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Antibiotic prescribing for respiratory infections: a cross-sectional analysis of the ReCEnT study exploring the habits of early-career doctors in primary care

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Abstract

Background: Antibiotic resistance is among the most important current public health issues. Most antibiotics are prescribed in primary care. There is strong consensus that they are overprescribed, especially for conditions such as upper respiratory tract infections (URTI) and acute bronchitis, where they provide limited benefit. Interventions to alter prescribing patterns have shown limited effect. Trainees in family practice may be an appropriate target, as their prescribing habits are still developing.

Objective: To establish prevalence and associations of trainee prescribing of antibiotics for URTI and acute bronchitis/bronchiolitis.

Methods: A cross-sectional analysis of the Registrar Clinical Encounters in Training (ReCEnT) study. ReCEnT is an ongoing cohort study of Australian General Practice (GP) trainees documenting the nature of their consultation-based clinical experiences. Trainees record details of 60 consecutive patient encounters every 6-month training term. Univariate and logistic regression analyses were conducted on data recorded in consultations related to URTI and acute bronchitis/bronchiolitis in six collection periods during 2010–12.

Results: Data from 401 trainees (94.7% response rate) were analysed. Antibiotics were prescribed in 21.6% of encounters for URTI and 73.1% of encounters for acute bronchitis/bronchiolitis. Trainees prescribing antibiotics were more likely to order tests, and to seek in-consultation advice. Logistic regression analysis demonstrated older patient age, Indigenous patient background, and practices in higher socioeconomic areas were significant predictors of antibiotic prescribing.

Conclusion: GP trainee antibiotic prescribing is higher than justified by guidelines. Understanding factors contributing to this pattern will assist in developing educational interventions to improve evidence-based prescribing habits during the early stages of these doctors' careers.

Keywords. Antibacterial agents, drug resistance, evidence-based medicine, general practice, graduate medical education, drug resistance, microbial, physician prescribing patterns.

Introduction

Antibiotic resistance is a major public health concern. Overuse of antibiotics contributes to resistance at both the individual and population level (1). Most prescriptions for systemic antibiotics are issued in primary care (1,2), in some cases for diagnoses for which antibiotic therapy is not recommended. Examples of this are acute upper respiratory tract infections (URTI) (3) and acute bronchitis (4), where current evidence-based guidelines do not recommend the use of antibiotic therapy (5). In spite of this, prescription rates for antibiotics in primary care in Australia remain high (6,7). In Australian general practice over 2010–11, GPs issued 2.06 million antibiotic prescriptions for URTI (with antibiotics being prescribed in 32.0% of presentations with this diagnosis) (7). An estimated 17.4 million prescriptions for systemic antibiotics for all indications were made during this time period.

Educational interventions to improve rational prescribing have, to date, had limited effect (8). This is in part due to the fact that doctors' prescribing decisions are influenced by a complex interplay of factors. Clinician characteristics, patient factors, health system factors and cultural norms influence how prescribing decisions are made (9). This includes the patient's presenting symptoms, comorbidities and social context, and also contextual factors such as the doctor's perception of patient expectations and fear of possible complications.

While there has been considerable study into the antibiotic prescribing habits of established practitioners (9,10), there is little research into the prescribing of early-career doctors. It has been shown that prescribing habits tend to be set early and remain stable over time (11). This is therefore an important area of study, as the developing prescribing habits of this group of health professionals will impact upon future antibiotic resistance patterns.

This study aims to establish the prevalence and associations of antibiotic prescribing by Australian vocational trainees in family practice [General Practice (GP) registrars] for URTI and acute bronchitis/bronchiolitis.

Methods

This was a cross-sectional analysis of the Registrar Clinical Encounters in Training (ReCEnT) study. ReCEnT is an ongoing, multicentre prospective cohort study of GP trainees in four Australian states, aiming to document the nature and associations of the in-practice consultation-based clinical and educational experiences of GP trainees. The study protocol is described in detail elsewhere (12). Briefly, trainees complete paper-based forms recording details of 60 consecutive consultations in each of their 6-month training terms and receive an individual feedback report about their clinical exposure and practice. Trainees may consent to have their data used for research purposes.

Trainee demographics and practice data are documented at the start of each collection period, and patient demographics and clinical details are recorded for each patient encounter. Educational factors are also recorded (sources of in-consultation advice or information, and identified learning goals).

Trainee variables recorded are age, gender, training term, whether in full-time or part-time (<32 hours/week) training, place of primary medical qualification (Australia or international), and whether the trainee had worked at the practice in a previous term.

Patient variables recorded are age, gender, Aboriginal or Torres Strait Islander (Indigenous) status, non-English-speaking background status, the patient being new to the practice and the patient being new to the trainee.

Practice variables recorded are size (small practice considered <5 doctors), rurality (very remote, remote, outer regional, inner regional or major city location) and billing policy. In Australia, consultation billing is at the discretion of the treating doctor. Some practices will routinely 'bulk bill': i.e. provide consultations at no cost to the patient and the refund from the national insurer is considered full payment. Practice postcode was used to determine the Australian Standard Geographical Classification-Remoteness Area (ASGC-RA) classification to define the practice locations' degree of rurality and Socioeconomic Index for Area (SEIFA) Index of Disadvantage.

Consultation variables recorded are duration, how the patient was billed and whether pathology or imaging tests were ordered. Educational factors included whether the trainee sought advice or information during the consultation (from their supervisor or other resources, such as specialists, books or electronic resources), or generated learning goals.

Diagnoses are coded according to the International Primary Care Classification (ICPC-2) and medications according to the Anatomic Therapeutic Chemical (ATC) Classification.

The analyses in this study used data from six collection periods during 2010–12 and were concerned especially with data from consultations in which problems coded as ICPC-2 codes R74 (URTI) and R78 (acute bronchitis/bronchiolitis) were managed. These diagnoses were chosen because current guidelines are clear about recommending against the use of antibiotics for these conditions.

Statistical analysis

Percentages of trainees' consultations managing R74 or R78-coded diagnoses were calculated with 95% confidence intervals (CIs).

Univariate analyses of association for prescription of antibiotics with patient, trainee, practice and consultation variables were conducted. Univariate analyses employed chi-square and Mann–Whitney tests (our data for continuous variables was non-normal on normal probability plot inspection). These analyses were performed for all relevant consultations (i.e. those in which URTI or acute bronchitis/bronchiolitis were diagnosed), and then separately for each diagnosis. Logistic regression models with dependent variable 'prescription of antibiotic' were constructed. All variables with $P < 0.20$ on univariate analysis were included in these multiple regression models. The logistic regression analyses were performed within a generalized estimating equations framework to adjust for clustering of patients within trainees.

A *post-hoc* chi-square analysis was performed to test whether trainees' asking a supervisor for in-consultation advice was

significantly associated with prescribing an antibiotic for a diagnosis of URTI or acute bronchitis/bronchiolitis.

Statistical analyses used SAS v9.3. Predictors were considered statistically significant if the *P* value was <0.05.

Results

The trainee response rate was 94.7%. A total of 48 539 patient encounters were recorded during the collection period, from a total of 401 individual trainees. Of the trainee sample, 68.6% were female and 73.3% completed their primary medical qualification in Australia, all of which are similar to the national GP trainee population (13). See Table 1 for the demographics of trainees and practices, and for consultation variables.

Prevalence of antibiotic prescribing

Patients were diagnosed with URTI in 3761 consultations (7.6% of total consultations), and acute bronchitis/bronchiolitis in 1020 consultations (2.1% of total consultations). Trainees prescribed antibiotics in 21.6% (95% CI: 20.1–23.1) of consultations for URTI and 73.1% (95% CI: 70.4–75.9) of consultations for acute bronchitis/bronchiolitis.

The univariate analysis of consultations for URTI and acute bronchitis/bronchiolitis combined is shown in Table 2. Antibiotics prescribed for each condition are shown in Table 3. The most commonly prescribed antibiotic for both indications was amoxicillin, followed by roxithromycin. In a small proportion of consultations for acute bronchitis/bronchiolitis (*n* = 51; 6.44%), two antibiotics were prescribed concurrently.

Associations: prescribing for URTI or acute bronchitis/bronchiolitis (combined data)

The associations of antibiotic prescribing for patients diagnosed with URTI or acute bronchitis/bronchiolitis are presented in Table 4. Antibiotic prescribing was associated with older patient age. In consultations where an antibiotic was prescribed the trainee was more likely to order imaging and pathology tests and seek in-consultation advice or information. Antibiotics were more likely to be prescribed for Indigenous patients, and patients from practices in higher socioeconomic status areas. There was a non-significant trend towards increased prescribing by trainees who completed their primary medical training outside Australia. Longer consultation time was associated with antibiotic prescribing.

Table 1. Trainee, practice and consultation variables

Variable	Class	*n* % (95% CIs) or mean (SD)
Trainee variables (*n* = 401)		
Trainee gender	Female	275 68.6% (64.0–73.2)
Pathway trainee enrolled[a]	General	311 77.8% (73.7–81.8)
	Rural	89 22.3% (18.2–26.3)
Qualified as a doctor in Australia	Yes	291 73.3% (68.9–77.7)
Trainee works full-time	Yes	644 78.6% (75.8–81.4)
Trainee age (years)	Mean (SD)	33.26 (6.73)
Trainee-term or practice-term variables (*n* = 834)		
Trainee training term	Term 1	335 40.2% (36.8–43.5)
	Term 2	290 34.8% (31.5–38.0)
	Term 3	157 18.8% (16.1–21.5)
	Term 4	52 6.2% (4.6–7.9)
Trainee worked at the practice previously	Yes	220 28.9% (25.6–32.1)
Practice routinely bulk bills[b]	Yes	125 15.3% (12.8–17.8)
Number of GPs working at the practice	1–4	262 32.0% (28.8–35.2)
	5–9	445 54.3% (50.9–57.8)
	10 or more	112 13.7% (11.3–16.0)
Rurality of practice	Major city	455 54.7% (51.3–58.1)
	Inner regional	278 33.4% (30.2–36.6)
	Outer regional/remote/very remote	99 11.9% (9.7–14.1)
SEIFA (decile) of practice[c]	Mean (SD)	989.2 (68.5)
Patient demographics (*n* = 48 539)		
Patient age (years)	Mean (SD)	40.47 (23.84)
Patient gender	Female	29 829 61.45% (61.02–61.89)
Indigenous status	Aboriginal or Torres Strait Islander	461 0.97% (0.89–1.06)
Non-English-speaking background	Yes	2499 5.26% (5.06–5.46)
Consultation variables		
Follow-up	Yes	28 573 57.7% (57.2–58.1)
Referral	Yes	8015 16.2% (15.8–16.5)
Imaging ordered	Yes	5731 11.6% (11.3–11.8)
Pathology ordered	Yes	11 617 23.4% (23.1–23.8)
Learning goals generated	Yes	9783 20.2% (19.8–20.5)
Sources of assistance used	Yes	9842 19.88% (19.5–20.2)
Consultation time (minutes)	Mean (SD)	16.84 (8.96)

[a]Missing data.

[b]Consultation at no cost to the patient.

[c]Socioeconomic Index for Area (SEIFA) Relative Index of Disadvantage.

Table 2. Consultations for URTI and acute bronchitis/bronchiolitis: univariate analysis

	Variable	Class	Antibiotics prescribed		
			No (n = 3211)	Yes (n = 1557)	P
Patient factors	Patient age group	0–4	878 (80%)	214 (20%)	<0.0001
		5–14	470 (75%)	158 (25%)	
		15–24	415 (71%)	169 (29%)	
		25–44	728 (66%)	383 (34%)	
		45–64	488 (58%)	354 (42%)	
		65–74	100 (42%)	139 (58%)	
		75+	92 (45%)	114 (55%)	
	Patient gender	Male	1335 (67%)	647 (33%)	0.936
		Female	1829 (68%)	878 (32%)	
	Indigenous	No	3196 (67%)	1541 (33%)	0.032
		Yes	15 (48%)	16 (52%)	
	Non-English-speaking background	No	2913 (67%)	1428 (33%)	0.391
		Yes	190 (74%)	68 (26%)	
	New patient to trainee	No	912 (67%)	448 (33%)	0.677
		Yes	2228 (68%)	1064 (32%)	
	New patient to practice	No	2895 (67%)	1416 (33%)	0.359
		Yes	244 (70%)	106 (30%)	
Trainee factors	Trainee gender	Male	1127 (66%)	587 (34%)	0.310
		Female	2084 (68%)	970 (32%)	
	Trainee age	Mean (SD)	34 (8)	33 (7)	0.299
	Employed full-time or part-time	Part-time	656 (71%)	271 (29%)	0.248
		Full-time	2533 (67%)	1269 (33%)	
	Training term	Term 1	1400 (67%)	692 (33%)	0.184
		Term 2	1062 (67%)	515 (33%)	
		Term 3	620 (70%)	271 (30%)	
		Term 4	129 (62%)	79 (38%)	
	Worked at the practice previously	No	2302 (69%)	1030 (31%)	0.087
		Yes	656 (63%)	393 (37%)	
	Qualified as a doctor in Australia	No	840 (62%)	510 (38%)	0.006
		Yes	2335 (69%)	1030 (31%)	
Practice factors	Practice size	Small	1029 (70%)	445 (30%)	0.263
		Large	2136 (66%)	1086 (34%)	
	Does the practice routinely bulk bill	No	2664 (67%)	1327 (33%)	0.529
		Yes	485 (70%)	203 (30%)	
	Rurality	Urban	2007 (70%)	859 (30%)	0.126
		Inner regional	900 (63%)	530 (37%)	
		Outer regional/remote	298 (65%)	162 (35%)	
Consultation factors	How was patient billed	Private	1324 (67%)	663 (33%)	0.039
		Bulk bill/no charge	1707 (69%)	780 (31%)	
		Other	18 (50%)	18 (50%)	
	Sought in-consultation advice	No	3094 (69%)	1399 (31%)	<0.0001
		Yes	117 (43%)	158 (57%)	
	Pathology ordered	No	3107 (68%)	1429 (32%)	<0.0001
		Yes	104 (45%)	128 (55%)	
	Imaging ordered	No	3181 (69%)	1457 (31%)	<0.0001
		Yes	30 (23%)	100 (77%)	
	SEIFA Index (decile)	Mean (SD)	6.6 (2.2)	6.7 (2.1)	0.102
	Consultation duration (minutes)	Mean (SD)	14 (7)	15 (7)	<0.0001

SEIFA, Socioeconomic Index for Area.

Upper respiratory tract infection

When analysed separately for patients diagnosed with URTI, antibiotic prescribing was significantly associated with older patient age and the trainee being male. If an antibiotic was prescribed, the trainee was more likely to order pathology tests, and more likely to seek in-consultation advice or information (see Table 4).

Table 3. Types of antibiotics prescribed

URTI			Acute bronchitis/bronchiolitis		
Antibiotic name	Frequency	%	Antibiotic name	Frequency	%
Amoxicillin	447	54.38	Amoxicillin	350	44.19
Roxithromycin	109	13.26	Roxithromycin	152	19.19
Phenoxymethylpenicillin	72	8.76	Amoxicillin and enzyme inhibitor	114	14.39
Amoxicillin and enzyme inhibitor	65	7.91	Doxycycline	50	6.31
Cefalexin	46	5.6	Clarithromycin	45	5.68
Erythromycin	29	3.53	Cefalexin	37	4.67
Clarithromycin	18	2.19	Erythromycin	23	2.9
Cefaclor	14	1.7	Cefaclor	13	1.64
Doxycycline	13	1.58	Other	8	1.01
Other	9	1.09			
Total	822	100	Total	792	100

Table 4. Associations of prescribing antibiotics—multiple regression analysis

	Variable (referent)	Respiratory infections (URTI and acute bronchitis/ bronchiolitis)		URTI		Acute bronchitis/ bronchiolitis	
		OR (95% CI)	*P* value	OR (95% CI)	*P* value	OR (95% CI)	*P* value
Patient factors	Patient age	1.02 (1.02–1.02)	**<0.0001**	1.02 (1.01–1.02)	**<0.0001**	1.01 (1.01–1.02)	**<0.0001**
	Indigenous	2.63 (1.34–5.14)	**0.005**				
	Non-English-speaking background			0.85 (0.58–1.26)	0.414		
	New patient to trainee					1.80 (1.32–2.45)	**0.0002**
Trainee factors	Trainee gender (female)			0.71 (0.53–0.94)	**0.018**	1.30 (0.89–1.88)	0.172
	Training part-time			0.82 (0.58–1.14)	0.236		
	Worked at practice previously	1.13 (0.91–1.42)	0.276				
	Training term (1)	0.98 (0.79–1.22)	0.867	1	0.983		
	2	0.82 (0.64–1.05)	0.110	1.00 (0.78–1.27)	0.154		
	3	1.05 (0.65–1.69)	0.851	0.79 (0.57–1.09)	0.740		
	4			1.10 (0.63–1.93)			
	Qualified in Australia (no)	1.25 (0.97–1.62)	0.083	1.23 (0.90–1.68)	0.191		
Practice factors	Rurality (urban)	1.10 (0.86–1.41)	0.458	1	0.369		
	Inner regional	0.90 (0.62–1.32)	0.591	1.17 (0.83–1.64)	0.679		
	Outer regional/remote/very remote			0.92 (0.60–1.39)			
	SEIFA index (decile)	1.05 (1.00–1.10)	**0.038**				
Consultation factors	Consultation duration (minutes)	1.01 (1.00–1.02)	**0.036**	1.01 (1.00–1.02)	0.203		
	How patient billed (private)	–	0.952	1	0.935	–	0.123
	Bulk billed	1.01 (0.84–1.20)		1.01 (0.83–1.23)	0.719	0.78 (0.58–1.07)	
	Other	–		1.23 (0.40–3.80)		–	
	Pathology	1.91 (1.40–2.60)	**<0.0001**	2.26 (1.58–3.24)	**<0.0001**	1.19 (0.63–2.25)	0.585
	Imaging ordered	3.31 (2.02–5.44)	**<0.0001**			1.68 (0.98–2.89)	0.060
	Sought in-consultation advice	3.46 (2.46–4.87)	**<0.0001**	2.88 (1.97–4.22)	**<0.0001**	1.43 (0.81–2.51)	0.215

OR, odds ratio; SEIFA, Socioeconomic Index for Area. Values in bold are significant (i.e., $P < 0.05$).

Acute bronchitis/bronchiolitis

In patients diagnosed with acute bronchitis/bronchiolitis, significant associations with antibiotic prescribing were older patient age and being a new patient to the trainee (see Table 4).

Sources of in-consultation advice

Help-seeking included asking for advice from a supervisor (1.49% of all consultations for URTI or acute bronchitis/bronchiolitis) or using guidelines or other online or printed resources (3.13%). Of those who prescribed an antibiotic, 6.35% consulted an electronic resource, with the most commonly used electronic resource being Therapeutic Guidelines (Australian evidence-based guidelines for prescribers, available in hardcopy or online) (5). Trainees who asked a supervisor for advice were significantly more likely to prescribe an antibiotic (odds ratio = 2.14; 95% CI: 1.34–3.43; $P = 0.001$).

Discussion

GP trainees prescribe antibiotics for URTI and acute bronchitis/bronchiolitis in a large proportion of consultations. Patient factors such as older age, coming from an Indigenous background and higher socioeconomic status were associated with increased prescribing. Male trainees, higher rates of in-consultation advice and information seeking, and ordering further investigations were also associated with increased prescribing. There was no significant association between antibiotic prescribing and more advanced training terms, or practice billing type.

Interpretation of findings and comparison with previous literature

This is the largest study of trainee consultations and antibiotic prescribing in respiratory infections (14). Rates of trainee encounters for URTI and acute bronchitis/bronchiolitis, and their prescribing of antibiotics in these conditions, are similar to those of their more established colleagues. A comparable study in established Australian GP reported a rate of 5.4% of encounters for URTI, and 2.5% of encounters for acute bronchitis/bronchiolitis and prescribed antibiotics in 32.0% of encounters for URTI (7) and 83.3% of encounters for acute bronchitis/bronchiolitis (6).

We found that patient age was significantly associated with antibiotic prescribing. Younger patients were less likely to receive an antibiotic. This has been attributed to the understanding held by many doctors that URTI in children is most likely to be of viral origin (15). Australian data demonstrate a decrease in the prescriptions of antibiotics for URTI in children from 1991 to 2003 (6). Considering all indications, children are prescribed proportionally more antibiotics than adults in Australia (6), but these figures include indications such as otitis media and tonsillitis, which were not included in our analysis.

Our study does not demonstrate any association between prescribing and rural or regional location. This is in contrast to other studies, which conclude that concerns regarding remoteness and access to medical care may impact upon prescribing in rural communities (16).

Time pressure is a reason commonly given by doctors for prescribing an antibiotic (10). However, our results demonstrate that consultation time was not shorter if an antibiotic was prescribed. If an antibiotic was prescribed, pathology tests and imaging were more likely to be ordered, potentially indicating (along with increased consultation time) that the cases were more complex or clinical signs were present to warrant further investigation.

Similarly, the association of seeking in-consultation advice or information with antibiotic prescribing may suggest that these cases were more complex. Examining this association further, trainees who asked advice from supervisors were significantly more likely to prescribe an antibiotic. Again, this may reflect that both prescribing and asking for advice are associated with more severe or complicated clinical scenarios, but current guidelines do not recommend severity of illness being an indication for antibiotic prescription (5). Thus, our findings suggest that supervisors may be giving their trainees non-evidence-based advice regarding treatment of these conditions. Qualitative interview data from Australian GP registrars demonstrates that this supervisor dynamic is powerful in shaping trainees' prescribing decisions (17).

In our study 6.35% of those trainees prescribing an antibiotic consulted an electronic resource, predominantly Therapeutic Guidelines (eTG). This is anomalous, as the eTG specifically state that antibiotics are not indicated in these conditions (5). We suspect that eTG here is being used for dose checking or choice of antibiotic (perhaps consulting recommendations for another condition such as pneumonia), after a decision has already been made to prescribe.

Strengths and limitations of the study

The strengths of this study are in the large sample size, the high response rate (unusual in studies of GPs), and the generalizability of our results. The demographics of our trainees resemble those of Australian GP trainees overall (13), and the practice locations span four of six Australian states and all five Australian urban/rural classifications.

Our analyses are limited to the diagnoses of URTI and acute bronchitis/bronchiolitis. The rationale was that current evidence-based guidelines are clear about recommending against use of antibiotics in these conditions. In other conditions such as otitis media, tonsillitis and sinusitis, use of antibiotics may be in part dependent on clinical factors on which we do not have complete data.

Our study measured antibiotics prescribed rather than prescriptions filled (or antibiotics consumed). While a limitation in some studies of antibiotic use, this is in fact a strength of this study which aims to establish the prescribing habits of trainees rather than volume of dispensed or consumed antibiotics. As such, our study methodology will not distinguish prescriptions written as a 'delayed prescribing strategy'. This strategy has been shown to reduce antibiotic usage, without having significant effect on clinical outcomes (8,18).

Implications for practice and policy

Our study demonstrates that GP trainees are prescribing antibiotics at a higher rate than recommended by evidence-based guidelines. This has serious implications for antibiotic resistance. With prescribing habits being set early and remaining stable over time (11), studying and intervening in the development of prescribing in early-career doctors is important. As awareness of knowledge gaps and lack of confidence also impact on their decision making, educational interventions to facilitate evidence-based prescribing at an early stage of training are likely to be beneficial.

Trainees learn about prescribing from a number of sources, including formal teaching sessions and informal discussions with supervisors, with most learning occurring opportunistically in the workplace (19). Qualitative studies of doctors in hospital and GP settings have shown that prescribing is influenced by the decisions of senior supervising clinicians (17), and that trainees develop behaviours and prescribing habits similar to their supervisors (20). This may explain the similarity in prescribing rates between trainee and more senior clinicians, particularly our finding that asking advice from a supervisor is associated with higher rates of prescribing. Further education on how to incorporate evidence-based medicine into practice and communicate within a hierarchical medical training environment, may assist trainees as they develop their prescribing habits throughout training.

Doctors' prescribing decisions are multifactorial and occur within a social and professional environment, such that both clinical and contextual factors are involved in the decision to prescribe an antibiotic. Exploring the factors associated with GP trainee prescribing of antibiotics for URTI and acute bronchitis/bronchiolitis will assist in targeting educational interventions for early-career doctors and can improve evidence-based prescribing with the aim of securing antibiotics for the future.

Declaration

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Conflict of interest: none.

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