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Title

Changes in early-career family physicians' antibiotic prescribing for upper respiratory tract infection and acute bronchitis: a multicentre longitudinal study.

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Changes in antibiotic prescribing for URTI and acute bronchitis

Article category

Epidemiology

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Abstract

Background

Inappropriate antibiotic prescription and subsequent antibacterial resistance is a major threat to health world-wide.

Objectives

We aimed to establish whether early-career 'apprenticeship-model' experience in family practice influences antibiotic prescribing for respiratory tract infections, and to also establish other associations of antibiotic prescribing changes during this early-career experience.

Methods

A longitudinal analysis (2010-2014) of a cohort study of Australian GP registrars' (vocational trainees') consultations. Registrars from five regional training programs recorded 60 consecutive consultations, once each six-month training Term, including the diagnoses managed and medications prescribed.

The outcomes were whether an antibiotic was prescribed for the diagnoses 'URTI' and 'acute bronchitis/bronchiolitis'. Generalised linear mixed modelling was used to account for repeated measures on registrars and to include the time component: 'Term'.

Results

856 registrars recorded 108,759 consultations, including 8,715 'URTI' diagnoses (5.15% of diagnoses) and 2,110 'acute bronchitis/bronchiolitis' diagnoses (1.25%). Antibiotics were prescribed in 16.3% [95%CI 14.9-17.8] of URTI and 72.2% [95%CI 69.6-74.6] of acute bronchitis/bronchiolitis diagnoses.

Moving from an earlier to later term did not significantly influence registrars' antibiotic prescribing for URTI (adjusted OR 0.95 [95%CI 0.87, 1.04],p=0.27) or acute bronchitis/bronchiolitis (OR 1.01 [95%CI 0.90-1.14],p=0.86). Significant associations of antibiotic prescribing for URTIs were the registrar being non-Australian educated, greater patient age, practices not privately billing patients, pathology being ordered, longer consultation duration, and the registrar seeking in-consultation information or advice (including from their supervisor).

Conclusions

Early-career experience/training failed to produce rational antibiotic prescribing for URTI and acute bronchitis/bronchiolitis. Our findings suggest that prescribing interventions could target the registrar-supervisor dyad.

MeSH terms

Family practice; Inappropriate prescribing; Physician practice patterns; Respiratory tract infections; Antibacterial agents; General practice

Background

The overuse of antibiotics and resultant harms including community and individual patient bacterial resistance and other patient harms is a major worldwide health problem.[1]

Much of the overuse of antibiotics is for treatment of respiratory tract infections (RTIs), mostly acute upper respiratory tract infection (URTI) or acute bronchitis.[1] For these conditions there is evidence of very little (acute bronchitis)[2] or no (URTI)[3] efficacy of antibiotics. Authoritative Australian guidelines clearly recommend against prescription of antibiotics for acute bronchitis or URTI.[4] Despite this, antibiotic prescribing rates for URTI and acute bronchitis in Australia are inappropriately high,[5,6] being in excess of quality indicators for relevant antibiotic prescribing.[7] There is considerable international variability in prescribing rates,[1] with Australian rates of prescription being relatively high amongst developed countries.[8]

Most antibiotic prescribing is performed in general practice (family practice) rather than in hospitals or other secondary care.[1] Despite this, most antimicrobial stewardship research focuses on hospital doctors' prescribing. While prescribing of antibiotics in hospitals may also not always be appropriate, hospitals are environments of low-prevalence/high-morbidity infections often requiring aggressive antibiotic treatment. Communities, however, are environments of high-prevalence/low-morbidity infections that often don't require antibiotic treatment. General practitioner (GP) registrars (family medicine vocational trainees), when transitioning from hospital to community, report considerable barriers to rational prescribing of antibiotics for RTIs[9] including clinical uncertainty, an established driver of non-rational antibiotic prescribing.[10] Given that GPs' antibiotic prescribing practices, once established, tend to remain consistent[11] this early-career GP group is of particular interest in the wider context of rational community antibiotic prescribing and antimicrobial stewardship.

In Australia, GP registrars, though vocational trainees, essentially function as independent clinicians (including for prescribing purposes). They do have recourse to advice from clinical supervisors (in an 'apprenticeship-like' model) and also receive an element of structured teaching time away from clinical practice.

Previous Australian[12] and Hong Kong studies [13] have suggested that participation in general practice vocational training may reduce RTI antibiotic prescribing rates of GPs. But these studies were cross-sectional studies with a clinician's past history of training (or, in the Australian study, a surrogate measure of previous vocational training) as the relevant variable, rendering causal inference problematic. Answering the question of whether vocational training or early experience in general practice reduces RTI antibiotic prescribing requires contemporaneous longitudinal data.

In this study we sought to establish whether use of antibiotics to manage URTIs and acute bronchitis changes with early-career 'apprenticeship-model' experience in general practice. We hypothesised that time (that is, increasing clinical experience) in a primary care setting would result in less antibiotic prescribing by vocational trainees. We also sought to establish other associations of change in antibiotic prescribing during this early-career general practice experience.

Methods

This was a longitudinal analysis of ten rounds of data collection (2010-14) from the Registrar Clinical Encounters in Training (ReCEnT) study. ReCEnT is an ongoing, multicentre cohort study of GP registrars from five of Australia's 17 Regional Training Providers (RTPs) in five of Australia's six states.

ReCEnT documents the in-practice clinical experiences of GP registrars, including their prescribing. The detailed ReCEnT methodology has been described previously.[14] Briefly, registrars complete paper-based forms recording details of 60 consecutive consultations around the midpoint of each of their three general practice training terms (six monthly for full-time registrars, twelve-monthly for part-time registrars). Registrars at one of the five RTPs also collected data during an optional fourth training term. Registrar and practice demographics are documented each collection period (that is, six- or twelve-monthly), and patient demographics, clinical details and educational actions (see below) are recorded for each patient encounter (that is, 60 encounters per training term).

Analyses

Our analyses were limited to problems/diagnoses classified as 'URTI' or 'acute bronchitis/bronchiolitis' (see below for definitions)

Outcome variable

For multivariable analyses, the outcome factor was whether an antibiotic (defined according to the Anatomic Therapeutic Chemical (ATC) Classification[15] codes J01: 'antibacterials for systemic use') was prescribed.

Independent variables

Registrar variables: The main variable of interest was registrar training term (Term 1, 2, 3 or 4), our measure of time for this analysis.

Other registrar variables were: age, gender, full-time or part-time status, and country of primary medical graduation (Australian or non-Australian).

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

Practice variables: rurality classification (major city, inner regional, outer regional, remote, very remote), socioeconomic index of the practice location, and billing policy (does the practice routinely bulk bill: that is, provide consultations reimbursed solely by government rebate, with no cost to the patient). Practice postcode was used to define the Australian Standard Geographical Classification-Remoteness Area (ASGC-RA)[16] classification (the degree of rurality) of the practice location, and to define the practice location's Socioeconomic Index for Area (SEIFA) Relative Index of Disadvantage decile.[17]

Consultation variables: duration, whether pathology or (for bronchitis/bronchiolitis) imaging tests were ordered, and number of problems addressed. We also recorded whether the registrar sought in-consultation advice or information (from their supervisor or other resources, such as specialists, books or electronic resources).

Problems/diagnoses addressed in the consultation were coded according to the International Primary Care Classification (ICPC-2).[18] The problems/diagnoses of interest were ICPC-2 codes R74 (upper respiratory tract infection (URTI)) and R78 (acute bronchitis/bronchiolitis) – conditions for which current Australian guidelines clearly recommend against management with antibiotics.

Statistical analysis

The unit of analysis was individual problem/diagnosis managed, rather than individual consultation. Proportions of problems/diagnoses coded as ICPC-2 codes 'URTI (R74)' and 'acute bronchitis/bronchiolitis (R78)'were calculated with 95% confidence intervals (95% CIs), adjusted for clustering within registrars. Proportions of individual antibiotics prescribed were also calculated.

To select potential correlates of antibiotic prescription for each of the problems/diagnoses 'URTI (R74)' and 'acute bronchitis/bronchiolitis (R78)', initial screening analyses were performed for each independent variable using logistic regression. For the variable 'time' (registrar term) univariate logistic regression was performed. For each of the other independent variables, screening models included both time and the relevant independent variable, to identify variables individually associated with antibiotic prescription after accounting for the direct effect of time.

Multivariable longitudinal analyses were then planned for each of R74 and R78, with prescription of antibiotics as the outcome factor. All independent variables with a p-value < 0.20 and a relevant effect size in initial screening analyses were included in the multiple regression models.

The variable 'Term' (registrar Term 1, 2, 3 or 4) has been used as the time component for the longitudinal analysis and treated as a continuous, fixed effect. Generalised linear mixed modelling was used to estimate the effect of time accounting for repeated measures on registrars. To account for potential correlation of prescribing probabilities within registrars, and within-registrar changes in these probabilities over time, random intercepts were estimated treating problems (Level 1) as nested within Term (Level 2), and Term as nested within registrar (Level 3). An exchangeable correlation structure was specified.

The covariates 'Australian medical graduate' and 'Registrar gender' remained constant within registrar over time. To assess whether these factors influenced antibiotic prescribing practices over time, we included a term representing the interaction between each factor and time in models where either constant factor was included. If the interaction term was not significant at $p<0.05$ it was removed.

Following a finding of association of antibiotic prescribing with in-consultation information-seeking in the longitudinal analysis, a post-hoc cross-sectional analysis of the univariate association of antibiotic prescribing for URTI (outcome) with consulting a supervisor (predictor) was conducted. This employed logistic regression within Generalised Estimating Equations to account for clustering within registrar.

In a further post hoc analysis we examined change in the proportion of URTI diagnoses compared to all URTI/ acute bronchitis/bronchiolitis diagnoses, employing chi-square for trend. Analyses were programmed using STATA 13.1 and SAS V9.4.

Ethics approval.

Ethical approval was from the Human Research Ethics Committee, University of Newcastle, Reference H-2009-0323.

Results

A total of 856 individual registrars (response rate 96.4 %) contributed 1,832 registrar-rounds of data (including details of 108,759 individual consultations and 169,303 problems/diagnoses).

The demographics of the participating registrars and practices are presented in Table 1.

Frequency of URTI and acute bronchitis/bronchiolitis and of antibiotic prescribing.

Patients were diagnosed with URTI in 8.01% (95%CI, 7.70-8.33) of consultations and with acute bronchitis/bronchiolitis in 1.94% (95%CI 1.81-2.07) of consultations. Further analysis was at the level of problem/diagnosis. Of all problems/diagnoses, 8,715 (5.15%, 95%CI 4.93-5.38) were classified as URTI (R74). Of all problems/diagnoses, 2,110 (1.25%, 95%CI 1.16-1.33) were classified as acute bronchitis/bronchiolitis (R78).

Of the URTI diagnoses/problems, 1,422 (16.3%, 95%CI 14.9-17.8) had antibiotics prescribed. Of the acute bronchitis/bronchiolitis diagnoses/problems, 1,524 (72.2%, 95%CI 69.6-74.6) had antibiotics prescribed.

The most commonly prescribed antibiotics for URTI were amoxicillin (53.1%) and roxithromycin (16.2%), and for acute bronchitis/bronchiolitis were amoxicillin (44.2%) and roxithromycin (16.3%) (see Table 2).

Associations of prescribing antibiotics: initial screening logistic regression analyses

For URTI, screening analysis showed a decrease in antibiotic prescribing with greater level of clinical experience (i.e. time). For URTI, there was an OR of 0.87 (CI 0.80-0.94, p-value < 0.001) for antibiotic prescribing with each additional 6-months (full-time equivalent) of experience. There was no significant difference in prescribing of antibiotics for acute bronchitis/bronchiolitis over time in the screening analysis (OR 1.01, 95%CI 0.90-1.14, p=0.86).

The characteristics associated with antibiotic prescribing and the p values of screening logistic regression associations of prescribing antibiotics for URTI are presented in Tables 3 and 4.

Associations of prescribing antibiotics: multivariable longitudinal analyses

As there was no significant temporal association of prescribing antibiotics for acute bronchitis/bronchiolitis on screening analysis, we did not proceed to multivariable analysis. For URTI, the results of the multiple generalised linear mixed model is presented in Tables 5. In this model the time variable was not significant after adjusting for covariates (adjusted OR 0.95 (0.87, 1.04), p=0.27).

A number of other independent factors were significantly associated with antibiotic prescribing for URTIs in the multivariable model: patient (increasing age), clinician (non-Australian medical graduate), practice (not routinely bulk-billing: that is, charging at least some patients a fee for the consultation) and consultation (pathology being ordered, longer consultations with fewer problems addressed, and information or advice being sought in-consultation).

Post hoc analyses

For URTI, seeking advice from a supervisor was associated with greater antibiotic prescribing in a univariate analysis (OR 1.81, 95%CI 1.21-2.69, p=0.004).

There was no change in proportions of URTI:acute bronchitis/bronchiolitis diagnoses over the course of training (chi-square for trend p=0.50).

Conclusions

Interpretation of findings: change in antibiotic prescribing over time

We found no change over time in prescribing of antibiotics for acute bronchitis/bronchiolitis. Despite our unadjusted results suggesting a decrease in antibiotic prescribing for URTIs over time in the first 18-24 months (full-time equivalent) of registrars' practice in general practice, after adjusting for potential mediators of the effect we found no reduction in antibiotic prescribing.

The lack of significance of 'time' in our models suggests that other (significantly associated) covariates are mediating the effect of time on antibiotic prescribing.

Interpretation of findings: independent variables associated with change in antibiotic prescribing over time

In our model a number of covariates were significantly associated with antibiotic prescribing for URTIs. The age of patients, the practice billing policy, whether pathology is ordered, the duration of consultations, the number of problems addressed, and whether in-consultation information or advice is sought vary both between registrars and within registrars over time. Thus, significant association of these variables with antibiotic prescribing (after adjusting for time) represent a combination of between-registrar and within-registrar effects on antibiotic prescribing practices.

Our results, then, suggest that the registrar moving from a non-bulk-billing to a routinely bulk-billing practice (one where the patient bears none of the consultation cost) may be associated with a reduced likelihood of antibiotic prescribing for URTIs. Conversely, seeking in-consultation information, ordering pathology, spending longer on the consultation, attending to fewer problems in the consultation, and seeing an older patient population were each associated with an increased probability of antibiotic prescribing.

Where registrars completed their training does not change within registrar over time. Thus our results show that at any given time, after adjusting for all other covariates, Australian-graduated registrars are less likely to prescribe antibiotics than non-Australian-graduated registrars.

Comparison with previous studies: frequency of prescribing

Our findings of antibiotic prescription frequency for acute bronchitis/bronchiolitis were broadly similar to a previous cross-sectional study of established Australian GPs,[6] though somewhat lower for URTI.

Strengths and limitations

Our longitudinal methodology, unlike previous cross-sectional analyses, allows confidence that we have measured changes in prescribing during early-career/vocational training in general practice. The large number of registrars providing detailed contemporaneous records of their individual clinical consultations provided us with adequate data to assess associations with antibiotic prescribing of multiple demographic, clinical and educational variables, and to adjust for these co-variates in our analysis. The response rate is particularly high for studies of GPs,[19] enhancing our study's validity. The study population from five of 17 regional vocational training providers across five of Australia's six states and all degrees of rurality/urbanicity also provides good generalisability to Australian registrars. While we have the registrars' diagnosis of each problem/diagnosis encountered, and its demographic associations, a limitation of our study is that we do not have further clinical contextual data: for example, temperature, comorbidities, sputum colour or measures of clinical severity (though, as above, we may have some surrogate markers of disease severity). But, while consideration of such clinical factors may be included in some acute bronchitis guidelines, this is not so for the Australian guidelines[4] which are applicable to our study population. Furthermore, recent evidence suggests that identifying these potentially higher risk subgroups at the index consultation does not confer clinically meaningful benefit from antibiotics in acute bronchitis.[20]

We are dependent upon registrars' diagnoses of the condition managed. Given the cognitive dissonance engendered by registrars' practice being inconsistent with educational messages received during training regarding antibiotic prescribing (as found in our earlier qualitative study[9]), there is potential with passage through training for mislabelling of diagnoses in order to better match intended prescribing decisions. This would include assigning a more 'acceptable' label of acute bronchitis when having elected to treat an URTI with antibiotics. We found, however, no change in proportion of URTI and acute bronchitis/bronchiolitis diagnoses over the course of training. We are also unable to determine whether prescriptions written were filled by patients –

however, the scope of our study is the prescribing decisions made by registrars rather than subsequent patient behaviours.

Implications for policy, practice and future research

Our principal finding of a lack of change in antibiotic prescribing for URTI and acute bronchitis/bronchiolitis in early-career/trainee GPs has considerable implications. Currently Australian GP registrars (like trainees in many countries) primarily learn to prescribe opportunistically, in the workplace. Our findings suggest that the current process of managing the transition of clinicians from hospital to community practice via a largely 'independent practitioner within an apprenticeship-like training' model is not adequately supporting early-career GPs in the very important area of rational prescribing of antibiotics for respiratory tract infections. The clinical implications at both the individual patient and community levels are clear.

The finding of an association of antibiotic prescribing with asking for supervisor advice is a finding of particular concern in this context. Caution should be exercised as this is a post hoc analysis (prompted by the finding in the longitudinal analysis of an association of antibiotic prescribing and information-seeking from any source). It is also univariate, so it is possible that supervisors were consulted for more severe cases. But current Australian guidelines are clear that this is still not an indication for antibiotics, and potential negative effects of interactions with supervisors in this situation have been documented.[9] Thus, our findings suggest that supervisors as well as registrars should be supported in making evidence-based therapeutic decisions in this area.

Educational interventions should address the barriers to rational prescribing described in this early-career GP population including the potential influences of the registrar-supervisor relationship and interaction.[9] Educational interventions should involve both registrar/trainee and supervisor. These interventions should rigorously evaluate efficacy in reducing prescribing.

Conclusions

In our large study population, early-career experience/training in general practice failed to produce more rational antibiotic prescribing for URTI and acute bronchitis/bronchiolitis. We suggest that educational interventions in antibiotic prescribing should target the registrar-supervisor dyad.

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Ethical approval

Ethical approval was from the Human Research Ethics Committee, University of Newcastle, Reference H-2009-0323.

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Conflicts of interest

None of the authors have any conflicts of interest.

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Table 1: Participating registrar (trainee), registrar-term and practice characteristics of all 856 registrars participating in the ReCEnT study 2010-14.

Variable	Class	n (%) [95% CIs] or Mean (SD)
Registrar variables (n=856)		
Registrar Gender	Male	294 (34.4)[31.2-37.6]
	Female	562 (65.7) [62.4-68.8]
Pathway registrar enrolled in	General	641 (75.2) [72.2-78.0]
	Rural	211 (24.8) [22.0-27.8]
Graduated as a doctor in Australia	No	182 (21.5) [18.9-24.4]
	Yes	664 (78.5) [75.6-81.1]
Registrar age (years)	Mean (SD)	32.5 (6.3)
Registrar-term or practice-term variables (n=1832)		
Registrar Training Term	Term 1	765 (41.8) [39.5-44.0]
	Term 2	538 (29.4) [27.3-31.5]
	Term 3	454 (24.8) [22.9-26.8]
	Term 4	75 (4.1) [3.3-5.1]
Registrar works fulltime	No	399 (22.2) [20.4-24.2]
	Yes	1395 (77.8) [75.8-79.6]
Does the practice routinely bulk bill	No	1502 (82.6) [80.8-84.2]
	Yes	317 (17.4) [15.8-19.2]
Number of GPs working at the practice	1-5 (small practice)	604 (33.7) [31.6-35.9]
	6-10+ (large practice)	1187 (66.3) [64.1-68.4]
Rurality of practice	Major City	1060 (57.9) [55.6-60.1]
	Inner Regional	521 (28.4) [26.4-30.6]
	Outer regional, remote or very remote	251 (13.7) [12.2-15.4]
SEIFA* Index (decile) of practice	Mean (SD)	5.4 (2.9)

* *Socio-economic Index for Area, Relative Index of Disadvantage.*

Table 2: Individual antibiotics prescribed for URTIs and acute bronchitis/bronchiolitis

URTI		acute bronchitis/bronchiolitis	
Antibiotic	***n (%)***	***Antibiotic***	***n (%)***
amoxicillin	767 (53.06)	amoxicillin	706 (44.15)
roxithromycin	187 (12.99)	roxithromycin	261 (16.32)
phenoxymethylpenicillin	156 (10.83)	amoxicillin and enzyme inhibitor	248 (15.51)
amoxicillin and enzyme inhibitor	108 (7.50)	doxycycline	153 (9.57)
cefalexin	84 (5.83)	clarithromycin	83 (5.19)
erythromycin	39 (2.71)	cefalexin	73 (4.57)
doxycycline	33 (2.29)	erythromycin	32 (2.00)
Clarithromycin	32 (2.22)	cefaclor	20 (1.25)
cefaclor	22 (1.53)	ciprofloxacin	6 (0.38)

Table 3: Characteristics associated with changes in antibiotics prescribing practice for Acute Upper Respiratory Infection *(n=8,715).*

Variable[1]	Class	Antibiotics Prescribing[2,3] No	Yes	p [4]
Time[5]	Mean (SD)	0.90 (0.90)	0.88 (0.90)	<0.001
Aboriginal or Torres Strait Islander patient	No	6886 (83.7%)	1339 (16.3%)	0.22
	Yes	82 (89.1%)	10 (10.9%)	
Australian medical graduation	No	1442 (76.8%)	435 (23.2%)	<0.001
	Yes	5774 (85.7%)	967 (14.3%)	
Practice routinely bulk bills	No	5794 (82.9%)	1195 (17.1%)	0.005
	Yes	1448 (86.7%)	222 (13.3%)	
Part- or full-time registrar	Part-time	1578 (86.1%)	254 (13.9%)	0.14
	Full-time	5616 (83.0%)	1150 (17.0%)	
Patient non-English speaking background	No	6507 (83.4%)	1291 (16.6%)	0.31
	Yes	491 (87.7%)	69 (12.3%)	
Pathology ordered	No	7110 (84.1%)	1340 (15.9%)	<0.001
	Yes	183 (69.1%)	82 (30.9%)	
Patient Gender	Male	2962 (84.0%)	565 (16.0%)	0.62
	Female	4162 (83.4%)	826 (16.6%)	
Patient age group	0-4	1980 (89.9%)	222 (10.1%)	<0.001
	5-14	1058 (86.7%)	162 (13.3%)	
	15-24	954 (84.6%)	173 (15.4%)	
	25-44	1759 (82.2%)	382 (17.8%)	
	45-64	1105 (79.3%)	289 (20.7%)	
	65+	344 (66.5%)	173 (33.5%)	
Patient/practice status	Seen registrar previously	1920 (83.3%)	385 (16.7%)	0.75
	New to Registrar and practice	4661 (84.0%)	890 (16.0%)	
	New to Practice	540 (83.5%)	107 (16.5%)	
Registrar gender	Male	2861 (82.0%)	627 (18.0%)	0.22

Variable[1]	Class	Antibiotics Prescribing[2,3] No	Yes	p [4]
	Female	4432 (84.8%)	795 (15.2%)	
Rurality	Major City	4956 (86.0%)	809 (14.0%)	<0.001
	Inner Regional	1724 (79.4%)	446 (20.6%)	
	Outer Regional/ Remote/Very Remote	613 (78.6%)	167 (21.4%)	
Sought information in-consultation	No	7021 (84.5%)	1283 (15.5%)	<0.001
	Yes	272 (66.2%)	139 (33.8%)	
Consult duration (minutes)	Mean (SD)	14 (6.6)	15 (6.6)	<0.001
SEIFA[6](decile)	Mean (SD)	6 (2.9)	6 (2.8)	0.53
Number of problems addressed in consultation	Mean (SD)	1 (0.7)	1 (0.7)	0.12
Patient age (years)	Mean (SD)	25 (21.7)	34 (23.9)	<0.001
Registrar age (years)	Mean (SD)	32 (6.7)	33 (6.8)	0.004

[1] *Models included a term for time and each covariate individually.*
[2] *Numbers may not total 8,715 due to missing data*
[3] *Caution should be exercised when interpreting frequencies. This analysis uses problems and not encounters as the population unit. Thus reported frequencies at the problem-level may not reflect the observed frequencies at the subject-level.*
[4] *p value of 'screening' logistic regression (adjusting for covariate and time)*
[5] *Where Term1=0, Term2=1, Term3=2, Term4=3*
[6] *Socio-economic Index for Area, Relative Index of Disadvantage.*

Table 4: Characteristics associated with changes in antibiotics prescribing practice for Acute bronchitis/bronchiolitis *(n=2,110)*

Variable[1]	Class	Antibiotics Prescribing[2,3] No	Yes	p [4]
Time[5]	Mean (SD)	0.91 (0.93)	0.91 (0.90)	0.86
Aboriginal or Torres Strait Islander patient	No	552 (27.7%)	1444 (72.3%)	0.24
	Yes	5 (17.2%)	24 (82.8%)	
Australian medical graduation	No	148 (25.9%)	424 (74.1%)	0.42
	Yes	432 (28.6%)	1079 (71.4%)	
Practice routinely bulk bills	No	495 (27.8%)	1283 (72.2%)	0.78
	Yes	88 (27.8%)	228 (72.2%)	
Part- or full-time registrar	Part-time	116 (28.0%)	298 (72.0%)	0.94
	Full-time	458 (28.0%)	1179 (72.0%)	
Imaging ordered	No	548 (29.1%)	1335 (70.9%)	<0.001
	Yes	38 (16.7%)	189 (83.3%)	
Patient non-English speaking background	No	532 (27.5%)	1401 (72.5%)	0.87
	Yes	29 (28.4%)	73 (71.6%)	
Pathology ordered	No	541 (28.4%)	1363 (71.6%)	0.084
	Yes	45 (21.8%)	161 (78.2%)	
Patient gender	Male	249 (27.9%)	643 (72.1%)	0.84
	Female	324 (27.5%)	856 (72.5%)	
Patient age group	0-4	200 (55.4%)	161 (44.6%)	<0.001
	5-14	31 (21.4%)	114 (78.6%)	
	15-24	32 (19.0%)	136 (81.0%)	
	25-44	104 (22.1%)	367 (77.9%)	
	45-64	113 (21.5%)	413 (78.5%)	
	65+	100 (23.9%)	319 (76.1%)	
Patient/practice status	Seen registrar previously	257 (34.1%)	496 (65.9%)	<0.001
	New to Registrar and practice	278 (23.4%)	908 (76.6%)	

Variable[1]	Class	Antibiotics Prescribing[2,3] No	Yes	p [4]
	New to Practice	42 (31.6%)	91 (68.4%)	
Registrar gender	Male	234 (30.5%)	532 (69.5%)	0.18
	Female	352 (26.2%)	992 (73.8%)	
Rurality	Major City	368 (29.3%)	887 (70.7%)	0.23
	Inner Regional	162 (25.7%)	469 (74.3%)	
	Outer Regional/Remote/ Very remote	56 (25.0%)	168 (75.0%)	
Sought information in-consultation	No	507 (28.1%)	1295 (71.9%)	0.24
	Yes	79 (25.6%)	229 (74.4%)	
Consult duration (minutes)	Mean (SD)	16 (7.5)	16 (7.1)	0.73
Number of problems addressed in consultation	Mean (SD)	2 (0.8)	2 (0.7)	0.28
Patient age (years)	Mean (SD)	32 (28.8)	42 (24.8)	<0.001
Registrar age (years)	Mean (SD)	33 (6.9)	33 (6.9)	0.85
SEIFA[5]	Mean (SD)	6 (2.8)	6 (2.9)	0.46

[1] Models included a term for time and each covariate individually.

[2] Numbers may not total 2,110 due to missing data

[3] Caution should be exercised when interpreting frequencies. This analysis uses problems and not encounters as the population unit. Thus reported frequencies at the problem-level may not reflect the observed frequencies at the subject-level.

[4] p value of 'screening' logistic regression (adjusting for covariate and time)

[5] Where Term1=0, Term 2=1, Term 3=2, Term4=3

[6]Socio-economic Index for Area, Relative Index of Disadvantage.

Table 5: Predictors of changes in antibiotics prescribing practice for Acute Upper Respiratory Infection: screening logistic regression (adjusted for time) and multiple generalised linear mixed model (fully adjusted) results.

		Screening (adjusted for time)		Fully adjusted	
Variable	Class	OR (95% CI)	P	OR (95% CI)	P
Time (term)[1]		0.87 (0.81,0.94)	0.0004	0.95 (0.87, 1.04)	0.27
Australian medical qualifications	Yes	0.52 (0.41,0.66)	<.0001	0.56 (0.43, 0.72)	<0.001
Practice routinely bulk bills	Yes	0.74 (0.60,0.91)	0.0054	0.69 (0.54, 0.87)	0.002
Part- or full-time registrar	Part-time	0.84 (0.68,1.03)	0.1442	0.87 (0.69, 1.1)	0.23
Pathology ordered	Yes	2.38 (1.75,3.23)	<.0001	1.96 (1.4, 2.74)	<0.001
Patient age (years)	0-4	0.60 (0.47,0.76)	<.0001	0.58 (0.45, 0.74)	<0.001
(referent: 15-24)	5-14	0.86 (0.66,1.10)		0.85 (0.65, 1.12)	<0.001
	25-44	1.24 (1.00,1.54)		1.29 (1.02, 1.62)	<0.001
	45-64	1.61 (1.28,2.03)		1.64 (1.28, 2.1)	<0.001
	65+	2.98 (2.26,3.93)		2.98 (2.21, 4.01)	<0.001
Sought information in-consultation	Yes	3.84 (2.92,5.04)	<.0001	3.50 (2.59, 4.72)	<0.001
Consult duration (minutes)	Mean (SD)		<.0001	1.03 (1.01, 1.04)	<0.001
Number of problems addressed in consultation	Mean (SD)		0.1241	0.75 (0.67, 0.84)	<0.001

Note: The variables "Registrar age" and "rurality" were tested for removal from the multivariable analysis, and their removal did not alter the results, so the variables were removed from the final model. The variable "Part- or full-time registrar" was tested for removal but remains in the model as its removal altered the results.

[1]*Where Term 1=0, Term 2=1, Term 3=2, Term 4=3*