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Restricting access to antibiotics: The effectiveness of a 'no repeats' government policy intervention

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ABSTRACT

Background: Australia has a high rate of antibiotic use. Government policy interventions are one strategy to optimise the use of antibiotics. On 1 April 2020, the Australian Government Department of Health introduced a policy intervention to increase the quality use of four antibiotics.

Objectives: To assess if the government policy intervention improved the appropriate supply of the four antibiotics amoxicillin, amoxicillin-clavulanic acid, cefalexin and roxithromycin.

Method: This study employed a retrospective cohort study design comparing a 10% sample (n = 345,018) of four antibiotics prescribed and dispensed in Australia during a three-month period (May, June, July) in 2019, and again in 2020 (after the policy intervention). The 10% sample of PBS data was obtained from the Australian Government Department of Health. Descriptive statistics, bivariate and multivariable logistic regression analysis were carried out.

Results: The results suggest the policy change improved the appropriate supply of original prescriptions in 2020 compared to 2019 OR = 1.75 (95% CI = 1.68–1.82, $p < 0.001$), and appropriate supply of repeat prescriptions OR = 1.56 (95% CI = 1.25–1.96, $p < 0.001$). In 2020, the proportion of appropriate supply of original prescriptions increased by an absolute difference of 1.8% (95% CI = 1.6–1.9%; $P < 0.001$), and appropriate supply of repeat prescriptions increased by 3.9% (95% CI = 2.2–5.5%; $P < 0.001$). The total number of antibiotic prescriptions prescribed and dispensed in 2019 (N = 219,960) reduced in 2020 (N = 125,058) after the policy intervention.

Conclusion: The study provides evidence for the impact of a government policy intervention to improve the appropriate supply of antibiotics, although some of the reduction in antibiotic use was likely due to the concomitant COVID-19 pandemic. Further research is required to assess the impact of the intervention outside a pandemic.

1. Introduction

Antibiotic resistance is a global public health threat.[1,2] There is a link between the use of antibiotics and an increase in antibiotic resistance, at both a population and individual level.[1,2] Australia has a high rate of antibiotic use with a defined daily dose (DDD) of antibiotics prescribed per 1000 people of 23.5, above the Organisation for Economic Cooperation and Development average of 17.8.[3] Reasons for this high rate may include prescribing software defaulting to automatically prescribe repeats, and the misuse of antibiotics for viral infections.[4,5]

In Australia, the government subsidises the cost of medicines for many medical conditions through the Pharmaceutical Benefits Scheme (PBS) and Repatriation Pharmaceutical Benefits Scheme (RPBS).[6] The PBS schedule lists the medicines supplied to patients at a government-subsidised price.[6] Each subsidised medicine is assigned a unique code according to its strength, quantity, and indication.[6] In the

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2019/20 financial year, the antibiotics amoxicillin, amoxicillin-clavulanic acid and cefalexin were included in the top 10 most frequently prescribed PBS drugs in Australia.[7]

Government policy interventions are one strategy to optimise the use of antibiotics. A systematic review examining the effect of reimbursement restriction government policy interventions to reduce antimicrobial use found mixed outcomes, with studies variously reporting an increase, decrease, or no change in total antibiotic use after the intervention.[8–12]

On 1 April 2020, the Australian Government Department of Health introduced a policy intervention.[13] Pre-existing PBS item codes for short term use of the four antibiotics (amoxicillin, amoxicillin–clavulanic acid, cefalexin and roxithromycin) had the repeat option removed in April 2020 and new PBS item codes introduced.[13] Prescriptions for the four antibiotics then had to meet specific criteria for a prescriber to increase the antibiotic quantity under the rules of subsidisation.[13] To prescribe repeats for these PBS codes, special authorisation had to be obtained from Services Australia or the Department of Veterans' Affairs for each repeat request.[6]

1.1. Aim

This study aimed to investigate whether the government policy intervention improved the appropriate supply of the four antibiotics amoxicillin, amoxicillin-clavulanic acid, cefalexin and roxithromycin.

2. Method

2.1. Study design and data source

A retrospective cohort study design was employed. A random, de-identified 10% sample of PBS and RPBS prescriptions for Australian non-paediatric formulations for short course amoxicillin, amoxicillin–clavulanic acid, cefalexin and roxithromycin prescribed and supplied in May, June, July 2019 and May, June, July 2020 was obtained from the Australian Government Department of Health. This was a random sample of people n = 345,018 who had a PBS/RPBS prescription dispensed by an approved PBS supplier (community pharmacy, hospital, or medical practice). The Department conducted the randomisation of the 10% sample. After applying the exclusion criteria n = 345,018.[6]

2.2. Inclusion criteria

Prescriptions were included in the study if they:

- Included amoxicillin, amoxicillin–clavulanic acid, cefalexin and roxithromycin.
- Were prescribed and supplied in May, June, July 2019 or May, June, July 2020.
- Were for short term use.

In 2019, there were nine relevant PBS item codes eligible for inclusion in the study. In 2020 the number of relevant PBS codes increased to 18. See Table 1 for the PBS codes.

2.2.1. Exclusion criteria

Prescriptions for the four antibiotics were excluded where:

- They were prescribed by dental practitioners (who were not subject to the change in policy).[13]
- They were paediatric strength antibiotics in the form of suspensions or dispersible tablets - eg. roxithromycin 50 mg dispersible tablets (the policy change did not apply).[13]
- More than one repeat was written (suggesting the doctor intended an extended course of antibiotics and was considered outside the scope of the study or a data entry error).
- They were prescribed or dispensed outside of May, June, or July of 2019 or 2020.
- Prescriptions which were prescribed in 2019 but supplied in 2020 (where the old PBS item code would be dispensed with a repeat, which was outside the intervention).
- The date of supply was prior to the date the prescription was written (eg. emergency verbal prescription).
- Had data missing in any field other than gender.
- They were private prescriptions, which occurs when the patient does not meet the PBS criteria or/and the medical practitioner identifies the prescription as private instead of a PBS or RPBS prescription. This data is not captured by the Australian Government.

2.2.2. Outcome Measures

The primary outcome for the study was to determine if the intervention resulted in an increase in the *appropriate* supply of amoxicillin, amoxicillin-clavulanic acid, cefalexin, and roxithromycin. The secondary outcome was to determine if the intervention resulted in a change in the *total* supply of the four antibiotics. This included the number of tablets/capsules, number of prescriptions, and proportion of prescriptions dispensed to general patients compared to repatriation and concession patients.

2.3. Appropriate supply of the prescriptions for the four antibiotics is defined as

- Original prescriptions supplied seven days or less after the date of prescription

It is likely if a patient went to the doctor and was prescribed an antibiotic, they would be in some discomfort so would start the antibiotic as soon as possible. The seven days accounts for delayed prescribing and delayed access to a pharmacy.[14]

- Repeat prescriptions supplied 10 days or less after the date of supply of the original prescription.

The longest recommended at-home treatment for the most common bacterial infections is ten days.[15] Dispensing the repeat in ten or fewer days, indicates the patient is continuing the original course of treatment.[16]

2.4. Statistical methods

Descriptive statistics were calculated and presented as median and interquartile range since the distribution of continuous data was skewed, while categorical variables are presented as counts and percentages. The supply of the antibiotics that were prescribed and supplied in the three-month window before the PBS change (May, June, July 2019) was compared with those prescribed and supplied after the PBS change (May, June, July 2020). Pearson's Chi-squared test and Wilcoxon rank-sum tests were used to test for the group differences. The same three months of both years were compared to reduce the seasonal variation in antibiotic use.[16]

Bivariate logistic regression was used to estimate the odds of original prescriptions dispensed $\leq$7 days and repeat dispensed $\leq$10 days in 2020 relative to 2019. Estimates of the logistic regression are presented as odds ratio (OR) and 95% confidence interval (CI). To estimate the probability of original prescriptions dispensed within 7 days after prescribing across PBS item codes by year, a multivariable logistic regression was fitted with PBS item code and year as covariates and an interaction term between PBS item code and year.

The WHO's Anatomical Therapeutic Chemical (ATC) and Defined

Daily Dose (DDD) index and ATC/DDD Toolkit were used to calculate the DDD per 1000 people per day for each antibiotic.[17] The population of Australia was estimated using the Australian Bureau of Statistics Estimated Resident Population, which was 25,365,700 people in June 2019 and 25,687,000 people in June 2020.[18]

This study received no funding, was approved by the University of Canberra Human Research Ethics Committee (HREC number 4759) and was supported by the Australian Government Drug Utilisation Sub Committee. The primary supervisor (MB), main researcher (JC) and statistician (VO) had full access to the data and other authors had access upon request. Statistical significance was set at $p < 0.05$. All statistical analyses were conducted using Stata version 17.0 (StataCorp, College Station, TX, USA).

3. Results

3.1. Baseline demographics

The proportion of gender was similar across both years. Patients who identified as female were 57.9% (127,290) in 2019 and 58.9% (73,643) in 2020. Patients who identified as male were 42.1% (92,667) in 2019 and 41.1% (51,400) in 2020. There were eighteen people who did not have a gender specified. The majority of the study prescriptions - 133,015 (60.5%) in 2019 and 67,291 (53.8%) in 2020 - were not subsidised by the government. In 2019 86,945 (39.5%) of the prescriptions and in 2020 57,767 (46.2%) of the prescriptions were for concession and repatriation patients, where the antibiotic prescriptions were subsidised by the government. This was significantly different between the two years, $P < 0.001$.

Table 1
Australian Pharmaceutical Benefits Scheme (PBS) item code changes. PBS Item codes included in the study for the four antibiotics amoxicillin, cefalexin, amoxicillin-clavulanic acid and roxithromycin, with their corresponding information, in May, June, and July of 2019 and 2020.

		PBS Code		Qty		Repeat?		Indication required
Drug	Strength	2019	2020	2019	2020	2019	2020	
Amoxicillin	250 mg	–	1198L	–	40	–	0	Patient must have a condition requiring prolonged oral antibiotic therapy.
		1884E	1884E	20	20	1	0	–
	500 mg	–	11947T	–	40	–	0	Patient must be a male with acute cystitis; OR, Patient must have pyelonephritis; OR, Patient must have a tooth avulsion; OR Patient must have salmonella enteritis; OR, Patient must have a condition requiring prolonged oral antibiotic therapy. Patient must have community acquired pneumonia
		1889K	1889K	20	20	1	0	–
	1g	–	12002Q	–	14	–	1	Patient must have community acquired pneumonia.
		8581P	8581P	14	14	1	1	Chronic bronchitis Clinical criteria: Patient must have acute exacerbations of the condition
Cefalexin	250 mg	–	11963P	–	40	–	0	Patient must have impaired renal function, AND •Patient must have a pin-site infection; OR •Patient must have an infection following cardiac device insertion; OR •Patient must have acute otitis externa; OR •Patient must have streptococcal pharyngitis or tonsillitis; OR •Patient must have mastitis; OR •Patient must have periorbital (preseptal) cellulitis; OR •Patient must have acute rheumatic fever; OR •Patient must have a diabetic foot infection; OR •Patient must have a widespread infection of dermatitis; OR •Patient must require treatment for prophylaxis for invasive group A streptococcal (iGAS) infection; OR •Patient must have impetigo; OR •Patient must have pyelonephritis; OR •Patient must have a condition requiring prolonged oral antibiotic therapy. Midwives may prescribe under this item for the treatment of mastitis only, where the patient has impaired renal function.
		3058Y	3058Y	20	20	1	0	–
	500 mg	–	11934D	–	40	–	0	Patient must have a pin-site infection; OR Patient must have an infection following cardiac device insertion; OR Patient must have acute otitis externa; OR Patient must have streptococcal pharyngitis or tonsillitis; OR Patient must have mastitis; OR Patient must have periorbital (preseptal) cellulitis; OR Patient must have acute rheumatic fever; OR Patient must have a diabetic foot infection; OR Patient must have a widespread infection of dermatitis; OR Patient must require treatment for prophylaxis for invasive group A streptococcal (iGAS) infection; OR Patient must have impetigo; OR Patient must have pyelonephritis; OR Patient must have a condition requiring prolonged oral antibiotic therapy. Midwives may prescribe under this item for the treatment of mastitis only.
		3119E	3119E	20	20	1	0	–
Amoxicillin + Clavulanic acid	500/125 mg	–	11941L	–	20	–	0	Patient must be a male with acute cystitis; OR Patient must have a condition requiring prolonged oral antibiotic therapy.
		1891 M	1891 M	10	10	1	0	Infection where resistance to amoxicillin is suspected or known (2020 only)
	850/125 mg	–	11933C	–	20	–	0	Patient must have periorbital (preseptal) cellulitis; OR Patient must have postpartum endometritis; OR Patient must have an exacerbation of bronchiectasis; OR Patient must have pyelonephritis; OR Patient must have pneumonia acquired in hospital or aged care; OR Patient must have a diabetic foot infection; OR Patient must have a condition requiring prolonged oral antibiotic therapy.
		8254K	8254K	10	10	1	0	Infection where resistance to amoxicillin is suspected or Proven (2020 restricted benefit)
Roxithromycin	150 mg	–	12001P	–	20	–	0	Patient must have a condition requiring prolonged oral antibiotic therapy.
		1760P	1760P	10	10	1	0	–
	300 mg	–	11993F	–	10	–	0	Patient must have a condition requiring prolonged oral antibiotic therapy.
		8016X	8016X	5	5	1	0	–

3.2. Antibiotics prescribed and dispensed

A total of 577,593 antibiotics prescriptions for the four antibiotics were supplied in 2019 and 2020, and after the application of exclusion criteria, 345,018 were included in this study. See Table 2 for the comparison of the supply of the four antibiotics amoxicillin, amoxicillin–clavulanic acid, cefalexin and roxithromycin that were prescribed and dispensed in May, June, July 2019 and May, June, July 2020. There was statistically significant difference in the supply of the antibiotics between 2019 and 2020 ($p < 0.001$). The DDD per 1,000 people per day was compared for each antibiotic (See Fig. 1).

3.3. Magnitude of change

In 2020 compared to 2019, it was more likely that the original prescription was dispensed seven days or less after the date of prescribing OR = 1.75 (95% CI = 1.68–1.82, $p < 0.001$). It was also more likely the repeat prescription was dispensed 10 days or less after the original prescription OR = 1.56 (95% CI = 1.25–1.96, $p < 0.001$).

When rates of use of different antibiotics were analysed, the probability that the original prescriptions would be supplied seven days or less after being prescribed was significantly different between 2019 and 2020 for all the antibiotic dose forms except for roxithromycin 300 mg (PBS code 08016X), cefalexin 250 mg (PBS code 03058Y) and amoxicillin 1 g (PBS code 08581P). Only the old PBS codes were used in the analysis due to the new PBS codes not existing in 2019 and therefore unable to be compared with itself (See Fig. 2).

In 2020 compared to 2019, the proportion of appropriate supply of original prescriptions increased by an absolute difference of 1.8% (95% CI = 1.6–1.9%; $P < 0.001$), and appropriate supply of repeat prescriptions increased by 3.9% (95% CI = 2.2–5.5%; $P < 0.001$). The total number of antibiotic prescriptions prescribed and dispensed in 2019 (N = 219,960) reduced in 2020 (N = 125,058) after the policy intervention.

4. Discussion

There was a significant increase in the appropriate supply of antibiotics and a major reduction in total antibiotic use in 2020 compared to 2019, which suggests the policy intervention positively impacted the appropriate supply of the four antibiotics.

Between May, June, July 2019 and May, June, July 2020 the total number of prescriptions decreased by 94,902, despite similar levels of general practice consultations between the years.[16] This decrease is consistent with the literature, as four studies from Canada or Taiwan reported a reduction in restricted antibiotic use in the community after a similar government policy intervention, and a different study from Canada reported no change despite additional antibiotics being added to the formulary at the time of the study.[9–12]

The large reduction in dispensing of repeats was not un-expected given the removal of the repeat option without additional authorisation. This may have also eliminated the unintentional prescribing of repeats resulting from inappropriate default settings in the prescribing software.[4]

It was hypothesised that by adding the new PBS code for an increased quantity with zero repeats, the change may appear to reduce the number of prescriptions, but the total number of tablets/capsules supplied may have remained the same. However, the total number of tablets/capsules for the four antibiotics supplied in the study period decreased in 2020 by approximately 1.4 million tablets/capsules. A decrease in supply occurred across all antibiotics and strengths (See Fig. 2). The four antibiotics consisted of the same proportion (6.8%) of all systemic antibiotics in both years, suggesting other antibiotics may have decreased as well.[16] A reduction in all antibiotics, not just the antibiotics primarily used for URTI, could suggest that the reduction in antibiotic supply was not only due to the reduction in URTI, which supports the findings of the study.

Table 2
Comparison of the supply of the four antibiotics amoxicillin, amoxicillin–clavulanic acid, cefalexin and roxithromycin that were prescribed and dispensed in May, June, and July of 2019 and 2020., 1 = Pearson's chi2 test. 2 = Wilcoxon rank-sum Tests.

Results	May, June, and July of 2019	May, June, and July of 2020	P-Value
Number of prescriptions dispensed	219,960	125,058	
Number of original prescriptions	187,383	12,398	
Number of repeat prescriptions	32,577	1,073	
Drug name$_1$			$P < 0.001$
Proportion of antibiotics supplied that were amoxicillin, n (%)	69,789 (31.7%)	29,576 (23.6%)	
Proportion of antibiotics supplied that were amoxicillin-clavulanic acid, n (%)	59, 320 (27.0%)	31,276 (25.0%)	
Proportion of antibiotics supplied that were cefalexin, n (%)	72,260 (32.9%)	59,564 (47.6%)	
Proportion of antibiotics supplied that were roxithromycin, n (%)	18,591 (8.5%)	4,642 (3.7%)	
Item code$_1$			$P < 0.001$
Proportion of antibiotics supplied for the PBS item code 01760P, n (%)	9,421 (4.3%)	2,203 (1.8%)	
Proportion of antibiotics supplied for the PBS item code 01884E, n (%)	3,125 (1.4%)	1,240 (1.0%)	
Proportion of antibiotics supplied for the PBS item code 01889K, n (%)	64,617 (29.4%)	27,002 (21.6%)	
Proportion of antibiotics supplied for the PBS item code 01891 M, n (%)	7,406 (3.4%)	3,714/(3.0%)	
Proportion of antibiotics supplied for the PBS item code 03058Y, n (%)	3,378 (1.5%)	2,581 (2.1%)	
Proportion of antibiotics supplied for the PBS item code 03119E, n (%)	68,885 (31.3%)	55,832 (44.6%)	
Proportion of antibiotics supplied for the PBS item code 08016X, n (%)	9,210 (4.2%)	2,210 (1.8%)	
Proportion of antibiotics supplied for the PBS item code 08254K, n (%)	51,869 (23.6%)	25,834 (20.7%)	
Proportion of antibiotics supplied for the PBS item code 08581P, n (%)	2,049 (0.9%)	910 (0.7%)	
Proportion of antibiotics supplied for the PBS item code 11933C, n (%)	0 (0.0%)	1,491 (1.2%)	
Proportion of antibiotics supplied for the PBS item code 11934D, n (%)	0 (0.0%)	1,067 (0.9%)	
Proportion of antibiotics supplied for the PBS item code 11941L, n (%)	0 (0.0%)	240 (0.2%)	
Proportion of antibiotics supplied for the PBS item code 11947T, n (%)	0 (0.0%)	315 (0.3%)	
Proportion of antibiotics supplied for the PBS item code 11963P, n (%)	0 (0.0%)	72 (0.1%)	
Proportion of antibiotics supplied for the PBS item code 11993F, n (%)	0 (0.0%)	121 (0.1%)	
Proportion of antibiotics supplied for the PBS item code 11998L, n (%)	0 (0.0%)	45 (0.0%)	
Proportion of antibiotics supplied for the PBS item code 12001P, n (%)	0 (0.0%)	119 (0.1%)	
Proportion of antibiotics supplied for the PBS item code 12002Q, n (%)	0 (0.0%)	62 (0.0%)	

(continued on next page)

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Table 2 (*continued*)

Results	May, June, and July of 2019	May, June, and July of 2020	P-Value
Number of tablets/capsules dispensed	3,568,002	2,175,698	
Defined Daily Doses (DDD) per 1,000 people per day supplied of amoxicillin	460,693	197,910	
DDD supplied of amoxicillin-clavulanic acid	321,518	179,834	
DDD supplied of cefalexin	352,962	295,892	
DDD supplied of roxithromycin	93,571	24,693	
Median number of days between prescription and supply of the original prescription (interquartile range) $_2$	0 (0–0)	0 (0–0)	$p < 0.001$
Median number of days between the supply of the original prescription and repeat supply(interquartile range)$_2$	5 (0–7)	0 (0–4)	$p < 0.001$
Proportion of original prescriptions dispensed seven days or less after prescribed$_1$, n (%)	210,714 (95.8%)	121,992 (97.5%)	$p < 0.001$
Proportion of repeat prescriptions dispensed ≤10 days after the original$_1$, n (%)	28,799 (88.4%)	990 (92.3%)	$p < 0.001$

The intervention has occurred during the COVID-19 pandemic and population lockdowns in Australia.[19] The Fourth Australian Report on Antimicrobial Use and Resistance has reported on the impact of the COVID-19 pandemic on antibiotic use.[16] The report showed significant reductions in antibiotics used for upper respiratory tract infections (URTI), including other antibiotics that did not have a PBS change.[16] The rate of use of antibiotics not normally used for URTI remained similar across the two years, suggesting the changes in circulating URTI may have accounted for some of the changes in antibiotic use, which is demonstrated by the decrease in influenza rates.[16,19,20] In Australia, there were 115,728 reported cases of laboratory confirmed influenza between 6 May and 28 July 2019 which dropped to just 453 between 4 May and 26 July 2020.[20] As URTI is a common indication the four antibiotics, the decrease in URTI would have resulted in a reduction in relevant antibiotic prescribing and supply.[16]

New-Zealand experienced similar levels of COVID-19 case numbers and also implemented public health measures similar to Australia in 2020.[21] In New Zealand pre-lockdown, there was a mean of 13.93 antibiotic prescriptions dispensed per week per 1,000 population (prescriptions/week/1,000). This fell by 35.6% to 8.97 prescriptions/week/1,000 during the level 3 and 4 alerts.[22] In Australia there was an even larger reduction, with a mean of 16.68 prescriptions/week/1,000 were dispensed during May, June, and July 2019 which fell by 43.9% to a mean of 9.36 prescriptions/week/1,000 in May, June, and July of 2020 (when restrictions after lockdown were beginning to slowly relax). This could suggest the reduction was not limited to the impact of COVID-19 pandemic and associated reduction in URTI.

The COVID-19 pandemic and related public health measures are also associated with a reduction in antibiotic use in other countries such as the United States of America and Scotland.[22–24] Further research is required to assess the extent and ongoing impact of the policy intervention post-COVID-19.

Antimicrobial stewardship and the quality use of medicines are central objectives of pharmacy practice. This paper highlights the impact government policy has on appropriate supply of antibiotics. This study could serve as an evidence base to inform future PBS changes for other antibiotics to optimise AMS and QUM.

4.1. Generalisability

The sample is a large, random, 10% sample of Australian PBS data, which is considered representative and is a common method of assessing drug utilisation.[25] The sample is large enough to give the study 90% power to detect a <1% change.

4.2. Limitations

This research investigates the appropriateness of dispensed prescriptions, not the appropriateness of prescribing. The high rate of antibiotic use is concerning, especially for cefalexin which is not recommended as first line therapy for any infection.[16] A future area of study could investigate whether the policy intervention increased the appropriateness of prescribing of the antibiotics studied.

Data on the antibiotics prescribed and dispensed outside the three-month period was not captured, so the supply of prescriptions for the four antibiotics was not entirely complete. It is possible a different proportion of original prescriptions were supplied more than seven days after being prescribed and repeats supplied more than 10 days after the original. Including prescriptions prescribed and supplied only during the three months selects for prescriptions filled only during those three months therefore a shorter time interval between prescribing and supply. However, it also removes the antibiotics supplied before the date a prescription was written (eg. via an emergency oral prescription) which skews the data towards a longer time interval. We aimed to minimise the

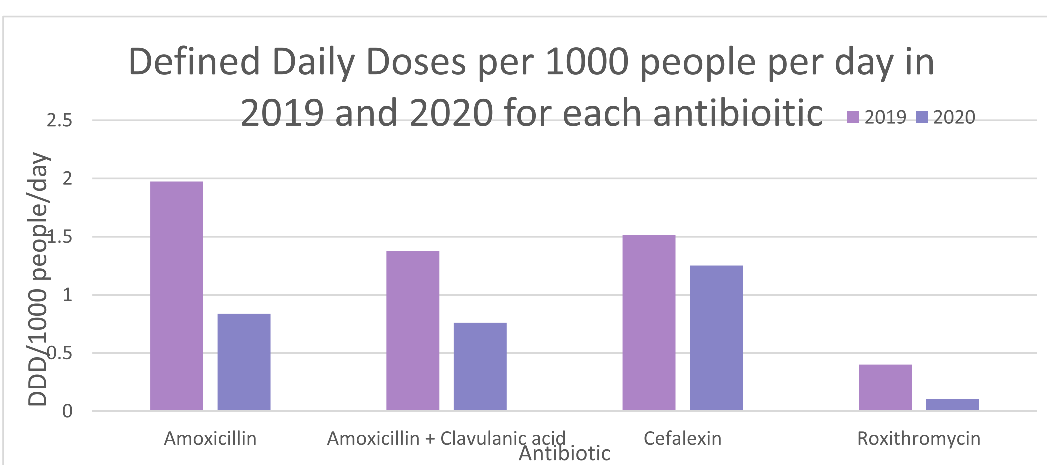

Fig. 1. Defined Daily Doses per 1000 people per day for the four antibiotics amoxicillin, cefalexin, amoxicillin-clavulanic acid and roxithromycin in May, June, and July of 2019 and 2020. Population estimates were used from the Australian Bureau of Statistics for July 2019 (25,365,700 people) and July 2020 (25,687,000 people).[26] DDD calculated using the Anatomical Therapeutic Chemical/Defined daily dose WHO Toolkit.[26].

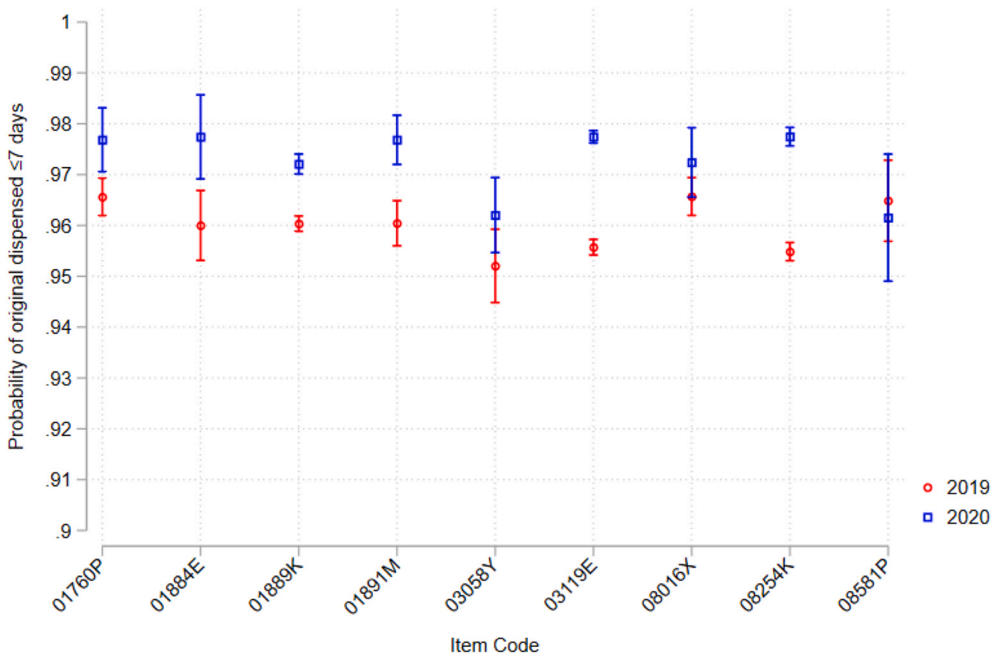

Fig. 2. Probability and 95% confidence interval of original prescriptions for the PBS item codes for the four antibiotics amoxicillin, cefalexin, amoxicillin-clavulanic acid and roxithromycin in May, June, and July of 2019 and 2020 being supplied appropriately (dispensed ≤7 days before prescription date) Odds ratio, Univariate regression. The new PBS codes were not included as they did not exist in 2019 therefore were unable to be compared. Significance was determined by overlap of the 95% confidence intervals.

impact of this on the data by using the same exclusion criteria for the time points in both years. The Fourth Australian Report on Antimicrobial Use and Resistance reported that in 2019 the proportion of repeat prescriptions for the four antibiotics that were supplied 10 days or less after the original, ranged from 51.3% (cefalexin) to 69.9% (roxithromycin), which is lower than the results of this study.[16] Further research is required to compare the supply over a longer period to further explore the impact of the change.

Data for private prescriptions was not captured. The Fourth Australian Report on Antimicrobial Use and Resistance estimated the proportion of private prescriptions dispensed were less than 10% for the four antibiotics included in the study in 2019.[16]

5. Conclusion

This study provides evidence for the effectiveness of government policy interventions on the appropriate supply of amoxicillin, amoxicillin-clavulanic acid, cefalexin, and roxithromycin, and on antimicrobial stewardship. The results suggest the policy had a positive impact on the appropriate supply of the four antibiotics. However, some of the recorded reduction in antibiotic use is likely attributable to the COVID-19 pandemic. Further research is required to assess the extent and ongoing impact of the intervention.

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Author statement

Juliet Contreras: Conceptualization, investigation, methodology, Writing – Original draft. Victor Oguma: Data curation, Formal Analysis. Lyn Todd: Supervision, writing – review and editing. Mark Naunton: Supervision, writing – Review and editing. Peter Collignon: Supervision, writing – review and editing. Mary Bushell: Conceptualization, methodology, supervision, writing – review and editing.

Declaration of competing interest

Declarations of interest: none.

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