The Volume-Quality Relationship in Antibiotic Prescribing: When More Isn’t Better

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Abstract
For many surgeries and high-risk medical conditions, higher volume providers provide higher quality care. The impact of volume on more common medical conditions such as acute respiratory infections (ARIs) has not been examined. Using electronic health record data for adult ambulatory ARI visits, we divided primary care physicians into ARI volume quintiles. We fitted a linear regression model of antibiotic prescribing rates across quintiles to assess for a significant difference in trend. Higher ARI volume physicians had lower quality across a number of domains, including higher antibiotic prescribing rates, higher broad-spectrum antibiotic prescribing, and lower guideline concordance. Physicians with a higher volume of cases manage ARI very differently and are more likely to prescribe antibiotics. When they prescribe an antibiotic for a diagnosis for which an antibiotic may be indicated, they are less likely to prescribe guideline-concordant antibiotics. Given that high-volume physicians account for the bulk of ARI visits, efforts targeting this group are likely to yield important population effects in improving quality.

Keywords
acute respiratory infections, antibiotic prescribing, primary care, quality of care

Introduction
For surgeries and high-risk medical conditions, higher volume physicians, on average, provide higher quality of care. However, the impact of volume on more basic medical conditions, where the acquisition of procedure- or diagnosis-specific expertise may be less relevant, has not been examined. Inappropriate antibiotic prescribing for acute respiratory infections (ARIs) is common and leads to many negative public health consequences including increased antibiotic resistance, adverse drug reactions, and increased cost. We examined whether primary care physicians who see a higher volume of ARI visits provide higher quality of care in terms of antibiotic prescribing.

Methods
We obtained electronic health record data for all 2012 adult ambulatory visits for ARIs to primary care physicians in a large integrated health system that was affiliated with an academic medical center. The health system is located in the Northeastern United States, and operates more than 20 hospitals and 400 outpatient sites. Based on prior work, we divided ARI diagnoses (based on International Classification of Diseases, Ninth Revision, Clinical Modification codes) into 2 groups: (1) “antibiotic-appropriate diagnoses” (antibiotics may be indicated), including streptococcal pharyngitis (034.x), otitis media (381.x, 382.x), sinusitis (461.x), and pneumonia (481.x, 482.x, 483.x, 485.x, 486.x), and (2) “non-antibiotic-appropriate diagnoses” (antibiotics are never indicated), including non-specific upper respiratory infection (URI; 460.x, 465.x), non-streptococcal pharyngitis (462.x), and bronchitis (466.x, 490.x, 491.21). We identified oral antibiotic prescriptions, and calculated the antibiotic prescribing rate for the following: all ARI visits, individual conditions, non-antibiotic-appropriate diagnoses, antibiotic-appropriate diagnoses, guideline concordance (for antibiotic-appropriate
### Table 1. Antibiotic Prescribing Rates for Acute Respiratory Infections Broken Down by Physician Volume Quintiles.

| No. of visits | 1 (1-3) (n = 158) | 2 (4-9) (n = 121) | 3 (10-32) (n = 133) | 4 (33-74) (n = 136) | 5 (75-1196) (n = 137) | P value* |
|---------------|------------------|------------------|-------------------|-------------------|----------------------|---------|
| Fraction of visits |                  |                  |                   |                   |                      |         |
| Antibiotic-appropriate ARI visits | 14 370 | 36% | 39% | 41% | 43% | 46% | .001 |
| Prescribing rates |                  |                  |                   |                   |                      |         |
| All ARI visits | 31 973 | 37% | 42% | 48% | 56% | 66% | <.001 |
| Non-antibiotic-appropriate ARI visits | 17 603 | 29% | 30% | 41% | 49% | 58% | <.001 |
| Upper respiratory infection | 7634 | 16% | 17% | 24% | 34% | 42% | <.001 |
| Acute bronchitis | 4580 | 59% | 55% | 55% | 67% | 75% | <.001 |
| Non-streptococcal pharyngitis | 5389 | 31% | 31% | 39% | 47% | 52% | <.001 |
| Antibiotic-appropriate ARI visits | 14 370 | 59% | 64% | 60% | 65% | 74% | <.001 |
| Otitis media | 3906 | 71% | 67% | 46% | 50% | 56% | .09 |
| Sinusitis | 8553 | 76% | 76% | 80% | 85% | 89% | <.001 |
| Streptococcal pharyngitis | 219 | 100% | 73% | 78% | 74% | 86% | .65 |
| Pneumonia | 1692 | 16% | 37% | 41% | 35% | 40% | .05 |
| Broad-spectrum antibioticsb | 15 987 | 55% | 54% | 60% | 63% | 65% | .001 |
| Guideline-concordant antibioticsc | 9340 | 63% | 60% | 46% | 45% | 44% | <.001 |

Note. ARI = acute respiratory infection.

*The P value is for linear trend across quintiles.

bThis represents the broad-spectrum antibiotic prescribing rate for all ARI visits at which an antibiotic was prescribed.

*cThis represents the guideline-concordant antibiotic prescribing rate for antibiotic-appropriate ARI visits at which an antibiotic was prescribed.

diagnoses only), and broad spectrum (across all visits at which an antibiotic was prescribed). We defined guideline concordance as antibiotic prescriptions for antibiotic-appropriate diagnoses that were the first-line antibiotic recommended for the specific condition based on national guidelines: amoxicillin-clavulanate or amoxicillin for sinusitis, a macrolide or doxycycline for pneumonia, amoxicillin or penicillin for streptococcal pharyngitis, and amoxicillin for otitis media. We defined broad-spectrum antibiotics as macrolides, quinolones, amoxicillin-clavulanate, and second- and third-generation cephalosporins. We divided physicians into quintiles by ARI visit volume and generated prescribing rates for each quintile using average prescribing rates for clinicians. We fitted a linear regression model of prescribing rates across quintiles to assess for a significant difference in trend.

**Results**

During 2012, 685 clinicians had 31 973 ARI visits and the overall antibiotic prescribing rate was 50%. For all ARI cases, physicians in higher volume quintiles were more likely to list an antibiotic-appropriate diagnosis versus a non-antibiotic-appropriate diagnosis (*P* < .001; Table 1). Physicians in higher volume quintiles had a higher antibiotic prescribing rate across all ARI visits (*P* < .001; Table 1), for non-antibiotic-appropriate ARI diagnoses (*P* < .001), for antibiotic-appropriate ARI diagnoses, and for 4 individual diagnoses: URI, bronchitis, non-streptococcal pharyngitis, and sinusitis (all *Ps* < .001). Broad-spectrum antibiotic prescribing increased significantly as volume increased (*P* = .001), whereas guideline-concordant antibiotic prescribing decreased significantly (*P* < .001; Table 1).

**Discussion**

Physicians with a higher volume of cases manage ARI in a very different manner. They are much more likely to list a diagnosis where an antibiotic may be appropriate. However, for both non-antibiotic-appropriate diagnoses and antibiotic-appropriate diagnoses, higher volume physicians are more likely to prescribe antibiotics. When they prescribe an antibiotic for a diagnosis for which an antibiotic may be indicated, they are less likely to prescribe guideline-concordant antibiotics. In contrast to previous studies on the volume-outcome relationship, for ARI visits, higher volume physicians appear to provide lower quality care than lower volume physicians.

The relationship between volume and quality is generally thought to be due to increasing physician experience leading to better performance or decision making, which in turn can lead to improved outcomes. However, in the case of ARI visits, additional volume is unlikely to add substantively to the physician’s expertise. In fact, at a certain threshold, higher volume may be associated with lower quality if physicians are rushed. Lower volume might also be a proxy for part-time status, which has been associated with higher quality.

One key limitation of our study is that it relies on physician diagnostic coding. Higher volume physicians may see a different patient mix, but physicians have substantial discretion in
selecting specific ARI diagnoses. Also, antibiotic prescribing is not always indicated for many visits even for “antibiotic-appropriate” diagnoses. In addition, it is possible that physicians who are more likely to prescribe are also simply more likely to document diagnoses well, resulting in a systematic reporting bias.

Another limitation is that we did not measure physicians’ overall visit volume or time spent with each patient, potential markers of whether a physician is rushed. And finally, this is a single health system study, which may constrain the generalizability of our results more broadly.

Our results help inform efforts to identify targets for intervention. Given that high-volume physicians account for the bulk of ARI visits, efforts targeting this group are likely to yield important population effects in improving quality.

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References
1. Halm EA, Lee C, Chassin MR. Is volume related to outcome in health care? A systematic review and methodologic critique of the literature. Ann Intern Med. 2002;137:511-520.
2. Shehab N, Patel PR, Rsrivasan A, Budnitz DS. Emergency department visits for antibiotic-associated adverse events. Clin Infect Dis. 2008;47:735-743.
3. Linder JA, Schnipper JL, Tsurikova R, et al. Electronic health record feedback to improve antibiotic prescribing for acute respiratory infections. Am J Manag Care. 2010;16:e311-e319.
4. Get Smart: Know When Antibiotics Work. Acute Bacterial Rhinosinusitis: Physician Information Sheet (Adults). http://www.cdc.gov/getsmart/campaign-materials/info-sheets/adult-acute-bact-rhino.html. Accessed April 1, 2014.
5. Chow AW, Benninger MS, Brook I, et al. IDSA clinical practice guideline for acute bacterial rhinosinusitis in children and adults. Clin Infect Dis. 2012;54:e72-e112.
6. Mandell LA, Wunderink RG, Anzueto A, et al. Infectious Diseases Society of America/American Thoracic Society consensus guidelines on the management of community-acquired pneumonia in adults. Clin Infect Dis. 2007;44(suppl 2):S27-S72.
7. Get Smart: Know When Antibiotics Work. Acute Pharyngitis in Adults. http://www.cdc.gov/getsmart/campaign-materials/info-sheets/adult-acute-pharyngitis.pdf. Accessed January 20, 2015.
8. Shulman ST, Bisno AL, Clegg HW, et al. Clinical practice guideline for the diagnosis and management of group A streptococcal pharyngitis: 2012 update by the Infectious Diseases Society of America. Clin Infect Dis. 2012;55:1279-1282.
9. Lieberthal AS, Carroll AE, Chonmaitree T, et al. The diagnosis and management of acute otitis media. Pediatrics 2013;131:e964-e999.
10. Steinman MA, Gonzales R, Linder JA, Landefeld CS. Changing use of antibiotics in community-based outpatient practice, 1991-1999. Ann Intern Med. 2003;138:525-533.
11. Parkerton PH, Wagner EH, Smith DG, Straley HL. Effect of part-time practice on patient outcomes. J Gen Intern Med. 2003;18:717-724.