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Non-Infection-Related And Non-Visit-Based Antibiotic Prescribing Is Common Among Medicaid Patients

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ABSTRACT **Ambulatory antibiotic stewardship policies focus on prescribing decisions made when patients present to clinicians with possible infections. They do not capture antibiotics prescribed outside of clinician visits or without clear indications for use. Antibiotic prescribing for vulnerable patients in the US has not been comprehensively measured. We measured the frequency with which all filled antibiotic prescriptions were associated with infections and in-person visits for Medicaid patients in the period 2004–13. We found that among 298 million antibiotic fills (62 percent for children) for 53 million patients, 55 percent were for clinician visits with an infection-related diagnosis, 17 percent were for clinician visits without an infection-related diagnosis, and 28 percent were not associated with a visit. Non-visit-based antibiotic prescriptions were less common for children than for adults and more common in the West than in other US regions. Large fractions of antibiotic prescriptions are filled without evidence of infection-related diagnoses or accompanying clinician visits. Current ambulatory antibiotic stewardship policies miss about half of antibiotic prescribing.**

The rate of antibiotics prescribed in the US is about double that in many other countries.[1–3] Approximately 80 percent of US antibiotic prescribing occurs in ambulatory care, and there is marked geographic and specialty variability—with family practice, pediatrics, and internal medicine accounting for most antibiotic prescriptions.[4,5] Antibiotics are one of the most commonly identified classes of medications associated with adverse drug events.[6,7] Potential complications include rashes, diarrhea,[8] and *Clostridioides difficile* infection.[9]

Antibiotic overuse also contributes to the development of antibiotic resistance, and already each year more than two million people in the US are sickened with and 23,000 die from infections caused by antibiotic-resistant bacteria.[10] Antibiotic-resistant infection treatment costs in the US have doubled since 2002 and now exceed $2 billion annually.[11]

Prior research has identified a substantial fraction of antibiotic use as clinically inappropriate. For example, between 1996 and 2010, physicians prescribed antibiotics to 60 percent of adults with a sore throat when only 10 percent required antibiotics[12] and prescribed antibiotics to 71 percent of adults with acute bronchitis, which generally should not require antibiotics at all.[13] A recent assessment of outpatient antibiotic prescriptions for a large national population found that 23 percent were clearly inappropriate and 35 percent were only potentially appropriate.[14]

Given these problems, reducing antibiotic overuse and improving the quality of antibiotic prescribing have been identified as important priorities. A wide range of national and regional public policies to decrease inappropriate antibiotic prescribing have been implemented and evaluated.[15–24] However, most of these stewardship programs rely on intervening for infection-related diagnoses during a clinical visit at which antibiotics are being prescribed. Recent studies of antibiotic prescribing have identified a subset of antibiotic prescriptions without clear evidence of a preceding clinical visit.[14,25] Such non-visit-based prescriptions raise particular policy and safety concerns: Non-visit-based antibiotics are missed by antibiotic stewardship policies that focus only on visits with a clear infection-related diagnosis.

Americans covered by Medicaid—the public health insurance program for people with lower incomes and the largest source of health care coverage in the US—are a particularly vulnerable population, including low-income children, pregnant women, and people with chronic disabilities. Antibiotic prescribing to Medicaid beneficiaries has not been comprehensively described.[26–28] We evaluated the frequency of non-infection-related and non-visit-based antibiotic prescribing in Medicaid over a ten-year period and assessed which patient or prescription characteristics were most likely to be associated with non-visit-based prescribing.

Study Data And Methods

OVERVIEW Using national Medicaid claims data for the latest ten years available at the time of our analyses, we identified all filled outpatient antibiotic prescriptions, determined whether the patients had had a clinician visit in the seven days before filling the prescription, and checked whether the visits had evidence of an infection-related diagnosis. We examined whether the rate of non-visit-based prescribing varied across patient or prescription characteristics or over time.

DATA SOURCE We used data for 2004–13 from Medicaid, which has joint state and federal funding and covered almost sixty million people in 2013. The Medicaid Analytic eXtract (MAX) includes complete information on paid claims for all patients enrolled in Medicaid and is available with a five-year delay.[29,30] Specific elements of the MAX data include all filled outpatient prescriptions covered by Medicaid, all inpatient and outpatient services with accompanying diagnosis and procedure codes, and eligibility files with basic demographic information and Medicaid identifiers that allow patient information to be linked across the different types of claims files.

We had data for fifty states and the District of Columbia, but data were missing from certain states in certain years. For example, data for 2013 were available for only twenty states at the time that we conducted our analysis (online appendix exhibit A1).[31]

MAX includes claims for antibiotic prescriptions filled in the outpatient setting; medications administered in inpatient settings are not included. Medications are identified by National Drug Code number, which we used to incorporate additional information from First Databank's National Drug Data File that specified the administration route (for example, oral or intravenous), form (for example, capsule, liquid, or ointment), and therapeutic class.

COHORT IDENTIFICATION We identified all claims for absorbable oral antibiotics filled in the outpatient setting. The unit of analysis was the prescription; patients could contribute multiple observations to the study cohort. We began by selecting all prescriptions for which the National Drug Code number corresponded to an antibiotic therapeutic class. To ensure adequate measurement of baseline comorbidities and medication use, for each filled prescription we checked whether the patient filling the prescription had been enrolled in Medicaid for at least 180 days before the date of prescription fill. We excluded several antibiotics: methenamine (used for urinary tract infection prophylaxis), non-oral antibiotics, and non-absorbable oral antibiotics (for example, vancomycin).

IDENTIFICATION OF VISITS BEFORE PRESCRIPTION We examined claims records to determine whether each antibiotic prescription had been preceded by any kind of clinical encounter. For each filled prescription we used the individual patient identifier to link to the MAX files for outpatient visits (including emergency department encounters), inpatient visits, and all other services. We identified the nearest preceding claim for several specific types of services.

▶ **CLINICIAN ENCOUNTER:** Using *Current Procedural Terminology*, Fourth Edition (CPT-4), codes and Healthcare Common Procedure Coding System codes, we identified visits with clinicians on the day of or in the seven days before the date of the antibiotic prescription fill, including outpatient visits, emergency department encounters, and hospitalizations.

▶ **INFECTION-RELATED ENCOUNTERS:** For all claims identified within the seven-day window, whether for clinician encounters or for other services, we reviewed the *International Classification of Diseases,* Ninth Revision (ICD-9), codes associated with the claims. We classified all 17,649 ICD-9 codes as either indicative of infectious conditions or not[14] (for a full list of ICD-9 codes with classifications, see appendix exhibit A2).[31] If a claim for a clinician visit within the seven-day window had an infection-related ICD-9 code, we classified the associated antibiotic prescription as infection related. We further subdivided the infection codes into those for acute and chronic infectious conditions.

▶ **ANY SERVICE:** This category included claims of any type, regardless of the type of care provided, whether or not a clinician was seen, or the associated diagnosis codes.

PRIMARY ANALYSIS For our primary analysis we checked for all of these visit types in the seven days before the day of the antibiotic prescription fill, including the day of the fill. Most analyses of ambulatory-based antibiotic prescribing have used visit-prescription windows of five or fewer days.[14,32] However, we chose seven days to allow more time for the delayed filling of antibiotic prescriptions that might occur for many reasons in real-world practice—especially for patients covered by Medicaid, who may face challenges with transportation and other logistic issues.

If, during the seven days preceding an antibiotic fill, we identified no encounters or only encounters that did not include a clinician visit, we classified the prescription as non–visit based. We compared the rates of non-visit-based prescribing across the characteristics of the prescriptions and patients, including antibiotic class; patient age, sex, and race; region of the country; and calendar year. Given the massive sample size, we did not test for the statistical significance of differences. Instead, we prespecified that differences of 5 percent in any category were clinically significant.

We identified two prespecified subsets of antibiotics that might often be prescribed outside of a face-to-face visit: those given for dental prophylaxis and those being used chronically.

▶ **PROPHYLAXIS FOR DENTAL PROCEDURES:** We identified filled prescriptions with limited quantities (for example, one or two doses) of four antibiotics commonly used prophylactically before dental or similar procedures—amoxicillin, azithromycin, cephalexin, and clindamycin—and classified these prescriptions as for dental prophylaxis.

▶ **CHRONIC PRESCRIPTIONS:** To account for antibiotic prescriptions that could be taken chronically (for example, for acne or immunosuppression prophylaxis), we identified all dispensed prescriptions with a duration longer than 21 days. We checked the filled prescription records for each relevant patient for 180 days both before and after the prescription being assessed. If the patient received more than a 90-day supply of that antibiotic during the 360 days checked, then we classified the prescription as chronic.

ALTERNATIVE ANALYSES

▶ **MEDICAID MANAGED CARE:** Many states enroll Medicaid patients in managed care plans, under which private insurers contract with the state to provide insurance for Medicaid patients. The medications and other services used by these patients are reported back to the states and are included in the data that states provide to the Centers for Medicare and Medicaid Services (CMS). Prior analyses have shown that these data are included completely and are of comparable quality to fee-for-service data in most, but not all, states.[33] Of particular concern for our analyses would be situations in which medication data were fully reported but some clinical encounters were missed, which would increase the apparent rate of non-visit-based antibiotic prescribing. Accordingly, we conducted an alternative analysis in which we excluded all antibiotic prescriptions dispensed to patients enrolled in Medicaid managed care.

▶ **REPEATED PRESCRIPTIONS:** Medicaid provides coverage for many patients with chronic medical conditions. Some of these patients receive extensive services at home (for example, a patient with chronic pulmonary disease who receives home nursing and respiratory therapy visits) and might be more likely to receive repeated antibiotic prescriptions without a visit to see a clinician. To assess whether this phenomenon affected our results, we conducted alternative analyses in which only the first prescription filled for each patient was included in the cohort, so that a patient who received repeated prescriptions would contribute only one observation.

LIMITATIONS Our analyses had several limitations. First was our use of claims data. Medicaid is the largest single insurer in the US, so the ability to use ten years of MAX data gave us an exceedingly large data set of prescriptions. But claims data reflect billing processes and thus do not contain complete clinical information. As a result, the data did not provide us with insights into the decision making behind the prescriptions we studied.

Second, though patients covered by Medicaid constitute a large percentage of the US population, prescribing practices for them might not be reflective of those for the entire population.

Third, we were unable to assess prescriber characteristics, which could be important predictors of non-visit-based prescribing.

Fourth, compared to data used in other analyses of antibiotic prescribing, our data were old. However, they were the most recent national data available for Medicaid at the time of our analysis. The lag in making national data available through MAX may be one reason why there has not previously been a comprehensive examination of antibiotic prescribing in Medicaid.

Fifth, we focused on absorbable oral antibiotics, which account for most outpatient antibiotics. Future studies could explore topical, intravenous, and nonabsorbable oral antibiotics, which we excluded.

Study Results

We identified over 357 million filled outpatient antibiotic prescriptions in the ten years of MAX data for 2004–13 (appendix exhibit A3).[31] Checking for at least 180 days of Medicaid eligibility prior to the fill date reduced this cohort to 304 million prescriptions. The additional exclusions described above yielded a cohort of 298 million prescriptions. Children received the majority of the prescriptions, with prescriptions for patients ages 0–5 accounting for over one-third of the sample (exhibits 1 and 2). Penicillins accounted for over 40 percent of the prescriptions—more than twice as much as macrolides or cephaloporins did (exhibit 1). The vast majority of prescriptions were for durations of five to twenty days. Only 0.2 percent of the filled antibiotic prescriptions met the criteria for dental prophylaxis, and 3.2 percent met our prespecified criteria for chronic antibiotic use (a supply for more than 90 days in a 360-day period) (data not shown).

The 298 million prescriptions were filled by 53 million patients (exhibit 2). The age distribution of patients as of the date on which they filled an antibiotic prescription was similar in both our prescription-level analysis (exhibit 1, to which patients could contribute multiple observations) and our patient-level analysis (exhibit 2, to which patients could contribute only one observation). Over 40 percent of the patients in the cohort were from the South, with the remaining patients split about evenly among other regions (exhibit 2). Reflecting the predominance of children in the cohort, comorbid diseases were rare, with a mean Charlson comorbidity score of 0.1 (data not shown).

In the entire cohort, 28 percent of the filled antibiotic prescriptions had no claims for a clinician encounter in the seven previous days (exhibit 3). About half of that 28 percent had claims in that period for medical services that were not clinician encounters, most commonly for laboratory testing or home care services by attendants or nurses (data not shown). The remaining 72 percent of antibiotic prescriptions were associated with a clinician visit: 55 percent included a diagnosis code for an infection, and 17 percent were not associated with an infection-related diagnosis (exhibit 3). Of the visits with infection-related diagnosis codes, 4 percent of the diagnosis codes corresponded to a chronic infection, based on the ICD-9 classification system (see appendix exhibit A2).[31]

We then compared the rates of non-visit-based antibiotic prescribing across characteristics of patients and medications. Antibiotic prescriptions for children were filled without a preceding clinician visit less often than were those for adults; there also were fewer filled antibiotic prescriptions for children associated with visits lacking a diagnosis code for infection. There were small differences by race and sex, but none met the prespecified threshold of 5 percent. Patients in the South and Midwest were less likely to have non-visit-based antibiotic fills and also had more antibiotic fills associated with infection-related visits. Rates of non-visit-based prescriptions were relatively similar across the most common major antibiotic classes, with slightly higher rates for the group of classes combined as "other" (exhibit 3). Prescriptions for antibiotics used chronically were non–visit based 70 percent of the time—far more than any other subgroup of prescriptions (data not shown).

There was a decrease in the proportion of non-visit-based antibiotic prescriptions over time, but even in the partial data available for 2013,

EXHIBIT 1

Patient and prescription characteristics in the cohort of antibiotic prescriptions in Medicaid, prescription-level analysis, 2004–13

Characteristics	No. or %
Number of prescriptions	297,514,611
Mean patient age (years) ± standard deviation at time of antibiotic dispensing	17.9 ± 17.6
Patient age at time of antibiotic dispensing, years (%)	
0–5	34.7
6–12	16.6
13–17	10.2
18–65	38.1
65 or older	0.4
Antibiotic class (%)	
Penicillins	40.4
Macrolides	19.7
Cephalosporins	15.9
Sulfa drugs	7.8
Fluoroquinolones	5.2
Other	11.0
Duration of prescription (%)	
More than 20 days	4.6
5–20 days	91.3
0–4 days	4.1
Year of prescription (%)	
2004	9.4
2005	9.0
2006	8.8
2007	8.9
2008	9.7
2009	11.3
2010	11.9
2011	12.7
2012	13.1
2013	5.1

SOURCE Authors' analysis of Medicaid data for 2004–13. **NOTES** At the time of our analysis, data for 2013 were available for only the twenty states listed in appendix exhibit A1 (see note 31 in text). The five most frequently prescribed "other" drugs were metronidazole, doxycycline, clindamycin, nitrofurantoin, and minocycline.

EXHIBIT 2

Patient and prescription characteristics in the cohort of antibiotic prescriptions in Medicaid, patient-level analysis, 2004–13

Characteristics	No. or %
Number of patients	52,904,389
Mean patient age (years) ± standard deviation at time of first antibiotic dispensing	15.7 ± 16.7
Patient age at time of first antibiotic dispensing, years (%)	
0–5	39.3
6–12	14.9
13–17	10.7
18–65	34.6
65 or older	0.5
Sex (%)	
Female	57.9
Male	42.1
Race (%)	
Black	22.5
White	43.9
Other	33.5
Region (%)	
Midwest	20.2
Northeast	17.3
South	41.0
West	21.4

SOURCE Authors' analysis of Medicaid data for 2004–13. **NOTE** "Other" race includes the 29 percent of the patients for whom race was "unknown."

22 percent of antibiotic prescriptions were not associated with a clinician visit (exhibit 4). The proportion of antibiotic prescriptions associated with a visit with no infection-related diagnosis remained about the same over the study period and was 19 percent in 2013.

Appendix exhibit A4 presents the results of the sensitivity analyses.[31] Excluding all prescriptions filled for patients in Medicaid managed care plans reduced the cohort size by over 65 percent, while still leaving almost 100 million prescriptions for analysis. In these analyses the proportion of antibiotics with no clinician visits in the seven days before prescription fill decreased from 28 percent to 21 percent. As in the main analysis, for about half of the filled prescriptions with no clinician visits, claims were identified within seven days for other services. We next limited the cohort to include only the first filled prescription from each patient, to address the potential impact on the results of patients with chronic illness who receive many repeated antibiotic prescriptions. This reduced the cohort size to fifty-three million prescriptions, or 18 percent of the original cohort, but the findings differed only slightly from the main results—with 28 percent of antibiotic prescriptions not associated with a clinician visit. Appendix exhibit A5 shows changes over time for the sensitivity analyses.[31]

Discussion

Our assessment of almost 300 million antibiotic prescriptions dispensed to Medicaid recipients found that 28 percent were not associated with a recent visit, and another 17 percent were dispensed without evidence of a visit that had an infection-related diagnosis. These large volumes of antibiotics dispensed without a clinical assessment or a specific diagnosis are missed by existing US antibiotic stewardship policies.

The US is the third-largest consumer of antibiotics in the world,[34] and its per capita consumption ranks it nineteenth of seventy-one countries.[35] Antibiotic prescribing in the US has decreased slightly, but this is mainly attributable to decreases among children, and there are still over 800 prescriptions per 1,000 Americans per year.[36] The US rate is much higher than rates in England and Sweden (607 and 325 prescriptions per 1,000 population, respectively). Looking to the future, some countries have aggressive goals to decrease inappropriate antibiotic prescribing (for example, Belgium is seeking a 50 percent reduction)[2] or much lower absolute targets for antibiotic use (for example, both Sweden and Norway have the goal of 250 prescriptions per 1,000 population).[2,3]

General US antibiotic stewardship policies include the National Action Plan for Combating Antibiotic-Resistant Bacteria, which set a goal of reducing inappropriate outpatient antibiotics by 50 percent by 2020[37] without clear guidance on how this would be measured or achieved. The Centers for Disease Control and Prevention (CDC) Core Elements of Ambulatory Antibiotic Stewardship recommend that all ambulatory practices commit to implementing stewardship, implement stewardship for at least one clinical scenario, track and report data on that scenario, and provide ongoing education to clinicians and patients.[38] Most recently, the Joint Commission has decided to implement ambulatory antimicrobial stewardship standards that reflect the CDC Core Elements.[39]

Policies that focus on specific diagnostic scenarios include the measures from the National Committee for Quality Assurance's Healthcare Effectiveness Data and Information Set (HEDIS) that assess prescribing for visits for nonspecific upper respiratory tract infections, pharyngitis, and acute bronchitis.[40] The Choosing Wisely campaign of the American Board of Internal Medicine and other specialty societies includes thirty-eight antibiotic-related recommendations, all of which specify a clinical scenario (for example, pediatric pneumonia, extremity wounds, and prophylactic antibiotics for mitral valve prolapse).[41]

What occurred clinically for the many non-

EXHIBIT 3

Frequency of clinical visits and infection codes within seven days before antibiotic fills, 2004–13

	No clinician visit	Clinician interaction, no infection	Clinician interaction, infection
Prescriptions filled	82,643,524 (27.8%)	50,138,735 (16.9%)	164,732,352 (55.4%)
Patient age, years (%)			
0–17	23.7	12.5	63.7
18–64	34.1	23.7	42.1
65 or older	41.0	25.1	55.4
Sex (%)			
Male	26.4	15.4	58.1
Female	28.6	17.8	53.6
Unknown	27.2	16.6	56.2
Race (%)			
White	27.8	15.8	56.4
Black	28.2	20.0	51.9
Other	27.5	16.5	56.0
Region (%)			
Midwest	23.9	17.0	59.0
Northeast	32.0	20.4	47.6
South	25.1	15.9	59.1
West	35.1	15.7	49.2
Antibiotic class (%)			
Penicillins	26.2	16.7	57.0
Macrolides	25.5	14.8	59.7
Cephalosporins	24.5	14.9	60.5
Sulfa drugs	31.0	16.0	53.0
Fluoroquinolones	29.3	20.3	50.4
Other	39.5	22.7	38.1

SOURCE Authors' analysis of Medicaid data, 2004-2013. **NOTES** The top five *International Classification of Diseases*, Ninth Revision (ICD-9), and *Current Procedural Terminology*, Fourth Edition (CPT-4), codes for "no clinician visit" (non-visit-based) were for ICD-9: urinary tract infection, site not specified; other unknown and unspecified cause of morbidity or mortality; supervision of other normal pregnancy; unspecified otitis media; and acute pharyngitis; and for CPT-4: personal care services; complete blood count; urine culture; urinalysis; and radiologic examination, chest, two views, frontal and lateral. For "clinician interaction, no infection" (non-infection-related), they were for ICD-9: routine infant or child health check, abdominal pain—unspecified site, cough, asthma—unspecified, and fever—unspecified; and for CPT-4: established patient office or other outpatient services, office or other outpatient visit for the evaluation and management of an established patient, complete blood count, emergency department visit, and intraoral-periapical first radiographic image. For "clinician interaction, infection," they were for ICD-9: acute pharyngitis; urinary tract infection, site not specified; unspecified otitis media; acute upper respiratory infections of unspecified site; and acute bronchitis; and for CPT: established patient office or other outpatient services; new or established patient emergency department services; office or other outpatient visit for the evaluation and management of an established patient; rapid step test; and radiologic examination, chest, two views, frontal and lateral.

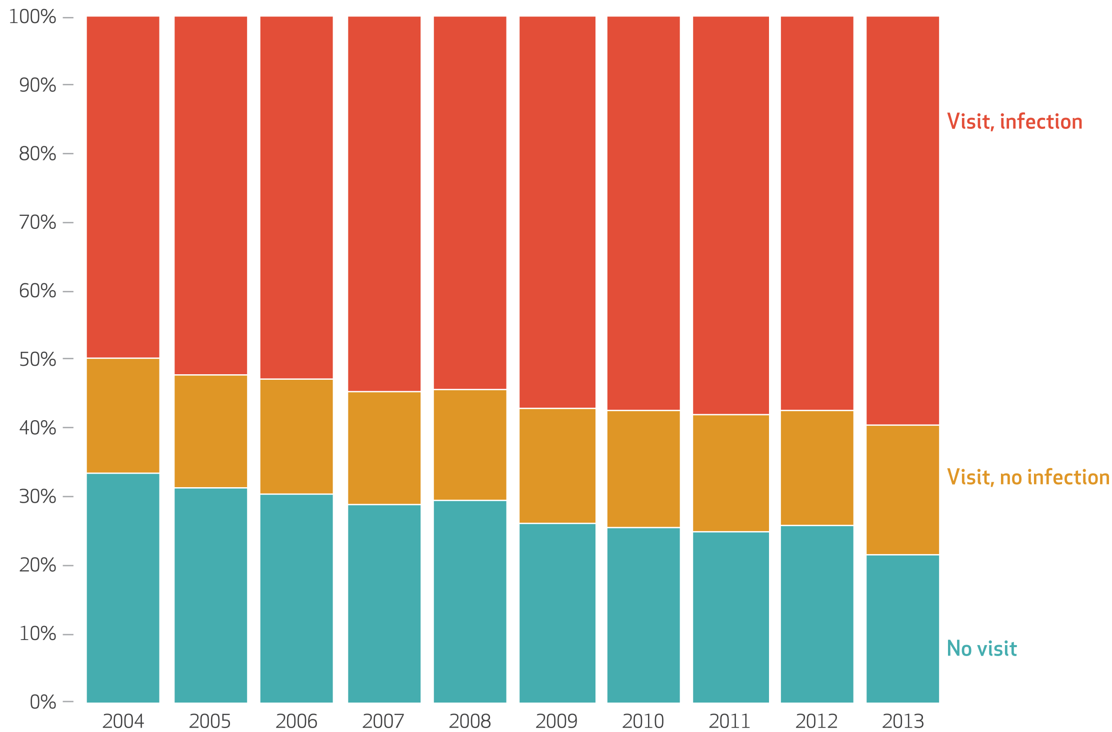
visit-based antibiotic prescriptions? Since our analyses were based on claims data, we could not determine what interactions took place between patients and prescribing clinicians that were not captured as an encounter billable to Medicaid. Given the time period we studied, we assume that most of these prescriptions were associated with a telephone interaction, although some communication may have occurred via email; electronic health record patient portals; or informal, uncaptured visits. About half of the 28 percent of prescriptions not associated with a recent visit had proximal claims for laboratory testing or home care services. Thus, prescribers were probably reacting to the results of lab tests that had been ordered based on reported patient symptoms or responding to calls from home care services. Even if these were the explanations, the events described would not be captured by existing ambulatory stewardship interventions.

Antibiotics may be used chronically for certain indications such as suppressive therapy in the setting of an infected prosthetic joint, but we found that such prescriptions accounted for only about 3 percent of the antibiotics. Similarly, prescriptions consistent with the agents and amounts dispensed for dental prophylaxis accounted for well under 1 percent of the antibiotics.

The MAX data provide relatively limited patient-level information, but we were able to evaluate the relative frequency of non-visit-based antibiotic prescribing across several major variables. Children more often had a claim for a clinician visit within the seven days preceding an antibiotic prescription than adults did, al-

EXHIBIT 4

Trends in non-visit-based antibiotic prescribing, by type of clinician visit, 2004–13



SOURCE Authors' analysis of Medicaid data for 2004–13. **NOTES** "No visit" means that there was no clinician visit ("non-visit-based"). "Visit, no infection," means that there was a visit but no infection-related diagnosis ("non-infection-related"). At the time of our analysis, data for 2013 were available for only the twenty states listed in appendix exhibit A1 (see note 31 in text).

though non-visit-based prescriptions still accounted for over 20 percent of the dispensing to children. For antibiotic prescriptions that were associated with a visit, children's visits were more likely than adults' visits to include a diagnosis code for infection. Whether this reflects a true difference in the types of assessments that occurred in the office or is an artifact, because adults more often have other medical conditions that may be used when submitting claims, could not be determined from our data source. We did not observe large differences in non-visit-based antibiotic prescribing by race or sex. However, variation by region was large, with much less non-visit-based prescribing in the South and Midwest than in the Northeast and West.

Over time there was a decrease in non-visit-based antibiotic prescriptions, an increase in infection-related visits, and no change in non-infection-related visits (exhibit 4). Despite these changes over time, in 2012—the latest year for which we had complete data—non-visit-based and non-infection-related prescribing accounted for 43 percent of the total (26 percent non-visit-based and 17 percent non-infection-related).

Beyond chronic antibiotic prescribing and dental prophylaxis, we examined several explanations and considered several important potential causes of artifacts in our analyses. Since Medicaid provides coverage for many patients with chronic illnesses, who may receive nursing or other clinical services at home that increase the opportunities for communication with prescribers outside of visits, we performed alternative analyses that included only one prescription per patient. These did not change our findings.

Medicaid patients increasingly receive coverage through managed care plans. We were concerned about two potential sources of mismeasurement on this basis. First, if the reporting of managed care claims to CMS was incomplete—in particular, if prescriptions were fully reported, but visits were not—then we might have erroneously identified prescriptions as non–visit based. Second, if managed care patients differed systematically from those enrolled in fee-for-service Medicaid, then our primary analyses could have averaged two quite different populations, thus yielding a less accurate depiction of clinical practice. Our alternative analysis that excluded managed care patients still included almost 100 million prescriptions, and the results differed substantively from those of our primary analysis: 21 percent versus 28 percent of antibiotic prescriptions were non–visit based, respectively. If the first explanation (incomplete reporting) was correct, then the true rate of non-visit-based antibiotic prescribing in Medicaid might have been closer to 21 percent, which is still a substantial fraction of prescriptions. If the second explanation (population differences or patient selection) was correct, then this might point to the existence of important variability in practice patterns that would warrant further exploration with more detailed clinical data.

Policy Implications

By failing to measure appropriate antibiotic prescribing, not including non-infection-related and non-visit-based prescribing, or focusing on narrow clinical scenarios, existing general and specific policies seem unlikely to improve antibiotic use on a large scale. To improve public health, ambulatory antibiotic stewardship policies should include comprehensive measurement of antibiotic use and comprehensive measures of appropriateness.

Comprehensive measures of antibiotic use could use claims or electronic health record data. Claims-based comprehensive measures of antibiotic use could be promulgated by Medicaid, health plans, or HEDIS and should include all sites of care—traditional primary care and specialty practices as well as retail clinics, urgent care centers, online care companies, and others. Health systems could use electronic health record data to report clinic- and clinician-level per patient antibiotic prescribing.

For appropriateness, we have developed a publicly available, comprehensive measure using ICD-9 or *International Statistical Classification of Diseases and Related Health Problems*, Tenth Revision (ICD-10), codes.[14] Finally, health systems, pharmacies, and payers should consider requiring a clear indication for all antibiotic prescribing, a solution that has been effective in improving inpatient antibiotic prescribing.[42]

Conclusion

Our evaluation of hundreds of millions of antibiotic prescriptions dispensed to Medicaid recipients revealed an alarmingly high proportion of prescriptions that were not infection related or visit based. Identifying the risks associated with such prescribing and designing interventions to improve the quality of antibiotic care will be important priorities for future study. From a policy perspective, current antibiotic stewardship recommendations and programs are missing a huge proportion of antibiotic prescribing. ■

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