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Title

Immediate and delayed antibiotic prescribing strategies used by Australian early-career general practitioners.

Running title

Antibiotic prescribing for respiratory tract infections.

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Abstract

Background:

Antibiotics are overused for non-pneumonia acute respiratory tract infections (ARTIs).

Aim:

To establish prevalence and explore associations of delayed and immediate antibiotic prescribing strategies of Australian early-career GPs for non-pneumonia ARTIs.

Design and Setting:

Cross-sectional analysis of data, September 2016 to December 2017, from the Registrar Clinical Encounters in Training cohort study.

Method:

Multinomial logistic regression of antibiotic prescribing ("no prescribing", "immediate prescribing", or "delayed prescribing") to manage an ARTI.

Results:

Of 7,156 new ARTI diagnoses, no antibiotics were prescribed for 4,892(68%), antibiotics were prescribed for immediate use for 1,614 diagnoses (23%) and delayed antibiotics were used for 650 diagnoses (9%). "Delayed prescribing" was used in 22% of otitis media, 16% of sinusitis, 13% of sore throat, 11% of acute bronchitis/bronchiolitis, and 5% of upper respiratory tract infection (URTI). "Delayed prescribing" was used for 29% of all prescriptions written. "Delayed prescribing" and "immediate prescribing" were associated with markers of clinical concern. "Delayed prescribing" was associated with longer duration of consultation and with fewer diagnoses/problems dealt with in the consultation.

Conclusion:

Australian early-career GPs use “no prescribing” for ARTIs substantially more than established GPs, but, except for URTIs, still prescribe antibiotics in excess of validated benchmarks. They may use “delayed prescribing” more often than European GPs. They may use “delayed prescribing” to manage diagnostic uncertainty and, possibly, conflicting influences on prescribing behaviour. Consequently, the use of “delayed prescribing” may enable a transition to an environment of more rational antibiotic prescribing for ARTIs.

Keywords:

Antibacterial agents, General Practice, Respiratory tract infections, Primary health care, Family practice

How this fits in:

In Australia, general practitioners (GPs) prescribe antibiotics for acute respiratory tract infections (ARTIs) well in excess of validated benchmarks. Australian early-career GPs (GP registrars: 13% of the GP workforce) use antibiotic “no prescribing” for ARTIs substantially more often than established Australian and European GPs, but still prescribe in excess of benchmarks, except for URTIs. They appear to use “delayed prescribing” of antibiotics to manage diagnostic uncertainty and, possibly, conflicting influences on prescribing of antibiotics for ARTIs. Consequently, the use of “delayed prescribing” may enable an acceptable transition to a future environment of more rational antibiotic prescribing for ARTIs in Australia.

Main Text

Introduction

Antibiotic resistance and rational antibiotic use are national priorities in Australia, but antibiotics remain overused for non-pneumonia acute respiratory tract infections (ARTIs).^(1, 2) ARTIs are common presentations to general practitioners (GPs).⁽³⁾ In 2017, 41.5% (n=10,215,109) of the Australian population were dispensed at least one systemic antibiotic in primary care, and Australia is in the highest 25% of countries (compared with European countries and Canada) in rates of community antibiotic use.^(2, 4)

When managing ARTIs, antibiotics are mostly not indicated.⁽¹⁾ Doctors' use of antibiotics can be classified as: "no prescribing", "delayed prescribing", and "immediate prescribing". "Delayed prescribing" is where the intention is to not use antibiotics unless certain criteria are met (for example, a deterioration in condition). A Cochrane review has shown that "no prescribing" and "delayed prescribing" significantly reduce consumption of inappropriate antibiotics for ARTIs compared to "immediate prescribing", with no difference in patient satisfaction between "delayed prescribing" and "immediate prescribing".⁽⁵⁾

Some drivers of prescribing antibiotics for ARTIs are diagnostic uncertainty and concern about potential serious illness consequences.^(6, 7) However, this concern may be misplaced because both "delayed prescribing" and "no prescribing" appear to be safe, with no difference in hospital admissions or death when compared to "immediate prescribing" in a UK cohort of almost 29,000 people.⁽⁸⁾ Additionally, "delayed prescribing" led to a significant reduction in re-consultation for new, worsening or non-resolving symptoms compared to both 'no prescribing' and 'immediate prescribing'.⁽⁸⁾

While there is ample literature, including a Cochrane review, of trials of delayed prescribing,⁽⁵⁾ there is little evidence for the use of delayed prescribing in practice.⁽⁹⁾

General practice training is an important time for early-career GPs, during which they develop approaches to diagnosing and managing ARTIs, including antibiotic prescribing practices. There is some evidence from qualitative studies that GPs' decision-making processes regarding antibiotic prescribing are consistent over time.(10)

In this study we aimed to describe the prevalence of antibiotic prescribing strategies ('immediate prescribing', 'delayed prescribing', and 'no prescribing') used by Australian early-career GPs (specialist GP vocational trainees or 'registrars') for initial presentations of non-pneumonia ARTIs. We also aimed to establish the determinants of registrars' choice of prescribing strategy.

Method

Participants:

This was a cross-sectional analysis of data from the Registrar Clinical Encounters in Training (ReCEnT) cohort study. Data was collected from September 2016 to December 2017. The study methodology has been described in detail elsewhere.(11) Briefly, ReCEnT is an ongoing (from 2010) cohort study of GP-registrars' in-practice clinical experiences undertaken in four of the eight Australian states and territories. It is a component of their educational program, facilitating reflection on practice and learning.(12, 13) Registrars may also consent to their data being used for research purposes.

Procedures:

Characteristics of participating GP-registrars and their practices are documented. Registrars then record sixty consecutive office-based consultations (approximately one week of consultations) once in each of three compulsory six-month general-practice-based training terms.

Problems/diagnoses are coded according to the International Classification of Primary Care, second edition (ICPC-2).(14) ARTI diagnoses were defined by codes R74 (upper respiratory tract infection (URTI)), R78 (acute bronchitis/bronchiolitis), R75 (acute sinusitis), H71 (acute otitis media), R72 (Strep throat), R76 (Tonsillitis, acute), R74008 (Pharyngitis;acute) ,R74006 (Infection;throat), R74017

(Pharyngitis) and R21005 (sore throat). R72, R76, R74008, R74006 and R74017 were grouped together as 'sore throat' for analysis.

Medications prescribed, provided in-consultation or recommended, are routinely recorded.

Antibiotic medications were identified using the Anatomic Therapeutic Chemical (ATC) Classification.

(15)

GP-registrars reported whether "delayed" or "immediate" prescribing was employed for diagnoses involving prescription of antibiotics. "No" prescribing was defined as the absence of prescription of an antibiotic for an ARTI diagnosis. GP-registrars recorded a "delayed" prescription when they asked the patient not to start the antibiotic immediately.

Outcome factors:

The primary outcome factor was whether a new ARTI diagnosis (that is a diagnosis for a first presentation – re-consultations were excluded from analysis) involved "delayed", "immediate" or "no" prescribing.

Independent variables:

After consideration of potential relevance of individual variables to our research question/outcome factor (including considerations of the literature, our clinical experience, and our experience with this study population and this data set), our analysis plan, a priori, included 24 variables that we deemed relevant. These variables related to the patient, GP-registrar, practice, and the consultation. Some require explanation: routinely bulk-bills (that is, there is no financial cost to the patient for the consultation), rurality (practice postcode was used to define the Australian Standard Geographical Classification-Remoteness Area (ASGC-RA) classification(16), socio-economic status of the practice location (Socioeconomic Index for Areas (SEIFA) Index of Relative Disadvantage(17) of the practice location), sought clinical information or assistance during the consultation (from their GP-supervisor,

from a specialist, or from electronic or hard-copy resources), and whether they generated any learning goals (clinical questions to be pursued after the consultation had finished).

Data Analysis:

The proportions of all ARTI diagnoses involving “delayed”, “immediate” and “no” prescribing were calculated with 95% Confidence Intervals (95%CI), and they were also calculated by type of ARTI.

Multinomial logistic regression for a nominal outcome was used within the generalised estimating equations (GEE) framework to account for repeated measures within GP-registrars. We used GEE for analyses, since our interest was in effect estimates averaged across registrars, rather than registrar-specific effects (as produced with mixed (random effects) models). To estimate the GEE, we assumed an exchangeable working correlation structure.

Multinomial logistic regression for a nominal outcome with 3 (non-ordered) levels produces 2 sets of statistics: for each of the two “test” levels compared to the reference level. Here, “delayed prescribing” was used as the reference level. The model odds ratios (OR) thus compared: “no prescribing” to “delayed prescribing”, and “immediate prescribing” to “delayed prescribing”. The results are equivalent to conducting two binary logistic models.

Covariates with a univariate p-value < 0.20 were considered for inclusion in the multiple regression model. For each outcome, a model with all selected covariates was fitted, after which model reduction was assessed. Covariates which were no longer significant (at $p < 0.20$) in the multivariable model were tested for removal from the model. If the covariate’s removal did not substantively change remaining coefficients in the model (by more than about 10%), the covariate was removed from the final model.

In a post-hoc analysis, association of “delayed prescribing”, “immediate prescribing” or “no prescribing” with seeking assistance from the registrar’s supervisor was tested using a chi-square statistic.

Analyses were programmed using STATA 14.0 (Statacorp, College Station, TX, USA) and SAS V9.4 (SAS Institute Inc., Cary, NC, USA).

Results

A total of 631 GP-registrars (response rate 97.3%) at 454 practices contributed 101,019 patient problems/diagnoses from 63,628 consultations. There were 7,156 new diagnoses of an ARTI. No antibiotics were prescribed for 4,892 diagnoses (68% [95%CI 67 to 69]); antibiotics were prescribed for immediate use for 1,614 diagnoses (23% [95%CI 22 to 24]); and delayed antibiotics were used for 650 diagnoses (9% [95%CI 8 to 10]). When prescribing antibiotics for ARTIs, GP-registrars used “delayed prescribing” 29% of the time.

The characteristics of participating GP-registrars and their practices are shown in Table 1. The frequencies of antibiotic prescribing strategies for ARTI diagnoses are shown in Figure 1 and Supplementary Table 1. Characteristics associated with ARTI diagnoses by antibiotic prescribing strategies are presented in Table 2.

Univariate and multivariable associations of antibiotic prescribing strategies are shown in Table 3. For each association in the table, the odds ratio represents a comparison of “immediate prescribing” or “no prescribing” to “delayed prescribing”. When any in-consultation information or assistance was sought (12% of new ARTI diagnoses), “no prescribing” was less likely than “delayed prescribing” (OR 0.41, 95%CI 0.29, 0.59) and “immediate prescribing” was more likely (OR 2.05, 95%CI 1.48, 2.84). When follow-up was arranged “immediate prescribing” was more likely than “delayed prescribing” (OR 1.31, 95%CI 1.01, 1.70). When imaging was ordered “no prescribing” was significantly more likely than “delayed” (OR 6.26, 95%CI 1.42, 27.7) and there was some evidence ($p=0.068$) for “immediate prescribing” being more likely than “delayed prescribing” (OR 3.90, 95%CI 0.90, 16.9).

Longer consultation duration was associated with use of “delayed prescribing” rather than “no prescribing”; for each additional minute of consultation duration, the odds of “no prescribing” decreased by about 2% (OR=0.98, 95% CI 0.96, 1.00). For each additional problem/diagnosis dealt with in the encounter both “no prescribing” (OR 1.87, 95%CI 1.55, 2.25) and “immediate prescribing” (OR 1.32, 95%CI 1.08, 1.60) were more likely than “delayed prescribing”. Finally, both “no prescribing” (OR 1.05, 95%CI 1.02, 1.08) and “immediate prescribing” (OR 1.03, 95%CI 1.00, 1.06) were more likely than “delayed prescribing” with additional year of age of the GP registrar.

In the post hoc analyses, when information or assistance was sought from a supervisor (2% of new ARTI diagnoses) “immediate prescribing” was used significantly more than both “delayed prescribing” (p=0.004) and “no prescribing” (p<0.001).

Discussion

Summary

Early-career GPs use antibiotic “no prescribing” for 68% of ARTIs, substantially more than established Australian GPs (43%).⁽¹⁾ Except for URTIs, they prescribe antibiotics in excess of validated benchmarks.⁽¹⁸⁾ They use “delayed prescribing” for 29% of antibiotic prescriptions for ARTIs. Prescribing antibiotics was associated with markers of diagnostic uncertainty such as seeking in-consultation assistance and arranging follow-up.

Strengths and Limitations

A high response rate, which is unusual for studies of GPs,⁽¹⁹⁾ along with very low missing data on antibiotic prescribing (0.3%) are strengths of our study. GP-registrar characteristics were reflective of the Australian GP-registrar population overall,⁽²⁰⁾ and their practices were located in major cities,

inner and outer regional, and remote practices. The participating RTOs train 43% of Australian GP registrars.(20)

A limitation is that contextual clinical details for the presenting conditions are not known so we are unable to judge how appropriate the prescription of antibiotics was for any individual problem/diagnosis. But our finding that total prescribing is greatly in excess of benchmarks for all ARTIs other than URTI, is robust because clinical judgement is implicit to the range of those benchmarks.(18) There is, however, a risk of misclassification bias and social desirability bias where a registrar does not accurately record an ARTI diagnosis because they decided to prescribe antibiotics. We regard this risk as likely to be small.

Finally, we did not have data on whether patients filled the delayed prescriptions or actually took dispensed antibiotics, nor did we have data on clinical outcomes. As our focus is registrars' prescribing behaviour, this is not a substantive limitation. The context for our findings, however, is that in RCTs of delayed prescribing 31% of delayed scripts will be filled (with delayed scripts provided at the consultation being more likely filled than those required to be collected later).(5)

Comparison with existing literature

GP-registrars in our study used "no prescribing" substantially more often than established Australian GPs in McCullough et al's modelling(1) for each of acute bronchitis/bronchiolitis (32% vs 15%), otitis media (26% vs 11%), and sore throat (41% vs 6%). For URTI, GP-registrars prescribed within the benchmark specified by the European Surveillance of Antimicrobial Consumption disease-specific benchmarks,(18) (which have been validated for use in Australian general practice),(21) but not for the other ARTIs reported here.

When prescribing antibiotics, it appears Australian GP-registrars are using "delayed prescribing" more often than European GPs. In a multi-country study, European GPs used "delayed prescribing"

for 12% of prescriptions written for Lower Respiratory Tract Infections/ARTIs with cough as the dominant symptom.(9) This is most closely comparable with acute bronchitis/bronchiolitis in our study – where registrars used delayed prescribing for 16% of prescriptions written. For all cases (including where no antibiotic was prescribed), European GPs used delayed prescribing in 6.3% ,(9) compared with 11% of bronchitis/bronchiolitis in our study.

Prescribing antibiotics was more likely where there are markers of clinical concern such as seeking information or assistance during the consultation (both “immediate prescribing” and “delayed prescribing” more likely than “no prescribing”) or arranging specific follow-up (“immediate prescribing” more likely). This suggests the GP-registrar may be addressing their diagnostic uncertainty regarding a more serious illness and the perceived consequences of not prescribing antibiotics.

We have previously found that on occasions when GP-registrars seek help from their supervisor they are significantly more likely to prescribe antibiotics for URTI and acute bronchitis (22) – diagnoses for which authoritative Australian guidelines recommend not prescribing antibiotics. Our data does not include clinical information to judge how appropriate antibiotic prescription was in other ARTIs, but we note that established GPs prescribe substantially more antibiotics for ARTIs in Australia than GP-registrars(1) and also more than in similar medical systems in Europe and Canada.(2) Consequently, one possibility is that GP-registrars may use “immediate prescribing” to be consistent with a supervisor’s and/or a practice-wide approach to ARTIs. This is consistent with findings of our qualitative research in this area(23) and may be supported by our finding of the GP-registrar being more likely to prescribe an antibiotic if the supervisor is asked for information or assistance.

Ordering imaging (e.g. chest X-ray) can also be interpreted as a marker of clinical concern, but it is strongly associated with “no prescribing”. In Australia GPs (including GP-registrars) can order imaging and expect it to be performed the same day, including a radiologist report. One interpretation of this association could relate to advice to confirm a possible pneumonia diagnosis

with a chest x-ray,(24) resulting in a delay initiating antibiotics at first presentation. Consequently, the GP-registrar may be diagnosing an ARTI and investigating further before deciding it is (or is not) pneumonia. That we also found some evidence ($p=0.068$) for “immediate prescribing” also being associated with imaging is consistent with the GP-registrar, in some cases, addressing their diagnostic uncertainty by taking a pre-emptive approach and deciding to prescribe antibiotics for a more severe ARTI whether or not a subsequent CXR demonstrates pneumonia.(23)

“Delayed prescribing” is associated with longer consultation duration. This may reflect more time being needed for complex or concerning presentations, with diagnostic uncertainty leading to the ‘safety net’ of delayed antibiotic prescribing. This is consistent with our qualitative findings in this area.(23) Alternatively, it may be that more time is needed to undertake explanation of “delayed prescribing” rather than “no prescribing”.

The finding that with each additional problem/diagnosis dealt with in the consultation “delayed prescribing” was increasingly less likely than both “no prescribing” and “immediate prescribing” could suggest that the GP-registrar is choosing a strategy that requires less explanation and, consequently, less time in a busy consultation.

Taken together, these associations with prescribing antibiotics (i.e. markers of clinical concern, increased duration of consult, fewer problems/diagnoses managed per consult) provide limited evidence that is congruent with qualitative findings. Some GP-registrars use “delayed prescribing” not only to address their own diagnostic uncertainty but also to accommodate conflicting influences on prescribing for ARTIs such as: national guideline advice against use of antibiotics, desire to adhere to antimicrobial stewardship, knowledge that delayed prescribing reduces antibiotic consumption, both perceived and actual expectation from patients that antibiotics are necessary, and a supervisor approach or practice culture to prescribing for ARTIs.(22, 23)

Finally, the associations of the individual respiratory infective illness classifications in this study, when compared to URTI, showed “immediate prescribing” was more likely than “delayed prescribing”, and “delayed prescribing” was more likely than “no prescribing”. The findings regarding otitis media, sore throat and sinusitis may partly reflect Australian guideline recommendations(24) that antibiotics are indicated for these diagnoses in selected situations (and that delayed prescribing is an option in some circumstances). But the associations of acute bronchitis (and the large effect sizes of these associations) can’t be reconciled with current Australian guideline recommendations that antibiotics are not indicated for acute bronchitis.(24)

Implications for practice and further research

“Delayed prescribing” represents a viable method for changing primary care practice to reduce consumption of antibiotics in the community and is already being used quite frequently by early-career GPs in Australia. As GP-registrars represent 13% of the Australian GP workforce by headcount,(20, 25) the findings have immediate as well as medium- and long-term general practice quality of care implications. Efforts to increase the use of both “delayed prescribing” and “no prescribing” for ARTIs are indicated, including in GP training programs. In particular, encouraging the use of “delayed prescribing” may enable an acceptable transition to a future environment of more rational antibiotic prescribing for ARTIs in primary care practice.

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Competing interests: No conflicts of interest to declare.

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Table 1: Characteristics of GP-registrars and their teaching practices

Registrar variables (n=631)		n (%)
Registrar gender	Female	384 (61%)
Qualified as doctor overseas	Yes	77 (12%)
Number of years worked in hospital prior to entering GP training	Mean $\pm$ SD	3.0 $\pm$ 2.6
Registrar round/practice variables (n=1070)		
Worked at the practice previously	Yes	224 (21%)
Registrar age (years)	Mean $\pm$ SD	32.5 $\pm$ 6.3
Registrar works Part-time	Yes	223 (22%)
Registrar training term	Term 1	414 (38%)
	Term 2	458 (43%)
	Term 3	198 (19%)
Practice rurality/urbanicity	Major city	728 (69%)
	Inner regional	237 (22%)
	Outer regional	94 (9%)
	Remote	0
	Very Remote	0
Practice location SES status (SEIFA index)	Mean $\pm$ SD	5.8 $\pm$ 2.9
Practice routinely bulk bills	Yes	367 (36%)
No. GPs(Full Time Equivalent) working at the practice	1-4	426 (41%)
	5+	602 (59%)

Table 2: Characteristics associated with acute respiratory tract infections

Variable	Class	All	No antibiotic	Immediate prescribing	Delayed prescribing	P
Patient age group	0-<5	1504 (21%)	1119 (23%)	258 (16%)	127 (20%)	<0.001
	5-14	1067 (15%)	722 (15%)	234 (14%)	111 (17%)	
	15-24	957 (13%)	673 (14%)	212 (13%)	72 (11%)	
	25-44	1901 (27%)	1296 (26%)	437 (27%)	168 (26%)	
	45-64	1156 (16%)	756 (15%)	275 (17%)	125 (19%)	
	65+	571 (8%)	326 (7%)	198 (12%)	47 (7%)	
Patient gender	Male	2931 (42%)	2036 (42%)	648 (41%)	247 (39%)	0.094
	Female	4086 (58%)	2761 (58%)	937 (59%)	388 (61%)	
Aboriginal and Torres Strait	No	6500 (98%)	4446 (98%)	1455 (98%)	599 (99.3%)	0.11
	Yes	115 (2%)	78 (2%)	33 (2%)	4 (0.7%)	
NESB	No	5974 (90%)	4049 (89%)	1374 (91%)	551 (91%)	0.079
	Yes	690 (10%)	505 (11%)	129 (9%)	56 (9%)	
Registrar gender	Male	3062 (43%)	2126 (43%)	681 (42%)	255 (39%)	0.28
	Female	4094 (57%)	2766 (57%)	933 (58%)	395 (61%)	
Registrar FT or PT	Part-time	1409 (20%)	992 (21%)	302 (19%)	115 (18%)	0.59
	Full-time	5520 (80%)	3757 (79%)	1249 (81%)	514 (82%)	
Term	Term 1	2749 (38%)	1861 (38%)	642 (40%)	246 (38%)	0.56
	Term 2	3227 (45%)	2223 (45%)	717 (44%)	287 (44%)	
	Term 3	1180 (16%)	808 (17%)	255 (16%)	117 (18%)	
Worked at practice previously	No	5818 (82%)	4012 (82%)	1295 (81%)	511 (80%)	0.71
	Yes	1277 (18%)	853 (18%)	300 (19%)	124 (20%)	
Qualified as doctor in Australia	No	750 (11%)	483 (10%)	213 (13%)	54 (8%)	0.011
	Yes	6390 (89%)	4397 (90%)	1397 (87%)	596 (92%)	
Practice size	Small	2911 (42%)	1976 (42%)	668 (43%)	267 (42%)	0.90
	Large	4009 (58%)	2763 (58%)	883 (57%)	363 (58%)	
Practice routinely bulk bills	No	4235 (62%)	2796 (60%)	1017 (66%)	422 (69%)	<0.001
	Yes	2609 (38%)	1887 (40%)	532 (34%)	190 (31%)	
Rurality	Major city	5157 (73%)	3597 (74%)	1103 (69%)	457 (71%)	0.01
	Inner regional	1444 (20%)	914 (19%)	383 (24%)	147 (23%)	
	Outer regional remote	475 (7%)	322 (7%)	115 (7%)	38 (6%)	
Patient/practice status	Existing patient	1530 (22%)	1045 (22%)	361 (23%)	124 (19%)	0.62
	New to registrar	4783 (68%)	3266 (68%)	1070 (67%)	447 (70%)	
	New to practice	712 (10%)	484 (10%)	157 (10%)	71 (11%)	

Variable	Class	All	No antibiotic	Immediate prescribing	Delayed prescribing	P
Sought help any source	No	6284 (88%)	4629 (95%)	1125 (70%)	530 (82%)	<0.001
	Yes	872 (12%)	263 (5%)	489 (30%)	120 (18%)	
Pathology ordered	No	6713 (94%)	4653 (95%)	1455 (90%)	605 (93%)	<0.001
	Yes	443 (6%)	239 (5%)	159 (10%)	45 (7%)	
Imaging ordered	No	7050 (99%)	4846 (99.1%)	1557 (96%)	647 (99.5%)	<0.001
	Yes	106 (1%)	46 (0.9%)	57 (4%)	3 (0.5%)	
Referral ordered	No	7084 (99%)	4848 (99.1%)	1593 (99%)	643 (99%)	0.86
	Yes	72 (1%)	44 (0.9%)	21 (1%)	7 (1%)	
Follow-up ordered	No	4849 (68%)	3529 (72%)	884 (55%)	436 (67%)	<0.001
	Yes	2307 (32%)	1363 (28%)	730 (45%)	214 (33%)	
Learning goals generated	No	6414 (94%)	4487 (96%)	1342 (87%)	585 (94%)	<0.001
	Yes	393 (6%)	165 (4%)	192 (13%)	36 (6%)	
Respiratory disease	Acute bronchitis	234 (10%)	237 (5%)	417 (26%)	80 (12%)	<0.001
	Acute otitis media	578 (9%)	148 (3%)	303 (19%)	127 (20%)	
	Acute URTI	4289 (60%)	3887 (79%)	179 (11%)	223 (34%)	
	Strep / Tonsillitis / Pharyngitis	1002 (14%)	412 (8%)	458 (28%)	132 (20%)	
	Acute Sinusitis	553 (8%)	208 (4%)	257 (16%)	88 (14%)	
Registrar age	mean (SD)	32 (5)	31 (5)	32 (6)	31 (4)	0.005
SEIFA index	mean (SD)	6 (3)	6 (3)	6 (3)	6 (3)	0.25
Consultation duration	mean (SD)	15 (7)	15 (7)	16 (7)	16 (6)	<0.001
Number of problems/diagnoses	mean (SD)	2 (1)	2 (1)	1 (1)	1 (1)	<0.001

Table 3: Associations with acute respiratory tract infections*

Variable	Class	Outcome class	Univariate		Adjusted	
			OR [95% CI]	p	OR [95% CI]	p
Patient age group	0-<5	No antibiotic	1.19 (0.93, 1.53)	0.1731	1.98 (1.39, 2.83)	<0.001
		Immediate prescribing	0.78 (0.59, 1.04)	0.0869	0.75 (0.51, 1.10)	0.14
	5-14	No antibiotic	0.87 (0.67, 1.14)	0.3124	1.16 (0.82, 1.66)	0.40
		Immediate prescribing	0.81 (0.60, 1.08)	0.1549	0.84 (0.57, 1.22)	0.36
	15-24	No antibiotic	1.25 (0.93, 1.68)	0.1422	1.35 (0.93, 1.97)	0.12
		Immediate prescribing	1.17 (0.85, 1.62)	0.3356	1.25 (0.84, 1.86)	0.27
	45-64	No antibiotic	0.78 (0.61, 1.01)	0.0575	0.69 (0.50, 0.95)	0.023
		Immediate prescribing	0.85 (0.64, 1.12)	0.2515	0.81 (0.57, 1.15)	0.23
Aboriginal	Yes	No antibiotic	0.90 (0.63, 1.28)	0.5656	0.75 (0.49, 1.17)	0.21
		Immediate prescribing	1.62 (1.12, 2.34)	0.0110	1.37 (0.86, 2.17)	0.19
	No	No antibiotic	2.81 (1.01, 7.80)	0.0472	1.73 (0.58, 5.14)	0.32
		Immediate prescribing	3.11 (1.09, 8.88)	0.0345	2.58 (0.86, 7.69)	0.090
Practice routinely bulk bills	Yes	No antibiotic	1.54 (1.25, 1.89)	<0.0001	1.34 (1.03, 1.74)	0.030
		Immediate prescribing	1.17 (0.94, 1.46)	0.1534	1.25 (0.95, 1.64)	0.12
Sought help any source	Yes	No antibiotic	0.20 (0.16, 0.26)	<0.0001	0.41 (0.29, 0.59)	<0.001
		Immediate prescribing	2.13 (1.68, 2.69)	<0.0001	2.05 (1.48, 2.84)	<0.001
Pathology ordered	Yes	No antibiotic	0.71 (0.51, 1.00)	0.0488	0.71 (0.46, 1.09)	0.12
		Immediate prescribing	1.46 (1.03, 2.08)	0.0341	1.02 (0.65, 1.59)	0.93
Imaging ordered	Yes	No antibiotic	2.04 (0.63, 6.63)	0.2380	6.26 (1.42, 27.7)	0.016
		Immediate prescribing	7.63 (2.37, 24.6)	0.0007	3.90 (0.90, 16.9)	0.068
Follow-up ordered	Yes	No antibiotic	0.71 (0.59, 0.86)	0.0003	0.88 (0.68, 1.13)	0.32
		Immediate prescribing	1.76 (1.44, 2.15)	<0.0001	1.31 (1.01, 1.70)	0.044
Learning goals generated	Yes	No antibiotic	0.52 (0.35, 0.77)	0.0010	1.35 (0.79, 2.29)	0.27
		Immediate prescribing	2.39 (1.64, 3.50)	<0.0001	1.36 (0.83, 2.23)	0.23
Respiratory disease	Acute otitis media	No antibiotic	0.06 (0.04, 0.08)	<0.0001	0.05 (0.04, 0.07)	<0.001
		Immediate prescribing	3.29 (2.45, 4.42)	<0.0001	3.04 (2.09, 4.43)	<0.001
	Strep / Tonsillitis / Pharyngitis	No antibiotic	0.16 (0.13, 0.21)	<0.0001	0.18 (0.13, 0.24)	<0.001
		Immediate prescribing	4.85 (3.65, 6.44)	<0.0001	4.31 (3.04, 6.11)	<0.001
	Acute Sinusitis	No antibiotic	0.12 (0.09, 0.16)	<0.0001	0.17 (0.12, 0.25)	<0.001
		Immediate prescribing	4.05 (2.94, 5.59)	<0.0001	3.68 (2.48, 5.48)	<0.001
	Acute bronchitis	No antibiotic	0.15 (0.11, 0.20)	<0.0001	0.16 (0.11, 0.24)	<0.001
		Immediate prescribing	6.97 (5.06, 9.59)	<0.0001	5.93 (4.00, 8.80)	<0.001

Variable	Class	Outcome class	Univariate		Adjusted	
			OR [95% CI]	p	OR [95% CI]	p
Registrar age		No antibiotic	1.02 (1.00, 1.05)	0.0442	1.05 (1.02, 1.08)	0.002
		Immediate prescribing	1.04 (1.01, 1.06)	0.0012	1.03 (1.00, 1.06)	0.026
Consultation duration		No antibiotic	0.99 (0.98, 1.00)	0.0905	0.98 (0.96, 1.00)	0.019
		Immediate prescribing	1.02 (1.00, 1.03)	0.0294	0.99 (0.97, 1.01)	0.19
Number of problems/diagnoses		No antibiotic	1.45 (1.28, 1.65)	<0.0001	1.87 (1.55, 2.25)	<0.001
		Immediate prescribing	1.21 (1.05, 1.39)	0.0088	1.32 (1.08, 1.60)	0.006

*The variables 'patient gender', 'Non-English Speaking Background', 'qualified as doctor in Australia' and 'rurality' were not significantly associated with the outcome and their removal did not alter other coefficients in the model, so these covariates were excluded from the multivariable model.

Figure 1: Frequency of antibiotic prescribing strategies