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## Time of Day and the Decision to Prescribe Antibiotics

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Clinicians make many patient care decisions each day. The cumulative cognitive demand of these decisions may erode clinicians' abilities to resist making potentially inappropriate choices. Psychologists, who refer to the erosion of self-control after making repeated decisions as *decision fatigue*,<sup>1,2</sup> have found evidence that it affects nonmedical professionals. For example, as court sessions wear on, judges are more likely to deny parole, the "easier" or "safer" option.<sup>3</sup>

In primary care, prescribing unnecessary antibiotics for acute respiratory infections (ARIs) is a common, in appropriate service. Clinicians may prescribe unnecessary antibiotics—again, the easy, safe option—due to perceived or explicit patient demand, a desire to do something meaningful for patients, a desire to conclude visits quickly, or an unrealistic fear of complications.<sup>4,5</sup> We hypothesized that decision fatigue, if present, would increase

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**Author Contributions:** Dr Linder had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

*Study concept and design:* Linder, Doctor, Friedberg, Meeker, Fox.

*Acquisition, analysis, or interpretation of data:* All authors.

*Drafting of the manuscript:* Linder, Fox.

*Critical revision of the manuscript for important intellectual content:* All authors.

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clinicians' likelihood of prescribing antibiotics for patients presenting with ARIs as clinic sessions wore on.

## Methods

The protocol for this study was approved by the Partners HealthCare Human Research Committee, including a waiver of patient informed consent. We merged billing and electronic health record data for patient visits to 1 of 23 Partners HealthCare–affiliated primary care practices between May 1, 2011, and September 30, 2012. We identified visit diagnoses using billing codes, and, using electronic health record data, identified visit times, antibiotic prescriptions, and chronic illnesses.<sup>6</sup>

We analyzed ARI visits by adults (aged 18–64 years), which occurred during two 4-hour sessions—8 AM to noon and 1 PM to 5 PM—Monday through Friday. We excluded visits by patients with chronic illnesses (eg, cancer, diabetes mellitus) or concomitant acute diagnoses (eg, skin infections) for which antibiotics would be indicated. We excluded clinicians who had fewer than 40 ARI visits during the study. Consistent with national guidelines, we classified specific ARI diagnoses as *antibiotics sometimes indicated* or *antibiotics never indicated* (Table).<sup>6</sup>

Clinicians worked in 4-hour morning and afternoon sessions; many clinicians worked only 1 session on a given day. We used the scheduled hour of each ARI visit (1 through 4) to represent visit time.

Using logistic regression, we estimated the probability of antibiotic prescribing for ARI visits as a function of session hour, number of visits per session, calendar month of visit, patient-level confounders (Table), and fixed effects for clinicians. We used generalized estimating equations to account for clinician-level clustering. We used SAS (version 9.3, SAS Institute) and considered  $P < .05$  statistically significant.

## Results

There were 21 867 ARI visits to 204 clinicians in 23 practices that met our inclusion criteria; 44% resulted in antibiotic prescriptions (Table). Antibiotic prescribing increased throughout the morning and afternoon clinic sessions for antibiotics sometimes indicated and antibiotics never indicated ARIs (Figure). Relative to the first hour of a session, the adjusted odds ratios of antibiotic prescribing in the second, third, and fourth hours were 1.01 (95% CI, 0.91–1.13), 1.14 (95% CI, 1.02–1.27), and 1.26 (95% CI, 1.13–1.41), respectively ( $P < .001$  for linear trend).

## Discussion

We found that primary care clinicians' likelihood of prescribing antibiotics for ARIs increased during clinic sessions, consistent with the hypothesis that decision fatigue progressively impairs clinicians' ability to resist ordering inappropriate treatments.

This finding should be interpreted in the context of the study design: we studied ARI visits in a single health care system, scheduled time was a proxy for actual visit time, and unmeasured confounding is possible. In addition, we used visit time as a proxy for decision fatigue, but other accumulating factors (eg, glucose depletion or general fatigue) could contribute to our findings.

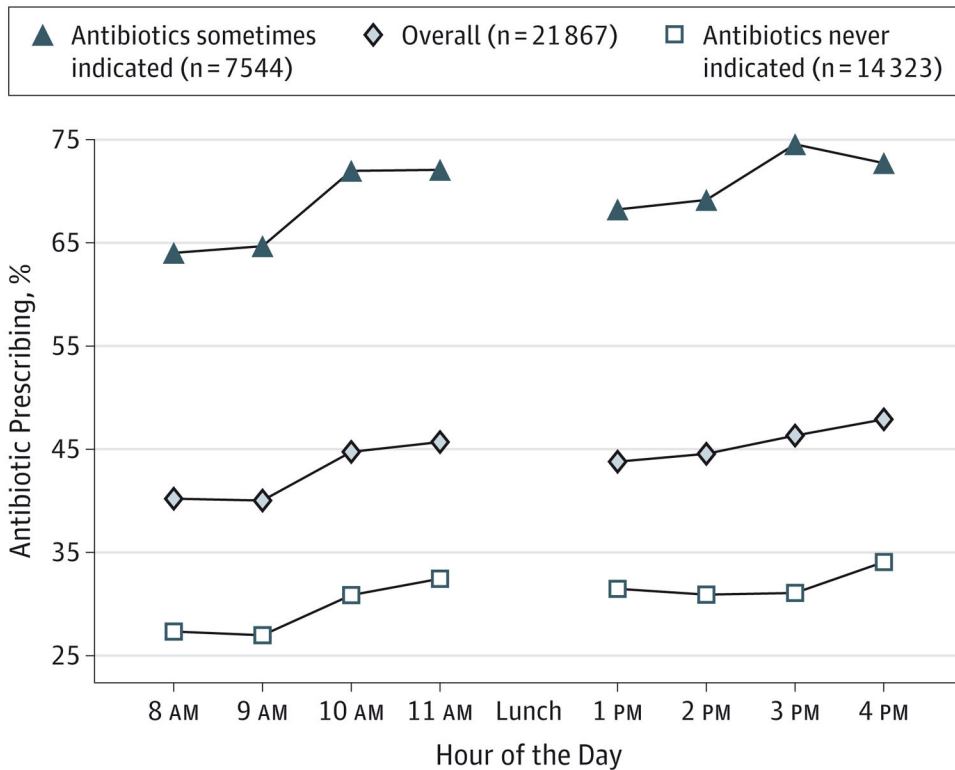
Remedies for decision fatigue might include time-dependent decision support, modified schedules, shorter sessions, mandatory breaks, or snacks.<sup>3</sup> Further studies could clarify the sources of the problem and test corresponding solutions.

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**Figure. Antibiotic Prescribing by Hour of the Day**

Diagnoses for which antibiotics are sometimes indicated were otitis media, sinusitis, pneumonia, and streptococcal pharyngitis. Diagnoses for which antibiotics are never indicated were acute bronchitis, nonspecific upper respiratory infection, influenza, and nonstreptococcal pharyngitis. Linear trend in session hours (combining 8 AM with 1 PM, 9 AM with 2 PM, 10 AM with 3 PM, and 11 AM with 4 PM):  $P < .001$  for antibiotics sometimes indicated;  $P < .001$  for all acute respiratory infection visits; and  $P < .002$  for antibiotics never indicated. During clinic sessions, the proportion of acute respiratory infection visits for which antibiotics were sometimes indicated did not vary significantly from hour to hour ( $P = .64$ ).

Table

Sample Characteristics and Antibiotic Prescribing<sup>a</sup>

Characteristic	Overall Sample (N = 21 867)	Antibiotic		P Value
		Prescribed (9722 [44%])	Not Prescribed (12 145 [56%])	
Patient age, mean (SD), y	40.4 (12.0)	40.9 (11.9)	40.0 (12.1)	<.001
Median annual household income by zip code, mean (SD), \$	76 481 (28 522)	78 134 (29 009)	75 158 (28 057)	<.001
Patient sex, No. (%)				
Men	7111 (33)	3115 (32)	3996 (33)	.18
Women	14 756 (67)	6607 (68)	8149 (67)	
Patient race/ethnicity				
White	15 958 (73)	7327 (75)	8631 (71)	<.001
Latino	2276 (10)	983 (10)	1293 (11)	
Black	1296 (6)	498 (5)	798 (7)	
Asian	1041 (5)	365 (4)	676 (6)	
Other/unknown	1296 (6)	549 (6)	747 (6)	
Language				
English	20 042 (92)	8969 (92)	11 073 (91)	.003
Spanish	1196 (5)	512 (5)	684 (6)	
Other	629 (3)	241 (2)	388 (3)	
Insurance				
Private	18 762 (86)	8367 (86)	10 395 (86)	.15
Medicaid	2003 (9)	856 (9)	1147 (9)	
Medicare	474 (2)	202 (2)	272 (2)	
None or other	628 (3)	297 (3)	331 (3)	
Clinician type				
Staff physician	17 206 (79)	7221 (74)	9985 (82)	<.001
Nurse practitioner or physician assistant	4196 (19)	2320 (24)	1876 (15)	
Fellow (physician trainee)	465 (2)	181 (2)	284 (2)	
Clinician is the primary care clinician				
Yes	4938 (23)	2180 (22)	2758 (23)	<.001
No	5708 (26)	2909 (30)	2799 (23)	
Unknown	11 221 (51)	4633 (48)	6588 (54)	
Diagnosis type <sup>b</sup>				
Antibiotics sometimes indicated	7544 (35)	5301 (55)	2243 (18)	<.001
Antibiotics never indicated	14 323 (65)	4421 (45)	9902 (82)	

<sup>a</sup>Percentages may not sum to 100 owing to rounding.

<sup>b</sup>Diagnoses for which antibiotics are sometimes indicated were otitis media (International Classification of Diseases, Ninth Revision [ICD-9] 381 and 382), sinusitis (ICD-9 461 and 473), pneumonia (ICD-9 481–486), and streptococcal pharyngitis (ICD-9 034.0). Diagnoses for which

antibiotics are never indicated were nonspecific upper respiratory infection (ICD-9 460, 464, and 465), acute bronchitis (ICD-9 466 and 490), influenza (ICD-9 487), and nonstreptococcal pharyngitis (ICD-9 462 and 463).

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