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Original Article

After-hours consultations and antibiotic prescribing for self-limiting upper respiratory tract infections in primary-care practices

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Abstract

Objectives: To determine the association between after-hours consultations and the likelihood of antibiotic prescribing for self-limiting upper respiratory tract infections (URTIs) in primary care practices.

Design: A cross-sectional analysis using Australian national primary-care practice data (MedicineInsight) between February 1, 2016 and January 31, 2019.

Setting: Nationwide primary-care practices across Australia.

Participants: Adult and pediatric patients who visited primary care practices for first-time URTIs.

Methods: We estimated the proportion of first-time URTI episodes for which antibiotic prescribing occurred on the same day (immediate prescribing) using diagnoses and prescription records in the electronic primary-care database. Adjusted odds ratios (ORs) and 95% confidence intervals (CIs) for the likelihood of antibiotic prescribing by the time of primary care visits were calculated using generalized estimating equations.

Results: Among 357,287 URTI episodes, antibiotics were prescribed in 172,605 episodes (48.3%). After adjusting for patients' demographics, practice characteristics, and seasons, we detected a higher likelihood of antibiotic prescribing on weekends compared to weekdays (OR, 1.42; 95% CI, 1.39–1.45) and on national public holidays compared to nonholidays (OR, 1.23; 95% CI, 1.17–1.29). When we controlled for patient presentation and diagnosis, the association between antibiotic prescribing and after-hours consultations remained significant: weekend versus weekdays (OR, 1.37; 95% CI, 1.33–1.41) and holidays versus nonholidays (OR, 1.10; 95% CI, 1.03–1.18).

Conclusions: Primary-care consultations on weekends and public holidays were associated with a higher likelihood of immediate antibiotic prescribing for self-limiting URTIs in primary care. This finding might be attributed to lower resourcing in after-hours health care.

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Upper respiratory tract infections (URTIs) are one of the most common reasons for medical consultations in primary care practices[1]; presentations occur mostly among children aged <5 years, followed by the elderly.[2] Most URTIs are self-limiting viral infections for which antibiotics are not indicated.[3–5] Therefore, clinical guidelines do not recommend immediate antibiotic prescribing in first-time, acute URTI presentations unless patients are considered at high risk of complications.[3–5] However, antibiotics are commonly overprescribed for URTIs in primary care practices, and this may contribute to antibiotic resistance. A previous study in Taiwan suggested that an intervention program of reducing undocumented antibiotic use for URTIs can effectively decrease the rate of antibiotic resistance in *Streptococcus pyogenes*.[6] In an Australian study, between 2010 and 2015 antibiotic prescribing rates were up to 40% for rhinosinusitis and unspecified URTIs, much more frequent than Australian guidelines recommend in primary care.[7] A better understanding of factors that trigger antibiotic overuse in URTI episodes and improve antibiotic prescribing in primary care is urgently needed.

An ecological study in the United Kingdom analyzed the proportion of consultations in which antibiotics were prescribed and found that, compared to regular daytime general practitioners, practitioners in after-hours primary care practices were more likely to prescribe antibiotics for patients.[8] However, it remains unclear whether the after-hours effect reflects excessive antibiotic prescribing on weekends or holidays or just a difference in the patient who present at those times. Although differences in the quality of healthcare provided at night or on weekends have been reported,[9] the higher antibiotic volume in after-hours consultations might also be attributed to sicker patients that doctors encounter.[10] Using an Australian national primary-care practice database, we conducted a cross-sectional study to investigate (1) the association between after-hours consultations and antibiotic prescribing in

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self-limiting URTIs in primary care practices and (2) the extent to which the association is mediated through characteristics of patient presentation at the encounter.

Methods

Data sources

We used electronic medical records of visits to a general practitioner between February 1, 2016 and January 31, 2019 (36 months) from MedicineInsight, an Australian national database of electronic primary care records that includes data from >650 primary-care practices and 3.6 million patients managed by NPS MedicineWise.[11] Approximately 98% of primary-care encounters were recorded by general practitioners, whereas 2% were recorded by nurse practitioners. MedicineInsight consists of several data sets that separately record patient demographic characteristics, chronic health conditions, details of encounters with the general practitioner including consultation reasons, diagnoses, prescriptions, medical examinations, and practice geographical information. A unique and anonymized identification number is assigned to each patient and practice so that the information pertaining to a patient or practice in different data sets can be linked. We used a 25% random sample of patients in the deidentified MedicineInsight data, which was the maximum sample available for research purposes.

The Human Research Ethics Committee at the University of New South Wales approved this study (no. HC180900).

URTI episodes and immediate antibiotic prescribing

We included "first-time" URTI episodes in MedicineInsight during the 36-month study period in our analyses. First-time episodes were defined as no other URTI presentation in the 30 days prior for the same patient. We used search terms based on earlier studies to identify URTI episodes from the encounter reason, diagnosis reason and prescription reason fields in the MedicineInsight database (Table 1).[12,13] If a search term was found in any 1 of these 3 fields from a patient's record, we counted a URTI episode on that day for the patient. We applied the following exclusion criteria: (1) URTI episodes that routinely require antibiotic treatment, such as pertussis and epiglottitis; (2) URTI episodes in which other infectious or noninfectious diseases were listed for the patient on the same day; (3) URTI episodes among patients with significant comorbidities (ie, cancers, diabetes, heart failure, chronic obstructive pulmonary disease, chronic renal failure, and other immune deficiencies) who might be at high risk for complications (Supplementary Table 1 online); (4) URTI episodes that occurred in outer regional and remote areas in Australia because antibiotic prescribing for URTIs in those settings might be influenced by other factors, including limited access to healthcare and a high incidence of rheumatic fever.[3] The primary-care practices in outer regions and remote areas accounted for 15% of total practices.

Outcome, temporal variables, and covariates

Our study outcome was immediate antibiotic prescribing for patients with a first-time URTI episode, defined by a record of a systemic antibiotic prescription on the same day as the "first-time" URTI episode (see Supplementary Table 2 online for antibiotics included). We estimated the proportion of encounters with immediate antibiotic prescribing in all included URTI encounters.

Our main factor of interest was the difference in prescribing on weekends and public holidays. We defined weekends as Saturday and Sunday. We selected 4 national public holiday periods in Australia: Christmas and New Year holiday (December 23–January 5), Australia Day (January 26), Easter weekend (Good Friday to Easter Monday, for which the dates differ by year), and Anzac Day (April 25). The potential effect modification by seasons in Australia was also considered (summer, December–February; autumn, March–May; winter, June–August; spring, September–November).

We extracted patient sex, age, and details of their clinical presentation reported at the time of the URTI episode. Clinical characteristics of the presentation included body temperature records (normal [<38°C], fever, or not recorded), suspected etiology as labeled by the general practitioner (viral, bacterial, or unspecified), and specific diagnoses (eg, tonsillitis, pharyngitis, sinusitis, otitis media, or unspecified URTIs which did not include the 4 specific diagnoses). We analyzed prior antibiotic use, practice locations, and socioeconomic factors as covariates. We estimated the prior use of antibiotics by calculating the number of antibiotic prescriptions the patient had in the past year before the URTI episode as a continuous variable. The practice locations (major cities or inner regional areas)[14] and the Index of Relative Socioeconomic Advantage and Disadvantage (in 5 quintiles)[15] were also considered.

Table 1. Search Terms Used in the Identification of Upper Respiratory Tract Infections (URTIs)[a]

Search Terms
Cough
Otitis media
Tonsillitis
URTI
Sinusitis
Pharyngitis
Laryngitis
Sore throat
Upper respiratory tract infection

[a]We searched the "encounter reason" field in the encounter data set, "diagnosis reason" field in the diagnosis data set, and "reason" field in the prescription data set. Those records containing any one of the terms in the list were defined as URTI episodes. Records were excluded from the analysis if containing any of the following terms: "whooping," "allerg," "vac," "immunization," "asthma," and "prophylaxis."

Statistical analysis

We calculated the proportion of URTI episodes for which immediate antibiotic prescribing was recorded for all URTI episodes and stratified by groups with different temporal factors and covariates. We then performed multivariable logistic regression with generalized estimating equations to test the association between URTI episodes on weekends, public holidays or seasons, and the likelihood of immediate antibiotic prescribing, adjusting for those covariates (ie, sex, age, previous antibiotic use, practice location, and Index of Relative Socioeconomic Advantage and Disadvantage) and the clustering of patients and practices. To better understand the extent to which the weekend, holiday, and seasonal effects were mediated through characteristics of the patient presentations and diagnoses at the time of URTI episodes, we used 2 models: model 1 only adjusted for patient demographic factors, previous antibiotic use, and practice

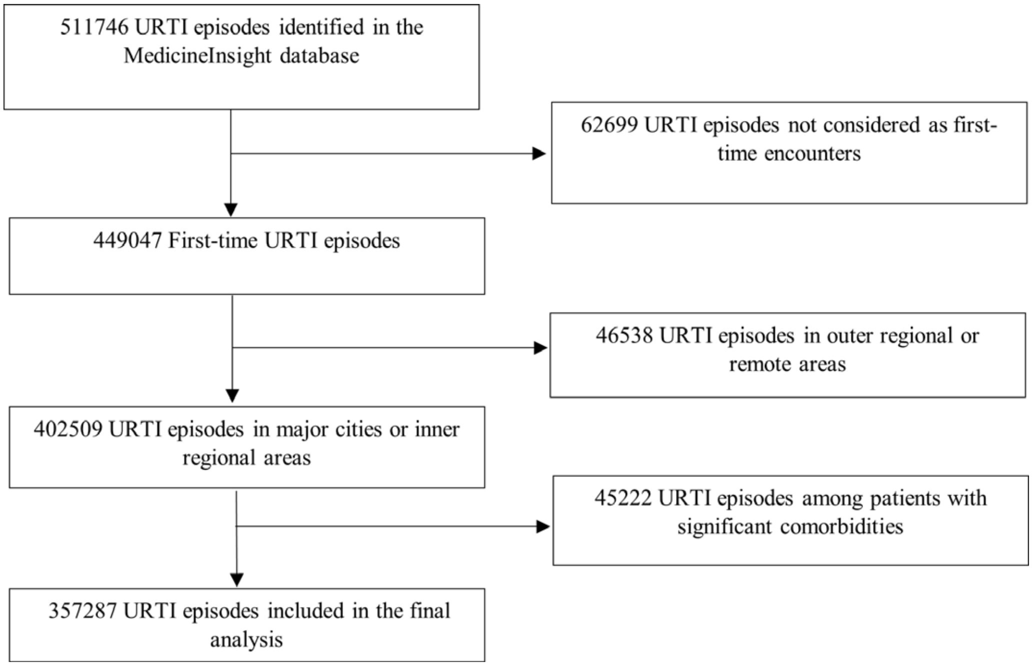

Fig. 1. Flowchart for the inclusion of upper respiratory tract infection (URTI) episodes in the study.

characteristics and model 2 additionally adjusted for body temperature, etiology as determined in the patient records, and specific diagnoses. We ran 2 models to compare the strength of association before and after controlling for clinical characteristics. We performed sensitivity analyses to examine associations by age, fever at presentation, recoded etiology of infection, and diagnosis type. All statistical analyses were conducted using SAS version 9.4 software (SAS Institute, Cary, NC).

Results

Our analyses included 357,287 first-time URTI episodes between February 2016 and January 2019 that met the inclusion criteria (Fig. 1, flowchart). As shown in Table 2, ~45% of episodes were among children aged <18 years and 50% were among adults aged aged 18–64 years. Fever was reported in 3% of all episodes and the proportion of URTIs labeled as bacterial origin was 4%. Of all episodes, 34% were assigned a diagnosis of tonsillitis, pharyngitis, sinusitis, or otitis media and 66% were considered unspecified URTIs. Antibiotics were prescribed on the same day in 172,605 episodes (48.3%), with a higher proportion prescribed for episodes occurring on weekends and public holidays. Seasonally, URTI episodes in summer were more likely to be prescribed antibiotics, but the proportion in winter was lower. Adults, patients with fever, URTIs labeled as bacterial, or URTIs with specific diagnoses had a relatively higher likelihood of immediate antibiotic prescribing. The distribution of antibiotic types is shown in Supplementary Table 3 (online). Narrow-spectrum penicillins (eg, penicillin, amoxicillin, and ampicillin) comprised the major type used for URTIs (58%), followed by co-amoxiclav (15%) and macrolides (12%).

After adjusting for patient demographics and practice characteristics in model 1, we found a higher likelihood of antibiotic prescribing on weekends compared to weekdays (odds ratio [OR], 1.42; 95% confidence interval [CI], 1.39–1.45) and on national public holidays compared to nonholidays (OR, 1.23; 95% CI, 1.17–1.29) (Table 3). After additionally adjusting for patient clinical presentation in model 2, the effect of weekends (vs weekdays: OR, 1.37; 95% CI, 1.33–1.41) and public holidays (vs not holidays: OR, 1.10; 95% CI, 1.03–1.18) remained significant. The seasonal effect on antibiotic prescribing was very small (summer vs winter: OR, 1.04; 95% CI, 1.01–1.06).

In the sensitivity analyses by different age groups (Table 4), weekends were significantly associated with a higher likelihood of antibiotic prescribing across all ages, but holidays were only significantly associated with a higher likelihood of antibiotic prescribing among adults. When we only considered those without fever nor a "bacterial etiology" label and those without specific diagnoses (Table 5), the association between antibiotic prescribing and after-hours visits remained significant throughout those subgroups.

Discussion

In this study on antibiotic prescribing for URTIs in Australian primary-care practices between February 2016 and January 2019, immediate antibiotic prescribing appeared to be high (almost 50%) and comparable to that found in the Australian study conducted earlier.[7] We detected a higher likelihood of immediate antibiotic prescribing on weekends, public holidays and during summer. Adjustment for patient presentations, such as suspected etiology, fever, and the type of URTIs, explained some of the variation associated with weekends and public holidays but did not fully explain the effects, suggesting the existence of other factors driving antibiotic prescribing behaviors on weekends and holidays.

Our study population mainly consisted of relatively young and healthy patients; due to our exclusion of people with significant comorbidities, 95% of patients were aged <65 years. However, we still observed a very high antibiotic prescribing rate overall (48.3%) and this was substantially higher for certain diagnoses such as tonsillitis (89.9%), pharyngitis (71.7%), sinusitis (84.6%), and otitis media (88.4%). Worldwide, antibiotic overuse for URTIs is a long-standing concern in clinical practice.[16] Although the origins of these URTI types can be bacterial and antibiotics might be indicated, the expected proportion of antibiotic prescribing in these conditions is not >40% in the guideline.[7] Our results did not differ substantially from previous

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Table 2. Proportion of First-Time Upper Respiratory Tract Infection (URTI) Episodes With Antibiotics Prescribed on the Same Day

Variable	URTI Episode, No. (%)	Proportion With Antibiotics Prescribed, No. %
Total	357,287 (100)	172,605/357,287 (48.3)
Demographic factors		
Sex		
Male	157,210 (44)	73,552/157,210 (46.8)
Female	200,077 (56)	99,053/200,077 (49.5)
Age group		
0–2 y	50,586 (14)	17,133/50,586 (33.9)
3–5 y	41,879 (12)	17,619/41,879 (42.1)
6–11 y	44,180 (12)	19,555/44,180 (44.3)
12–17 y	26,739 (7)	13,261/26,739 (49.6)
18–44 y	126,929 (36)	68,543/126,929 (54.0)
45–64 y	50,164 (14)	27,209/50,174 (54.2)
≥65	16,180 (5)	9,285/16,810 (55.2)
Socioeconomic index		
1 (most disadvantaged)	37,367 (11)	17,940/37,367 (48.0)
2	45,935 (13)	21,593/45,935 (47.0)
3	84,847 (24)	41,208/84,847 (48.6)
4	71,613 (20)	34,548/71,613 (48.2)
5 (most advantaged)	115,905 (33)	56,625/115,905 (48.9)
Area remoteness		
Major cities	289,618 (81)	139,646/289,618 (48.2)
Inner regional areas	67,651 (19)	32,950/67,651 (48.7)
Clinical characteristics		
Body temperature		
Not recorded	234,836 (66)	115,324/234,836 (49.1)
Without fever (<38°C)	111,662 (31)	50,332/111,662 (45.1)
With fever (≥38°C)	10,789 (3)	6949/10789 (64.4)
Etiology labels		
Unspecified origins	248,504 (70)	153,098/248,504 (61.6)
Viral	93,766 (26)	5,091/93,766 (5.4)
Bacterial	15,017 (4)	14,416/15,017 (96.0)
Diagnosis of URTIs		
Tonsillitis	33,588 (9)	30208/33588 (89.9)
Pharyngitis	18,579 (5)	13315/18579 (71.7)
Sinusitis	37,208 (10)	31481/37208 (84.6)
Otitis media	33,731 (9)	29808/33731 (88.4)
Unspecified URTIs	234,181 (66)	67793/234181 (29.0)
Temporal factors		
Day of week		
Weekdays	321,071 (90)	152,446/321,071 (47.5)
Weekends	36,216 (10)	20,159/36,216 (55.7)
Season		
Winter	119,886 (34)	55,673/119,886 (46.4)
Spring	94,318 (26)	46,662/94,318 (49.5)
Summer	58,984 (17)	30,888/58,984 (52.4)
Autumn	84,099 (24)	39,382/84,099 (46.8)

(*Continued*)

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Table 2. (*Continued*)

Variable	URTI Episode, No. (%)	Proportion With Antibiotics Prescribed, No. %
Public holidays		
No	349,243 (98)	168,020/349,243 (48.1)
Yes	8,044 (2)	4,585/8,044 (57.0)

Table 3. Multivariable Analysis Evaluating the Association Between Temporal Factors and the Proportion of Immediate Antibiotic Prescribing in Upper Respiratory Tract Infection (URTI) Episodes

Variable	Model 1, OR (95% CI)[a]	Model 2, OR (95% CI)[b]
Day of week		
Weekdays	1.00	1.00
Weekends	1.42 (1.39–1.45)	1.37 (1.33–1.41)
Season		
Winter	1.00	1.00
Spring	1.13 (1.11–1.15)	1.03 (1.00–1.05)
Summer	1.21 (1.19–1.24)	1.04 (1.01–1.06)
Autumn	1.02 (1.00–1.03)	1.01 (0.98–1.03)
Public holidays		
No	1.00	1.00
Yes	1.23 (1.17–1.29)	1.10 (1.03–1.18)

Note. OR, odds ratio; CI, confidence interval.
[a]Model 1: Logistic generalized estimating equation model adjusting for sex, age groups, the socioeconomic index, the remoteness of areas, the number of antibiotic prescriptions for a patient in the previous year, and clustering in patients and practices.
[b]Model 2: Model 1 + clinical characteristics (ie, body temperature, etiology labels and diagnosis of URTIs).

reports from Australia between 2010 and 2015 showing that 89% of otitis media and 94% of tonsilitis or pharyngitis episodes received antibiotics.[7] In the United States between 2010 and 2011, 72% of sinusitis episodes and 80% of otitis media episodes received antibiotics.[17] Furthermore, our study added to the knowledge regarding the determinants for antibiotic prescribing in URTI episodes, especially the influence of after-hours visits on this potentially unnecessary use.

A German study showed that the overall antibiotic prescribing rate on Friday was higher than other working days of a week in primary care.[18] An ecological study in the United Kingdom reported a higher likelihood of overall antibiotic prescribing in after-hours clinics compared with daytime primary-care practices.[8] Previous studies have suggested that doctors might see more severe conditions on weekends or holidays compared with weekdays.[19,20] Our main analysis showed that adjusting for factors that might be related to the severity of the presentation, such as fever, presumed causes, or prominent localizing features (ie, encounters with specific diagnoses), can explain some but not all of the excess antibiotic prescribing on weekends and holidays. In sensitivity analyses, the weekend effect remained significant across all subgroups; thus, other important factors might exist that determine whether antibiotics are prescribed for URTIs. Several issues at both the health-system level and practice level may explain the higher prescribing that we observed. Clinicians often have a higher workload, more limited time and access to laboratory diagnostics for decision making in after-hours service.[21] The lack of laboratory diagnostics contributes to uncertainty in the etiology, and general practitioners may be more likely to use antibiotics under this circumstance.[22] They are also more likely to encounter unfamiliar patients or patients requesting quick solutions.[21,23] All of these challenges may contribute to greater antibiotic prescribing in after-hours care. Therefore, organization-level support, such as providing decision support systems, may be needed to support better decision making for antibiotic use in after-hours primary care, such as computer programs for general practitioners, that can offer antibiotic prescribing recommendations according to the patient's health conditions,[24] increasing staff recruitment,[25] and improving laboratory capacity (eg, rapid point-of-care pathology testing) in primary care.[21] Healthcare facilities could also consider antibiotic stewardship interventions, such as providing feedback on prescribing patterns to general practitioners with high prescribing rates on weekends or holidays.

We detected variation in antibiotic prescribing patterns among different subgroups. Compared with patients with unspecified URTIs, patients with specific URTIs were much more likely to receive antibiotics. For general practitioners, targeted educational programs may be needed to increase awareness of rational antibiotic use in those conditions. It is reassuring that children aged <5 years, the most susceptible population for URTIs,[2] received a lower proportion of antibiotic prescriptions than other age groups. Although the weekend effect remained strong in all subgroups, the public-holiday effect was not significant among children, patients with fever or labeled with an infection of "bacterial origin," and patients with localizing features in the subgroup analysis. To our knowledge, no studies have examined the heterogeneity of after-hours effects in different patient groups. Further studies are needed to understand the underlying reasons, which were not captured in our study.

The major strength of our study was the use of large and representative national primary-care data sets.[11] This study also had several limitations. We used records of prescriptions of antibiotics rather than the actual use of antibiotics. General practitioners may have prescribed the antibiotics immediately but asked patients to only take them if the URTI symptoms did not improve (ie, delayed treatment strategy).[3,5] We were only able to identify the after-hours consultations according to the day of the week and holidays; thus, encounters occurring in the evening of weekdays were not identified as after-hours consultations. Therefore, we may have underestimated the after-hours effect on antibiotic prescribing. Although we had some information regarding the patients' presentations, laboratory data were limited. We were not able to discern severity just through body temperature or presumed etiology. Notably, a high proportion of encounters lacked records of body temperature or etiology. We lacked the information regarding

Table 4. Multivariable Analysis Evaluating the Association Between Temporal Factors and the Proportion of Immediate Antibiotic Prescribing in Upper Respiratory Tract Infection (URTI) Episodes by Age Group

	Preschool Group, Aged 0–5 Years		School Age Group, Aged 6–17 Years		Young/Middle-Aged Adults, Aged 18–64 Years		Older Population, Aged ≥65 Years	
Variable	No. (%)	OR (95% CI) [a]	No. (%)	OR (95% CI)	No. (%)	OR (95% CI)	No. (%)	OR (95% CI)
Day of week								
Weekdays	82,071 (36.9)	1.00	63,965 (45.4)	1.00	159,668 (53.1)	1.00	15,367 (54.7)	1.00
Weekends	10,394 (43.1)	1.31 (1.23–1.39)	6,954 (54.6)	1.36 (1.27–1.45)	17,425 (63.1)	1.41 (1.35–1.47)	1,443 (60.6)	1.33 (1.17–1.51)
Seasons								
Winter	31,042 (37.7)	1.00	23,912 (43.2)	1.00	59,563 (51.6)	1.00	5,369 (54.6)	1.00
Spring	23,851 (39.2)	0.99 (0.94–1.04)	18,960 (47.5)	1.04 (0.99–1.09)	46,925 (54.9)	1.04 (1.01–1.07)	4,582 (55.9)	1.00 (0.91–1.09)
Summer	14,728 (38.8)	0.97 (0.92–1.03)	11,824 (52.5)	1.08 (1.02–1.15)	29,382 (58.8)	1.07 (1.03–1.11)	3,050 (55.6)	0.87 (0.78–0.97)
Autumn	22,844 (35.0)	0.98 (0.93–1.03)	16,223 (44.9)	1.00 (0.95–1.06)	41,223 (53.4)	1.03 (1.00–1.07)	3,809 (55.0)	0.93 (0.84–1.02)
Public holidays								
No	90,557 (37.5)	1.00	69,495 (46.1)	1.00	172,891 (53.9)	1.00	16,300 (55.1)	1.00
Yes	1,908 (42.5)	1.00 (0.87–1.15)	1,424 (57.2)	1.02 (0.87–1.19)	4,202 (63.2)	1.15 (1.05–1.26)	510 (59.4)	1.28 (1.04–1.59)

Note. OR, odds ratio; CI, confidence interval.
[a]Logistic generalized estimating equation model adjusting for sex, the socioeconomic index, the remoteness of areas, the number of antibiotic prescriptions for a patient in the previous year, body temperature, etiology labels, the diagnosis of URTIs, and clustering in patients and practices.

Table 5. Multivariable Analysis Evaluating the Association Between Temporal Factors and the Proportion of Antibiotic Prescribing in Upper Respiratory Tract Infection (URTI) Episodes, by Patients' Body Temperature, Etiology Labeled by General Practitioners, and URTI Diagnoses

	URTIs with Fever or “Bacterial Etiology” Label		URTIs Without Fever nor “Bacterial Etiology” Label		URTIs with a Specified Diagnosis[a]		Unspecified URTIs	
Variable	No. (%)	OR (95% CI)[b]	No. (%)	OR (95% CI)[b]	No. (%)	OR (95% CI)[c]	No. (%)	OR (95% CI)[c]
Day of week								
Weekdays	21,770 (81.5)	1.00	299,301 (45.0)	1.00	109,361 (84.7)	1.00	211,710 (28.2)	1.00
Weekends	3,267 (87.9)	1.60 (1.43–1.80)	32,949 (52.5)	1.37 (1.33–1.41)	13,745 (88.4)	1.38 (1.30–1.46)	22,471 (35.6)	1.39 (1.34–1.43)
Season								
Winter	8,516 (80.4)	1.00	111,370 (43.8)	1.00	387,05 (85.6)	1.00	81,181 (27.8)	1.00
Spring	6,926 (81.6)	1.02 (0.94–1.12)	87,392 (46.9)	1.03 (1.00–1.05)	33,694 (85.1)	0.96 (0.92–1.01)	60,624 (29.7)	1.06 (1.03–1.09)
Summer	4,226 (85.4)	1.24 (1.11–1.39)	54,758 (49.8)	1.03 (1.00–1.06)	23,106 (84.8)	0.96 (0.91–1.01)	35,878 (31.5)	1.09 (1.06–1.13)
Autumn	5,369 (84.0)	1.27 (1.15–1.40)	78,730 (44.3)	1.00 (0.98–1.03)	27,601 (84.8)	0.95 (0.91–1.00)	56,498 (28.3)	1.03 (1.00–1.06)
Public holidays								
No	24,434 (82.2)	1.00	324,809 (45.5)	1.00	119,604 (85.2)	1.00	229,639 (28.8)	1.00
Yes	603 (87.2)	1.03 (0.79–1.34)	7,441 (54.6)	1.10 (1.03–1.17)	3,502 (84.3)	0.92 (0.83–1.03)	4,542 (36.0)	1.21 (1.13–1.31)

Note. OR, odds ratio; CI, confidence interval.
[a]Included episodes where patients were specifically diagnosed with tonsillitis, pharyngitis, sinusitis, and otitis media.
[b]Logistic generalized estimating equation model adjusting for sex, age group, the socioeconomic index, the remoteness of areas, the number of antibiotic prescriptions for a patient in the previous year, body temperature, etiology labels, the diagnosis of URTIs, and clustering in patients and practices.
[c]Logistic generalized estimating equation model adjusting for sex, age group, the socioeconomic index, the remoteness of areas, the number of antibiotic prescriptions for a patient in the previous year, body temperature, etiology labels, and clustering in patients and practices.

whether these visits were conducted in person or virtually, which may explain the differences in prescribing. We also lacked detailed information regarding characteristics of general practitioners, such as their ages or levels of experience, which might influence antibiotic prescribing.[26] Additionally, the method of linking records of encounters general practitioners to prescription records on the same day does not guarantee that the URTIs were the real reasons for antibiotic prescribing. The use of free text to identify both URTIs and antibiotic prescriptions may lead to some misclassification. However, because the proportions we estimated resembled those described in an earlier study in Australia,[7] the misclassification was probably not substantial. Finally, we have excluded the URTI encounters in remote areas; therefore, our findings may not be generalizable to antibiotic prescribing patterns in those areas.

In conclusion, weekends and public holidays were associated with a higher likelihood of immediate antibiotic prescribing for self-limiting URTIs in primary care, which might be attributed to a lack of resources in after-hours health care. Antibiotic stewardship programs, such as providing feedback on antibiotic prescribing patterns to general practitioners and increasing organization-level support on the healthcare resources, may improve antibiotic use in after-hours consultations. Future multicenter studies with detailed and accurate clinical information of patients' clinical presentations and medical examination results may directly assess the appropriateness of antibiotic prescribing and assist in validating our findings. A better understanding of the reasons underlying the high antibiotic prescribing behavior is needed in primary care practices.

Supplementary material. To view supplementary material for this article, please visit https://doi.org/10.1017/ice.2022.160

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