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Original Article

Inappropriate outpatient antibiotic use in children insured by Kentucky Medicaid

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Abstract

Objective: To describe risk factors associated with inappropriate antibiotic prescribing to children.

Design: Cross-sectional, retrospective analysis of antibiotic prescribing to children, using Kentucky Medicaid medical and pharmacy claims data, 2017.

Participants: Population-based sample of pediatric Medicaid patients and providers.

Methods: Antibiotic prescriptions were identified from pharmacy claims and used to describe patient and provider characteristics. Associated medical claims were identified and linked to assign diagnoses. An existing classification scheme was applied to determine appropriateness of antibiotic prescriptions.

Results: Overall, 10,787 providers wrote 779,813 antibiotic prescriptions for 328,515 children insured by Kentucky Medicaid in 2017. Moreover, 154,546 (19.8%) of these antibiotic prescriptions were appropriate, 358,026 (45.9%) were potentially appropriate, 163,654 (21.0%) were inappropriate, and 103,587 (13.3%) were not associated with a diagnosis. Half of all providers wrote 12 prescriptions or less to Medicaid children. The following child characteristics were associated with inappropriate antibiotic prescribing: residence in a rural area (odds ratio [OR], 1.09; 95% confidence interval [CI], 1.07–1.1), having a visit with an inappropriate prescriber (OR, 4.15; 95% CI, 4.1–4.2), age 0–2 years (OR, 1.39; 95% CI, 1.37–1.41), and presence of a chronic condition (OR, 1.31; 95% CI, 1.28–1.33).

Conclusions: Inappropriate antibiotic prescribing to Kentucky Medicaid children is common. Provider and patient characteristics associated with inappropriate prescribing differ from those associated with higher volume. Claims data are useful to describe inappropriate use and could be a valuable metric for provider feedback reports. Policies are needed to support analysis and dissemination of antibiotic prescribing reports and should include all provider types and geographic areas.

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Antibiotic use is a well-known driver of antimicrobial resistance. The majority of use occurs in the outpatient setting,[1] where an estimated 30% of prescriptions are inappropriate.[2,3] The Centers for Disease Control and Prevention (CDC) Core Elements of Outpatient Antibiotic Stewardship highlight the need for action and interventions, as well as tracking and reporting of measurable antibiotic use outcomes, to improve outpatient antibiotic prescribing.[4]

Kentucky consistently has one of the highest rates of pediatric outpatient antibiotic prescribing in the United States, with an estimated 1281 antibiotic prescriptions per 1,000 children, compared to the national average of 760 antibiotics per 1,000 children in 2017 (CDC Office of Antibiotic Stewardship, Personal Communication, August 18, 2020).[5] Previous analyses have identified significant variation in volume of antibiotic prescribing to children based on geographic location, patient demographics, and provider type.[3,6-8] Children of younger age (0–2 years), living in the South are prescribed antibiotics at higher rates.[3] Additionally, white children and those living in rural areas have higher rates of prescription receipt.[6,7] In Kentucky, antibiotic prescribing rates to Kentucky Medicaid children are as much as 3 times higher in rural areas compared to more urban areas in Kentucky and national rates.[9]

Less is known about appropriateness of antibiotic prescribing to children, an important component of understanding overuse, gaining provider buy-in, and successfully implementing interventions to decrease use. Claims data and diagnostic codes are useful in describing the appropriateness of antibiotic prescribing in outpatient settings.[2,7] Chua et al[10] reported the appropriateness of outpatient antibiotic prescribing among privately insured patients of all ages in the United States using a comprehensive classification scheme to link antibiotic prescriptions to associated medical claims

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within the preceding 3 days.[10] We are not aware of similar data for children covered by public insurance, who account for nearly 40% of all children in the United States.[11]

In 2017, 590,000 children were enrolled in Kentucky Medicaid, 328,515 of whom received an antibiotic prescription. The primary objective of this study was to identify provider and patient-level risk factors for inappropriate antibiotic prescribing within the pediatric Kentucky Medicaid population.

Methods

Study design, participants, and data source

We conducted a cross-sectional analysis using Kentucky Medicaid medical and pharmacy claims data from January 1, 2017, to December 31, 2017. Outpatient claims for children age 19 years or under were included. Medical claims are representative of all billed encounters, and pharmacy claims represent filled prescriptions. The following variables were extracted from pharmacy claims: patient age, sex, ZIP code, and prescriber type (general practitioner, nurse practitioner, pediatrician, physician assistant, other). Geographic location was assigned using the patient's ZIP code and Rural–Urban Continuum Codes (RUCC).[12] RUCC codes were further categorized as urban (RUCC 1–3), suburban (RUCC 4–6) and rural (RUCC 7–9). Patient race or ethnicity was obtained from Medicaid enrollment data. We used the Feudtner pediatric complex chronic conditions classification system[13] to identify the presence of a chronic condition by querying all available medical claims at the patient level.

Antibiotic prescriptions were identified from pharmacy claims using the National Drug Code (NDC). We included oral or injectable antibiotics commonly prescribed in the outpatient setting. This list was agreed upon by authors (B.W. and M.S.), and a full list of included antibiotics is provided in Appendix A (online). Associated diagnoses, using *International Classification of Diseases, Tenth edition* (ICD-10), were identified by linking antibiotic prescriptions to medical claims within 3 days prior to the prescription fill date.[7]

Appropriateness classification scheme

The appropriateness of antibiotic prescriptions was determined using an ICD-10 classification scheme previously published and now publicly available.[10] Based on all associated ICD-10 codes, each antibiotic prescription was assigned to 1 of 4 mutually exclusive categories: appropriate, potentially appropriate, inappropriate, or not associated with an indication. This classification was hierarchical such that if any of the medical claims associated with a given prescription were for a diagnosis that should always be treated with an antibiotic, the prescription was defined as appropriate. Similarly, if no associated claims were appropriate but at least 1 of the medical claims was for a condition that sometimes requires antibiotics, the prescription was defined as potentially appropriate. Our main outcome was inappropriate prescriptions —those prescriptions that were only associated with medical claims for diagnoses for which antibiotics are never indicated. Prescriptions were classified as not associated with an indication if there was no medical claim identified within 3 days prior. A modified version of the Clinical Classifications Software (CCS)[14] was used to group similar ICD-10 diagnoses for summarizing indications. We have used this classification scheme to describe appropriateness of antibiotic prescriptions.

Statistical methods

Descriptive statistics were used to summarize the number of antibiotic prescriptions by appropriateness category: appropriate, potentially appropriate, inappropriate, and not associated with a diagnosis. Patient variables, prescriber type, and most frequent antibiotics prescribed were summarized for each category. Due to the large sample size, we did not calculate statistically significant differences between groups in descriptive analyses because statistical significance may not correlate with clinical significance.

Multivariable logistic regression was used to determine the association between prescriber characteristics and prescriber performance related to inappropriate antibiotic prescribing. Providers were separated into quartiles by volume of antibiotic prescriptions written in 2017. To further analyze providers who regularly prescribe antibiotics to Medicaid children, those who wrote at least 1 antibiotic prescription per month were included in the regression analysis. Provider analysis was performed at the provider level and geographic location was defined as the setting (rural, urban, or suburban) where most of their patients reside. A provider was identified as a high inappropriate prescriber if >25% of their prescriptions were classified as inappropriate. Multivariable logistic regression was used to determine adjusted odds ratios and their 95% confidence intervals (CIs) of inappropriate prescribing by provider characteristics. The volume of antibiotics prescribed by each provider was included as a continuous variable in the regression model.

A generalized linear mixed model was used to assess patient characteristics associated with higher risk of receiving an inappropriate prescription. A random-effects mixed model was used to account for multiple prescriptions for each patient. Being prescribed an antibiotic by a high inappropriate prescriber (as previously defined) was a covariate in the patient model. All analyses were performed using the statistical software R (https://www.r-project.org/) and SAS (https://www.sas.com/). A test was considered statistically significant if its P value was <.05.

Results

In total, 10,787 providers wrote 779,813 antibiotic prescriptions for 328,515 children insured by Kentucky Medicaid in 2017. Overall, 154,546 (19.8%) of these antibiotic prescriptions were appropriate, 358,026 (45.9%) were potentially appropriate, 163,654 (21.0%) were inappropriate; 103,587 (13.3%) were not associated with an indication (Table 1). Of the 328,515 children included in this study, 143,310 (43.6%) had 1 antibiotic prescription filled in 2017, 78,609 (23.9%) had 2 prescriptions filled, and 106,596 (32.5%) had 3 or more prescriptions filled.

The following groups had higher proportions of inappropriate prescriptions: children aged 0–2 years (24.2%), those with a rural residence (23.0%), those seen by general practitioners (22.4%), and those seen by other prescribers (23.2%), (Table 1). The most common provider specialties classified as "other" who wrote inappropriate prescriptions included dentists (15.5% of antibiotics were inappropriate), physical medicine and rehabilitation (PM&R) practitioners (23.9%), oral surgeons (35.1%), and emergency medicine practitioners (18.6%). Dentists and PM&R practitioners wrote 1.8% and 1.5% of all antibiotic prescriptions, respectively, while all other practitioner groups wrote 0.6% or less, by volume. The 6 most frequently prescribed antibiotics and appropriateness distribution are shown in Figure 1. Amoxicillin was the most frequently prescribed for all categories. Azithromycin was the second most

Table 1. Antibiotic Prescription Characteristics and Appropriateness

Characteristic	Overall	Prescriptions, No. (%)			
		Appropriate	Potentially Appropriate	Inappropriate	Not Associated With Diagnosis
Overall	779,813	154,546 (19.8)	358,026 (45.9)	163,654 (21.0)	103,587 (13.3)
Sex					
Female	414,862 (53.2)	90,817 (21.9)	182,482 (44.0)	84,978 (20.5)	56,585 (13.6)
Male	364,947 (46.8)	63,728 (17.5)	175,542 (48.1)	78,675 (21.6)	47,002 (12.9)
Age group					
0–2 y	178,053 (22.8)	20,857 (11.7)	98,289 (55.2)	43,132 (24.2)	15,775 (8.9)
3–9 y	300,975 (38.6)	77,335 (25.7)	129,090 (42.9)	60,515 (20.1)	34,035 (11.3)
10–19 y	300,785 (38.6)	56,354 (18.7)	130,647 (43.4)	60,007 (20.0)	53,777 (17.9)
Race/ethnicity					
White, NH	600,516 (77.0)	119,111 (19.8)	276,308 (46.0)	126,857 (21.1)	78,240 (13.0)
Black, NH	57,502 (7.4)	12,291 (21.4)	24,946 (43.4)	11,454 (19.9)	8,811 (15.3)
Hispanic	27,620 (3.5)	6,207 (22.5)	13,086 (47.4)	5,411 (19.6)	2,916 (10.6)
Other	16,385 (2.1)	3,213 (19.6)	7,665 (46.8)	3,315 (20.2)	2,192 (13.4)
Not provided	77,790 (10.0)	13,724 (17.6)	36,021 (46.3)	16,617 (21.4)	11,428 (14.7)
Residence					
Urban	312,947 (40.1)	62,221 (19.9)	147,800 (47.2)	59,096 (18.9)	43,830 (14.0)
Suburban	167,435 (21.5)	34,328 (20.5)	76,439 (45.7)	35,795 (21.4)	20,873 (12.5)
Rural	299,431 (38.4)	57,997 (19.4)	133,787 (44.7)	68,763 (23.0)	38,884 (13.0)
Prescriber[a]					
General practitioner	262,098 (33.6)	48,125 (18.4)	123,764 (47.2)	58,804 (22.4)	31,405 (12.0)
Nurse practitioner	317,710 (40.8)	72,141 (22.7)	150,917 (47.5)	61,660 (19.4)	32,992 (10.4)
Pediatrician	78,329 (10.1)	13,738 (17.5)	38,214 (48.8)	16,744 (21.4)	9,633 (12.3)
Physician assistant	65,796 (8.4)	15,742 (23.9)	30,351 (46.1)	13,473 (20.5)	6,230 (9.5)
Other	55,595 (7.1)	4,732 (8.5)	14,680 (26.4)	12,918 (23.2)	23,265 (41.9)
Chronic condition					
Chronic condition (any)	106,164 (13.6)	19,748 (18.6)	45,359 (42.7)	26,945 (25.4)	14,112 (13.3)
Cardiovascular	36,613 (4.7)	6,850 (18.7)	15,093 (41.2)	9,465 (25.9)	5,205 (14.2)
Other congenital or genetic defect	30,746 (3.9)	5,748 (18.7)	12,595 (41.0)	8,585 (27.9)	3,818 (12.4)
Neurologic/neuromuscular	22,926 (2.9)	4,263 (18.6)	8,863 (38.7)	7,248 (31.6)	2,552 (11.1)
Metabolic	19,310 (2.5)	3,268 (16.9)	8,565 (44.4)	4,772 (24.7)	2,705 (14.0)
Gastrointestinal	18,114 (2.3)	3,203 (17.7)	6,635 (36.6)	5,627 (31.1)	2,649 (14.6)
Premature/neonatal	10,560 (1.4)	1,733 (16.4)	4,772 (45.2)	3,066 (29.0)	989 (9.4)
Renal/urologic	5,221 (0.7)	1,148 (22.0)	1,279 (24.5)	1,796 (34.4)	998 (19.1)
Respiratory	5,385 (0.7)	858 (15.9)	1,924 (35.7)	1,889 (35.1)	714 (13.3)
Hematologic/immunologic	4,198 (0.5)	810 (19.3)	1,661 (39.6)	1,025 (24.4)	702 (16.7)
Miscellaneous devices/transplant	1,351 (0.2)	189 (14.0)	383 (28.4)	452 (33.5)	327 (24.2)
Malignancy	433 (0.1)	45 (10.4)	106 (24.5)	171 (39.5)	111 (25.6)

Note. NH, non-Hispanic.
[a]Prescriber classifications described as coded by Medicaid claims. General practitioner category includes family medicine providers.

commonly prescribed and was more frequently classified as inappropriate (28%).

Analysis of associated diagnoses revealed the most frequent diagnoses for appropriate antibiotic prescriptions were streptococcal pharyngitis (50.1%) and urinary tract infections (9.37%). The most frequent diagnoses for potentially appropriate prescriptions were acute suppurative otitis media (25.4%), acute pharyngitis, not specified as streptococcal (14.3%), acute sinusitis (13.0%), and skin and subcutaneous tissue infections (5.6%). The most frequent diagnoses for inappropriate prescriptions were acute upper respiratory infection (19.1%), acute bronchitis (12.5%), and nonsuppurative otitis media (11.4%).

Overall, 10,787 unique providers wrote antibiotic prescriptions to children. Among them, 25% wrote <3 prescriptions, while the

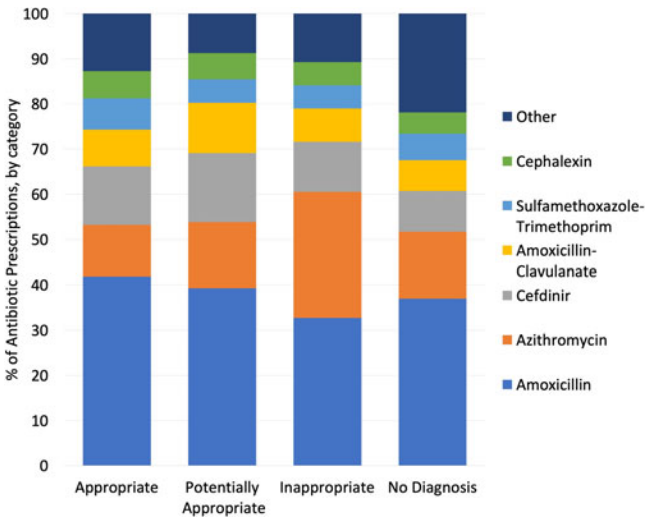

Fig. 1. Top 6 antibiotics prescribed, by appropriateness category. Percentages of most commonly prescribed antibiotics to children by appropriateness classification are presented. Source: Kentucky Medicaid claims, 2017.

highest prescriber, by volume, wrote 4,748 prescriptions. The median was 12 antibiotic prescriptions per provider and the median rate of inappropriate prescriptions was 21.9%. Providers were subsequently divided by quartiles based on their antibiotic prescribing volumes (number of prescriptions written) in 2017: 1–2, 3–12, 13–58, and 59–4,748 (Fig. 2). Nurse practitioners and pediatricians were more prevalent in the higher-volume quartile 4; 43.0% of quartile 4 providers were nurse practitioners and 10.9% were pediatricians. General practitioners and other providers were more common in the lower-volume quartile 1 (41.5% and 28.6%, respectively). Provider groups, by volume, were then compared by percentage of inappropriate prescriptions (Fig. 2B). Providers who wrote 12 or fewer prescriptions in 2017, which represents 50% of all providers included in the study, had a higher percentage of prescriptions classified as inappropriate. Based on clinical significance and distribution of inappropriate prescribing rates; only quartiles 3 and 4 were included in the multivariable logistic regression of provider characteristics.

Table 2 shows the results of the multivariable logistic regression model of provider characteristics associated with inappropriate prescribing. Only providers who wrote >12 prescriptions in 2017 were included. The odds of being a highly inappropriate prescriber were 1.54 and 1.65 times higher for suburban and rural areas, respectively, compared to urban areas. General practitioners had higher odds of inappropriate prescribing (OR, 1.25; 95% CI, 1.06–1.4) than nurse practitioners. Inappropriate prescribing was not significantly associated with volume of prescribing in the regression model.

Table 3 describes patient characteristics associated with higher risk for an inappropriate antibiotic prescription in multivariable analysis. Children had 4 times higher odds of receiving an inappropriate antibiotic if they saw an inappropriate prescriber (OR, 4.15; 95% CI, 4.1–4.2). Younger children (aged 0–2 years) and those with a chronic condition were also more likely to receive an inappropriate antibiotic (ORs 1.39 and 1.31, respectively).

Discussion

We used an appropriateness classification scheme[10] to evaluate pediatric antibiotic prescribing using Medicaid claims data from a high

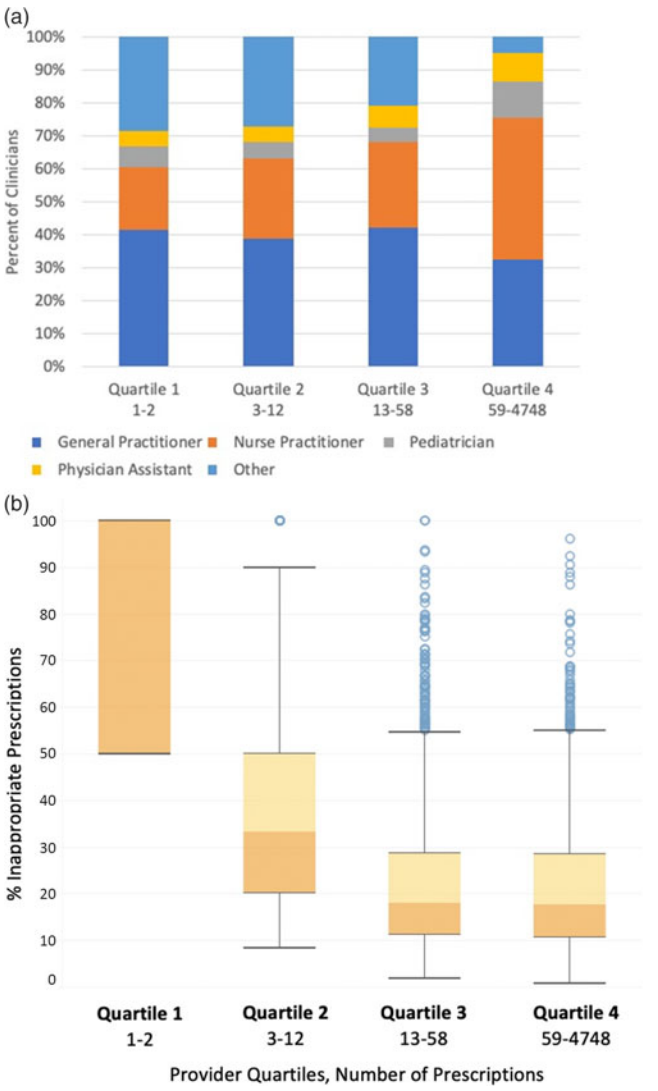

Fig. 2. Distribution of inappropriate prescriptions by volume of prescribing. **A.** Distribution of provider types by provider volume quartile. Percentages of antibiotic prescriptions by provider types. Groups 1-4 represent quartiles of antibiotic prescribing by annual volume, where providers in Group 1 wrote 1-2 antibiotics to children in 2017, Group 2 wrote 3-12, Group 3 wrote 13-58, and Group 4 wrote 59-4748. Source: Kentucky Medicaid claims, 2017. **B.** Distribution of inappropriate prescribing by provider volume quartile. Percentages of inappropriate prescriptions written by providers, described by provider quartiles of antibiotic prescribing by annual volume. Source: Kentucky Medicaid claims, 2017.

prescribing state. We assessed 779,813 antibiotic prescriptions to children and found that 21% were inappropriate and 13% lacked a recent medical claim to identify a diagnosis. In comparison, Chua et al[10] found that 23.2% of antibiotic prescriptions were inappropriate and that 28.5% of antibiotics were not associated with a recent diagnosis code. Our data suggest that that children may be more likely to have an associated medical claim. Previous studies have shown variation in volume of antibiotic prescribing by patient characteristics such as sex, age, race or ethnicity, and area of residence.[3,6-8] Despite higher volume of prescribing to females and white, non-Hispanic children, rates of inappropriate use were not higher in these populations. Younger patients, aged 0–2 years, received higher percentages of inappropriate prescriptions.

Our work in the pediatric Kentucky Medicaid population has revealed variations in the volume of antibiotic prescribing across

Table 2. Adjusted Odds Ratios for Association Between Prescriber Characteristics and Prescriber Behavior on Inappropriate Antibiotic Prescribing[a]

Predictors	Odds Ratio (95% CI)
Geographic area	
Urban	Reference
Suburban	1.54 (1.31–1.81)
Rural	1.65 (1.44–1.89)
Provider type[b]	
Nurse practitioner	Reference
General practitioner	1.25 (1.08–1.44)
Pediatrician	1.21 (0.93–1.57)
Physician assistant	1.00 (0.79–1.27)
Other	1.03 (0.86–1.24)
Volume prescribed	1.01 (0.98–1.03)

Note. CI, confidence interval.
[a]Inappropriate prescribing was defined as >25% of antibiotics prescribed being inappropriate.
[b]Only providers who wrote at least 13 prescriptions were included.

Table 3. Adjusted Odds Ratios for Association Between Patient Characteristics and Patient Being Prescribed an Inappropriate Antibiotic[a]

Predictors	Odds Ratio (95% CI)
Inappropriate prescriber	4.15 (4.1–4.2)
Race	
White, NH	Reference
Black, NH	1.09 (1.06–1.12)
Hispanic	1.02 (0.99–1.06)
Other	1.06 (1.01–1.11)
Not provided	1.02 (0.99–1.04)
Age	
10–19 y	Reference
3–9 y	1.05 (1.03–1.07)
0–2 y	1.39 (1.37–1.41)
Geographic area	
Urban	Reference
Suburban	1.03 (1.01–1.06)
Rural	1.09 (1.07–1.1)
Sex	
Female	Reference
Male	1.06 (1.04–1.07)
Chronic condition	1.31 (1.28–1.33)

Note. CI, confidence interval; NH, non-Hispanic.
[a]Inappropriate prescribing defined as receipt of an inappropriate antibiotic.

the state, with concerning trends of very high rates in certain rural counties.[9] These findings are consistent with a statewide analysis of pediatric Tennessee prescribing data.[15] The current study builds on this existing research by incorporating appropriateness of prescribing. We found higher rates of inappropriate use in rural areas, compared to urban and suburban areas of residence. This finding persisted after adjusting for patient age, sex, presence of chronic conditions, and provider characteristics, and it highlights the need for stewardship efforts that are inclusive of rural areas.

Our prior work has also identified an increase in volume of antibiotic prescribing by nurse practitioners. In 2017, nurse practitioners wrote 39% of all antibiotic prescriptions to Kentucky Medicaid children, compared to general practitioners (31%), pediatricians (10%), and physician assistants (8%).[9] However, the percentage of inappropriate prescriptions by these prescriber types did not correlate with volume of prescribing. In fact, nurse practitioners had the lowest rate of inappropriate prescriptions, compared to general practitioners, pediatricians and physician assistants. This is a key finding because advanced practitioners are sometimes criticized as being responsible for excessive antibiotic prescribing.[16] Notably, "other" prescribers that did not meet one of the previously mentioned categories had the highest frequency of inappropriate antibiotic prescriptions and antibiotic prescriptions that lack an associated medical claim to identify a diagnosis. This finding requires further investigation to determine whether these prescriptions are a result of refills and/or visits that are outside our dataset (ie, inpatient claims, dental claims, telephone visits, etc).

Consistent with other antibiotic studies,[8,17] amoxicillin was the most frequently prescribed antibiotic for all appropriateness categories. Azithromycin, the second most commonly prescribed antibiotic, was more frequently associated with inappropriate diagnoses. This finding is also consistent with previous studies that suggest overprescribing of azithromycin for pediatric conditions.[18,19] This analysis shows there could be some benefit to specifically targeting azithromycin to reduce inappropriate use. However, efforts to reduce inappropriate prescribing should be comprehensive to include all medications commonly prescribed to children.

To our knowledge, this is the first study to compare the volume of antibiotic prescribing to appropriateness at the individual provider level. Volume of antibiotic prescriptions is frequently used to describe antibiotic use at a national, regional, and state level.[3,5,8] Prescription data are used to describe antibiotic prescribing variables, but they lack an indication for each prescription and thus ability to assess for appropriateness. Identifying top prescribers by volume alone is one method for targeting providers for stewardship interventions. Our findings suggest that it may be necessary to consider both volume and appropriateness of prescribing when identifying targets for outpatient stewardship interventions.

This study has several limitations. Our findings are limited to the Kentucky Medicaid pediatric population and may not be generalizable to other states or commercially insured children. Also, our limited data set did not contain the place of service variable to allow for comparisons across outpatient settings such as medical offices, urgent care centers, and emergency departments. Duration of therapy and appropriateness of antibiotic selection for specific diagnoses were outside the scope of this study, but these factors could offer additional opportunities for improving antibiotic prescribing. Nonclinical factors that have previously been identified as contributing to inappropriate antibiotic use, such as patient expectations[20] and personal provider characteristics[21] (ie, years in practice), cannot be assessed using medical claims.

Additional limitations are those inherent to claims-based research, such as reliance on accurate billing data for identification of diagnoses and uncertainty of associated visit and prescribing data. Assessment of the clinical appropriateness was based solely on available medical claims and therefore inferred. There is also concern that monitoring diagnostic codes could lead to "diagnosis shifting," which occurs when a clinician manipulates a diagnostic

code to justify the need for an antibiotic.[4] This practice can be missed when monitoring a single condition, but it could be identified by an increase in "potentially appropriate" diagnoses in the classification scheme described in this study. However, strengths of claims-based research include the ability to assess prescribing on a wide scale; thus, diagnostic codes are frequently used for practical assessment of appropriateness of antibiotic prescribing by various researchers and national stewardship experts.[2,7]

Existing studies describing the appropriateness of antibiotic prescribing to children are limited to larger databases of all ages[2,10,22] and/or specific outpatient settings within an organization.[23-25] Medicaid children have been identified as an important target for antibiotic stewardship due to higher rates of parental misconceptions and higher impact of interventions.[26,27] Use of this antibiotic appropriateness classification scheme with state-level claims data identifies important targets for outpatient stewardship interventions. First, we have described a contrast in appropriateness of antibiotic prescribing in urban versus suburban and rural areas. Many existing outpatient stewardship initiatives are limited to large, academic medical centers.[28,29] The only existing national policy for outpatient stewardship, the Joint Commission mandates for Ambulatory Care Accredited Centers,[30] is unlikely to incorporate smaller, rural practices. Taken together, these data highlight the importance of identifying methodologies for outpatient antimicrobial stewardship in rural areas. Second, our findings highlight the importance of including all provider types in stewardship initiatives. Among Kentucky Medicaid recipients pediatricians are only responsible for ˜10% of all antibiotic prescribing to children, so interventions directed solely toward pediatricians would have a limited effect on overall prescribing. Our finding that visits with an inappropriate prescriber had the strongest association with inappropriate antibiotic use suggests that ongoing provider education is still needed.

The overall findings of this study support the use of appropriateness classifications for describing antibiotic use on a wide scale. The use of provider feedback reports are recommended to improve antibiotic use,[4] but current quality metrics of antibiotic prescribing in children are often limited to specific diagnoses such as viral upper respiratory infections or streptococcal pharyngitis.[31,32] A more comprehensive approach to appropriateness of antibiotic prescribing, along with specific conditions, could strengthen provider feedback reports. The CDC and Pew Charitable Trusts encourage health insurers to take an active role in outpatient antibiotic stewardship efforts.[33,34] This study confirms the ability to utilize statewide claims data to generate a meaningful antibiotic use metric at the individual provider level. Our research team is actively pursuing a pilot intervention study to disseminate provider feedback reports to providers across Kentucky, using Medicaid data.

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Conflicts of interest. All authors report no conflicts of interest relevant to this article.

Supplementary material. To view supplementary material for this article, please visit https://doi.org/10.1017/ice.2021.177

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