Predictors of Broad-Spectrum Antibiotic Prescribing for Acute Respiratory Tract Infections in Adult Primary Care

Michael A. Steinman, MD
C. Seth Landefeld, MD
Ralph Gonzales, MD, MSPH

Antibiotics are commonly prescribed for acute respiratory tract infections (ARTIs). Some of this use, such as for the common cold and uncomplicated acute bronchitis, is almost always unnecessary. For other infections, such as otitis media and acute sinusitis, antibiotics provide some benefit, but the value of their use as first-line treatment has been debated.

Even for conditions in which antibiotic use might be justified, many experts have expressed concern about substantial overuse of newer broad-spectrum antibiotics such as the quinolones, amoxicillin/clavulanate, second- and third-generation cephalosporins, and second-generation macrolides. Recent studies have documented frequent use of nonrecommended and second-line antibiotics for patients with acute sinusitis, and found that nonrecommended antibiotic use increased over the last decade among patients with sore throat. These agents, while providing little therapeutic benefit for most patients, add substantially to health care costs. More importantly, frequent use of these agents promotes bacterial resistance and contributes to high rates of prescribing, wide variations in practice patterns, and the strong association of ARTIs, especially by internists and physicians in the Northeast and South. These independent predictors of broad-spectrum antibiotic prescribing were physician specialty (odds ratio [OR], 2.4; 95% confidence interval [CI], 1.6-3.5 for internal medicine physicians compared with general and family physicians) and geographic region (OR, 2.6; 95% CI, 1.4-4.8 for Northeast and OR, 2.4, 95% CI, 1.4-4.2 for South [both compared with West]). Other independent predictors of choosing a broad-spectrum agent included black race, lack of health insurance, and health maintenance organization membership, each of which was associated with lower rates of broad-spectrum prescribing. Patient age, sex, and urban vs rural location were not significantly associated with prescribing choice.

Conclusions Broad-spectrum antibiotics are commonly prescribed for the treatment of ARTIs, especially by internists and physicians in the Northeast and South. These high rates of prescribing, wide variations in practice patterns, and the strong association of nonclinical factors with antibiotic choice suggest opportunities to improve prescribing patterns.

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Author Affiliations: Division of Geriatrics and VA National Quality Scholars Program, San Francisco VA Medical Center, San Francisco, Calif (Drs Steinman and Landefeld), and Department of Medicine, University of California, San Francisco (Drs Steinman, Landefeld, and Gonzales).

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Corresponding Author and Reprints: Michael A. Steinman, MD, Division of Geriatrics, San Francisco VA Medical Center, 4150 Clement St, Box 181-G, San Francisco, CA 94121 (e-mail: mstein@itsa.ucsf.edu).
drug cost and formulary restrictions, and pharmaceutical detailing and marketing.11-17 However, most studies of outpatient antibiotic prescribing have focused on the decision to treat or not to treat, rather than on the choice of a particular antibiotic. Information about which factors affect the choice of a particular drug could help efforts to improve both the quality and the quantity of antibiotic prescribing.

In this study, we sought to identify factors associated with the prescribing of broad-spectrum antibiotics by primary care physicians caring for patients with nonpneumonic ARTIs.

METHODS
Sample and Data Set
We used data from the National Ambulatory Medical Care Survey (NAMCS) between 1997 and 1999. Conducted annually by the National Center for Health Statistics, the NAMCS is a nationally representative probability sample of patient visits to community-based outpatient physicians.18-20

Upon selection for participation in this survey, physicians were asked to complete a standardized encounter form for each eligible patient visit during a 1-week period. Eligible encounters ranged from each patient encounter in small practices to every fifth encounter in large practices. Visits outside the physician office (eg, in nursing homes), visits to federal facilities, and visits to hospital-based outpatient or emergency departments were not included. Over the study period, approximately 1800 physicians were recruited each year, with approximately 63% to 69% agreeing to participate.18-20

All information was recorded by the physician or office staff on a standardized form. This form had space for up to 3 diagnoses and 6 medications, which were converted by NAMCS data entry staff into International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes and a standardized drug coding schema.21 Using a 4-step process, each patient visit was weighted by the inverse probability of its selection (ie, the number of visits in the population that the sampled visit was taken to represent).20 Using these weights, data from this survey can be extrapolated to the universe of community-based outpatient visits that occur in the United States each year.

Inclusion Criteria and Definitions
The study sample was drawn from 3151 patient visits made by adults aged 18 years or older who received a primary, secondary, or tertiary diagnosis of a nonpneumonic ARTI. These diagnoses included nasopharyngitis (ie, the common cold) or upper respiratory tract infection (URTI) not otherwise specified (ICD-9-CM codes 460 and 465), acute or unspecified sinusitis (ICD-9-CM codes 461 and 473.9), suppurative or nonsuppurative otitis media (ICD-9-CM codes 381.0-381.4 and 382), acute or unspecified bronchitis and bronchiolitis (ICD-9-CM codes 466 and 490), and other URTI including pharyngitis, laryngitis, tracheitis, and streptococcal sore throat (ICD-9-CM codes 462, 464, and 34.0). During the study period, these diagnoses accounted for 7% of all adult outpatient visits to community-based physicians in the United States, and for 44% of all visits involving an antibiotic prescription.

We excluded 66 visits that involved a concomitant diagnosis with other common outpatient infections that might be treated with an antibiotic, including chronic sinusitis (ICD-9-CM codes 473.0-473.8), influenza (ICD-9-CM code 487), bacterial or unspecified pneumonia (ICD-9-CM codes 481-483 and 485-486), urinary tract infection or acute/unspecified cystitis (ICD-9-CM codes 599.0, 599.5, and 599.9), cellulitis, carbuncle, or furuncle (ICD-9-CM codes 680-682), prostatitis or pelvic inflammatory disease (ICD-9-CM codes 601 and 614), and sexually transmitted diseases including syphilis, gonococcal infections, and other venereal infections (ICD-9-CM codes 90-99 and 647.0-647.2).

We subsequently excluded 1054 visits to pediatricians and nonprimary care physicians (ie, physicians with specialties other than general practice, family practice, or internal medicine). In the NAMCS database, most internal medicine subspecialists were coded separately from generalists and were excluded from this analysis. Finally, we excluded an additional 50 visits for which the patient was referred to the treating physician.

Of the remaining 1257 patient visits, 1257 involved an antibiotic. Antibiotics were defined as antibacterial agents commonly available in oral or intramuscular form for outpatient use. We did not count polymyxins and aminoglycosides in our tally of antibiotics, as these medications are used almost exclusively in topical form for outpatients. Similarly, we did not count antimycobacterial medications as antibiotics, as they are commonly used in the treatment of typical ARTIs. Of the remaining agents, we classified the quinolones, amoxicillin/clavulanate, second- and third-generation cephalosporins, and azithromycin and clarithromycin as broad-spectrum antibiotics. All other antibiotics were classified as narrow-spectrum.

Thirty-seven (3%) of 1257 patients received more than 1 antibiotic, for a total of 1298 antibiotic prescriptions. For most of our analyses, the patient was the unit of analysis (ie, patients who received at least 1 broad-spectrum antibiotic were counted in the broad-spectrum antibiotic category). For our analysis evaluating use of specific agents, we made the antibiotic the unit of analysis, such that each antibiotic was counted separately.

Analysis
To identify patients with active comorbid conditions, we searched the 3 diagnosis fields for common chronic diseases that were listed alongside the ARTI diagnosis. These included chronic obstructive pulmonary disease or asthma (ICD-9-CM codes 491-493 and 496), congestive heart failure (ICD-9-CM code 428), ischemic or hypertensive heart disease (ICD-9-CM codes 410-414, 402, and 404), diabetes mellitus (ICD-9-CM code 250), malignant neoplasms and neoplasms of uncer-
tain or unspecified behavior (ICD-9-CM codes 140-208 and 235-239), cerebrovascular disease (ICD-9-CM codes 430-438), acute or chronic renal disease (ICD-9-CM codes 403 and 580-588), and human immunodeficiency virus infection (ICD-9-CM code 042). Comorbid conditions were recorded in 96 (8%) of 1257 patients receiving an antibiotic.

In each analysis, we adjusted for patient weights to make our point estimates of antibiotic prescriptions nationally representative. These weights are assigned in inverse proportion to the probability of a visit being selected from the universe of patient visits. As such, they denote the number of visits in the US population that are represented by the sampled visit. To account for the sample’s hierarchical design, we adjusted for clustering at the level of the individual physician, thus increasing the variance around our point estimates to account for nonindependence of observations within the sampling frame. The 1981 visits in our sample were conducted by 558 physicians, with a mean (SD) of 3.6 (2.8) visits per physician. The intracluster correlation coefficient for broad-spectrum antibiotic prescriptions among these physicians was 0.31. Additional cluster identifiers based on the local geographic sampling unit were not available in the public-use data set at the time of this analysis, and could not be used in our calculations.

Adjusting for patient weights and physician-level clustering, we performed bivariate analyses with the design-based F test, which is analogous to a χ² test for complexly sampled data. Multivariable analyses were performed with generalized estimating equations, using forward stepwise regression with P<.10 to stay and P<.05 to report. We checked for potential interactions, none of which added significantly to the model.

All analyses were performed using STATA statistical software (Intercooled Version 6.0; STATA Corp, College Station, Tex). All results except raw numbers are presented after adjustment for patient weights. P<.05 was considered significant. This research was approved by the Committee on Human Research of the University of California, San Francisco.

RESULTS

Of 1981 adults with nonpneumonic ARTIs that participated in the NAMCS, the most common diagnoses were sinusitis (24% of patient visits), the common cold and nonspecific URTIs (24%), and acute bronchitis (23%). Less common diagnoses were pharyngitis, laryngitis, or tracheitis (11%), otitis media (5%), and combinations of more than 1 ARTI (13%).

Antibiotics were prescribed to 63% of patients with an ARTI, ranging from 46% of patients with the common cold or nonspecific URTI to 69% of patients with sinusitis and 83% of patients with more than 1 ARTI (FIGURE 1). Similarly, prescriptions for broad-spectrum antibiotics were common, but varied across conditions. Broad-spectrum agents were chosen in 54% of patients prescribed an antibiotic, ranging from 33% of patients with pharyngitis, laryngitis, or tracheitis to 69% of patients with otitis media. Overall, broad-spectrum therapy was ordered for more than half of patients prescribed an antibiotic for each type of ARTI except pharyngitis, laryngitis, or tracheitis (FIGURE 1).

Azithromycin and clarithromycin were the most commonly prescribed broad-spectrum agents, comprising 21% of all antibiotic prescriptions for patients with ARTIs. These were followed by second- and third-generation cephalosporins (17% of prescriptions), amoxicillin/clavulanate (8%), and the quinolones (7%). Prescriptions for these agents varied substantially across diagnoses (FIGURE 2).

Among patients prescribed antibiotics, several factors were associated with choice of a broad-spectrum agent (TABLE). On unadjusted analyses, there was substantial variation by diagnosis, comorbidity, sex, national region, and physician specialty (P<.05 for each). On multivariable analysis controlling for diagnosis and comorbidity, the strongest independent predictors of broad-spectrum antibiotic choice were national region and physician specialty, with physicians in the Northeast and South and internists prescribing at particularly high rates. Other independent predictors included black (non-Hispanic) patient race, patient health maintenance organization membership, and lack of patient health insurance for the visit, each of which was associated with lower rates of broad-spectrum antibiotic prescribing.
The association between prescribing behavior and physician specialty and region appeared additive. The percentage of patients whose antibiotic regimen included a broad-spectrum agent ranged from 41% for general and family physicians in the Midwest and West, to 50% for general and family physicians in the Northeast and South, to 56% for internists in the Midwest and West, to 76% for internists in the Northeast and South.

The total volume of broad-spectrum antibiotic prescriptions depends on overall rates of antibiotic prescribing and the proportion of those prescriptions that are for broad-spectrum agents. Our primary analysis measured only the proportion of broad-spectrum prescriptions among patients who received an antibiotic. To control for overall rates of antibiotic prescribing, we rebuilt our multivariable analysis to compare patients who received a broad-spectrum antibiotic with all other patients (ie, those who received either a narrow-spectrum agent or no antibiotic at all). After controlling for diagnosis and comorbidity, broad-spectrum antibiotic prescribing was still significantly predicted by internal medicine specialty (odds ratio [OR], 1.6; 95% confidence interval [CI], 1.2-2.3) compared with general and family physicians in regions. The percent variations in prescribing between different geographic regions and patient attitudes to environmental constraints can play an equal or greater role in physician decision making.

First, when primary care physicians prescribe antibiotics for ARTIs, they choose a broad-spectrum agent more than half the time. Second, there is wide variation in prescribing of broad-spectrum agents among different groups of patients and physicians, even after controlling for diagnosis and comorbidities. Internists and physicians in the Northeast and South were particularly likely to prescribe broad-spectrum antibiotics. More than three quarters of antibiotic regimens among patients seen by internists in these regions involved a broad-spectrum agent. Other factors including patient race, health maintenance organization membership, and insurance status were also significantly associated with choice of a broad-spectrum agent.

It is difficult to quantify the correct amount of broad-spectrum antibiotic prescribing, yet several features suggest that the rates we observed are too high. Many of the diseases we studied do not require any antibiotic therapy at all, such as the common cold and acute bronchitis.

Overall rates of medication use and variation in prescribing between physicians stem from a wide array of factors that affect clinical decisions. Traditional biomedical factors (characteristics of diseases, drugs, and physician knowledge) form one important set of inputs to the prescribing decision. However, a host of other factors ranging from physician and patient attitudes to environmental constraints can play an equal or greater role in physician decision making. Physicians with a similar knowledge base may make different judgments about the relative importance of various characteristics of a drug, such as its efficacy, ease of use, adverse effect profile, cost, and potential effect on resistance in the community. Numerous studies document that patient expectations, driven by explanatory models of illness and increasingly by direct-to-consumer advertising, can be a major driver of prescribing behavior. For example, physicians are far more likely to prescribe an antibiotic when they think their patient expects a drug, even though these perceptions often do not match the reality of patients’ wishes.

Quantitative differences in cure rates between broad- and narrow-spectrum agents often do not match the reality of patients’ wishes. Drug samples can also influence prescribing decisions for individual patients, as do the wide range of other marketing efforts such as advertisements, gifts, and promotional detailing. Finally, formulary restrictions and other external constraints can promote the use of certain drugs over others.

Variation in prescribing behavior between different geographic regions and
specialties may reflect an asymmetrical distribution of this wide range of factors. For example, knowledge of recommended treatment strategies for ARTIs may vary between groups of physicians. Perhaps more importantly, the medical culture in which physicians practice (ie, within a specialty or geographic region) may impart different values to therapeutic decisions. Highlighting this point, Metlay et al demonstrated that infectious disease specialists are more likely than generalists to incorporate public health concerns into their choice of antibiotic. In addition, the distribution of environmental factors may have substantial heterogeneity. For example, different degrees of managed care penetration (and attendant formulary restrictions) may help explain regional differences in patterns of care, and pharmaceutical marketing efforts may be greater in areas where the perceived reward is higher.

Other studies of antibiotic choice confirm the complex interplay of these influences and highlight the role of factors other than a standardized application of accurate clinical knowledge. In a recent study of nonrecommended antibiotic use among patients with pharyngitis, only nonclinical characteristics (ie, calendar year and type of health plan) were associated with medication choice. In contrast, another study of patients with sinusitis found that prescribing of second-line antibiotics was predicted by older age, comorbidity, and specialist care. Other research about whether patients receive an antibiotic has documented a similar mix of clinical and nonclinical inputs into the prescribing decision, including the patient’s clinical presentation, age, and perceived patient expectation for antibiotics, as well as physician factors such as clinician age, specialty, method of enumeration, and practice volume.

It is difficult to disentangle the web of factors that contribute to variation in broad-spectrum antibiotic prescribing. However, cultural factors shared within physician specialties and geographic regions that impact prescribing could serve as important targets for intervention efforts. The use of opinion leader programs, clinical champions, and one-on-one education (termed academic detailing) have been among the most effective strategies for modifying prescribing patterns.

### Table. Predictors of Broad-Spectrum Antibiotic Choice Among Patients Prescribed an Antibiotic

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Unweighted Sample (N = 1257)</th>
<th>Patients Prescribed a Broad-Spectrum Antibiotic, %†</th>
<th>Adjusted OR (95% CI) of Broad-Spectrum Antibiotic Prescription</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagnosis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Common cold and nonspecific URTI</td>
<td>222</td>
<td>51</td>
<td>Referent</td>
</tr>
<tr>
<td>Sinusitis</td>
<td>325</td>
<td>53</td>
<td>1.1 (0.6-1.8)</td>
</tr>
<tr>
<td>Otitis media</td>
<td>64</td>
<td>65</td>
<td>1.9 (0.9-3.7)‡</td>
</tr>
<tr>
<td>Acute bronchitis</td>
<td>276</td>
<td>62</td>
<td>1.5 (0.9-2.5)</td>
</tr>
<tr>
<td>Other URTI§</td>
<td>153</td>
<td>33</td>
<td>0.4 (0.2-0.7)‖</td>
</tr>
<tr>
<td>&gt;1 of the above</td>
<td>217</td>
<td>58</td>
<td>1.4 (0.8-2.3)†</td>
</tr>
<tr>
<td>Comorbidity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absent</td>
<td>1161</td>
<td>53</td>
<td>Referent</td>
</tr>
<tr>
<td>Present</td>
<td>96</td>
<td>69</td>
<td>1.7 (1.0-3.0)‖</td>
</tr>
<tr>
<td>Age category, y¶</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18-39</td>
<td>522</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>40-59</td>
<td>454</td>
<td>56</td>
<td></td>
</tr>
<tr>
<td>≥60</td>
<td>281</td>
<td>58</td>
<td></td>
</tr>
<tr>
<td>Sex¶</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>501</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Women</td>
<td>756</td>
<td>57</td>
<td></td>
</tr>
<tr>
<td>Race/ethnicity</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>White non-Hispanic</td>
<td>1073</td>
<td>55</td>
<td>Referent</td>
</tr>
<tr>
<td>Black non-Hispanic</td>
<td>98</td>
<td>43</td>
<td>0.5 (0.3-0.9)‖</td>
</tr>
<tr>
<td>Other race non-Hispanic</td>
<td>27</td>
<td>51</td>
<td>1.1 (0.5-2.4)ONO</td>
</tr>
<tr>
<td>Hispanic, any race</td>
<td>59</td>
<td>51</td>
<td>0.7 (0.3-1.5)ONO</td>
</tr>
<tr>
<td>Primary source of payment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private insurance</td>
<td>787</td>
<td>55</td>
<td>Referent</td>
</tr>
<tr>
<td>Medicare</td>
<td>171</td>
<td>59</td>
<td>0.8 (0.5-1.2)ONO</td>
</tr>
<tr>
<td>Medicaid</td>
<td>64</td>
<td>47</td>
<td>0.8 (0.4-1.7)ONO</td>
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<tr>
<td>Self-pay</td>
<td>144</td>
<td>42</td>
<td>0.5 (0.3-0.8)ONO</td>
</tr>
<tr>
<td>Other</td>
<td>91</td>
<td>53</td>
<td>0.8 (0.4-1.7)ONO</td>
</tr>
<tr>
<td>Health maintenance organization membership</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>800</td>
<td>55</td>
<td>Referent</td>
</tr>
<tr>
<td>No</td>
<td>370</td>
<td>51</td>
<td>0.6 (0.5-0.9)ONO</td>
</tr>
<tr>
<td>Region</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>West</td>
<td>193</td>
<td>49</td>
<td>Referent</td>
</tr>
<tr>
<td>Midwest</td>
<td>379</td>
<td>44</td>
<td>1.3 (0.7-2.3)ONO</td>
</tr>
<tr>
<td>Northeast</td>
<td>245</td>
<td>63</td>
<td>2.6 (1.4-4.8)ONO</td>
</tr>
<tr>
<td>South</td>
<td>440</td>
<td>59</td>
<td>2.4 (1.4-4.2)ONO</td>
</tr>
<tr>
<td>Location</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td>959</td>
<td>56</td>
<td>Referent</td>
</tr>
<tr>
<td>Rural</td>
<td>298</td>
<td>48</td>
<td>0.7 (0.4-1.0)‡</td>
</tr>
<tr>
<td>Physician specialty</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General practice/family practice</td>
<td>868</td>
<td>46</td>
<td>Referent</td>
</tr>
<tr>
<td>Internal medicine</td>
<td>389</td>
<td>68</td>
<td>2.4 (1.6-3.5)ONO</td>
</tr>
</tbody>
</table>

Abbreviations: CI, confidence interval; OR, odds ratio; URTI, upper respiratory tract infection. *Broad-spectrum antibiotics included the quinolones, amoxicillin/clavulanate, second- and third-generation cephalosporins, and azithromycin and clarithromycin. †As a percentage of the total number of patients prescribed an antibiotic, adjusted for sample weights. ‡P<.10. §Includes pharyngitis, laryngitis, and tracheitis. ‖P<.05. ¶Age and sex did not meet prespecified statistical criteria for inclusion in the final multivariate model.

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physician prescribing.54,55 The success of these interventions has been attributed to their ability to address local cultures of practice by modeling approaches to drug use in a context that resonates with the audience.56,57 Similarly, other successful interventions have accounted for the unique patient, physician, and system influences that impact a discrete group of physicians, simultaneously addressing multiple targets to change the local culture of practice and thereby improve prescribing.58

Our findings should be interpreted in light of this study's limitations. Although better than most surveys of its kind, the response rate of the NAMCS was incomplete, and like all surveys there was potential for inaccurate data collection. Our data included little clinical information. For instance, there was no indication if the study visit was an initial or follow-up appointment. Also, our comorbidity variable likely missed many patients with quiescent comorbid conditions, although by preferentially capturing patients with active comorbidities, we likely overestimated the association between comorbidity and broad-spectrum antibiotic prescribing. Although we were unable to completely eliminate other clinical confounders (eg, specialty-based differences in illness severity and regional differences in microbiological resistance), these confounders are unlikely to fully account for the intergroup variation that we observed. Other important clinical variables such as age did not predict broad-spectrum antibiotic choice, even when comorbidity was not included in the multivariate model. Moreover, our findings persisted after expanding the analysis to include patients who did not receive an antibiotic, thus making it unlikely that physicians with the highest proportion of broad-spectrum agents were merely reserving antibiotic therapy for their sickest patients.

In summary, our findings show high rates of broad-spectrum antibiotic prescribing, even among conditions for which antibiotic therapy is not indicated at all. Controlling for clinical characteristics, physician specialty and region were strongly associated with choice of broad-spectrum agents. Further investigation, both globally and locally, is needed to more clearly delineate the forces that contribute to this variation. Whatever these reasons, past experience shows that interventions relying on passive education or a one-size-fits-all approach are not enough. Instead, interventions that focus on understanding and changing shared cultures of practice will be most likely to improve the quality of medication prescribing.

**Author Contributions:** The authors had full access to the data, which is contained in a publicly accessible data set available from the Centers for Disease Control and Prevention. Study concept and design: Steinman, Gonzales. Acquisition of data: Steinman. Analysis and interpretation of data: Steinman, Landefeld, Gonzales. Drafting of the manuscript: Steinman, Gonzales. Critical revision of the manuscript for important intellectual content: Steinman, Landefeld, Gonzales. Statistical expertise: Steinman. Obtained funding: Steinman, Landefeld, Gonzales. Administrative, technical, or material support: Steinman. Study supervision: Landefeld, Gonzales.

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