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Paediatric antibiotic prescribing in a nationwide direct-to-consumer telemedicine platform in France, 2018–2021

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Background: Recent regulatory and reimbursement changes facilitated the development of teleconsultation within primary care. French guidance advises against antibiotic prescribing in children in teleconsultation. We assessed paediatric antibiotic prescribing on a French teleconsultation platform.

Methods: This cross-sectional observational study analysed paediatric (0–14 years) visits on a national direct-to-consumer teleconsultation platform between January 2018 and December 2021. Teleconsultations with complete information regarding diagnosis (ICD-10 coding) and prescriptions were included. We assessed antibiotic prescription rates per 100 visits across diagnoses and used logistic regression to identify factors associated with antibiotic prescribing.

Results: In the 37 587 included paediatric teleconsultations (median age 3 years) performed by 713 general practitioners (GPs) and 89 paediatricians, antibiotics were prescribed for 12.1%. Respiratory tract infections (RTIs) accounted for 49.5% of antibiotic prescriptions. Antibiotic prescription rates per 100 visits were: sinusitis, 69.5%; urinary tract infections, 62.2%; pharyngitis, 59.0%; pneumonia, 45.5%; otitis, 46.6%; bronchitis, 19.6%; rhinitis, 11.6%; bronchiolitis 6.6%. Antibiotic prescription rates were higher in GPs than paediatricians [OR 2.21 (IC95% 2.07–2.35)], among physicians aged 45–54 and over 65 [OR 1.66 (1.48–1.85) and 1.48 (1.32–1.66), respectively], in female practitioners [OR 1.13 (1.05–1.21)], in children 3–6 years old [OR 1.41 (1.28–1.56)] and over 6 [OR 1.50 (1.35–1.66)], during winter [OR 1.28 (1.21–1.37)] and for RTIs [OR 1.99 (1.87–2.10)]. Antibiotic prescription rates were lower in doctors with extensive experience in teleconsultation [OR 0.92 (0.86–0.98)].

Conclusions: Despite current recommendations, paediatric patients were frequently prescribed antibiotics during acute care teleconsultations. Specific antibiotic stewardship campaigns should target paediatric teleconsultations.

Introduction

Antibiotic overprescribing and inappropriate use are major concerns that directly contribute to the global emergence of antimicrobial resistance.[1,2] Notably, there is compelling evidence indicating a high prevalence of inappropriate antibiotic use in children. For example, in the USA, it is estimated that 29% of antibiotics prescribed to children are inappropriate.[3] France exhibits elevated levels of drug prescriptions, especially in paediatric care and particularly regarding antibiotics.[4] A French study evaluating antibiotic prescribing in paediatric primary care revealed that an antibiotic regimen is prescribed in more than 25% of paediatric in-person consultations.[5] Respiratory tract infections (RTIs) accounted for more than 80% of antibiotic prescriptions,

with presumed viral RTIs being responsible for 41% and 24% of all antibiotic prescriptions by general practitioners (GPs) and paediatricians, respectively.[5] Within this study, more than 65% of children diagnosed with bronchitis and managed by GPs received antibiotics.[5] In parallel, antimicrobial resistance has emerged, with, for example, faecal carriage rates of extended-spectrum beta-lactamase-producing *Enterobacteriaceae* up to 10% in the paediatric community in France.[6]

Teleconsultation refers to the provision of medical care remotely through the utilization of information and communication technologies, such as smartphones and webcams, without an in-person visit.[7] Teleconsultation offers several advantages, including enhanced convenience, reduced travel and waiting times, improved access to healthcare, decreased transmission of infections and lower costs.[8] During the COVID-19 pandemic, legislation expanded coverage for teleconsultation services in several countries, leading to a massive increase in their use. For example, in the USA, teleconsultation went from accounting for less than 1% of Medicare primary care visits before 2020 to 46% of all visits in April 2020.[9] Similarly, in France, the national health insurance system started reimbursing teleconsultations in September 2018, but the use of teleconsultation actually took off during the COVID-19 pandemic: reimbursement claims counted 9.4 million teleconsultations in 2021 compared to only 80 000 in 2019, and in 2021, approximately 4% of all general practice visits were teleconsultations.[10]

However, there are concerns about the quality of care in telemedicine, including whether physicians can make an accurate diagnosis without a face-to-face interview and physical examination, whether the use of point-of-care tests and follow-up visits is appropriate, and whether the collection of health data is of sufficient quality to understand medical reasoning and assess the quality of care. Whereas studies evaluating antibiotic use in paediatric teleconsultation are scarce,[11–14] they suggest the possibility of higher prescription rates compared to face-to-face visits.[15] For example, in a North-American study involving 4604 paediatric teleconsultations for RTIs, Ray *et al*. found that antibiotics were prescribed in 52% of teleconsultation visits, whereas urgent care and primary care visits had prescription rates of 42% and 31%, respectively.[11]

In France, there is explicit guidance advising against antibiotic prescribing during paediatric teleconsultations due to the concern that accurately diagnosing bacterial infections in children without an in-person physical examination is unlikely.[16] However, following article 8 (article R.4127–8) of the French Public Health Code, antibiotic prescribing remains at the discretion of the doctor in charge. There is no data about whether French physicians providing paediatric teleconsultation services adhere to the guidelines and in what proportion they prescribe antibiotics.

We aimed to assess antibiotic prescribing for French children seen in teleconsultation and identify potential areas for improvement in future stewardship campaigns.

Materials and methods

Data source and study population

We used data from the Qare® platform, a national private direct-to-consumer French telemedicine platform that ranks second in volume of teleconsultations conducted in France.[17] Qare® provides access to all patients, regardless of their health insurance coverage, and is available for all private doctors and hospital practitioners across the entire French territory. Qare® offers both acute care teleconsultations and follow-up visits. Qare® emits good practice recommendations but respects the autonomy of the doctors who work with Qare® in making their own therapeutic decisions and prescriptions.

For each teleconsultation conducted on the Qare® platform, patients are required to provide information regarding the primary reason for seeking medical attention, any known allergies and ongoing or recent treatments. Qare® uses an internal electronic health record (EHR) system, enabling practitioners to structure and streamline data collection. Patients can share additional test results (e.g. urinary dipstick, pregnancy test, laboratory and imaging reports, hospital discharge summaries) before or during the teleconsultation. Remote clinical examination is facilitated through a webcam and may include assessments of general appearance, respiratory rate and skin examination. Patients can also submit photographs and measure their body temperature during the teleconsultation. Connected tools may further enrich the clinical evaluation with, for example, blood pressure measurements, capillary blood glucose levels, cardio-pulmonary auscultation and ear-nose-throat examinations, but these were not available during the present study. On the Qare platform, every physician in charge of a patient has access to comprehensive patient data, which includes information and outcomes of all previous teleconsultations on Qare. Physicians who have not previously treated a patient do not have access to their health data.

In this cross-sectional observational study, we included paediatric (0–14 years) teleconsultations on the Qare® platform from January 2018 to December 2021, performed by GPs and paediatricians (as defined by their diplomas recorded by the French Medical Association). In line with previous studies,[5,18] the cut-off of 15 years was chosen because it is commonly used by French law to define paediatric care. We only included teleconsultations with complete and structured information on diagnosis (i.e. ICD-10 coding) and prescriptions (i.e. written using the prescription assistance software provided within the EHR system). All other teleconsultations were excluded.

Variables and definitions

Diagnostic classification

We re-classified all diagnostic codes based on the ICD-10 classification. Each teleconsultation was categorized as an RTI or a non-RTI illness, as in previous publications.[5] Non-infectious codes were defined as those that do not correspond to any infectious classification codes. RTIs encompassed rhinitis, pharyngitis, bronchitis, bronchiolitis, otitis, laryngitis, sinusitis, COVID-19 and pneumonia. Non-RTIs included urinary tract infections (UTI), digestive tract infections, skin and soft tissue infections, genital infections, other infections and prevention visits (immunization). Infections were also categorized according to the presumed causal agent [i.e. presumed bacterial, viral, fungal or parasitic infections; Supplementary Table S1 (available as Supplementary data at *JAC-AMR* Online)].[5] The presumption of viral or bacterial cause was made arbitrarily based on epidemiological data (e.g. rhinopharyngitis is mostly of viral origin, while acute otitis media is potentially of bacterial origin).

Antibiotic prescribing information

For each teleconsultation, we categorized all prescribed drugs as either systemic antibiotics or other drugs. Systemic antibiotics included all drugs belonging to class J01 of the ATC classification, excluding topical antibiotics. Prescriptions were automatically transcoded with ATC codes, since the VIDAL drug database was used at the time of prescription.[19] For each prescribed antibiotic, the spectrum of the molecule and the duration of the prescription were extracted. As per definitions from the European

Centre for Disease Prevention and Control, broad-spectrum antibiotics included amoxicillin-clavulanate (J01CR), macrolides (except erythromycin) (J01FA except J01FA01), cephalosporins (J01D) and fluoroquinolones (J01MA).[20] Furthermore, antibiotic spectrum was classified according to the WHO's AWaRe scheme: 'Access', 'Watch' or 'Reserve'.[21] In the AWaRe scheme, Access drugs are first- or second-choice antibiotics that offer the best therapeutic value while minimizing the potential for antimicrobial resistance; Watch drugs are only indicated for a specific and limited number of infective syndromes more prone to be a target of antibiotic resistance and thus prioritized as targets of stewardship programmes and monitoring; Reserve drugs are last-resort agents for highly selected patients (e.g. life-threatening infections due to multi-drug resistant bacteria), closely monitored and prioritized as targets of stewardship programmes to ensure their continued effectiveness. Any antibiotic prescription exceeding 7 days was categorized as a 'long prescription'.[22]

Other variables

For each teleconsultation, we collected physicians' characteristics such as specialty (GP or paediatrician), age and sex.[23] As in previous studies, we also extracted patient socio-demographic characteristics, including age and ZIP code; each region of France was further dichotomized as North versus South,[5] with ZIP codes below the Lyon–Bordeaux line coded as 'South'. For each teleconsultation, we extracted the season, distinguishing between summer (April–September) and winter (October–March).[24] We also coded whether the teleconsultation was performed by a practitioner having 'extensive experience in teleconsultation' (defined as having already conducted more than 3000 teleconsultations on Qare®) and categorized the teleconsultation duration as less or more than 5 minutes; these thresholds are routinely used as internal quality criteria on the Qare® platform.

Statistical analysis

First, we described the characteristics of paediatric teleconsultations on Qare®, using descriptive metrics such as median with interquartile range for quantitative variables and proportions with 95%CI for qualitative variables. Second, we described antibiotic prescriptions and calculated antibiotic prescription rates per 100 teleconsultations, both overall and stratified by diagnoses and diagnostic categories. Third, the analysis was stratified to compare antibiotic prescription rates between GPs and paediatricians, using Chi-square tests to compare proportions. Fourth, we used univariable logistic regression analysis to examine the association between physician, patient and teleconsultation characteristics and antibiotic prescribing. Explanatory variables were *a priori* categorized according to published cut-offs (e.g. patient and practitioner age). In this exploratory univariable analysis, associations were expressed as crude OR and 95%CI. *P* values <0.05 were considered significant. Data were extracted directly from the Qare® data warehouse, and statistical analyses were carried out using RStudio v.1.1.463 (R Studio, Vienna, Austria).

Ethics

The use of data from the Qare® platform is compliant with the general data protection regulation. When they create an account on the platform, all patients (or their legal guardians in the case of children) provide written consent to participate in research and retain the right to retract their consent at any time. Additionally, all patients and physicians were informed by e-mail about the purpose of this study and had the opportunity to withdraw their participation. As per French regulation, no additional ethical clearance is needed for such studies.

Results

Description of included paediatric teleconsultations

Over the 4-year study period, 1 376 095 teleconsultations were performed on the Qare® platform. The number of teleconsultations on Qare® was lower in 2018 and 2019 than in 2020 and 2021 (i.e. 9303, 64 929, 495 975 and 805 888 teleconsultations per year, respectively) because of the COVID-19 pandemic and lockdowns. In total, 167 581 paediatric teleconsultations were identified over the study period; 18 211 (11%) were excluded because they were not conducted by GPs or paediatricians and 111 783 (67%) due to insufficient diagnostic and prescribing information; excluded teleconsultations were mainly teleconsultations with unstructured text conclusions without any ICD-10 diagnostic code (Figure 1). We included 37 587 paediatric teleconsultations, of which 15 410 (41%) were performed by 713 GPs and 22 177 (59%) by 89 paediatricians (Table 1).

The median age of children was 3 years (IQR 1–6), and most (71%) resided in the northern part of France. The median age of participating physicians was 37 years (IQR 33–51), and 29% of teleconsultations were performed by female practitioners. About 10% of the physicians had an extensive experience with teleconsultation, accounting for 51% of teleconsultations. Most teleconsultations (57%) occurred during the winter season. RTIs represented 37% of the total number of teleconsultations.

Description of antibiotic prescriptions

Among the 37 587 included paediatric teleconsultations, antibiotics were prescribed for 4557, resulting in a prescription rate of 12.1 antibiotics per 100 teleconsultations (i.e. 12.1%). RTIs accounted for 49.5% of antibiotic prescriptions (Table 2); 16.4% of children diagnosed with an RTI were prescribed antibiotics. Overall, 37.1% of antibiotics were prescribed for presumed bacterial infections, 36.8% for presumed viral infections, 25.6% for other infectious diseases (e.g. eye infections, contact with an infected person, sexually transmitted infections), 0.2% for presumed fungal infections and 0.1% for presumed parasitic infections.

Across specific diagnoses, antibiotic prescription rates per 100 teleconsultations were as follows: sinusitis, 69.5%; UTIs, 62.2%; pharyngitis, 59.0%; otitis, 46.6%; pneumonia, 45.5%; bronchitis, 19.6%; rhinitis, 11.6%; skin infections 9.0%; bronchiolitis 6.6%; genital infections, 6.5%; COVID-19, 5.7%; digestive tract infections, 1.4% (Supplementary Table S2).

The mean duration of antibiotic prescriptions was 5.6 days (SD 4.6), and only 11.5% of antibiotics were prescribed for more than 7 days (Table 2). The most frequently prescribed antibiotics were amoxicillin (37.2%) and macrolides (31.5%), followed by amoxicillin-clavulanate (10.7%), second generation cephalosporins (7.5%) and third generation cephalosporins (5.0%). Other antibiotic classes accounted for less than 5% each. More than half (51.5%) of the antibiotic prescriptions were classified as broad-spectrum agents, whereas 50.3% fell into the 'Watch' category according to WHO's AWaRe classification.

Comparison between general practitioners and paediatricians

The antibiotic prescription rate was higher among GPs than paediatricians (overall antibiotic prescription rate 17.2% versus. 8.6%, respectively, $P<0.001$). This difference between GPs and paediatricians was found consistently across all physician and patient subgroups, except for physicians 35–44 years old (11.4% versus. 10.1% for GPs and paediatricians, respectively, $P=0.129$; Table 3).

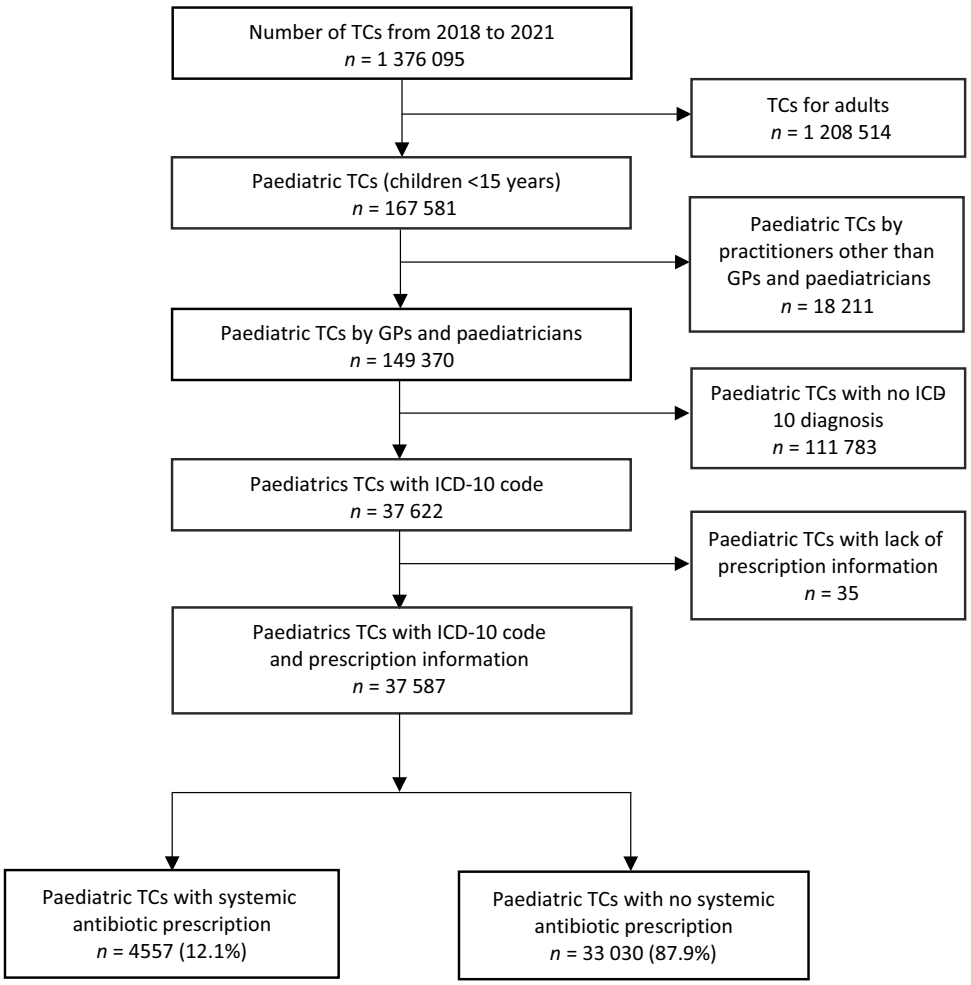

Figure 1. Flowchart of the teleconsultations included in the study (2018–2021).

Factors associated with antibiotic prescribing

In univariable logistic regression analysis, higher antibiotic prescription rates were observed in GPs than paediatricians [OR 2.21 (IC95% 2.07–2.35)], among physicians 45–54 years and >65 years compared to those <35 years [OR 1.66 (1.48–1.85) and 1.48 (1.32–1.66), respectively], among female compared to male practitioners [OR 1.13 (1.05–1.21)], for children 3–6 years and >6 years old compared to children younger than 1 year [OR 1.41 (1.28–1.56) and 1.50 (1.35–1.66), respectively], during winter compared to summer [OR 1.28 (1.21–1.37)], and in case of RTI compared to non-RTI [OR 1.99 (1.87–2.10); Table 4]. Antibiotic prescription rates were lower in physicians with extensive experience in teleconsultation [OR 0.92 (0.86–0.98)]. There were no significant differences in antibiotic prescription rates according to region and teleconsultation duration.

Discussion

Main findings

To our knowledge, this study is the first to scrutinize paediatric antibiotic prescribing in the context of French teleconsultation. If physicians respected current clinical guidelines regarding antibiotic use in teleconsultation, we would expect a prescription rate close to 0. In this large cross-sectional study using data obtained from a nationwide direct-to-consumer teleconsultation platform, we observed that, despite current recommendations, paediatric patients were frequently prescribed antibiotics during acute care teleconsultation, with an antibiotic prescription rate of 12.1 per 100 teleconsultations. About half of these prescriptions were for RTIs, and about one-third of prescriptions were for presumed viral infections. About half of the prescriptions were broad-spectrum agents. Antibiotic prescribing was higher when the teleconsultation was conducted by a GP, by a female doctor, when the doctor was 45–55 years or >65 years old, the child was older than 2 years old, in case of RTI, and when the teleconsultation occurred in winter. Antibiotic prescription rates were lower among doctors with extensive experience in teleconsultation.

Interpretation and implications

There are several potential reasons for the antibiotic prescribing patterns we observed in French paediatric teleconsultations.

Table 1. Characteristics of paediatric teleconsultations included in the study ($N=37\,587$)

Variable	*n*	(%)
Physician characteristics		
Specialty		
General practitioner ($n=713$)	15 410	41.0
Paediatrician ($n=89$)	22 177	59.0
Age, years		
<35	4609	12.2
35–44	5540	14.7
45–54	7629	20.2
55–65	10 196	27.1
>65	6070	16.1
Sex		
Women	10 997	29.2
Men	26 590	70.8
Patient characteristics		
Age, years		
<1	5918	15.7
1–2	5546	14.7
3–6	13 348	35.5
>6	9033	24.0
Region		
North	26 674	71.0
South	10 913	29.0
Teleconsultation characteristics		
Season		
Summer	16 352	43.5
Winter	21 235	56.5
Duration of teleconsultation		
≥5 min	37 567	99.9
<5 min	20	0.1
Physician's experience		
≥3000 teleconsultations	19 260	51.2
<3000 teleconsultations	18 327	48.8
Diagnosis		
RTIs	13 771	36.6
Non-RTIs	23 816	63.4
Skin infection	3424	—
Digestive tract infection	3334	—
Urinary tract infection	839	—
Genital infection	184	—
Other infection	5504	—
Non-infectious disease	10 531	—
Antibiotic prescription	4557	12.1

Table 2. Antibiotic prescriptions for paediatric teleconsultations included in the study ($N=4557$)

Variable	*n*	(%)
Diagnosis		
RTIs	2254	49.5
Non-RTIs	2129	51.5
Antibiotic prescription >7 days	525	11.5
Antibiotic class		
Amoxicillin	1695	37.2
Macrolide	1440	31.5
Amoxicillin-clavulanate	488	10.7
C2G	344	7.5
C3G	228	5.0
Fluoroquinolones	194	4.2
Fosfomycin	84	1.8
Other	84	1.8
AWaRE classification		
Access	2267	49.7
Watch	2290	50.3
Reserve	0	

C2G, second generation cephalosporin; C3G, third generation cephalosporin.

As a first explanation, teleconsultation may reflect practices in primary care medicine in face-to-face consultations. A previous study showed that French GPs prescribe antibiotics in 26% of their face-to-face consultations, with high antibiotic prescription rates for infections of presumed viral origin, such as 65.2% for bronchitis and 21.7% for common colds.[5] Unnecessary prescription of antibiotics to treat viral infections may stem from culturally entrenched inappropriate prescribing habits seen both in telemedicine and face-to-face visits. For example, despite a notable reduction in broad-spectrum antibiotic use in recent years,[18] French children are still five times more likely than Dutch children to receive antibiotics.[25]

The pursuit of patient satisfaction or fear of how patients will react if they are refused an antibiotic prescription may also drive inappropriate antibiotic use. In a study of paediatric patients with RTIs who accessed care through a direct-to-consumer teleconsultation platform in the US, 55% received a prescription for an antibiotic, and providers were more likely to receive a favourable 5-star rating from parents when antibiotics were prescribed.[14]

In our study, teleconsultation led to fewer antibiotic prescriptions than the rates observed in a French national study of ambulatory face-to-face consultations.[5] Nevertheless, whether teleconsultation leads to higher rates of inappropriate antibiotic use than traditional face-to-face primary care visits remains unclear, and the current evidence points to contradictory findings. Two recent systematic reviews have indicated insufficient evidence to confidently conclude that remote consulting significantly impacts antibiotic prescribing in primary care.[15,26] However, the authors concluded that most of the included studies were at high risk of bias, emphasizing the need for high-quality research to be conducted in this area.

To date, most antibiotic stewardship efforts have focused on improving prescribing practices in hospital and in-person primary care settings. However, to our knowledge, there is still limited attention given to addressing antibiotic prescribing in teleconsultation.[24] There are several tools and strategies that could be explored to improve antibiotic prescribing in teleconsultation. For example, integrating artificial intelligence-enabled algorithms, such as automatic alerts within patients' EHR could assist in promoting appropriate prescribing decisions. In the case of viral illnesses, non-prescription orders could also be implemented in EHR systems. Other avenues for improving antibiotic prescribing in teleconsultation include initial and continuous medical education and improving patient literacy through digital communication

Table 3. Antibiotic prescription rates for paediatric teleconsultations according to physician specialty

	TCs conducted by general practitioners		TCs conducted by paediatricians		
Variable	TCs, *N* (%)	TCs with antibiotic prescription, *N* (%)	TCs, *N* (%)	TCs with antibiotic prescription, *N* (%)	*P*
Physician characteristics					
Age, years					
<35	3781 (24.5)	465 (12.3)	828 (3.7)	43 (5.2)	<0.001
35–44	3214 (20.8)	365 (11.4)	2323 (10.4)	234 (10.1)	0.129
45–54	3730 (24.2)	750 (20.1)	3899 (17.5)	548 (14.1)	<0.001
55–65	1337 (8.6)	294 (22.0)	8859 (39.9)	443 (5.0)	<0.001
>65	1410 (9.1)	407 (28.9)	4660 (21.0)	533 (11.4)	<0.001
Missing values	1938 (12.5)	371 (19.1)	1605 (7.0)	104 (5.4)	—
Sex					
Women	6592 (42.7)	1105 (16.8)	4405 (19.8)	310 (7.0)	<0.001
Men	6756 (43.8)	1157 (17.1)	16 162 (72.8)	1490 (9.2)	<0.001
Missing values	2062 (13.4)	390 (18.9)	1607 (7.2)	105 (6.5)	—
Patient characteristics					
Age, years					
<1	1236 (8)	201 (16.3)	4681 (21.1)	389 (8.3)	<0.001
1–2	1485 (9.6)	263 (17.7)	4061 (18.3)	330 (8.1)	<0.001
3–6	5706 (37.0)	1062 (18.6)	7642 (34.4)	743 (9.7)	<0.001
>6	6352 (41.0)	1013 (15.9)	2679 (12)	273 (10.2)	<0.001
Missing values	631 (4.1)	113 (17.9)	3111 (14.0)	0	—
Region					
North	10 164 (65.9)	1810 (17.8)	15 472 (69.7)	1349 (8.7)	<0.001
South	4744 (30.7)	759 (16.0)	6168 (27.8)	527 (8.5)	<0.001
Missing values	502 (3.2)	83 (16.5)	534 (2.4)	29 (1.5)	—
Teleconsultation characteristics					
Season					
Summer	6138 (39.8)	1060 (17.3)	10 214 (46.0)	682 (6.7)	<0.001
Winter	9272 (60.2)	1592 (17.2)	11 960 (54.0)	1223 (10.2)	<0.001
Duration of TC					
≥5 min	15 390 (99.8)	2650 (17.2)	22 174 (100)	1905 (8.6)	<0.001
<5 min	20 (0.02)	2 (10.0)	0	0	N/A
Physician's experience					
≥3000 TCs	6073 (39.4)	1330 (21.9)	13 187 (59.4)	927 (7.0)	<0.001
<3000 TCs	9337 (60.6)	1322 (14.2)	8987 (40.5)	978 (10.9)	<0.001
Diagnosis					
RTIs	6249 (40.5)	1468 (23.5)	7520 (33.9)	786 (10.5)	<0.001
Non-RTIs	9161 (59.5)	1184 (12.9)	14 654 (66.1)	1119 (7.6)	<0.001
All TCs	15 410	2652 (17.2)	22 177	1905 (8.6)	<0.001

≥3000 TCs, Consultation made by a physician with ≥3000 TCs; TC, teleconsultation. N/A, not available.

platforms such as social media, podcasts, and webinars, and including connected tools (e.g. e-stethoscope) to support decisions by remote clinical diagnosis.[27]

Limitations

Our study has several limitations. First, we had to exclude a large number of teleconsultations because of missing data on diagnosis and prescriptions (mainly unstructured diagnostic data made of free text). Second, our analysis was based on teleconsultations with an ICD code, but coding is an expertise that clinicians may not have,[28] with a potential risk of misclassification bias; furthermore, the organization of diagnostic information in the database relied on semi-structured data requiring recoding. Third, we could not evaluate the proportion of delayed antibiotic prescriptions that were written and filled because we did not have access to information regarding drug delivery in community pharmacies. Fourth, our study is limited to a single French telemedicine platform, and antibiotic prescribing practices may vary in other telemedicine platforms (e.g. different practitioner profiles) and countries (e.g. different epidemiology and accessibility to telemedicine). Thus, caution should be exercised in extrapolating these findings to other settings. Fourth, this study relied on a large dataset of routinely collected information, but several essential

Table 4. Factors associated with antibiotic prescribing during paediatric teleconsultations (*N* = 37 587)

Variable	TCs with antibiotic prescription *N* = 4557 (12.1%)	TCs with no antibiotic prescription *N* = 33 030 (87.9%)	OR	95%CI	*P*
Physician characteristics					
Specialty					
General practitioner	2652 (17.2)	12 758 (82.8)	2.21	2.07–2.35	<0.001
Paediatrician	1905 (8.6)	20 269 (91.4)	1	—	—
Missing values	0	3			
Age, years					
<35	508 (11.0)	4101 (89.0)	1	—	<0.001
35–44	599 (10.8)	4941 (89.2)	0.98	0.86–1.11	—
45–54	1298 (17.0)	6331 (83.0)	1.66	1.48–1.85	—
55–65	737 (7.2)	9459 (92.8)	0.63	0.56–0.71	—
>65	940 (15.5)	5130 (84.5)	1.48	1.32–1.66	—
Missing values	475 (10.4)	3068 (9.2)			
Sex					
Women	1415 (12.9)	9582 (87.1)	1.13	1.05–1.21	<0.001
Men	2647 (11.5)	20 274 (88.5)	1	—	—
Missing values	495 (10.8)	3174 (9.6)			
Patient characteristics					
Age, years					
<1	590 (10.0)	5328 (90.0)	1	—	<0.001
1–2	593 (10.7)	4953 (89.3)	1.08	0.96–1.22	—
3–6	1805 (13.5)	11 543 (86.5)	1.41	1.28–1.56	—
>6	1286 (14.2)	7747 (85.8)	1.50	1.35–1.66	—
Missing values	283 (6.2)	3459 (10.4)			
Region					
North	3159 (12.3)	22 478 (87.7)	1	—	—
South	1286 (11.8)	9627 (88.2)	0.95	0.88–1.01	0.15
Missing values	112 (2.4)	925 (2.8)			
Teleconsultation characteristics					
Season					
Summer	1742 (10.7)	14 610 (89.3)	1	—	<0.001
Winter	2815 (13.3)	18 420 (86.7)	1.28	1.21–1.37	—
Duration of TC					
≥5 min	4555 (12.1)	33 012 (87.9)	1.24	0.36–7.80	0.77
<5 min	2 (10.0)	18 (90.0)	1	—	—
Physician's experience					
≥3000 TCs	2257 (11.7)	17 003 (88.3)	0.92	0.86–0.98	0.01
<3000 TCs	2300 (12.5)	16 027 (87.5)	1	—	—
Diagnosis					
RTIs	2254 (16.4)	11 517 (83.6)	1.99	1.87–2.10	<0.001
Non-RTIs	2303 (9.6)	21 513 (90.4)	1	—	—

TCs, teleconsultations.

patient characteristics, such as socio-economic status, were not available, and we cannot exclude residual confounding due to unmeasured variables.

Conclusion

In this large-scale study, antibiotics were prescribed in 12.1% of paediatric teleconsultations, while it should be close to null according to current guidelines. About one-third of antibiotic prescriptions were for presumed viral infections, and broad-spectrum agents accounted for about half of the prescriptions. Specific efforts should aim at improving the quality of paediatric antibiotic prescribing in telemedicine, notably through better awareness and implementation of clinical guidelines.

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Transparency declarations

B.M. is responsible for antibiotic stewardship and improvement of the EHR at Qare®. F.D. is data scientist at Qare®. J.S. is medical director at Qare®. All other authors: none to declare.

Author contributions

Original idea: B.M., E.L. and J.C. Study design: E.L. and J.C. Data collection: F.D. Data analysis: B.M. Study supervision: E.L., J.C. and J.S. First draft of the manuscript: B.M. and J.C. Review of the manuscript for critical intellectual content: all authors. Approval of the final version of the manuscript: all authors.

Supplementary data

Tables S1 and S2 are available as Supplementary data at *JAC-AMR* Online.

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