CSIRO PUBLISHING

RESEARCH PAPER
https://doi.org/10.1071/SH23096

SEXUAL HEALTH

The chlamydia care cascade of young people attending Australian general practices; a descriptive study to assess gaps in care

J. Jung[A,B,*], R. Biezen[A], J. L. Goller[C], J. Hocking[C], P. Chondros[A] and J. Manski-Nankervis[A]

For full list of author affiliations and declarations see end of paper

***Correspondence to:**
J. Jung
Department of General Practice, Melbourne Medical School, University of Melbourne, Carlton, Vic., Australia
Email: changjune.jung@unimelb.edu.au

Handling Editor:
Weiming Tang

ABSTRACT

Background. Most chlamydia infections in Australia are diagnosed in general practice. The care cascade concept (testing, treatment and re-testing) can be utilised to explore the management of chlamydia infections. We explored the chlamydia care cascade among young people attending general practices in Australia. **Methods.** We analysed de-identified electronic medical record data for 16–29-year-old individuals attending 70 Australian general practices between January 2018 and December 2020. Five outcomes: (1) chlamydia testing, (2) positivity, (3) treatment, (4) re-testing and (5) re-infection were summarised as annual counts and proportions per calendar year. Logistic regression was used to investigate the association of age, gender and clinic location with each outcome. **Results.** During the study period, a total of 220 909 clinical episodes involving 137 358 16–29-year-olds were recorded. Of these episodes, 10.45% (n = 23 077, 95% CI 8.73–12.46) involved a chlamydia test. Of 1632 chlamydia cases, 88.79% (n = 1449, 95% CI 86.37–90.82) had appropriate antibiotics recorded as defined in Australian sexually transmitted infection management guidelines. Of 183 chlamydia cases that did not have appropriate antibiotics recorded, 46.45% (n = 85) had re-attended the clinic within 90 days of diagnosis. Among 1068 chlamydia cases that had appropriate antibiotic recorded in 2018 and 2019, 22.57% (n = 241, 95% CI 20.15–25.18) were re-tested within 6 weeks to 4 months of their diagnosis. One-third of episodes of chlamydia cases that did not have a re-test recorded (n = 281) had re-attended the clinics within 4 months of diagnosis. **Conclusion.** Our study provides insight into chlamydia management by analysing general practice medical records, indicating substantial gaps in testing and re-testing for 16–29-year-olds. These data can also be used to explore the impact of future interventions to optimise chlamydia management.

Keywords: care cascade, chlamydia, electronic health record, epidemiology, general practice, primary care, routinely collected clinic data, sexually transmissible infection.

Received: 23 May 2023
Accepted: 13 September 2023
Published: 2 October 2023

Cite this:
Jung J *et al.* (2023)
Sexual Health, **20**(6), 542–549.
doi:10.1071/SH23096

Introduction

Chlamydia infection is the most frequently notified sexually transmissible infection (STI) in Australia, and notification rates have been increasing from 368.8 per 100 000 people in 2015 to 434.5 per 100 000 in 2019.[1] Chlamydia infection can result in serious reproductive health complications, including pelvic inflammatory disease (which can cause fallopian tube scarring, ectopic pregnancy, infertility and chronic pelvic pain) in women and epididymo-orchitis in men.[2–4] Timely diagnosis and treatment have the potential to prevent these complications.

The 'care cascade' concept was developed to identify gaps in HIV care[5] and has been adapted to other infections, including chlamydia.[6] For chlamydia infection, the care cascade consists of three steps: (1) testing, (2) treatment and (3) re-testing. Royal Australian College of General Practitioners guidelines[7] recommend opportunistic testing for all sexually active people under 30 years old. Re-testing at 3 months following treatment is also recommended[2] because of the risk of re-infection.[8,9] In most situations, a test of cure or re-testing within

4 weeks after treatment is not recommended, as it may result in false positive results from the remnants of a previous infection.[2,10]

Sexual health care in Australia is provided predominantly through primary care services. These include specialist services, such as sexual health clinics and family planning clinics, and general practice clinics. General practice is Australia's mainstream primary healthcare setting, and it is here that the majority of chlamydia tests and infections are diagnosed.[1,11] The youngest legal age for consensual sex in Australia is 16 years,[12] and clinical guidelines recommend that general practitioners (GPs) conduct opportunistic testing for those under 30 years of age who are sexually active,[7] as two-thirds of chlamydia diagnoses occur in this group.[1] Understanding chlamydia management of this at-risk population attending general practices is an important step to strengthen chlamydia care in Australia. Hence, we explored the chlamydia care cascade for 16–29-year-olds attending Australian general practices. Given the impact that COVID-19 had on general practice attendance and the lower STI notification data,[1] we also took the opportunity to explore the impact that COVID-19 had on chlamydia care in 2020.

Methods

GPs are often the first point of contact in the Australian health system, and approximately 80% of Australians saw a GP between 2018 and 2020.[13] There were over 37 000 GPs working across 8147 general practices in Australia[14] and approximately 1874 clinics were in Victoria.[15–20]

We undertook a descriptive study to explore the testing, treatment and re-testing steps of the chlamydia care cascade in general practice. We used routinely collected general practice data that included 220 909 clinical episodes of care for 137, 358 individuals aged 16–29-years attending 70 general practices (69 were in the state of Victoria) between 1 January 2018 and 31 December 2020.

Inclusion and exclusion criteria

Patients were included if they had attended a participating general practice at least once in each calendar year between 2018 and 2020 and were aged between 16 and 29 years old at the time of their attendance.

Chlamydia pharyngeal, urogenital and rectal infections were included, and chlamydia eye infection was excluded.

Data sources

General practice data were obtained from the Patron repository, which is part of the University of Melbourne's Data for Decisions initiative.[21] Patron contains de-identified patient data extracted from the electronic health records (EHR) of participating general practices. These data were extracted by GRHANITE®, a privacy protection data extraction software. The dataset included demographic characteristics of patients; geographical remoteness of general practices; name, date and result of pathology investigations performed; name, quantity, date and instruction of prescribed medications.

Variables and data management

We identified patients tested for chlamydia by identifying investigation names containing 'chlamydia' or 'ct' and investigation results containing chlamydia nucleic acid amplification. The definitions of five outcomes that aligned with the chlamydia care cascade are as follows:

1. Chlamydia testing – the proportion of chlamydia tests (pharyngeal, urogenital or rectal) performed at least once in a calendar year among clinical episodes of individuals who attended a GP clinic at least once in each calendar year.
2. Positivity – the proportion of individuals with a chlamydia test who had at least one positive test result in each calendar year. Chlamydia tests without test results recorded in the EHR were excluded.
3. Treatment – the proportion of chlamydia positive cases that had appropriate antibiotic prescription recorded in their prescription history in each calendar year. Appropriate antibiotics were determined based on the treatment options recommended by Australian STI Management Guidelines for use in primary care and Therapeutic Guidelines.[2,22] Chlamydia positive cases were defined as appropriately treated based on the quantity of two antibiotics (14 tablets of doxycycline 100 mg or 2 tablets of azithromycin 500 mg) (Supplementary Table S1). Because timely antibiotic treatment is an important part of managing chlamydia infection, we set two time criteria for appropriate antibiotic prescription: (a) within 14 days prior to the sample collection date in recognition that the GP may prescribe antibiotic treatment concurrently with pathology referral for a chlamydia test but there may be a delay in the patient undertaking the test; and (b) within 31 days from the sample collection date. Any positive cases identified following repeat testing within 4 weeks from the first positive sample collection date were excluded from the analysis of chlamydia treatment, as these tests may represent false-positive results from previous infections and would not warrant treatment.
4. Re-testing – the proportion of appropriately treated chlamydia cases that were re-tested between 6 weeks to 4 months (42–122 days) from their first positive chlamydia result in a calendar year. The sample collection date of the first positive chlamydia result in a calendar year was used as the date of chlamydia diagnosis, and the re-testing period was measured from the sample collection date of the first chlamydia positive result to the sample collection date of the next chlamydia test. Re-testing before 6 weeks may detect non-viable chlamydia nucleic acid that is still clearing following treatment. We extended

our re-testing period up to 4 months, as we calculated the re-testing period from the sample collection date of the positive test rather than treatment date.

5. Re-infection – the proportion of positive test results on re-testing. Repeated tests without test results were excluded. We did not have data for 2021; hence, we were not able to explore re-testing of patients that had a chlamydia positive test between September and December 2020.

Explanatory categorical variables were created for pre-COVID-19 (2018, 2019) and during COVID-19 calendar years (2020), gender (male, female, other), general practice location (metropolitan, regional, rural) and age group (16–19 years, 20–24 years, 25–29 years). Metropolitan clinics were defined as clinics located in the Modified Monash Model (MMM)[23] category 1, regional clinics in MMM category 2–3, and rural clinics in MMM category 4–5 areas. There were no participating clinics located in the MMM category 6–7 areas.

Statistical analysis

Data were analysed using Stata statistical software V15.[24] Each of our chlamydia care cascade outcomes (1–5) were summarised as counts and percentages for the overall study period as well as by calendar year, general practice location, and individual sex and age group.

A single logistic regression model was used to estimate unadjusted odds ratios (ORs) to examine the effect of each explanatory variable (year, gender, clinic location and age group) on each outcome (chlamydia testing, positivity, treatment, re-testing and re-infection). For each outcome, adjusted odds ratios (aORs) were estimated using a multiple logistic regression model with all explanatory variables included in the model. All models used robust standard errors to adjust the clustering effect of general practice. Estimates of the ORs and aORs were reported with 95% confidence interval (CI) and *P*-values. The intra-cluster correlation coefficient (ICC) for each outcome was estimated using a one-way analysis of variance and was reported with 95% CI. An ICC is defined as the proportion of the true total variation in the outcome that can be attributed to the differences between the general practices.[25]

Ethics

The study was approved by the Human Ethics Committee at the University of Melbourne (2021-20894-20306-4).

Results

Study sample characteristics

A total of 137 358 individuals aged 16–29 years attended the 70 general practices during the study period, with 58 560 individuals contributing data to more than one calendar year. In 2020, the number of individuals attending metropolitan general practices (n = 64 522) was lower compared with 2018 (n = 75 199) and 2019 (n = 80 544), whereas the number attending regional and rural clinics was similar between years (Table 1). Of the clinical episodes, 69.7% (n = 153 922) were from individuals attending metropolitan general practices. Females had more clinical episodes than males (57.7% vs 42.2%), and 43.4% of clinical episodes (n = 129 234) were from 25 to 29-year-olds (Table 2). The distribution of the ICC for our study outcomes ranged from 0 to 0.045 (Table S2).

Chlamydia testing and chlamydia positivity

Overall, approximately 10% of consultations among 16–29-year-olds involved a chlamydia test (Table 2). The percentage of chlamydia tests performed was similar in 2018 (11.1%) and 2019 (10.5%) but slightly less in 2020 (9.8%, aOR 0.88, 95% CI 0.80–0.97). The proportion of attending individuals tested for chlamydia did not vary by clinic location, but males (6.7%, aOR 0.47, 95% CI 0.39–0.57) were less likely to be tested for chlamydia than female attendees (13.3%). Compared with 16–19-year-olds (6.7%), 20–24-year-olds (11.7%, aOR 1.83, 95% CI 1.65–2.03) and 25–29-year-olds (11.3%, aOR 1.75, 95% CI 1.47–2.09) were more likely to be tested for chlamydia.

Among those tested, chlamydia positivity was approximately 7% each year (Table 2). Positivity was higher in males (9.1%, aOR 1.67, 95% CI 1.46–1.90) than females (5.9%), and there were no positive cases in individuals of other gender. Compared with those attending metropolitan general practices (6.1%), chlamydia positivity was higher in regional (8.5%, aOR 1.36, 95% CI 0.94–1.97) and rural general practices (8.5%, aOR 1.30, 95% CI 1.05–1.60). By age-group, 25–29-year-olds (4.7%, aOR 0.52, 95% CI 0.43–0.64) were less likely to be diagnosed with chlamydia than 16–19-year-olds (9.0%) and 20–24-year-olds (8.5%).

Table 1. Total number of individuals attending clinics by years and clinic locations.

Clinic Location	Year	Number of clinics	Number of individuals attended clinics	Number of individuals attended per clinic
Metropolitan clinics	2018	42	50 322	1198
	2019	42	54 530	1298
	2020	42	49 070	1168
Regional clinics	2018	7	8743	1249
	2019	7	9233	1319
	2020	7	9520	1360
Rural clinics	2018	21	12 553	598
	2019	21	13 468	641
	2020	21	13 470	641

Table 2. Factors associated with chlamydia testing and chlamydia positivity.

	Chlamydia testing							Chlamydia positivity						
	Clinical episodes *N*	Chlamydia tests performed *n* (%)	Unadjusted		Adjusted[A]		*P*	Chlamydia tests performed[B] *N*	Positive chlamydia cases *n* (%)	Unadjusted		Adjusted[A]		*P*
			OR[C]	95% CI	aOR[D]	95% CI				OR[C]	95% CI	aOR[D]	95% CI	
Overall	220 909	23 077 (10.5)						22 936	1556 (6.8)					
Year							0.03							0.52
2018	71 618	7935 (11.1)		Ref		Ref		7814	552 (7.1)		Ref		Ref	
2019	77 231	8077 (10.5)	0.94	0.88–1.00	0.94	0.88–1.01		8070	528 (6.5)	0.92	0.80–1.07	0.92	0.79–1.07	
2020	72 060	7065 (9.8)	0.87	0.80–0.95	0.88	0.80–0.97		7052	476 (6.8)	0.95	0.83–1.09	0.95	0.83–1.09	
Clinic location							0.97							0.04
Metropolitan	153 922	16 178 (10.5)		Ref		Ref		16 045	972 (6.1)		Ref		Ref	
Regional	27 496	2948 (10.7)	1.02	0.72–1.45	1.04	0.75–1.46		2944	250 (8.5)	1.44	1.00–2.07	1.36	0.94–1.97	
Rural	39 491	3951(10.0)	0.95	0.69–1.30	1.03	0.76–1.38		3947	334 (8.5)	1.43	1.16–1.78	1.30	1.05–1.60	
Gender							<0.001							<0.001
Female	126 281	16 775 (13.3)		Ref		Ref		16 681	987 (5.9)		Ref		Ref	
Male	92 961	6210 (6.7)	0.47	0.39–0.56	0.47	0.39–0.57		6615	561 (9.1)	1.59	1.37–1.85	1.67	1.46–1.90	
Other	90	7 (7.8)	0.55	0.26–1.18	0.56	0.26–1.19		7	0 (0)	–	–	–	–	
Age group, years							<0.001							<0.001
16–19	47 626	3199 (6.7)		Ref				3171	285 (9.0)		Ref		Ref	
20–24	77 329	9070 (11.7)	1.85	1.63–2.09	1.83	1.65–2.03		9019	767 (8.5)	0.94	0.78–1.13	0.96	0.80–1.15	
25–29	95 954	10 808 (11.3)	1.76	1.43–2.17	1.75	1.47–2.09		504	504 (4.7)	0.50	0.40–0.62	0.52	0.43–0.64	

CI, confidence interval.

[A]Excludes individuals of unknown gender.

[B]Excludes chlamydia tests performed that did not have test results.

[C]Unadjusted odds ratio (OR) were estimated using single logistic regression model with robust standard errors

[D]Adjusted odds ratio (aOR) were estimated using multiple logistic regression model with robust standard errors, which include all explanatory variables as covariates (year, clinic location, gender and age group) in the same model.

There were 141 (0.6%) chlamydia tests that had the date of sample collection but did not have test results. Those were excluded from the denominator of chlamydia positivity.

Chlamydia treatment

Overall, there was a total of 1675 positive chlamydia cases; 2.6% of them (n = 43) were from repeated tests performed within 4 weeks of the first positive test and were excluded from the chlamydia treatment analysis. Of the remaining 1632 chlamydia cases, 88.8% (n = 1449) had appropriate antibiotic prescriptions recorded (Table 3). Our outcome of appropriate chlamydia treatment did not statistically vary by year, clinic location, gender or age group.

Of chlamydia cases that did not have appropriate antibiotics recorded (N = 183); 52.5% (n = 96) were prescribed either doxycycline or azithromycin. However, they were prescribed between 31 and 90 days from the sample collection date (suggesting a delay in treatment) or they were not prescribed the correct quantity of doxycycline or azithromycin (suggesting inadequate treatment). In addition, 46.5% (n = 85) of these positive cases re-attended the clinic within 90 days of the positive sample collection date but did not have either doxycycline or azithromycin prescriptions recorded.

Chlamydia re-testing and chlamydia re-infection of those re-tested

Among appropriately treated chlamydia cases in 2018 and 2019, 22.6% (n = 241) were re-tested within 42–122 days of diagnosis (Table 4). The proportion re-tested did not vary by year and age group, but males (16.5%, aOR 0.54, 95% CI 0.39–0.76) were less likely to be re-tested than females (25.9%), and chlamydia cases in rural clinics (16.2%, aOR 0.64, 95% CI 0.42–0.97) were less likely to be re-tested than those in metropolitan (24.6%) and regional (23.4%) clinics.

Overall, 12.6% (n = 15) of those who were re-tested for chlamydia in 2018 had a positive result compared with 5.8% (n = 7) in 2019 (Table 4). Contrasted with those in metropolitan clinics (8.6%), chlamydia re-infection was higher in regional clinics (15.0%, aOR 1.87, 95% CI 0.69–5.36) but lower in rural clinics (5.3%, aOR 0.42, 95% CI 0.11–1.67). The highest re-infection proportion was observed in 16–19-year-olds (13.9%) and the lowest in 25–29-year-olds (4.6%, aOR 0.26, 95% CI 0.05–1.36).

Of chlamydia cases not re-tested within the recommended period (42–122 days, n = 827), 23.2% (n = 192) were re-tested within 42 days (suggesting being re-tested too early), and 34.0% (n = 281) re-attended the clinic within 4 months after being diagnosed but were not re-tested (suggesting a missed opportunity for re-testing).

Table 3. Factors associated with chlamydia treatment.

	Chlamydia positive cases	Positive cases with appropriate treatment	Unadjusted		Adjusted[A]		P
	N	n (%)	OR[B]	95% CI	aOR[C]	95% CI	
Overall	1632	1449 (88.8)					
Year							0.09
2018	582	506 (86.9)	Ref		Ref		
2019	551	502 (91.1)	1.54	1.02–2.31	1.58	1.04–2.41	
2020	499	441 (88.4)	1.14	0.80–1.64	1.13	0.78–1.64	
Clinic location							0.96
Metropolitan	1021	908 (88.9)	Ref		Ref		
Regional	271	240 (88.5)	0.96	0.66–1.40	1.01	0.69–1.49	
Rural	340	301 (89.0)	0.96	0.52–1.77	1.10	0.56–2.15	
Gender							0.38
Female	1039	917 (88.3)	Ref		Ref		
Male	585	526 (89.9)	1.19	0.85–1.64	1.15	0.84–1.57	
Age group, years							0.14
16–19	291	249 (85.7)	Ref		Ref		
20–24	814	729 (89.6)	1.45	1.02–2.05	1.44	1.00–2.07	
25–29	527	471 (89.4)	1.42	0.93–2.15	1.36	0.90–2.06	

CI, confidence interval.
[A]Excludes individuals of unknown gender.
[B]Unadjusted odds ratio (OR) were estimated using single logistic regression model with robust standard errors.
[C]Adjusted odds ratio (aOR) were estimated using multiple logistic regression model with robust standard errors, which include all explanatory variables as covariates (year, clinic location, gender and age group) in the same model.

Table 4. Factors associated with chlamydia re-testing and chlamydia re-infection.

	Chlamydia re-testing (42–122 days post diagnosis)							Chlamydia re-infection (42–122 days post diagnosis)						
	Positive chlamydia cases	Re-tested cases	Unadjusted		Adjusted[A]		P	Re-tested cases[B]	Re-infected cases	Unadjusted		Adjusted[A]		P
	N	n (%)	OR[C]	95% CI	aOR[D]	95% CI		N	n (%)	OR[C]	95% CI	aOR[D]	95% CI	
Overall	1068	241 (22.6)						240	22 (9.2)					
Year							0.79							0.09
2018	545	119 (21.8)		Ref		Ref		119	15 (12.6)		Ref		Ref	
2019	523	122 (23.3)	1.09	0.82–1.44	1.04	0.78–1.39		121	7 (5.8)	0.43	0.16–1.15	0.42	0.16–1.14	
Clinic location							0.11							0.16
Metropolitan	662	163 (24.6)		Ref		Ref		162	14 (8.6)		Ref		Ref	
Regional	171	40 (23.4)	0.93	0.65–1.35	0.94	0.65–1.36		40	6 (15.0)	1.87	0.68–5.10	1.87	0.69–5.36	
Rural	235	38 (16.2)	0.59	0.40–0.88	0.64	0.42–0.97		38	2 (5.3)	0.59	0.15–2.25	0.42	0.11–1.67	
Gender							<0.001							0.49
Female	690	179 (25.9)		Ref		Ref		178	16 (9.0)		Ref		Ref	
Male	375	62 (16.5)	0.57	0.41–0.78	0.54	0.39–0.76		62	6 (9.7)	1.08	0.31–0.85	1.55	0.44–5.46	
Age group, years							0.31							0.27
16–19	185	36 (19.5)		Ref		Ref		36	5 (13.9)		Ref		Ref	
20–24	534	117 (21.9)	1.16	0.76–1.77	1.16	0.75–1.78		116	13 (11.2)	0.78	0.23–2.66	0.61	0.18–2.11	
25–29	349	88 (25.2)	1.39	0.92–2.11	1.40	0.89–2.19		88	4 (4.6)	0.30	0.06–1.43	0.26	0.05–1.36	

CI, confidence interval.
[A]Excludes individuals of unknown gender.
[B]Excludes one individual in 2019 due to lack of test result.
[C]Unadjusted odds ratio (OR) were estimated using single logistic regression model with robust standard errors.
[D]Adjusted odds ratio (aOR) were estimated using multiple logistic regression model with robust standard errors, which include all explanatory variables as covariates (year, clinic location, gender and age group) in the same model.

Discussion

We found substantial gaps in chlamydia management for 16–29-year-olds attending Australian general practice during 2018–2020. The most significant gaps related to testing and re-testing, with only one-tenth of patients tested and one-fifth of positive cases re-tested within recommended timeframes. The main barriers to performing chlamydia testing in GP clinics include a lack of time to discuss testing and conduct a follow-up, a lack of a formal recall and reminder system, and a patient's embarrassment and lack of knowledge about chlamydia.[26] Although most chlamydia cases had appropriate antibiotic prescriptions recorded within 31 days of their diagnosis, we found that most of those who did not have an antibiotic prescription recorded did re-attend their clinic following the positive diagnosis, suggesting that treatment either did not occur, was not recorded or occurred elsewhere.

Our findings showed that fewer individuals attended general practices and a lower proportion tested in 2020 during the first year of the COVID-19 pandemic compared to 2018 and 2019. A recent study showed a significant reduction in the number of patients attending a sexual health clinic in Melbourne, Australia, in 2020 due to the COVID-19 pandemic,[27] and the lower chlamydia testing proportion in 2020 may have been related to COVID-19 pandemic restrictions. However, we found that the proportion of positive tests was similar in 2020 to 2018 and 2019, which contrasts with the data reported by the Kirby Institute.[1] This is likely due to the difference in data source; the Kirby Institute analysed nation-wide data whereas our study analysed general practice data, for which most practices were in Victoria.

We identified an important intervention gap in chlamydia re-testing where one-third of young people with chlamydia infections re-attending the general practices within 4 months were not re-tested. An earlier Australian study[28] identified similar missed opportunities for re-testing, in which 32% of young people re-attended the general practices within 4 months of treatment but were not re-tested between 2008 and 2009.[28] Chlamydia re-infection substantially increases a woman's risk of developing pelvic inflammatory disease by up to 20% for each repeated infection,[29] and optimising the re-testing aspect of chlamydia management is important to detect re-infection in a timely manner. Over 97% of Australian general practices use an electronic medical software to record their clinical consultations.[30,31] Pop-up alert computerised clinical decision support system have been shown to

increase chlamydia and syphilis testing,[32,33] and pop-up alerts integrated within the medical software can offer a mechanism to prompt GPs to discuss and organise chlamydia re-testing at the point of care, thereby reducing the proportion missed for re-testing.

We found that males were less likely to be tested for chlamydia but were more likely to be diagnosed upon testing than females. The higher testing proportion in females may be due to differences in health-seeking behaviour. For example, females are more likely to participate in preventative health screening activities, such as an annual health check and seeking lifestyle advice from medical practitioners to optimise their health.[34] In addition, GPs also have more opportunities to perform chlamydia testing in females while discussing reproductive health issues, such as contraception, cervical cancer screening or antenatal care. These findings also suggest that chlamydia testing in males may have been targeted at high-risk groups. One example of an at-risk male group is men who have sex with men (MSM). Current guidelines[2] recommend a 3-monthly STI screening for MSM. Regular targeted STI screening in these male groups may result in an increased proportion being diagnosed with chlamydia. We were not able to explore this as our data did not have patient's sexual practice. The role of general practice in providing sexual health care to MSM could be further explored.

There are several limitations to our study. The majority of general practices in our study were in the state of Victoria, Australia; hence, results may not be generalised nationally. In addition, regional and rural GP clinics may be underrepresented; hence, comparisons between clinic location should be interpreted cautiously. We may also have underestimated the proportion appropriately treated, as individuals who did not have doxycycline or azithromycin medication may have been provided with a handwritten prescription or may have been prescribed another antibiotic due to a medication allergy. Lastly, we were not able to identify individuals who attended different clinics for their antibiotic treatment and re-testing, so we potentially overestimated treatment and re-testing gaps.

Our study strengths included the large sample size and the use of routinely collected general practice clinic data, which provided an insight into a real-world scenario of chlamydia STI care delivery in general practices. The ICC provided may also inform the design of future cluster-based studies in primary care.[25]

This study demonstrated the value of utilising routinely collected general practice data in a research setting, highlighting testing and re-testing as major gaps in chlamydia care and missed opportunities for re-testing. Digital interventions integrated within the EHR can be utilised as a possible intervention strategy to reduce gaps in chlamydia care, and the routinely collected clinical data can be utilised to explore the effectiveness of further intervention strategies on chlamydia management.

Supplementary material

Supplementary material is available online.

References

1 Kirby Institute. HIV, viral hepatitis and sexually transmissible infections in Australia: annual surveillance report 2021. Sydney: Kirby Institute, UNSW Sydney; 2021. p. 9–16.
2 Australasian Society for HIV, Viral Hepatitis and Sexual Health Medicine (ASHM). Australian STI management guidelines for use in primary care. 2021. Available at http://www.sti.guidelines.org.au/sexually-transmissible-infections/chlamydia [accessed May 2022]
3 Gaydos CA. Chlamydia trochomaris. In: Goldman MB, Troisi R, Rextode KM, editors. Women and health. 2nd edn. San Diego, United States: Elsevier Science & Technology; 2013. pp. 445–59.
4 Goller JL, De Livera AM, Guy RJ, *et al.* Rates of pelvic inflammatory disease and ectopic pregnancy in Australia, 2009–2014: ecological analysis of hospital data. *Sex Transm Infect* 2018; 94(7): 534–41. doi:10.1136/sextrans-2017-053423
5 Subbaraman R, Nathavitharana RR, Mayer KH, *et al.* Constructing care cascades for active tuberculosis: a strategy for program monitoring and identifying gaps in quality of care. *PLoS Med* 2019; 16(2): e1002754. doi:10.1371/journal.pmed.1002754
6 Gray RT, Callander D, Hocking JS, *et al.* Population-level diagnosis and care cascade for chlamydia in Australia. *Sex Transm Infect* 2020; 96(2): 131–6. doi:10.1136/sextrans-2018-053801
7 The Royal Australian College of General Practitioners. Guidelines for preventive activities in general practice. 9th edn, updated. East Melbourne: RACGP; 2018. pp. 61–5.
8 Richey CM, Macaluso M, Hook EW III. Determinants of reinfection with *Chlamydia trachomatis*. *Sex Transm Dis* 1999; 26(1): 4–11. doi:10.1097/00007435-199901000-00002
9 Lang AS, An der Heiden M, Jansen K, *et al.* Not again! Effect of previous test results, age group and reason for testing on (re-) infection with *Chlamydia trachomatis* in Germany. *BMC Infect Dis* 2018; 18(1): 424. doi:10.1186/s12879-018-3323-2
10 Gaydose CA, Crotchfelt KA, Howell MR, *et al.* Molecular amplification assays to detect chlamydial infections in urine specimens from high school female students and to monitor the persistence of chlamydial DNA after therapy. *J Infect Dis* 1998; 177(2): 417–24. doi:10.1086/514207
11 Grulich AE, de Visser RO, Smith AMA, Risse CE, Richters J. Sex in Australia: sexually transmissible infection and blood-borne virus history in a representative sample of adults. *Aust N Z J Public Health* 2003; 27(2): 234–41. doi:10.1111/j.1467-842X.2003.tb00814.x.
12 Australian Institute of Family Studies, Australian Government. Age of consent laws in Australia; 2021. Available at https://aifs.gov.au/resources/resource-sheets/age-consent-laws-australia [accessed August 2023]
13 Australian Bureau of Statistics. Patient experiences in Australia: summary of findings. Canberra: ABS; 2019-20. Available at https://www.abs.gov.au/statistics/health/health-services/patient-experiences/2019-20 [accessed July 2023]
14 Gordon J, Britt H, Miller GC, *et al.* General practice statistics in Australia: pushing a round peg into a square hole. *Int J Environ Res Public Health* 2022; 19: 1912. doi:10.3390/ijerph19041912
15 Eastern Melbourne Primary Health Network. EMPHN needs assessment report; 2018. p. 36. Available at https://www.emphn.org.au/images/uploads/files/EMPHN-Needs-Assessment_Final-DoH-2018-2021.pdf [accessed July 2023]
16 Gippsland Primary Health Network. Gippsland PHN health needs assessment; 2021. p. 21. Available at https://gphn.org.au/wp-content/uploads/2022/04/Gippsland-PHN-Health-Needs-Assessment-November-2021-APPROVED-website-version.pdf [accessed July 2023]
17 Murray Primary Health Network. Population health needs assessment 2018-2022; 2018. p. 21. Available at https://www.murrayphn.org.au/wp-content/uploads/2019/02/Murray-PHN-Needs-Assessment.pdf [accessed July 2023]

18 North Western Melbourne Melbourne Primary Health Network. Health need assessement 2022 to 2025, p. 1. 2021. Available at https://nwmphn.org.au/wp-content/uploads/2022/06/NWMPHN-Health-Needs-Assessment-Summary_Public-Release.pdf [accessed July 2023]
19 South Eastern Melbourne Primary Health Network. Annual need assessment 2022-2025; 2022. p. 10. Available at https://irp.cdn-website.com/b60ea18f/files/uploaded/SEMPHN_2022%20Health%20Needs%20Assessment%20Upd.pdf [accessed July 2023]
20 Western Victoria Primary Health Network. WVPHN needs assessment; 2021. p. 7. Available at https://westvicphn.com.au/wp-content/uploads/2022/04/2021-WVPHN-Needs-Assessment-FINAL-Public.pdf [accessed July 2023]
21 The University of Melbourne. Data for decisions and the patron program of research. 2023. Available at https://medicine.unimelb.edu.au/school-structure/general-practice/engagement/data-for-decisions [accessed May 2022]
22 Therapeutic Guidelines. Approach to chlamydia trachomatis infection. 2022. Available at https://www.tg.org.au/ [accessed May 2022], subscription required.
23 Australian Government, Department of Health and Aged Care. Modified monash model 2021. 2023. Available at https://www.health.gov.au/health-topics/rural-health-workforce/classifications/mmm [accessed May 2022]
24 StataCorp. Stata statistical software: release 15. College Station, TX: StataCorp; 2017.
25 Adams G, Gulliford MC, Ukoumunne OC, *et al.* Patterns of intra-cluster correlation from primary care research to inform study design and analysis. *J Clin Epidemiol* 2004; 57(8): 785–94. doi:10.1016/j.jclinepi.2003.12.013
26 Hocking JS, Parker RM, Pavlin N, *et al.* What needs to change to increase chlamydia screening in general practice in Australia? The views of general practitioners. *BMC Public Health* 2008; 8: 425. doi:10.1186/1471-2458-8-425
27 Chow EPF, Hocking JS, Ong JJ, *et al.* Sexually transmitted infection diagnoses and access to a sexual health service before and after the national lockdown for COVID-19 in Melbourne, Australia. *Open Forum Infect Dis* 2021; 8(1): offa536. doi:10.1093/ofid/ofaa536
28 Bowring AL, Gouillou M, Guy R, *et al.* Missed opportunities-low levels of chlamydia retesting at Australian general practices, 2008-2009. *Sex Transm Infect* 2012; 88(5): 330–4. doi:10.1136/sextrans-2011-050422
29 Davies B, Ward H, Leung S, *et al.* Heterogeneity in risk of pelvic inflammatory diseases after chlamydia infection: a population-based study in Manitoba, Canada. *J Infect Dis* 2014; 210(Suppl 2): S549–S5. doi:10.1093/infdis/jiu483
30 Statista. Percentage of primary care physicians in selected countries using electronic medical records (EMR) as of 2019. 2023. Available at https://www.statista.com/statistics/236985/use-of-electronic-medical-records/ [accessed May 2022]
31 Canaway R, Boyle DI, Manski-Nankervis J-AE, *et al.* Gathering data for decisions: best practice use of primary care electronic records for research. *Med J Aust* 2019; 210(6): S12–6. doi:10.5694/mja2.50026
32 Walker J, Fairley CK, Walker SM, *et al.* Computer reminders for chlamydia screening in general practice: a randomized controlled trial. *Sex Transm Dis* 2010; 37(7): 445–50. doi:10.1097/OLQ.0b013e3181cfcb4c
33 Bissessor M, Fairley CK, Leslie D, *et al.* Use of a computer alert increases detection of early, asymptomatic syphilis among higher-risk men who have sex with men. *Clin Infect Dis* 2011; 53(1): 57–8. doi:10.1093/cid/cir271
34 Deeks A, Lombard C, Michelmore J, Teede H. The effects of gender and age on health related behaviors. *BMC Public Health* 2009; 9: 213. doi:10.1186/1471-2458-9-213

Data availability. The data that support this study cannot be publicly shared due to ethical or privacy reasons.

Conflicts of interest. Jane Hocking is an Associate Editor of *Sexual Health*. To mitigate this potential conflict of interest they were blinded from the review process. All other authors declare that they have no conflicts of interest.

Declaration of funding. This research project is supported by the Royal Australian College of General Practitioners with funding from the Australian Government under the Australian General Practice Training program.

Acknowledgements. This research used de-identified patient data from the Patron primary care data repository (extracted from consenting general practices), that has been created and is operated by the Department of General Practice, The University of Melbourne: www.gp.unimelb.edu.au/datafordecisions. We thank participating general practices who shared their data and made this study possible.

Author affiliations

[A]Department of General Practice, Melbourne Medical School, University of Melbourne, Carlton, Vic., Australia.

[B]Melbourne Sexual Health Centre, Alfred Health, Melbourne, Vic., Australia.

[C]Melbourne School of Population and Global Health, University of Melbourne, Carlton, Vic., Australia.