.17. Cronbach's α coefficient was 0.71, indicating good interitem reliability.

We used χ^2 and t tests to compare responders and nonresponders and examine differences in attitudes among physician specialty groups. We used ANOVA and t tests to examine associations between categorical physician variables and summary pneumonia practice scores and Spearman correlations to examine relationships between continuous physician factors and the summary pneumonia practice score. Variables statistically significant at the 0.1 level in univariate analyses were entered into stepwise multivariable linear regression models. We also examined these relationships using hierarchical models and the general estimating equation to account for clustering of physicians by medical group

and hospital.[15] The hierarchical models produced nearly identical results to the linear regression models that we present here. Two-tailed *P* values of $\leq$.05 were considered statistically significant. All analyses were performed with STATA 6.0 (Stata Corp., College Station, Tex) and SPSS 8.0 (SPSS, Inc., Chicago, Ill) software.

RESULTS

Physician Characteristics

We received completed surveys from 345 (55.6%) of the 621 eligible physicians. Characteristics of respondents and nonrespondents are shown in Table 1. Response rates at the hospitals ranged from 42% to 68% ($P < .001$). Generalists and those at the larger, university hospital responded at somewhat higher rates. However, there were no significant differences between responders and nonresponders in age, gender, or years in clinical practice.

All respondents were attending physicians in active clinical practice. On average, they had been in clinical practice for 20 years and reported managing 22 pneumonia inpatients per year (range 1–250/y). They reported spending a median of 10 hours a week in direct inpatient care (interquartile range [IQR], 5–20) and 30 hours a week in direct outpatient care (IQR, 20–40). One quarter of respondents were affiliated with the university hospital. The remaining physicians were evenly divided between teaching and non-teaching community hospitals. Seventy-nine percent of respondents were generalists (general internal medicine/general practice [*n* = 160], family practice [*n* = 101], geriatrics [*n* = 8], and community medicine [*n* = 3]). Eight percent of physicians practiced pulmonary medicine (*n* = 19) or infectious diseases (*n* = 10). The remaining 44 physicians were in other medical specialties, including cardiology, gastroenterology, and rheumatology. The predominant reimbursement arrangement was salary (71%), fee-for-service (19%), and capitation (8%).

Table 1. Hospital, Demographic, and Practice Characteristics of Study Respondents and Nonrespondents

	Respondents		Non-respondents	
Characteristics	***n***	**%**	***n***	**%**
Hospital characteristics				
Hospital*				
A	85	68	40	32
B	19	59	13	41
C	75	52	70	48
D	45	45	55	55
E	53	57	40	43
F	19	42	26	58
G	49	60	32	40
Size*				
Small	19	59	13	41
Medium	241	52	223	48
Large	85	68	40	32
Teaching hospital				
Yes	224	54	191	46
No	121	59	84	41
University hospital*				
Yes	85	68	40	32
No	260	52	238	48
Physician characteristics				
Female gender	180	52	133	48
Mean age, ±SD	47.5 ± 11.6		47.3 ± 9.6	
Mean years in practice, ±SD	20.4 ± 12.2		20.1 ± 9.9	
Specialty group*				
Generalists	272	60	180	40
Pulmonary/ infectious diseases	29	45	35	55
Other specialists	44	42	61	58

* P < *.001 for differences between responders and nonresponders.*

Antibiotic Conversion Decision

Table 2 shows the factors that physicians rated as "very important" in their decision about when to convert a hospitalized pneumonia patient from intravenous to oral antibiotic therapy. The factors rated most important by nearly all respondents were the absence of suppurative or metastatic complications (e.g., empyema, abscess, or endocarditis) and ability to maintain oral intake. Clinical features judged the least pertinent were normalization of the white count and resolution of the infiltrate on chest x-ray.

Physicians were asked to indicate the vital sign threshold values at which they consider a typical, uncomplicated patient with pneumonia clinically ready to be converted from intravenous to oral antibiotic therapy. The median threshold values were: temperature $\leq$100°F (37.8°C; IQR, 99.5–100.4); respiratory rate $\leq$20 breaths/minute (IQR, 20–24); heart rate $\leq$100 beats/minute (IQR, 90–100); systolic blood pressure $\geq$100 mm Hg (IQR, 90–100); and room air oxygen saturation $\geq$90% (IQR, 90–91). Of all the vital signs, there was the greatest variation in opinion about the temperature at which it is appropriate to convert a patient from intravenous to oral antibiotics, with thresholds ranging from 98°F to 102°F. One in 5 physicians (19%) indicated that the patient's temperature should be 99°F or less before beginning oral therapy, while 1 in 7 respondents (15%) identified a threshold value of 101°F or greater. The majority of physicians (64%) felt comfortable converting to oral antibiotics once the temperature was 100°F (37.8°C) or less.

To better understand physician decision making, we asked about three practice beliefs regarding the management of typical, uncomplicated pneumonia cases. First, 58% agreed and 37% disagreed with the traditional clinical rule that "patients should be afebrile for 24 hours before conversion to oral antibiotics." In contrast, only 19% of physicians felt that "patients should receive a standard duration of intravenous antibiotics (e.g., 5–7 days)," while the majority (77%) disagreed that this traditional practice was necessary. Finally, 42% of respondents agreed and

Table 2. Clinical Factors Considered "Very Important" in Judging when to Convert Patients with Pneumonia from Intravenous to Oral Antibiotic Therapy

Clinical Factor	Percent Rated as "Very Important" (*N* = 345)
No evidence of suppurative infection	93
Able to maintain oral intake	79
Respiratory rate returned to baseline	64
No positive blood cultures	63
Temperature returned to normal	62
Oxygenation returned to baseline	55
Mental status returned to baseline	50
General appearance	46
Heart rate returned to baseline	42
Microbiologic etiology	39
Comorbid conditions stabilized	38
Blood pressure returned to baseline	27
White blood cell count returned to normal	17
Resolution of infiltrate on chest x-ray	8

53% disagreed that "most patients will be reluctant to be discharged after just a 2- or 3-day hospital stay" that might result if patients were rapidly converted to oral antimicrobial agents.

Differences in Pneumonia Practice Beliefs by Medical Specialty Group

Differences in pneumonia practice beliefs among the different medical specialties are displayed in Table 3. In pairwise comparisons, there were significant differences between pulmonary/infectious diseases physicians and other specialists for 3 of the 5 individual items. However, there were no significant differences between generalists and pulmonary/infectious diseases specialists except for opinions about the appropriate temperature threshold value. The most significant discrepancies among specialty groups were observed for ratings of the importance of the white blood cell count normalizing and radiographic infiltrate resolving before a patient was ready to be switched from intravenous to oral antimicrobials.

Overall differences between generalists and specialists on the summary pneumonia practice score are displayed in Table 4. Other specialists were the least predisposed to early conversion to oral antibiotics, and pulmonary and infectious diseases physicians the most predisposed to early switch, with generalist physicians having intermediate attitudes ($P < .019$ for trend). In pairwise comparisons, we found significant differences in summary practice scores between pulmonary/infectious diseases physicians and other medical specialists ($P < .01$), as well as between generalists and other medical specialists ($P < .04$). In contrast, there were no significant differences between generalists and pulmonary/infectious diseases respondents. Among generalists, family practitioners ($n = 101$) and general internists ($n = 158$) had similar attitudes about early antibiotic conversion (total scores 0.50 vs 0.47, $P = .20$). Family practitioners were less inclined toward early switching to oral therapy compared with pulmonary/infectious diseases physicians ($P < .04$).

Other Factors Associated with Pneumonia Practice Beliefs

Several other physician characteristics were strongly associated with reluctance towards early antibiotic conversion, including older age, more involvement in inpatient

Table 3. Differences in Pneumonia Practice Beliefs Between Generalist and Specialist Physicians

Clinical Practice Statement	Pulm/ID* (*n* = 29)	Generalists (*n* = 270)	Other Specialists (*n* = 44)	*P* Value†
Patients should be afebrile for 24 hours before being converted to oral antibiotics, % agree.	45	59	57	.46
Patients should receive a standard duration of intravenous antibiotics, % agree.	10	18	30	.09‡
It is very important that the white blood cell count return to normal prior to conversion to oral antibiotics, % agree.	3	17	29	.02[b]
It is very important that the infiltrate on chest x-ray resolves prior to conversion to oral antibiotics, % agree.	0	7	23	.0001[b,c]
Temperature should be ≤99°F before switching to oral antibiotics, % agree.	3	19	25	.08[a,b]

* *Pulm/ID indicates pulmonary medicine and infectious diseases specialists.*

† *P values presented are for overall comparisons between the 3 groups. Statistically significant pairwise comparisons are indicated by the superscripts as follows:* [a] *pulmonary/ID versus generalists (P ≤ .05);* [b] *pulmonary/ID versus other specialists (P ≤ .05);* [c] *generalists versus other specialists (P ≤ .05).*

‡ *Pulmonary/ID versus other specialists P = .06 and generalists versus other specialists P = .06.*

Table 4. Associations Between Physician Characteristics and Pneumonia Practice Summary Scores*

Categorical Physician Variables	*n*	Practice Score Mean (SD)	Univariate Analysis *P* Value	Multivariate Analysis *P* Value
Specialty				
Pulmonary/infectious diseases	28	0.44 (.12)	.019	NS
Generalists	270	0.48 (.18)		
Other specialists	44	0.54 (.16)		
Hospital teaching status				
Teaching	221	0.47 (.17)	.03	NS
Nonteaching	121	0.51 (.18)		
Hospital university affiliation				
University	83	0.44 (.16)	.019	NS
Nonuniversity	259	0.49 (.18)		
Gender				
Female	65	0.42 (.16)	.002	NS
Male	277	0.49 (.18)		
Continuous Physician Variables	**Correlation Coefficients†**		**Univariate Analyses *P* Value**	**Multivariate Analyses *P* Value**
Physician age	0.30		<.001	<.0001
Years in practice	0.34		<.001	NS
Hours of direct inpatient care	0.34		<.001	<.0001
% Time in direct inpatient care	0.27		<.001	NS
Total hours in patient care	0.27		<.001	NS
Total hours in nonpatient care	−0.15		.008	NS
Total work hours	0.15		.006	NS
Guideline attitude score	−0.14		.01	.02
Personality agreeableness score	0.21		<.001	.006

** Pneumonia practice summary score is an aggregate measure based on responses to the 5 items listed in Table 3. Scores range from 0 (most) to 1 (least) predisposed to early conversion to oral antibiotics. See the Methods section for details about the construction and reliability of the score. We were unable to compute a practice score for three respondents due to partly missing data.*

† Spearman correlation coefficients expressing the relation between the pneumonia practice summary score and the specified physician characteristic. Positive values indicate that the more of the characteristic, the less predisposed toward early antibiotic conversion. In the case of the Guideline Attitude Score, the negative correlation indicates that less favorable attitudes about guidelines were associated with cautious attitudes about early conversion.

Variables not significantly associated with pneumonia practice summary scores in the univariate analyses included: percent of income paid by salary, number of pneumonia cases per year, time spent on continuing medical education, time spent on quality assurance activities, job satisfaction, journal reading habits, physician autonomy, risk avoidance, or personality intellect score.

NS indicates not significant at the $P \leq .05$ *level. The overall model* R^2 *for the final multivariate model was 0.25.*

care, and more total clinical hours worked (see Table 4). Those who were based at the university hospital, who spent more time on non-patient care matters (research and administration), or who had more favorable opinions about practice guidelines were more predisposed towards early switch to orals. Practice beliefs were not associated with personality factors such as risk avoidance or intellect or other measures of professional activities, including pneumonia experience (cases/year), journal reading habits, or continuing medical education hours.

Multivariate Predictors of Pneumonia Practice Beliefs

In multivariable models, 4 physician characteristics were independently associated with cautious attitudes towards early conversion: older age, more time spent in direct inpatient care, less favorable opinions about practice guidelines, and a greater agreeableness personality score (Table 4). None of the physician specialty groupings were an independent predictor of practice beliefs in either the stepwise linear models or in hierarchical models that accounted for clustering by medical group or hospital affiliation.

DISCUSSION

The decision about when to convert a patient from intravenous to oral antibiotics is central to the inpatient management of community-acquired pneumonia as well as many other serious infectious diseases. Once patients are converted to oral antibiotics, they are usually discharged within a day or so (in the absence of other active problems), so the timing of conversion is a major determinant of length of stay and total cost of care. This study explored the factors that physicians consider important in determining readiness for antibiotic conversion and assessed the variations in underlying beliefs that may explain differences observed in clinical practice. Insight into these factors could be used to design medical practice guidelines and refine their corresponding implementation strategies.

The diverse group of physicians we studied identified absence of suppurative infection and bacteremia, ability to maintain oral intake, and normalized respiratory rate, temperature, oxygenation, and mental status as the most important clinical factors determining readiness for antibiotic conversion. Abnormalities in vital signs, ability to maintain oral intake, and mental status have been shown in previous work to be key criteria for judging overall clinical stability in pneumonia and are associated with the risk of clinical deterioration and short-term mortality.[7,8,16,17] A small but significant proportion of physicians also emphasized normalization of the white count and resolution of the chest x-ray infiltrate, 2 traditional teachings that lack supportive evidence. Normalization of the white count, while a sensible physiological marker of infection, has never been independently associated with important pneumonia outcomes, and radiographic infiltrates can take weeks to months to resolve.[18,19]

There was general consensus about what constituted stable vital signs for the purposes of conversion to oral antibiotics except in the case of temperature. While 58% of physicians agreed that patients should be afebrile for 24 hours prior to the switch to oral therapy, there was broad difference of opinion about the exact definition of stable temperature, with just as many physicians saying this was $\leq$99°F (37.2°C) as $\leq$101°F (38.3°C). Because of this considerable variation in what physicians seem to regard as "afebrile" or "stable" temperature, local and national pneumonia guidelines and pathways should include explicit definitions of such terms so that recommendations can be operationalized in real world practice.

Fortunately, there is evidence to support specific recommendations. Several studies indicate that once a patient's temperature is 100°F (37.8°C) or less for 24 hours (and he or she is otherwise stable), he or she can be switched to oral therapy because the subsequent risk of clinical deterioration is very low.[7,20] In addition, there are no differences in outcomes between patients who are discharged shortly after being switched to oral antibiotics compared to those who were observed for 24 hours or longer.[21,22]

Our survey identified other barriers to streamlining inpatient antibiotic therapy. One in 5 physicians felt that patients should receive a standard duration of intravenous therapy. This traditional practice is unnecessary in most cases for 2 reasons. First, several trials have shown that short courses of intravenous therapy in pneumonia are safe and effective.[23–25] Second, the improved bioavailability of many new antibiotics allows oral preparations to rapidly achieve adequate serum levels (in patients with a functioning gastrointestinal tract). Once patients are stable according to objective criteria, they can be safely converted to oral antibiotics regardless of the number of days of intravenous therapy already received.

The modest differences we observed in practice style among medical specialty groups were intriguing. The overall trend was that pulmonologists and infectious diseases specialists were the most predisposed to early antibiotic conversion, generalists were intermediate, and other medical specialists the least predisposed to early switch. However, pulmonary and infectious diseases specialists and generalists seemed to think alike in pairwise comparisons. The fact that other medical specialists were the least predisposed towards early antibiotic conversion may reflect their relative lack of familiarity with the current pneumonia literature or national practice guidelines compared to their pulmonary/infectious diseases or generalist colleagues.[26] These differences do not appear to be related to pneumonia experience per se, because annual pneumonia caseload was not a predictor of practice beliefs.

However, our multivariate analyses revealed that other physician characteristics were the important independent determinants of pneumonia practice attitudes, not specialty training. Not surprisingly, older physicians and those with more years in practice tended to hold more traditional practice beliefs, a finding reported previously.[27] We were surprised that physicians with greater inpatient activities were less predisposed to early antibiotic conversion, though these clinicians may treat more severely ill patients.

The strengths of our study are that we surveyed attending physicians across a broad spectrum of medical specialties in a diverse group of hospitals. In addition, all study participants actually care for patients with pneumonia so our findings should reflect the attitudes and beliefs of real world clinicians. However, as with all physician survey research, we measured self-reported attitudes and practices, not actual behavior. In our survey, physicians were asked to consider the "typical uncomplicated patient" with pneumonia. It is possible that different physicians may have somewhat different conceptions of what this might be. Finally, our findings may be more indicative of generalists or those in academic settings because these groups were more likely to complete our questionnaire. However, the significance of any modest response bias is probably small because our analyses controlled for differences in medical specialty and hospital setting.

In conclusion, physicians believed that patients with community-acquired pneumonia could be safely switched from intravenous to oral antibiotics once they were able to maintain oral intake, the vital signs and mental status had stabilized, and there was no evidence of metastatic infection. However, there was considerable variation in several underlying antibiotic practice beliefs. Guidelines and pathways designed to promote more evidence-based, cost-effective approaches to pneumonia care will need to include educational strategies that address the heterogeneity in practice beliefs we observed.

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