Applied Epidemiology in North Coast NSW

A thesis submitted for the degree of Master of Philosophy (Applied Epidemiology) at
The Australian National University

Dr Megan Ellis

2023–2024

FIELD PLACEMENT

North Coast Population and Public Health (NCPPH)

ACADEMIC SUPERVISORS

Dr Rosalina Sa`aga-Banuve and Prof Tony Stewart

FIELD SUPERVISORS

Robin Auld and Genevieve O'Neill

North Coast Population & Public Health Directorate

Australian National University

ORIGINALITY STATEMENT

I hereby declare that this submission is my own work and to the best of my knowledge, does not contain materials previously published or written by another person, or substantial proportions of material accepted for the award of any other course of study at the Australian National University or another educational institution, except where due acknowledgement is made. Any contribution to this research made by others is acknowledged in the thesis. The intellectual content of this thesis is the product of my own work, except where the assistance of others in the project's design, conception, style, presentation, or wording is acknowledged.

M. Ellis

Megan Ellis

25 October 2024

ACKNOWLEDGEMENTS

The highlight of my MAE journey has been all the wonderful people I have met and learnt from over the past 20 months. This thesis would not be possible without the guidance of my amazing supervisors. Rosa, thank you for your warmth, encouragement and rapid responses even when you were overseas. Many thanks to Tony for your insightful feedback and expertise. Thank you Robbie, for always being approachable, producing great ideas for my projects and being dedicated to my progress. Gen, thank you so much for your support and patience, especially during the challenging phases of this program, making me laugh with your stories and being a wonderful role model.

I feel incredibly fortunate to have worked with many talented and welcoming individuals at NCPPH. A big shout out to Jen Heslop for her help with my epi project and giving me the opportunity to get involved in the Hep C DBS and PASH events. I am grateful to have been included as a member of the epi team, thanks Rach for always being a friendly face and source of great humour. Thank you Jess de Dassel, for all your amazing editing skills and sharing your academic expertise, in addition to making the Coffs office a fun place to work – I will miss the baked goods and dress up Fridays.

Thank you to my AFPHM mentor Michael Douglas, for supporting both my career and personal development. I am very grateful to Valerie Delpech for being my AFPHM supervisor and field placement director, thanks for sharing your wisdom and guidance throughout my placement.

Many thanks to the ANU MAE teaching and administration staff and my MAE 2023–24 cohort members, in particular I would like to thank my MAE buddy PJ for listening to my rants, appreciating my memes and coming up with the best puns.

Finally, thank you to my family for your patience, love and support, which was best displayed when you drove my car from Perth to Coffs while I was at ANU for course block.

Abstract

I undertook my Master of Philosophy in Applied Epidemiology (MAE) placement at North Coast Population and Public Health (under NSW Health) in Coffs Harbour from March 2023 to October 2024. This thesis presents the activities and projects I was involved in during my placement.

The first chapter provides an overview of my field placement and the activities I was involved in. The second chapter presents an epidemiological study examining syphilis testing trends for people who use drugs attending sexual health services in North Coast NSW between 2022 and 2023. Chapter three reports an investigation of a gastrointestinal illness outbreak in attendees to a Tweed Heads birthday dinner. The fourth chapter is a data analysis of Q fever notifications in North Coast NSW between 2014 and 2023. The fifth chapter presents the evaluation of the residential aged care facilities acute respiratory infection outbreak surveillance system in North Coast NSW. Finally, chapter six details my teaching experience during the lessons from the field and teaching first year MAE students' sessions.

The work presented in this thesis demonstrates my ability to meet the core competencies required for the MAE program and contribute to public health research and practice.

TABLE OF CONTENTS

Chapter I

MAE field placement overview

Overview of experiences at North Coast Population and Public Health

CHAPTER CONTENTS

ABBREVIATIONS

AFPHM	Australasian Faculty of Public Health Medicine
ANU	The Australian National University
CALD	Culturally and Linguistically Diverse
DBS	Dry Blood Spot
LHD	Local Health District
MAE	Master of Philosophy in Applied Epidemiology
MNC	Mid North Coast
NCIMS	Notifiable Conditions Information Management System
NCPPH	North Coast Population and Public Health
NDARC	National Drug and Alcohol Research Centre
NSW	New South Wales
NNSW	Northern New South Wales
PASH	Positive Adolescent Sexual Health
PCR	Polymerase Chain Reaction
TGA	Therapeutic Goods Australia
SAFETYNET	South Asia Field Epidemiology and Technology Network

ACKNOWLEDGEMENT OF COUNTRY

I acknowledge the traditional owners of the land covered by the North Coast Population and Public Health: the Bundjalung, Githabul, Gumbaynggirr, Yaegl, Birpai, Dunghutti and Nganyaywana Nations.

MAE FIELD PLACEMENT

I commenced my Master of Philosophy in Applied Epidemiology (MAE) field placement at North Coast Population and Public Health (NCPPH) on the 6th of March 2023. Concurrent to this I embarked on the start of my advanced training in Public Health Medicine (AFPHM).

NCPPH is regional Public Health Unit managed and funded via Mid North Coast (MNC) Local Health District (LHD) and delivered across both MNC and Northern NSW (NNSW) LHDs.[1] The north boundary is Tweed Heads and the south boundary is Johns River, see maps below (Figure 1 and 2).[2, 3] There are offices in Coffs Harbour (where I was based), Port Macquarie and Lismore as well as clinics located throughout the region.[1] The estimated population in 2021 for MNC was 226,422 residents and for NNSW was 304,857 residents.[2, 3] Of this population, ~6.7% in MNC and ~5.7% in Northern NSW identified as Aboriginal and/or Torres Strait Islander, compared to 3.4% in NSW and 3.2% in Australia.[4] The traditional custodians of the lands encompassing NCPPH include the Bundjalung, Githabul, Yaegl, Birpai, Dunghutti, Gumbaynggirr and Nganyaywana Nations.

Figure 1. Mid North Coast LHD[2]

Figure 2. Northern NSW LHD[3]

NCPPH is led by the Director of Public Health who reports to the MNC Chief Executive. NCPPH serves a broad range of functions including Aboriginal public health, epidemiology, bio-preparedness, refugee health, communicable disease, environmental health, tuberculosis, sexual health, hepatitis clinics, needle syringe programs and immunisation. My position was under the epidemiology team, however I was able to work with members from various teams as part of different projects and activities.

EXPERIENCES DURING MY PLACEMENT

Routine reporting

As a member of the epidemiology team, I was involved in routine monitoring of communicable disease. I regularly prepared and presented reports on notifiable conditions for the region and the respiratory illness summary report. This gave me exposure to using the Notifiable Conditions Information Management System (NCIMS), hospital records (Powerchart), emergency department data (PHREDDS), R software and PowerBI. It was a great chance to learn more about diseases in this region and improve my written and oral presentation skills. I enjoyed combining information from different data sources and considering contextual factors to better understand disease trends and guide public health action.

Scabies in CALD seasonal workers

I had a major involvement in the public health unit's management of a scabies outbreak in international seasonal workers at a hostel in Coffs Harbour. It was interesting working with CALD (culturally and linguistically diverse) populations, learning more about their culture and working together to manage issues relating to language barriers and reduced access to healthcare. I learnt a lot about scabies, risk management, health promotion and environmental health. I was responsible for liaising with the general practitioners and pharmacists. A major issue we had to manage was the national shortage of permethrin, which greatly impacted small regional areas, however we were able to successfully source enough permethrin by pooling together stock from different community pharmacies in Coffs Harbour. This was a good example of an outbreak where the aim was control instead of investigation, due to the numerous barriers making it difficult for the seasonal workers to access healthcare we decided to treat all those at risk with permethrin instead of waiting for formal medical diagnosis.

NDARC symposium

I was fortunate to receive a travel scholarship from the National Drug and Alcohol Research Centre (NDARC) to attend their annual research symposium in October 2023 as an early career researcher. This was an excellent opportunity to network and learn from many great academics in this field which I am passionate about. There was a large emphasis on rural and regional drug and alcohol issues which was relevant to my region. I met other drug and alcohol clinicians in North Coast NSW who invited my public health unit to join their research node focusing on local drug and alcohol research.

<u>PASH conference</u>

I was involved in the 2023 Positive Adolescent Sexual Health (PASH) conference and community forum. The 3-day event was attended by over 650 high school students. The conference involved 16 topics and 153 concurrent sessions covering topics including contraception, sexually transmitted infections, gender identity, tattoos, party drugs and mental health. My role was to be a welfare officer and assist with logistics. I really enjoyed meeting the various speakers and supporters at the event and hearing about their diverse backgrounds (such as sexual health nurses, lawyers and social activists) and learning about the various organisations that help youth overcome barriers to accessing sexual health and related services in regional Australia.

<u>Health promotion at the Splendour in the Grass Music Festival</u>

I was grateful to be given the opportunity to take part in health promotion activities run by PASH at the 2023 Splendour in the Grass festival. It was Australia's largest music and arts festival with around 35,000 patrons estimated per day. I was based at the two PASH tents, providing education to patrons about topics relating to sexual health, drug and alcohol and blood borne viruses. Other health promotion activities included handing out safe sex packs as well as distributing infographic posters about syphilis. Overall, it was great to play an active role in this public health intervention that was able to effectively target a group of high-risk individuals who are less likely to engage with health services in the community.

<u>Hep C DBS validation sub-study</u>

Dry blood spot (DBS) testing for hepatitis C has been introduced with much success in NSW. The aim of this sub-study was to validate hepatitis C DBS results against routine Polymerase Chain Reaction (PCR) venepuncture testing, with the ultimate aim of getting Therapeutic Goods Australia (TGA) approval and funding for more widespread use of DBS nationally. This sub-study was run in collaboration between Ministry of Health and NCPPH. It involved 1000 participants at a large prison facility. I was involved in planning of the activation, including budgeting and logistics. I was also involved in data collection in the prison which involved setting up, consenting participants, data entry and preparing pathology samples for processing.

<u>Housing for Health Ballina Project</u>

I was incredibly excited to be involved in the Housing for Health Ballina Project in March 2024. The NSW Housing for Health program aims to improve health for Aboriginal people and communities by improving their living environment following the 'Housing for Health Methodology'.[5] I was involved in Survey-Fix 2 which is the second phase of testing and fixing health-hardware need to undertake practices in the home to maintain residents' personal health and safety. Together with the NCPPH environmental health team we assisted 12 local community members to complete house surveys for 29 houses owned or managed by the Burabi and Bunjum Aboriginal Corporations.

1st SAFETYNET Scientific Conference

In September 2023, I volunteered at the 1st South Asia Field Epidemiology and Technology Network (SAFETYNET) Scientific Conference held at the Australian National University (ANU) campus in Canberra. This was a fantastic networking occasion and opportunity to hear about field epidemiology studies and investigations performed by my overseas counterparts.

Summary of activities related to MAE competency requirements

This is a summary of the projects and other activities I completed to satisfy the required MAE core requirements:

Design and conduct an epidemiological study

- Syphilis testing trends for people who use drugs attending sexual health services in North Coast NSW, a retrospective cohort study.

Investigation of an acute public health problem or threat (typically a disease outbreak)

- Investigation of a gastrointestinal illness outbreak at a birthday dinner in a Tweed Heads restaurant.

Analysis of a public health dataset

- Epidemiology of Q fever notifications in North Coast NSW
- The analysis of public health datasets was also performed in my epidemiological project on syphilis testing trends for people who use drugs attending sexual health services as well as my evaluation of the residential aged care facility acute respiratory infection outbreak surveillance system in North Coast NSW.

Evaluation of a surveillance or other health information system

- Evaluation of the residential aged care facility acute respiratory infection outbreak surveillance system in North Coast NSW.

Literature review

- All projects involved a targeted literature review to develop the study protocol and were later used to write the introduction and discussion sections of the chapters.
- The search strategy I used for the epidemiological study examining the literature on syphilis and substance use is summarised in Chapter II.

Lay summary

- In October 2023, I prepared a written media statement for the MNC and NNSW LHD media team targeted at parents of school aged children, advising them to continue monitoring for respiratory and gastrointestinal illness symptoms in their children even after the winter season and encouraging them to respond appropriately. See Appendix A for the document I wrote.

Preparation of an advanced draft of a paper for publication

- The epidemiological study presented in Chapter II is an advanced draft of a paper that I will be submitting to the Medical Journal of Australia.

An abstract and oral presentation of the project at a scientific conference

- ISBRA and APSAAR: 3rd World Congress on Alcohol and Addictions
    - Melbourne, September 2024
    - Oral presentation (10 minute)
- 25th IUSTI World Congress incorporating the Australasian Sexual and Reproductive Health Conference
    - Sydney, September 2024
    - Poster presentation
- NSW Epi grand rounds
    - Virtual, July 2024
    - Presented with co-speaker Dr Kym Collins as part of a "Syphilis in North Coast NSW" presentation

A summary of the scholar's teaching experience.

- Lessons from the field session on point of care test validation in a prison setting
- Teaching to first year scholars on public health in different contexts

Table 1 provides a summary of the MAE course requirements and the chapter they are located in within this thesis.

Table 1: Summary of MAE core competencies, by thesis chapter

	Thesis chapter					
MAE core competencies	I	II	III	IV	V	VI
Evaluating a surveillance system					✓	
Investigation of an acute public health problem			✓			
Analysis of a public health dataset		✓		✓	✓	
Design and conduct an epidemiological study		✓				
Literature review		✓				
Communication with a lay audience	✓					
Conference presentation		✓				
Draft for peer-review publication		✓				
Teaching field epidemiology						✓

REFERENCES

1. Mid North Coast Local Health District. About the North Coast Public Health Unit (NCPHU) [Internet]. [cited 2023 March 8]. Available from: https://mnclhd.health.nsw.gov.au/public-health/about-the-north-coast-public-health-unit-ncphu/.
2. NSW Health. Mid North Coast. [cited 2023 March 8]. Available from: https://www.health.nsw.gov.au/lhd/Pages/mnclhd.aspx.
3. NSW Health. Northern NSW. [cited 2023 March 8]. Available from: https://www.health.nsw.gov.au/lhd/Pages/nnswlhd.aspx.
4. Australia Bureau of Statistics. 2021 Census Aboriginal and/or Torres Strait Islander people. Australia Bureau of Statistics; 2021. Accessed 2023 March 13. Available from: https://abs.gov.au/census/find-census-data/search-by-area
5. NSW Health. Housing for Health [Internet]. Sydney (AU): NSW Health; 2021 [updated 2021 Jul 26; cited 2024 Apr 8]. Available from: https://www.health.nsw.gov.au/environment/aboriginal/Pages/housing-for-health.aspx.

APPENDIX

Appendix A: Lay summary - NSW Health advice to parents ahead of children returning to school (media statement)

Although the winter season has passed respiratory and gastrointestinal viruses remain in the community and can still cause serious illness. Children attending schools and early childcare centers are at increased risk of infection due to their close proximity to large groups of people. With the upcoming return to school, it is important that parents continue to follow health advice to prevent the spread of these highly contagious illnesses.

Director North Coast Population and Public Health, Dr Valerie Delpech, said "there has been a 90% increase in COVID-19 cases in North Coast NSW residents in the last four weeks (from 64 to 121 cases a week). Influenza and RSV (respiratory syncytial virus) also remain a concern, especially in children aged 5 years and under."

"It is important that if your child becomes unwell that they do not attend school, childcare or other gatherings to prevent the spread of disease in our community. They should also have a rapid antigen or PCR test to determine if they have COVID-19" Dr Delpech said.

If your child has any of these symptoms, please keep them at home:

- Fever and/or they are taking fever-reducing medication (like paracetamol) to control their fever.
- Cold or flu symptoms (runny nose, sore throat, cough).
- Vomiting or diarrhoea.

Protect yourself and others around you from the virus by:

- Washing your hands often for 20 seconds with soap and water.
- Using alcohol-based hand sanitizers when you can't use soap and water.
- Avoiding touching your eyes, nose and mouth.
- Cover coughs and sneezes with a tissue OR sneeze into your elbow instead of your hands.
- Ensuring indoor spaces are well ventilated.
- Cleaning and disinfecting surfaces you use often, like benchtops, desks and doorknobs.
- Keep up to date with vaccines.

If you are concerned about your child's health, please seek early medical review from your doctor. Health advice and information is also available via the free Healthdirect Australia service, staffed by registered nurses 24-hours a day, on 1800 022 222. Visit the link Raising Children Network for additional resources for parents and carers on how to keep their children healthy.

Chapter II

Design and conduct an epidemiological study

Syphilis testing trends in people attending sexual health services in North Coast NSW, by self-reported substance use: a retrospective cohort study

CHAPTER CONTENTS

PROLOGUE

Study rationale

Since 2020 there has been an outbreak of infectious syphilis cases in North Coast New South Wales (NSW). This study utilised sexual health service syphilis testing data to improve our understanding of the epidemiology of syphilis in this region. It aimed to determine if the rise in syphilis notifications, particularly in women and their sexual partners, could be related to substance use. It also provided insight into the coverage of syphilis testing for different demographic groups. This is one of the first studies, to our knowledge, examining the relationship between syphilis test positivity and substance use in regional Australia. Substance use is a major issue in North Coast NSW and it is important for us to determine the potential impact it can have on other public health issues.

My role

The idea for this project was conceived by my field supervisors with my input in response to the recent syphilis epidemic in our region and because of my interest in addiction medicine. To assess the validity of the substance use variable for measuring recent substance use in an individual, I performed an audit prior to this study comparing Community Health and Outpatient Care (CHOC) substance use data with the more detailed and regularly updated electronic medical record notes. I analysed the substance use information recorded for 130 randomly selected SHS clients and found that there were very few records with conflicting substance use classifications between datasets, suggesting that this variable in the CHOC data is likely a valid measure of an individual's recent substance use.

I prepared the study protocol and ethics applications with input from the sexual health team. Once I received data extracted by the clinical systems program lead, I performed data cleaning and analysis in R, with advice from the Australian National University (ANU) statisticians and my supervisors. Finally, I led the writing of the manuscript and prepared the presentation of this work as a poster and oral presentation for conferences and the NSW Health epi grand rounds.

Lessons learnt

This project substantially improved my knowledge on sexual transmitted infections and the impact of social factors on disease risk and transmission. This was my first opportunity to use my new R skills to perform statistical tests and produce figures and tables. I was very grateful for the passion and support of the sexual health team and greatly valued their input when developing the study protocol, analysing the data and preparing the manuscript. I really enjoyed the intersection of substance use, public health and sexual health that this project provided.

Preparing for the conference presentations I learned that a lot of consideration goes into the design of a poster and that for both oral presentation slides and poster presentations often “less is more” and images and figures are the most important aspect.

Public health implications

This study provides further evidence towards the relationship between substance use and syphilis. Importantly it provides support for this association occurring in regional settings. The study suggests that people who use substances could potentially be affected by the syphilis outbreak in this region. A major intervention to control syphilis outbreaks is early testing, treatment and contact tracing which is why identification of priority groups is important. This study suggests that future public health interventions in our regions should target people who use substances, especially those reporting recent injecting drug use, women and young adults. This could take the form of point of care screening programs in needle syringe program sites or targeted health promotion campaigns at drug and alcohol clinics.

MAE course requirements

The following MAE core course requirements were completed with this project: design and conduct an epidemiological study, analysis of a public health dataset; preparation for journal article submission and conference presentation.

Acknowledgements

I would like to thank Dr Dan Chateau, Dr Erin Walsh, Dr Tsheten Tsheten and Daniel Berry for your assistance with the statistics and R. I am incredibly grateful for the HIV and related programs (HARP)/ sexual health team for offering their valuable input and assistance. In particular, I would like to thank Jen Heslop, Mark Fuller, Dr Vincent Cornelisse, Dr Jane Schapiro, Dr Geoffrey Stewart and Dr Kym Collins. I would like to acknowledge the NCPPH director Dr Valerie Delpech for her wonderful insight and advice as well as epidemiologist Dr Jess de Dassel for her fantastic data visualisation and editing skills. Finally, I would like to thank my amazing supervisors Prof Tony Stewart, Dr Rosalina Sa’aga-Banuve, Robin Auld and Genevieve O’Neill for their contribution at all stages of this project’s journey.

Literature review

As part of the preparation for this study, I performed a targeted literature review to guide the development of my research question and proposal. I searched the PubMed database, key words used included: “syphilis” AND “drug use*” OR “substance use*”. I filtered by year range from 2013 to current and only included full texts. In addition to this I identified relevant journal articles from snowballing by reference scanning and citation tracking.

Presentation opportunities

I presented this study at the following conferences/ events:

- 25th IUSTI World Congress incorporating the Australasian Sexual and Reproductive Health Conference
    - Sydney, September 2024
  - Poster presentation (Appendix E)
  - IUSTI early career/ student full scholarship recipient
- ISBRA and APSAAR: 3rd World Congress on Alcohol and Addictions
    - Melbourne, September 2024
    - Oral presentation (10 minute) (Appendix F)
- NSW Epi grand rounds
    - Presented virtually in collaboration with Dr Kym Collins as part of a "Syphilis in North Coast NSW" presentation
    - Our presentation was shared (on request) to other NSW LHDs for use by syphilis working groups and drug and alcohol services.

Preparation of an advanced draft of a paper for publication

This project has been formatted as a manuscript for submission to the Medical Journal of Australia. Please note that figures and tables are at the end of the chapter as per journal guidelines.

ABBREVIATIONS

aRR	Adjusted relative rate
CHOC	Community Health and Outpatient Care
CI	Confidence interval
eMR	Electronic medical records
HARP	HIV and related programs
IVDU	Intravenous drug use
LHD	Local Health District
MAE	Master of Philosophy in Applied Epidemiology
MNC	Mid North Coast
MSM	Men who have sex with men
NCPPH	North Coast Population and Public Health
Non-PWUD	People who do not use drugs
NNSW	Northern New South Wales
NSW	New South Wales
PCR	Polymerase chain reaction
PWUD	People who use drugs
RPR	Rapid plasma reagin
RR	Relative rate
SHS	Sexual health services
STI	Sexually transmitted infections
TPPA	Treponema pallidum particle agglutination

Draft manuscript

Authors

Megan Ellis[1,2], Robin Auld[1], Kym Collins[1], Vincent J Cornelisse[1,3,4], Jenny Heslop[1], Genevieve K O'Neill[1], Rosalina Sa'aga-Banuve[2], Jane Shapiro[1], Tony Stewart[2] and Valerie Delpech[1]

[1]North Coast Population and Public Health, NSW Health.

[2]Australian National University.

[3]Kirby Institute, University of New South Wales, Sydney.

[4]School of Translational Medicine, Monash University, Melbourne.

Acknowledgements

We acknowledge the sexual health, communicable disease and health promotion staff (HIV and related programs (HARP)) at the North Coast Population and Public Health Directorate and the Traditional owners of the land on which we work and live.

Data sharing statement

The de-identified data we analysed are not publicly available, but requests to the corresponding author for the data will be considered on a case-by-case basis.

Competing interests

No relevant disclosures.

Abstract

Objective: Examine the relationship between substance use and syphilis testing trends for clients tested at sexual health services (SHS) in a regional setting.

Study design: Retrospective analysis of de-identified, routinely collected sexual health syphilis testing data.

Setting, participants: Clients aged 16 years and over seen at six SHS clinics on the North Coast of NSW between 1 January 2022 to 31 December 2023

Main outcome measures: Syphilis positive test count, test positivity rate and relative rates.

Results: We included a total of 4,952 tests in the analysis. People reporting substance use had a syphilis test positivity which was 3.2 times higher than those who did not report substance use (11.3% vs 3.5%, relative rate (RR) 3.2, 95% confidence interval (CI) 2.34–4.31). We observed a statistically significant association between recency of intravenous drug use and positivity rate. The highest

positivity rate was in people reporting injecting drug use in the past three months (18.9%, RR 6.8, CI 4.4–10.3), followed by people reporting injecting drug use in the last 3–12 months (14.5%, RR 5.3 CI 2.5–9.8), people reporting non-injecting drug use (6.6%, RR 2.4, CI 1.3–4.1) and people reporting injecting drug use longer than 12 months ago (4.4%, RR 1.6 CI 0.8–4.1).

Conclusions: We found a strong relationship between recent substance use, including injecting drug use, and syphilis among SHS clients in a regional setting. The study highlights the importance of promoting syphilis testing and other targeted health promotion interventions among people who use drugs.

SUMMARY BOX

The known: The North Coast of NSW is experiencing an outbreak of infectious syphilis with a concerning rise among women and their sexual partners.

The new: People reporting substance use had greater syphilis test positivity rates compared to those who did not. Rates were highest in young adults, women and those who reported recent intravenous drug use.

The implications: We should prioritise people who use substances when designing syphilis screening programs and other public health interventions.

INTRODUCTION

A worldwide resurgence of syphilis cases has seen incidence rise by 60% between 1999 and 2019.[1] In Australia, infectious syphilis (less than 2 years since the date of onset) notifications have more than tripled over the past decade from 2,058 in 2014 to 6,413 notifications in 2023.[2] Those at highest risk include Aboriginal and/ or Torres Strait Islander people, especially in remote communities, and men who have sex with men (MSM).[3] However, there has been a recent shift in the demographics of cases, with an increase in the positive test rate and notifications of females and their sexual partners.[4] Female infectious syphilis notifications in Australia rose nearly eight-fold from 2014 to 2023.[2] Syphilis in females of reproductive age is of particular concern because of the risk of congenital syphilis, which can result in stillbirth, neonatal death, premature birth, and clinical syphilis in the newborn.[5]

North Coast NSW, hereafter referred to as North Coast, encompasses both the Mid North Coast and Northern NSW Local Health Districts (MNC LHD and NNSW LHD). Since 2020, there has been an outbreak of infectious syphilis in this region. By 2023 there were 79 cases of infectious syphilis in the North Coast, which was 3.9 times greater than the five-year average between 2015 and 2019.[6] Similar to trends seen elsewhere there was a marked rise among women of reproductive age and their sexual partners in the North Coast, especially in MNC LHD.[6]

Targeted and effective public health responses to syphilis outbreaks must be informed by an understanding of local epidemiological drivers. The National Drug Strategy Household Survey 2019 reported that North Coast had the highest proportion of people engaging in recent illicit drug use in Australia.[7] Alcohol use was also disproportionately higher in this region with 23.7% of people reporting risky use in their lifetime (age-standardised per cent).[7] During the North Coast syphilis outbreak, sexual health clinicians noted an increase in substance use reported in those testing positive for syphilis. Over the years numerous overseas studies have found an association between substance use and sexually transmitted infections (STIs), including syphilis.[8, 9] In Australia, the few studies which have examined injecting drug use as a risk factor for syphilis have largely been conducted in major cities[4, 10] The aim of this study was to examine the relationship between syphilis testing trends and substance use in North Coast sexual health service (SHS) clients.

METHODS

Study population and design

A retrospective cohort study of routinely collected data at North Coast SHS was performed. This included data from all six SHS clinics in the North Coast region. The study population inclusion criteria were clients tested for syphilis at the North Coast SHS between 1 January 2022 and 31 December

2023 (inclusive) and exclusion criteria were clients aged less than 16 years at the time of specimen collection. SHS in North Coast are free and available for anyone attending their service, STI screens are offered to clients who request one or have an increased risk of an STI. Current STI testing guidelines recommend syphilis testing for all people who have a STI screen.

Variable definitions

As part of routine clinical reporting, sexual health clinicians recorded if clients were engaging in recent substance use (yes/no). Clients categorised as “yes” reported using illicit substances and/or misusing licit substances, including alcohol; they are herein referred to as “People who use drugs (PWUD)”; those categorised as “no” as “non-PWUD”.

A positive syphilis test was defined as a positive *Treponema pallidum* nucleic acid amplification test (e.g. on a swab of a syphilis lesion), or reactive treponemal serology test (e.g. *Treponema pallidum* particle agglutination, TPPA), or reactive non-treponemal serology test (e.g. rapid plasma reagin, RPR).[3]

When examining the demographics of clients tested, we used “gender” which was a combination of the sex and current gender identity variables. For analysis of test positivity only the gender identity variable was used.

Data collection and extraction

As part of routine care, SHS clinic data are routinely entered into the Community Health and Outpatient Care electronic medical records (CHOC eMR) by SHS clinicians after client interactions and include data on client demographics and syphilis test results. Data from 1 January 2022 to 31 December 2023 were extracted from the CHOC database into Excel spreadsheets (Microsoft Office 2013; WA, USA) on 18 January 2024 for this study.

Data Analysis

Statistical analyses were performed with R version 4.3.1.[11] Duplicate records were removed, however recurrent client interactions which involved repeat syphilis testing (at different time points) for the same individual were included.

Test positivity rate was the number of positive tests which detected syphilis divided by total number of syphilis tests, expressed as a percentage. Descriptive analysis of syphilis total test count and positive test count was conducted according to gender, age group, Indigenous status, geographical location, sexual orientation, history of incarceration, sex work, substance use and injecting drug use risk. Results were aggregated and cell counts less than five were displayed as “<5” to prevent identification of individuals.

To compare test positivity between the substance use groups and for each demographic risk factor, relative rate and confidence intervals were generated using Poisson regression. Multivariate analysis of PWUD syphilis test positivity rates was performed using Poisson regression models to determine adjusted relative rates (aRRs) with 95% confidence intervals (CI). Variables were included in the model if $p<0.05$ in the initial univariate analyses. To determine syphilis trends over time the Cochrane Armitage test of trend was performed separately for PWUD and non-PWUD groups. Statistical significance was set at $p<0.05$.

Ethics

The project was approved by the North Coast NSW Human Research Ethics Committee (Ethical Approval Number HREA376 2023/ETH01062) and Australian National University Human Research Ethics Committee (Ethics Approval Number H/2023/1269).

RESULTS

There were 4,952 syphilis tests meeting the study's inclusion and exclusion criteria (Figure 1). Table 1 summarises the demographics of clients tested. The median age of clients was 35 years (interquartile range: 27–50 years). MNC accounted for 31% of the tests (see Table 1). The proportion of people who were PWUD was greater in MNC compared to NNSW (12.4% vs 9.0%). Overall, syphilis test positivity for all clients was 4.3%.

Univariate analysis

Test positivity rate was 3.2 times greater among PWUD compared to non-PWUD (Table 2). Syphilis test positivity was greatest in those who injected drugs in the past 3 months, followed by the past 3–12 months (Figure 2). Non-injecting drug users and those with unknown drug use history also had a significantly higher test positivity compared to those who did not report any drug use (Figure 2).

For the PWUD group, univariate analysis showed that syphilis test positivity was significantly greater in: clients residing in MNC, identifying as heterosexual or bisexual, women, clients reporting a recent history of incarnation and those aged between 16–30 years (Table 3).

In those reporting history of sex work (n=240), test positivity was 2.0% (1/50) in the PWUD group and 2.1% (4/190) in the non-PWUD group. Due to low numbers, further analysis was not performed.

Multivariate analysis

We reduced the number of parameters entered into the multivariate model, due to limitations in modelling as a result of the low number of positive tests (n = 54) and missing demographic data (Table 4). Test positivity rate for PWUD was 4.39 greater in MNC compared to NNSW (95% CI 2.29–9.15, p

<0.001). Test positivity rate in PWUD women was over double the rate for men (aRR 2.36, 95% CI 1.30–4.31, p = 0.005). Test positivity was significantly greater in PWUD clients aged 16–30 years compared to those aged 31 years and older (aRR 1.78, 95% CI 1.01–3.10, p = 0.043). There was no significant difference in aRR between the PWUD heterosexual group and the combined homosexual, bisexual or queer group (aRR 1.25, 95% CI 0.66– 2.46, p = 0.50) (Table 4). Due to limitations in modelling, the history of incarceration variable was unable to be included in multivariate analysis.

Changes in testing and test positivity over time

There was a general rise in the number of syphilis tests performed in non-PWUD clients over the study period with a corresponding significant decrease in positivity over the study period (p <0.001) (Figure 3).

Testing for the PWUD group was fairly stable over time, however there was a notable rise in testing performed in the final quarter (Oct–Dec 2023) (Figure 4). No significant trend was found for PWUD positivity rates over time (p = 0.08).

Discussion

Our study found that people attending North Coast sexual health services with a recent history of drug use were more likely to test positive for syphilis than people without a history of drug use. Women were at greater risk than men. Recent IVDU was associated with the highest syphilis test positivity rate, however non-injecting drug use was also associated with a higher test positivity rate compared to people who reported no drug use.

The association between substance use and syphilis test positivity is likely due to a combination of biological, behavioural and social factors.[12] Substance use can directly influence syphilis transmission risk through its effect on sexual behaviour. Some substances can lead to an increase in the number of sexual encounters by heightening sexual desire and decreasing sexual inhibition.[13] In particular, methamphetamine, has been associated with an increased number of casual sex partners and condomless casual sex.[14, 15] Overall, the contribution of substance use to number of sexual interactions and high risk sexual behaviour can result in greater risk of syphilis transmission leading to an increased positive test count and therefore positivity.

Social factors contribute to both disease prevalence and test coverage. PWUD may have lower engagement with health services due to stigma, discrimination and mistrust of health staff which results in less frequent STI screening and delays in diagnosis, treatment and contact tracing leading to increased syphilis transmission and prevalence.[16]

A major contributor to the raised test positivity in PWUD is the network effect.[17] PWUD often have interrelated social networks, making them more likely to be sexually active with a network of people who also use substances and infrequently screen for syphilis therefore increasing their risk. This effect could be further amplified by chemsex, whereby people utilise substances to facilitate or enhance sexual encounters. Although typically associated with MSM, it is possible that chemsex in heterosexual networks could be contributing to the increasing rates of syphilis seen in this cohort.

PWUD are also more likely to experience other socioeconomic disadvantages which increases their risk of syphilis while also decreasing their likelihood of health service contact and testing. A review of female infectious syphilis cases in British Columbia found that those who used substances were significantly more likely to have a history of unstable housing, mental illness, income assistance and street involvement.[18] Similarly, Dickson-Gomez et al.[19] found that precarious housing situations were linked with increased frequency of substance use and sexual risk behaviours.[19]

In this study we saw that PWUD test positivity was significantly greater in people who had a recent history of incarceration. This is not surprising as people in prison are a well-established high-risk group for STIs.[20] A survey of NSW and Queensland people in prison found that 2.7% of males and 4.2% of females reported previous history of syphilis.[21] This could be related to sexual behaviour, for example it was found that both heterosexual male and female people in prison had a greater number of lifetime opposite-sex partners compared to the general community.[21] Consistent with our findings, a study of females engaging in substance use in Oakland, California found that history of incarceration in the past year was associated with increased odds of a recent STI.[22] In that study, transactional sex was found to be a major contributor to this risk, it was proposed that even short periods of incarceration can disrupt an individual's relationships, housing and employment which can lead to reliance on sex exchange and therefore increase transmission risk.[22]

There is currently limited evidence in the literature of non-sexual transmission of syphilis from shared needles. Loza et al.[23] found a significant association between syphilis titres and frequency of injecting drug use as well as receptive needle sharing in the past month, however causality cannot be established due to numerous confounders. [23]

Among PWUD, we found that syphilis test positivity rates were greatest in women and those aged 16–30 years. This is very concerning due to the potential risk of congenital syphilis in this group. Similarly, Carter et al.[4] found that syphilis positive test rates for women tested in sexual health clinics in Australian cities were greater in those reporting recent IVDU. An association between increased drug use and syphilis notifications in females has also been reported in studies in Canada and the United States.[16,24,25] A study from Copen et al.[26] found that amongst people engaging in substance use with syphilis, women were more likely to participate in transactional sex (35%), compared to MSW (16.8%) and MSM (16.6%, p<0.0001). Transactional sex is typically risky and could be contributing to the increased syphilis test positivity seen in women in our study setting. This finding could also be a result of differences in testing coverage between genders at SHS. MNC LHD has seen a rise in heterosexual syphilis cases in the past few years, some local health professionals believe this is likely the result of a few untreated individuals transmitting the disease to the heterosexual network in this region. The higher test positivity could also reflect the targeted testing of women identified through contact tracing by SHS, and the rate is therefore unlikely to be representative of the wider community.

The population of NNSW is 1.3 times greater than MNC, however the test count was 2.2 times greater in NNSW suggesting MNC has poorer testing coverage.[27] This could be due to the increased awareness and access to SHS and STI testing in NNSW. NNSW has a higher proportion of MSM and historically has dedicated more resources to local SHS and community engagement.

We found that MNC had significantly greater syphilis test positivity rates compared to NNSW. The reason for this disparity between LHDs could be due to differences in social and cultural demographics of the populations, for example MNC has a greater proportion of Aboriginal and/ or Torres Strait Islander people, who have higher reported rates of syphilis.[3]

Differences in test positivity could also reflect the greater use of substances in MNC. We found a greater proportion of PWUD tested for syphilis at SHS in MNC over NNSW. While there is currently limited data on substance use by LHD, state hospital data suggests that methamphetamine use is a problem in MNC.[28] In 2021/2022, MNC was the LHD with the highest methamphetamine-related hospitalisation rate per 100,000 in NSW (MNC 223.3, NNSW 116 and NSW 138.9).[28]

We found an overall increase in syphilis testing over time; this coincided with a decrease in positivity suggesting successful public health interventions targeted at reducing the risk of congenital syphilis including local syphilis general practitioner and antenatal education sessions, fact sheets and health promotion posters. In contrast, no significant trend in syphilis testing and positivity in PWUD over time was found, suggesting that more work needs to be done to address this group.

This study adds to the growing body of evidence, identifying PWUD as a priority group for public health syphilis screening and intervention. In order to address gaps, greater efforts are needed to expand screening programs in non-traditional settings such as drug and alcohol services, mental health services, emergency care and prison settings. For example, an opt-out STI screening program could be introduced at general practices and emergency departments for anyone in the MNC region, aged 30 years and under. Point of care testing, which has recently been introduced to the region, will enable further outreach to non-clinical settings such as community organisations and peer support group sites. Since recent IVDU had the greatest risk, needle syringe programs should be considered in screening programs. Another public health intervention would be to increase clinician and community awareness about the association between syphilis and substance use. Finally, we need to address the high rates of substance use in this region by increasing the availability of substance use treatment services (such as expanding community withdrawal and hospital liaison services), promoting supportive clinical environments, and increasing the availability of clean injecting equipment.

Limitations

The data was de-identified and repeat results in the same individual could not be determined, which may have led to inflation of rates in people who had frequent STI screening. All positive tests, including those who adequately responded to treatment but had an ongoing positive serology, were included in analysis as we were unable to limit to tests indicating active infection. This study has limited generalisability. In North Coast, around 32.1% of syphilis cases are diagnosed in SHS, with the majority diagnosed by general practitioners (43.6%).[6] The association between substance use and syphilis in people who do not attend the SHS has not been explored. The findings are also limited to a regional area of Australia therefore findings may not be generalisable to metropolitan or remote regions.

Due to the stigma associated with substance use and concerns about confidentiality there was likely underreporting of substance use which would result in misclassification of participants. We acknowledge that clinicians might have different personal definitions of “substance use” potentially leading to inconsistent and misclassification of clients. We also acknowledge the inherent limitations of using routinely collected datasets for research, however we believe that this dataset was the best available data source to find key trends. Data on substance use was not routinely recorded until late 2021 therefore we were unable to examine long term trends. Differences in test positivity rates between groups may be due to confounding factors, such as different baseline demographic characteristics, which were not able to be controlled in multivariate analysis due to limitations in modelling. Finally, there were also a high proportion of unknown or missing data which limited analysis of risk factors.

CONCLUSION

There is currently limited research examining the relationship between substance use and syphilis, despite growing syphilis incidence rates nationally and globally. We found that people reporting substance use had increased syphilis test positivity. Addressing the ongoing syphilis outbreak in the North Coast requires targeted, adequately resourced interventions specifically tailored to PWUD. Our findings could inform responses to syphilis outbreaks in other regional areas of Australia with high levels of substance use.

References

1. Tao Y-T, Gao T-Y, Li H-Y, Ma Y-T, Li H-J, Xian-Yu C-Y, et al. Global, regional, and national trends of syphilis from 1990 to 2019: the 2019 global burden of disease study. *BMC Public Health* 2023;23: 754.
2. Department of Health and Aged Care. National Communicable Disease Surveillance Dashboard. Canberra: Department of Health and Aged Care, 2023. https://nindss.health.gov.au/pbi-dashboard/ (viewed Dec 2023).
3. NSW Health. Syphilis: NSW Control Guideline for Public Health Units NSW. Sydney: NSW Health, 2021. https://www.health.nsw.gov.au/Infectious/controlguideline/Documents/nsw-syphilis-song.pdf (viewed Dec 2023).
4. Carter A, McManus H, Ward JS, Vickers T, Asselin J, Baillie G, et al. Infectious syphilis in women and heterosexual men in major Australian cities: sentinel surveillance data, 2011–2019. *Med J Aust* 2023;218: 223-8.
5. Walker GJ, Walker DG. Congenital syphilis: a continuing but neglected problem. *Semin Fetal Neonatal Med* 2007;12: 198-206.
6. North Coast Population and Public Health. NCPPHD Syphilis Surveillance Report - December 2023. Lismore: North Coast Population and Public Health, 2024 (Unpublished).
7. Australian Institute of Health and Welfare. National Drug Strategy Household Survey 2019 (AIHW cat. no. PHE 270). Canberra: AIHW, 2020. https://www.aihw.gov.au/reports/illicit-use-of-drugs/national-drug-strategy-household-survey-2019/data (viewed 2023 Dec).
8. Su S, Mao L, Zhao J, Chen L, Jing J, Cheng F, et al. Epidemics of HIV, HCV and syphilis infection among synthetic drugs only users, heroin-only users and poly-drug users in Southwest China. *Sci Rep* 2018;8: 6615.
9. Hwang L-Y, Ross MW, Zack C, Bull L, Rickman K, Holleman M. Prevalence of sexually transmitted infections and associated risk factors among populations of drug abusers. *Clin Infect Dis* 2000;31: 920-6.
10. Aung ET, Fairley CK, Ong JJ, Chen MY, Phillips TR, Tran J, et al. Incidence and Risk Factors for Early Syphilis Among Men Who Have Sex With Men in Australia, 2013–2019: A Retrospective Cohort Study. *Open Forum Infect Dis* 2023;10: 1-10.
11. R Core Team (2023). R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/.
12. Strathdee SA, Bristow CC, Gaines T, Shoptaw S. Collateral damage: A narrative review on epidemics of substance use disorders and their relationships to sexually transmitted infections in the United States. *Sex Trasnm Dis* 2021;48: 466-73.
13. Calsyn DA, Cousins SJ, Hatch-Maillette MA, Forcehimes A, Mandler R, Doyle SR, et al. Sex under the influence of drugs or alcohol: Common for men in substance abuse treatment and associated with high-risk sexual behavior. *Am J Addict* 2010;19: 119-27.
14. Moradi S, Moradi Y, Rahmani K, Nouri B, Moradi G. The association between methamphetamine use and number of sexual partners in men who have sex with men: a systematic review and meta-analysis. *Subst Abuse Treat Prev Policy* 2022;17: 27.
15. McKetin R, Lubman DI, Baker A, Dawe S, Ross J, Mattick RP, et al. The relationship between methamphetamine use and heterosexual behaviour: evidence from a prospective longitudinal study. *Addiction* 2018;113: 1276-85.

16. Kidd SE, Grey JA, Torrone EA, Weinstock HS. Increased methamphetamine, injection drug, and heroin use among women and heterosexual men with primary and secondary syphilis—United States, 2013–2017. *MMWR Morb Mortal Wkly Rep* 2019;68: 144.

17. Reno H, Fox B, Highfill C, McKee A, Trolard A, Liang SY, et al. The emerging intersection between injection drug use and early syphilis in nonurban areas of Missouri, 2012–2018. *J Infect Dis* 2020;222: S465-S70.

18. Willemsma K, Barton L, Stimpson R, Pickell I, Ryan V, Yu A, et al. Characterizing female infectious syphilis cases in British Columbia to identify opportunities for optimization of care. *Canada Communicable Disease Report= Releve des Maladies Transmissibles au Canada* 2022;48(2-3): 68-75.

19. Dickson-Gomez J, McAuliffe T, Quinn K. The effects of housing status, stability and the social contexts of housing on drug and sexual risk behaviors. *AIDS Behav* 2017;21: 2079-92.

20. Spaulding AC, Rabeeah Z, del Mar González-Montalvo M, Akiyama MJ, Baker BJ, Bauer HM, et al. Prevalence and management of sexually transmitted infections in correctional settings: a systematic review. *Clin Infect Dis* 2022;74: S193-S217.

21. Butler T, Malacova E, Richters J, Yap L, Grant L, Richards A, et al. Sexual behaviour and sexual health of Australian prisoners. *Sex Health* 2012;10: 64-73.

22. Knittel AK, Lorvick J. Self-reported sexually-transmitted infections and criminal justice involvement among women who use drugs. *Addict Behav Rep* 2019;10: 100219.

23. Loza O, Patterson TL, Rusch M, Martínez GA, Lozada R, Staines-Orozco H, et al. Drug-related behaviors independently associated with syphilis infection among female sex workers in two Mexico–US border cities. *Addiction* 2010;105: 1448-56.

24. Drame F, Bomma S, Miranda W, Gelberg K, Hart-Malloy R. Evaluation of drug-related risk behaviors among females diagnosed with early syphilis in New York State (excluding New York City), 2013 to 2018. *Sex Transm Dis* 2021;48: S40.

25. Raval M, Gratrix J, Plitt S, Niruban J, Smyczek P, Dong K, et al. Retrospective cohort study examining the correlates of reported lifetime stimulant use in persons diagnosed with infectious syphilis in Alberta, Canada, 2018 to 2019. *Sex Transm Dis* 2022;49: 551-9.

26. Copen CE, Brookmeyer KA, Haderxhanaj LT, Hogben M, Torrone EA. Sexual Risk Behaviors Among Persons Diagnosed With Primary and Secondary Syphilis Who Reported High-Risk Substance Use: Data From the National Notifiable Diseases Surveillance System, 2018. *Sex Transm Dis* 2022;49: 99.

27. ABS Customised Data Services, received 7 November 2023. Estimated Resident Population (ERP) based on the 2021 Census. 2011-2021 Final, 2022 Preliminary.

28. Centre for Epidemiology and Evidence. HealthStats NSW. Sydney : NSW Ministry of Health, 2021. www.healthstats.nsw.gov.au (viewed Apr 2024).

FIGURES AND TABLES

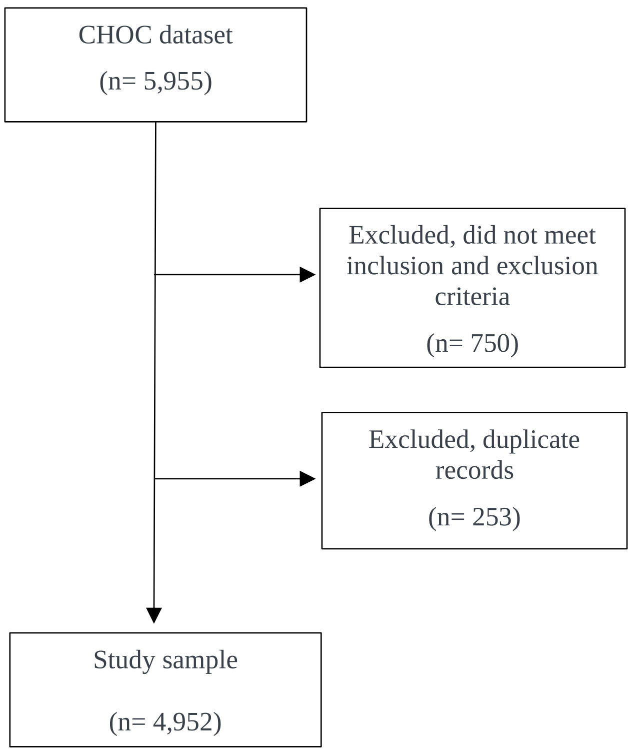


Figure 1. Flow diagram of record selection

Table 1. Demographics of people who underwent syphilis testing at North Coast SHS, 1 January 2022 to 31 December 2023, by substance use group, every occasion of testing counted

Characteristic	Syphilis Tests at SHS, N = 4,952	Syphilis Tests in PWUD, N = 497	Syphilis Tests in Non-PWUD, N = 4,455
LHD			
NNSW	3,395 (69%)	304 (61%)	3,091 (69%)
MNC	1,557 (31%)	193 (39%)	1,364 (31%)
Age group (years)			
16-30	1,874 (38%)	97 (20%)	1,777 (40%)
31-50	1,850 (37%)	225 (45%)	1,625 (36%)
51-65	863 (17%)	130 (26%)	733 (16%)
> 65	365 (7.4%)	45 (9.1%)	320 (7.2%)
Gender			
Cisgender man	3,386 (68%)	395 (79%)	2,991 (67%)
Transgender man	8 (0.2%)	<5	6 (0.1%)
Indeterminate man	<5	<5	<5
Cisgender woman	1,518 (31%)	94 (19%)	1,424 (32%)
Transgender woman	10 (0.2%)	0 (0%)	10 (0.2%)
Indeterminate woman	0	0	0
Other	28 (0.6%)	6 (1.2%)	22 (0.5%)
Sexual orientation			
Homosexual	1,795 (36%)	222 (45%)	1,573 (35%)
Heterosexual	2,565 (52%)	193 (39%)	2,372 (53%)
Bisexual	405 (8.2%)	44 (8.9%)	361 (8.1%)
Queer	28 (0.6%)	<5	27 (0.6%)
Unknown	159 (3.2%)	37 (7.4%)	122 (2.7%)
Indigenous status			
Neither Aboriginal nor Torres Strait Islander	4,475 (90%)	396 (80%)	4,079 (92%)
Aboriginal and/or Torres Strait Islander	295 (5.9%)	73 (15%)	222 (5.0%)
Unknown	182 (3.7%)	28 (5.6%)	154 (3.5%)
History of incarceration			

Characteristic	Syphilis Tests at SHS, N = 4,952	Syphilis Tests in PWUD, N = 497	Syphilis Tests in Non-PWUD, N = 4,455
Within 6 months	37 (0.7%)	21 (4.2%)	16 (0.4%)
More than 6 months ago	82 (1.7%)	47 (9.5%)	35 (0.8%)
Never	4,070 (82%)	283 (57%)	3,787 (85%)
Unknown	763 (15%)	146 (29%)	617 (14%)
Sex work			
Sex work undertaken within the past 12 months ago	139 (2.8%)	15 (3.0%)	124 (2.8%)
Sex work undertaken more than 12 months ago	101 (2.0%)	35 (7.0%)	66 (1.5%)
No sex work undertaken	3,550 (72%)	305 (61%)	3,245 (73%)
Unknown	1,162 (23%)	142 (29%)	1,020 (23%)

Table 2. Syphilis test count, test positivity and relative rate in North Coast SHS clients, 1 January 2022 to 31 December 2023, by substance use

Substance use	Total tests, N = 4952	Positive tests, N =213	Test positivity	Relative rate	95% CI	p-value
Non-PWUD	4,455	157	3.52%	Ref		
PWUD	497	56	11.27%	3.20*	2.34, 4.31	<0.001

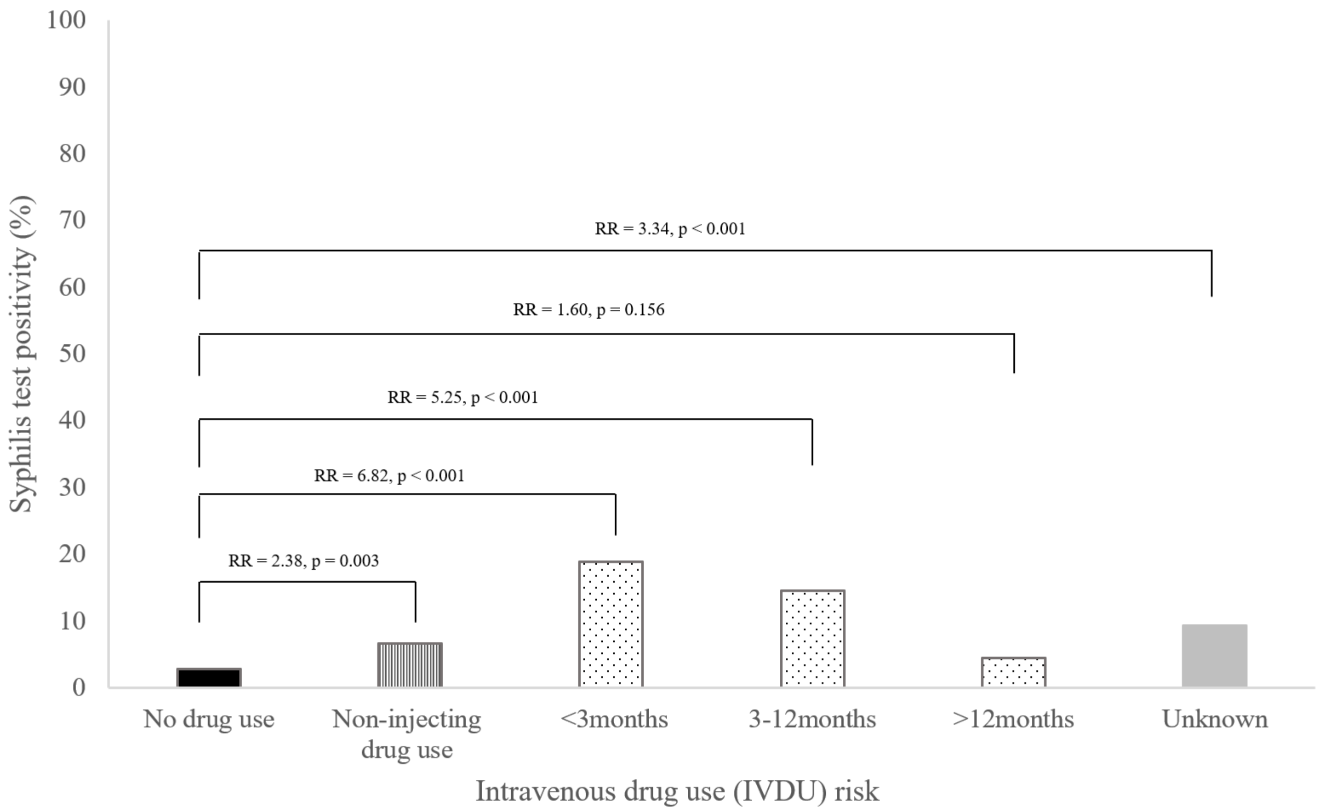


Figure 2. Syphilis test positivity rate in North Coast SHS clients, 1 January 2022 to 31 December 2023, by IVDU risk

Table 3. Syphilis positive test count, test positivity and relative rate for each demographic group in North Coast SHS clients, 1 January 2022 to 31 December 2023, by substance use

	PWUD					Non-PWUD				
Predictor	Positive tests (n)	Test positivity	Relative rate	95% CI	p-value	Positive tests (n)	Test positivity	Relative rate	95% CI	p-value
LHD										
NNSW	11	3.6%	Ref			45	1.5%	Ref		
MNC	45	23.3%	6.44	3.46, 13.11	<0.001	112	8.2%	5.64	4.02, 8.05	<0.001
Current gender identity										
Men	31	7.8%	Ref			117	3.9%	Ref		
Women	25	26.6%	3.41	1.99, 5.76	<0.001	40	2.8%	0.71	0.49, 1.01	0.07
Other	-	-	-	-	-	-	-	-	-	-
Age group (years)										
16–30	24	24.7%	2.42	1.36, 4.31	0.002	48	2.7%	0.6	0.42, 0.86	0.006
31–50	23	10.2%	Ref			73	4.5%	Ref		
51–65	7	5.4%	0.53	0.21, 1.17	0.14	31	4.2%	0.94	0.61, 1.42	0.78
> 65	-	-	0.43	0.07, 1.47	0.26	5	1.6%	0.35	0.12, 0.78	0.02
Indigenous status										
Neither Aboriginal nor Torres Strait	42	10.6%	Ref			128	3.1%	Ref		
Aboriginal and/or Torres Strait Islander	13	17.8%	1.68	0.87, 3.04	0.10	23	10.4%	3.30	2.07, 5.04	<0.001
Unknown	-	-	0.34	0.02, 1.54	0.28	6	3.9%	1.24	0.49, 2.58	0.60
Sexual orientation										
Homosexual	10	4.5%	Ref			64	4.1%	Ref		
Heterosexual	37	19.2%	4.26	2.20, 9.04	<0.001	68	2.9%	0.70	0.50, 0.99	0.044
Bisexual	7	15.9%	3.53	1.28, 9.20	0.011	13	3.6%	0.89	0.47, 1.55	0.69
Queer	-	-	-	-	-	-	-	-	-	-
Unknown	-	-	1.20	0.18, 4.55	0.81	12	9.8%	2.42	1.24, 4.31	0.005
History of incarceration										
Never	29	10.2%	Ref			-	-	-	-	-
Within 6 months	10	47.6%	4.65	2.15, 9.22	<0.001	-	-	-	-	-
More than 6 months ago	-	-	0.42	0.07, 1.38	0.23	-	-	-	-	-
Unknown	15	10.3%	1.0	0.52, 1.84	0.99	-	-	-	-	-

Dash (-) indicates low lumbers, removed to prevent re-identification

Table 4. Syphilis test positivity adjusted relative rates in North Coast SHS clients who reported recent substance use, 1 January 2022 to 31 December 2023, by LHD, current gender identity, age group and sexual orientation using multivariate analysis

Predictor	Adjusted relative rate	95% CI	p-value
LHD			
NNSW	Ref		
MNC	4.39	2.29, 9.15	<0.001
Current gender identity			
Men	Ref		
Women	2.36	1.30, 4.31	0.005
Age group (years)			
16-30	1.78	1.01, 3.10	0.043
>30	Ref		
Sexual orientation			
Homosexual, Bisexual or Queer	Ref		
Heterosexual	1.25	0.66, 2.46	0.500

Unknown categories and gender identity other not included in table and analysis

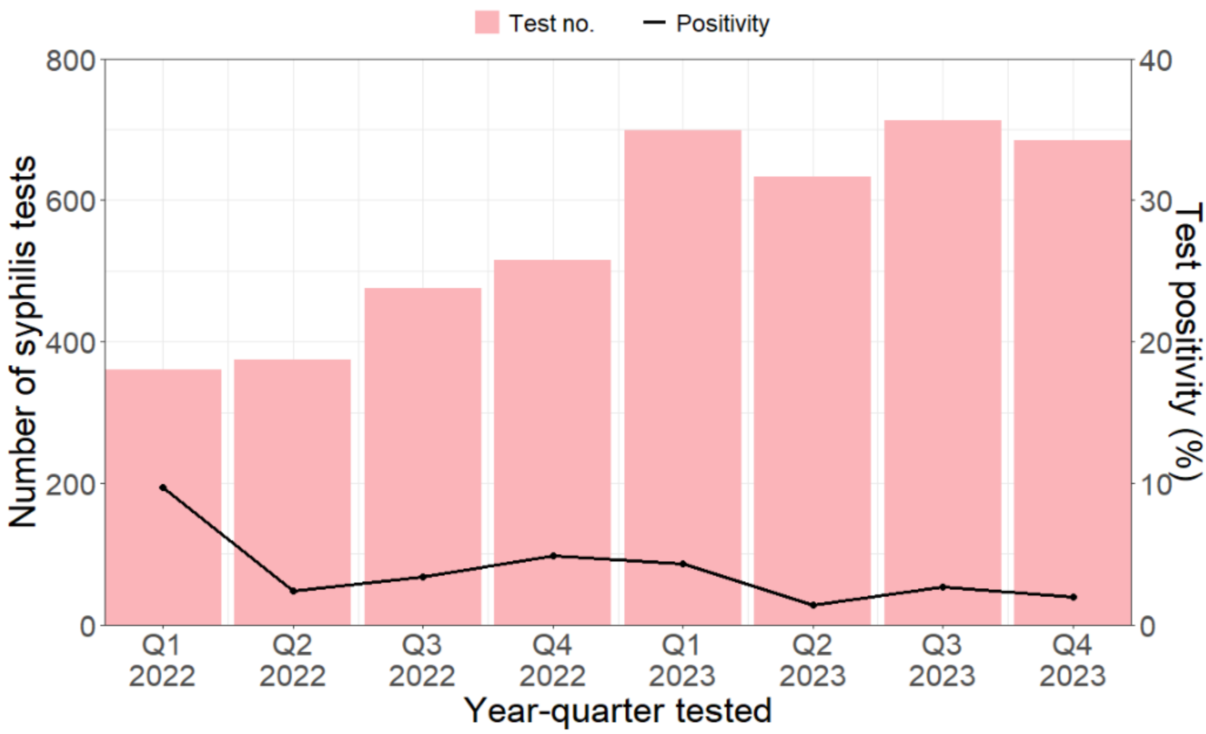


Figure 3. Number of syphilis tests and tests positivity (%) by quarter for SHS clients in North Coast region, 1 January 2022 to 31 December 2023, clients who denied recent substance use (non-PWUD)

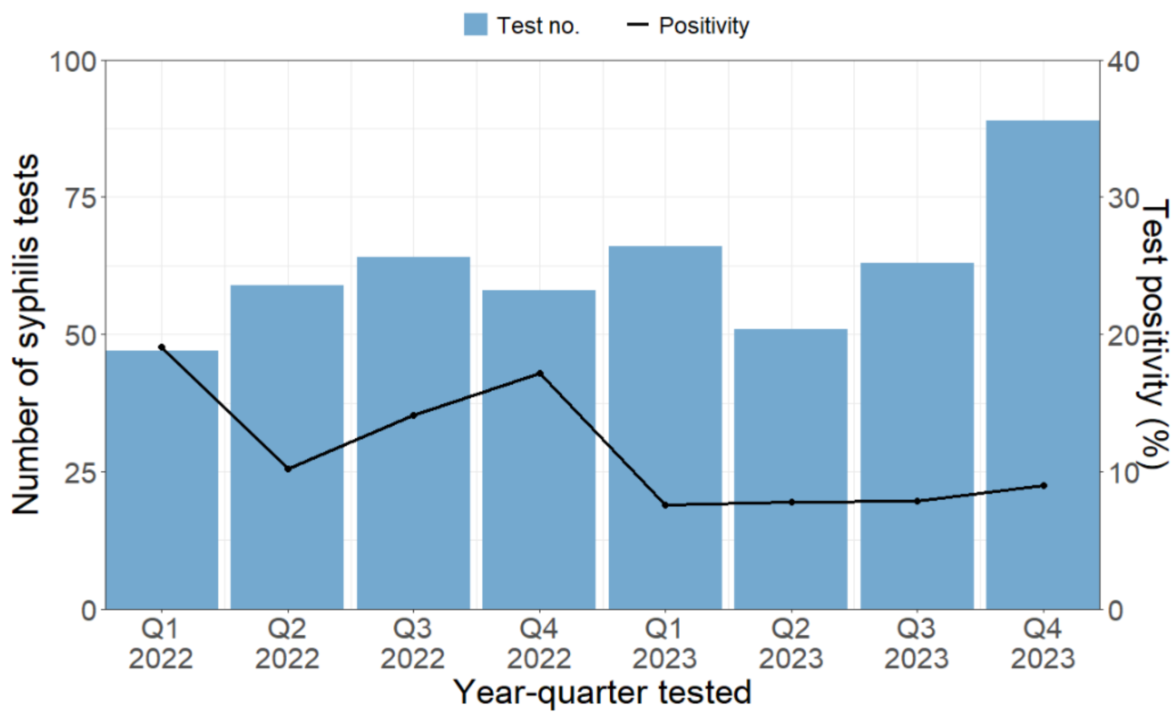


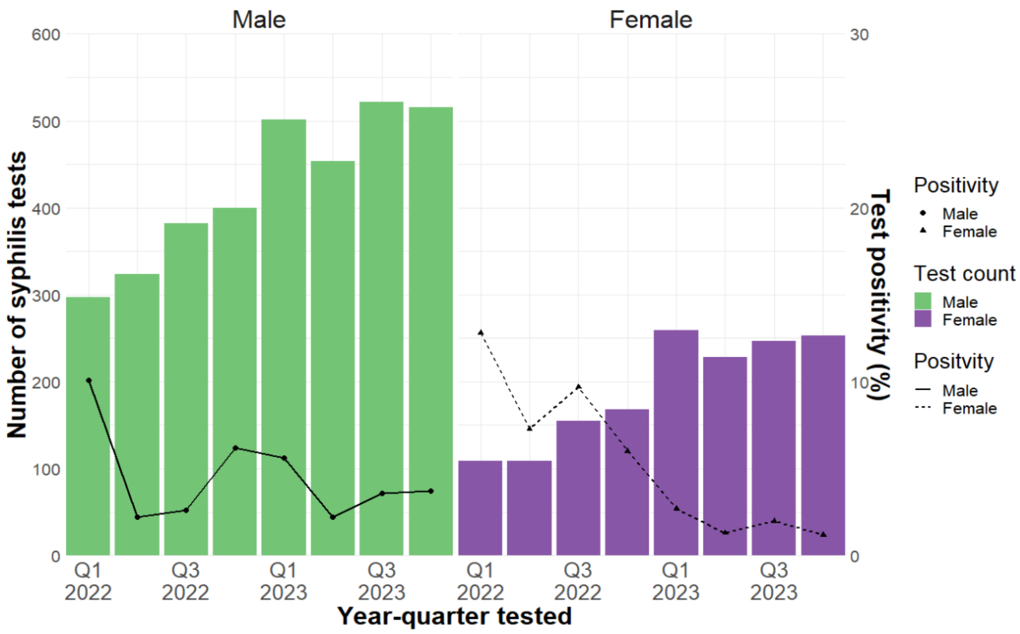
Figure 4. Number of syphilis tests and tests positivity (%) by quarter for SHS clients in North Coast region, 1 January 2022 to 31 December 2023, clients who reported recent substance use (PWUD)

APPENDICES

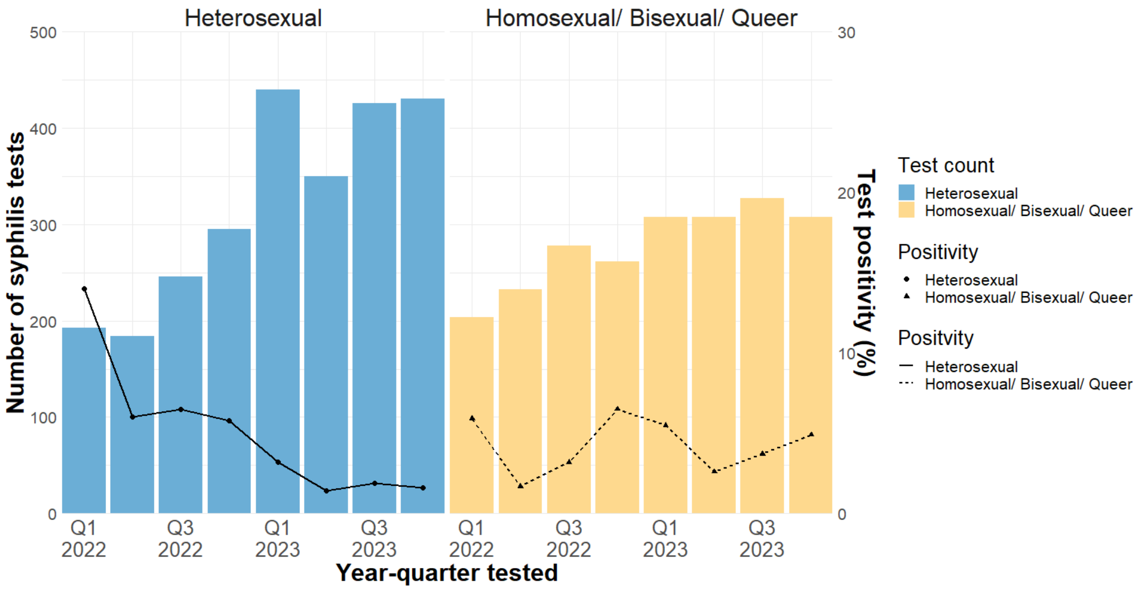
Appendix A to D show the additional table and figures removed from the manuscript prepared for journal article submission.

Appendix A. Syphilis test count, test positivity and relative rate in North Coast SHS clients, 1 January 2022 to 31 December 2023, by IVDU risk

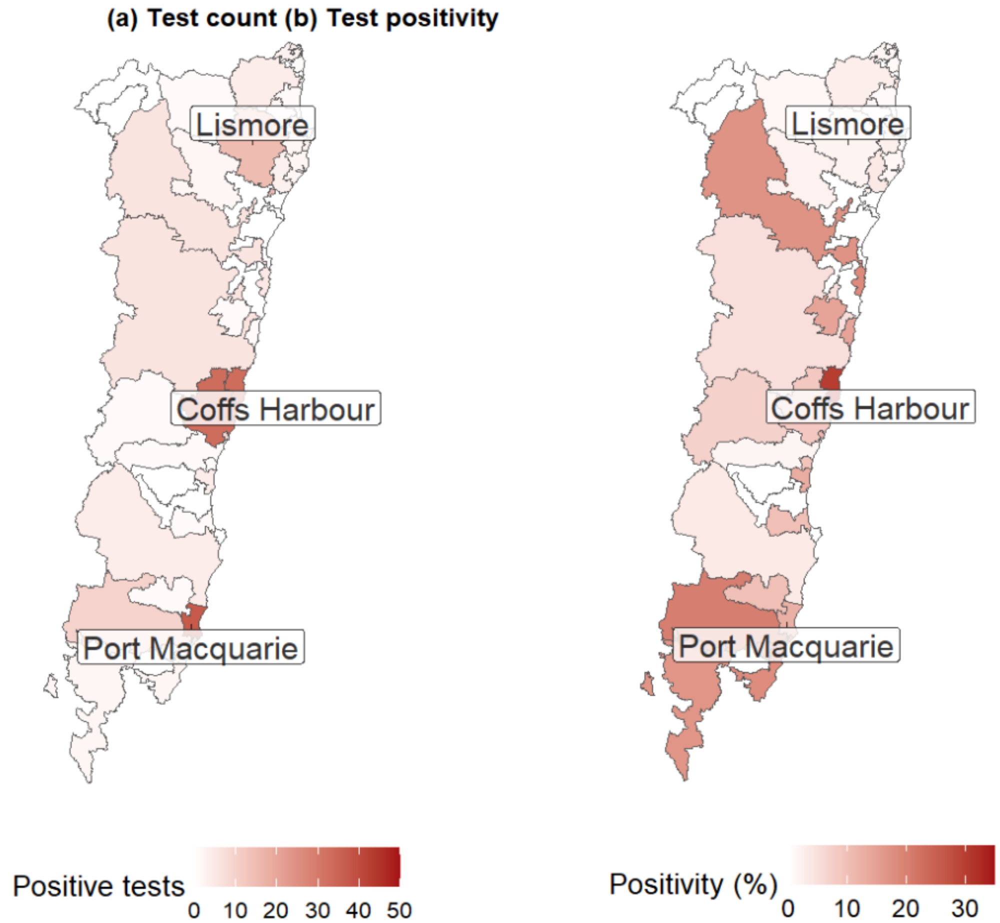
IVDU risk	Total tests, N =4952	Positive tests, N = 213	Test positivity	Relative rate	95% CI	p-value
No drug use	3,794	105	2.77%	Ref		
Non-injecting drug use (recent)	197	13	6.6%	2.38	1.28, 4.08	0.003
Last injected >12months	226	10	4.42%	1.60	0.78, 2.90	0.156
Last injected 3-12months	62	9	14.52%	5.25	2.47, 9.78	<0.001
Last injected <3months	143	27	18.88%	6.82	4.38, 10.25	<0.001
Unknown type of drug use	530	49	9.25%	3.34	2.36, 4.66	<0.001



Appendix B. Number of syphilis tests and tests positivity (%) by quarter for SHS clients in North Coast region, 1 January 2022 to 31 December 2023, by gender



Appendix C. Number of syphilis tests and tests positivity (%) by quarter for SHS clients in North Coast region, 1 January 2022 to 31 December 2023, by sexual orientation (queer and unknown categories removed due to low test number)



Appendix D. Geographical distribution of syphilis test count (a) and test positivity (b) for SHS clients in the North Coast region, 1 January 2022 to 31 December 2023

Appendix E: IUSTI conference poster

Syphilis testing trends in people attending sexual health services in North Coast NSW 2022–2023, by self-reported substance use

Megan Ellis[1,2], Robin Auld[1], Kym Collins[1], Vincent J Cornelisse[1,3,4], Jenny Heslop[1], Genevieve K O'Neill[1], Rosalina Sa aga-Banuve[1], Jane Shapiro[2], Tony Stewart[2] and Valerie Delpech[1]

Author affiliations
[1]North Coast Population and Public Health, NSW Health, [2]Australian National University, [3]Kirby Institute, UNSW, Sydney. [4]School of Translational Medicine, Monash University, Melbourne.

Email: megan.ellis@health.nsw.gov.au

Australian National University

North Coast Population & Public Health Directorate

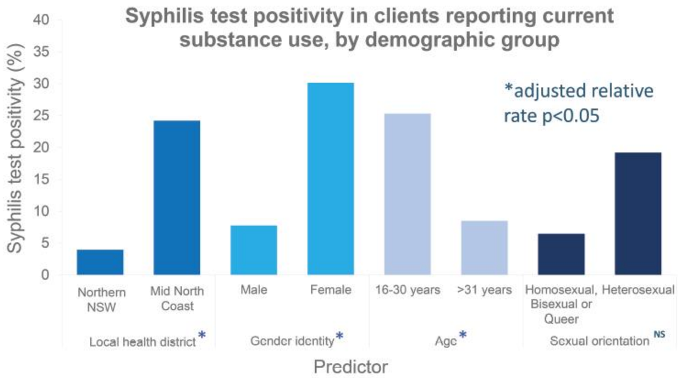
BACKGROUND

- Ongoing syphilis outbreak in Mid North Coast (southern North Coast NSW) since 2020
- Very high rates of substance use in this region[1]
- Limited previous research examining the relationship between syphilis and drug use

Aim: examine the relationship between syphilis testing trends and substance use in North Coast sexual health clients

METHODS

- Retrospective analyses of routinely collected sexual health service data
- Data on clients tested for syphilis between 1 January 2022 and 31 December 2023 was examined
- Self-reported substance use (at time of data collection) and demographic information
- Descriptive analysis of test count and test positivity
- Univariate and multivariate analysis were used to generate relative rates

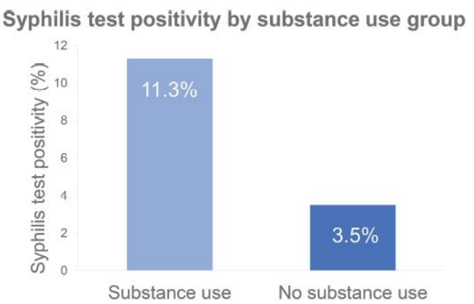


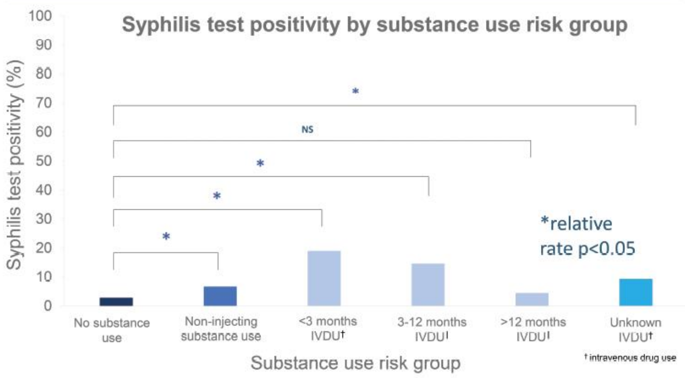
For those reporting current substance use, syphilis test positivity was significantly greater in those residing in the Mid North Coast, females and clients aged 16 to 30 years.

RESULTS

- Total of 4,952 tests
- Current substance use n=157, no substance use n=4,455
- Median age 35 years, 69% male
- 52% heterosexual, 36% homosexual, 8% bisexual

Syphilis test positivity was over three times higher among people who reported substance use (relative rate = 3.2, p<0.05)





Compared to those not using substances, test positivity was significantly greater in those with recent IVDU, non-injecting substance use and unknown IVDU.

Conclusions

- People using substances are a priority group for syphilis public health interventions
- Health professionals should consider the role of biological, behavioural and social factors to their client's risk of syphilis
- Health services should consider expanding screening to non-traditional settings

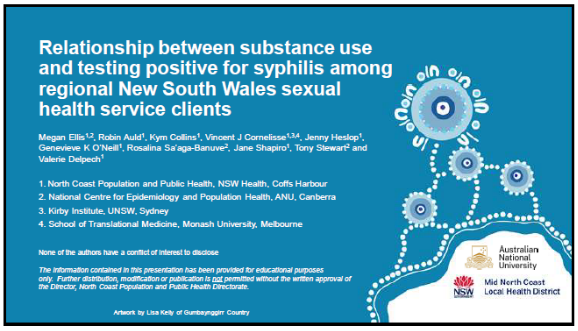
References
1) Australian Institute of Health and Welfare. National Drug Strategy Household Survey 2019 [Internet]. Canberra: AIHW; 2020 Jul 16 [cited 2024 Jul 5]. AIHW cat. no. PHE 270. Available from: https://www.aihw.gov.au/reports/illicit-use-of-drugs/national-drug-strategy-household-survey-2019/data.
Image: Adapted from mid-north-coast-map [Online Image]. Arts Mid North Coast. Available from: https://artsmidnorthcoast.com/about-us/mid-north-coast-map/.
Icons: https://thenounproject.com/

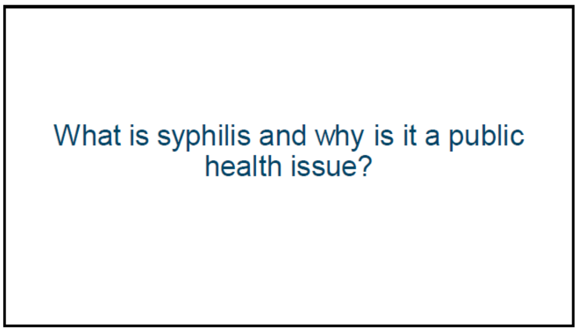
Artwork by Lisa Kelly of Gumbaynggirr Country

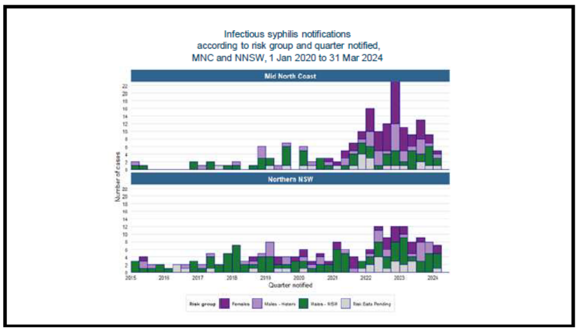
Mid North Coast Local Health District

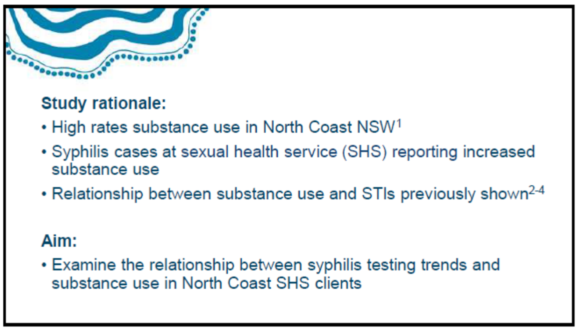
Produced August 2024

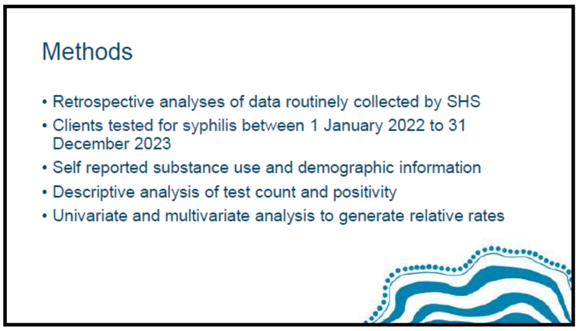
Appendix F: World Congress on alcohol and addictions conference slides

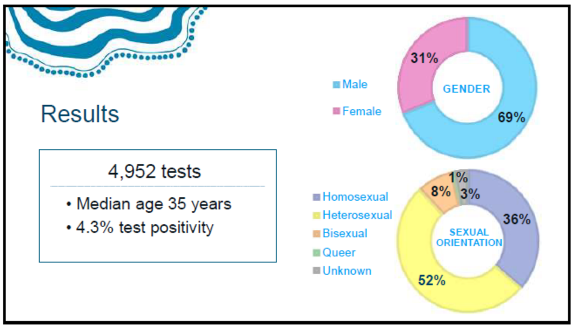


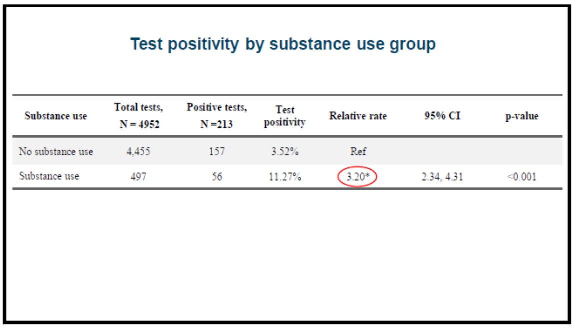




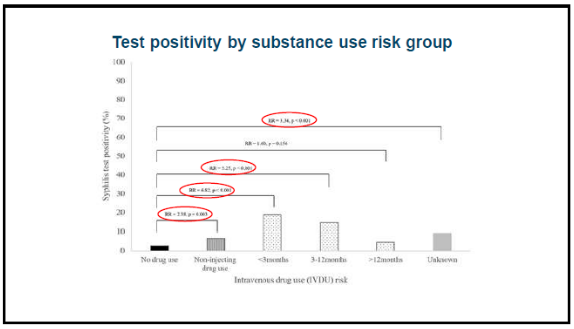


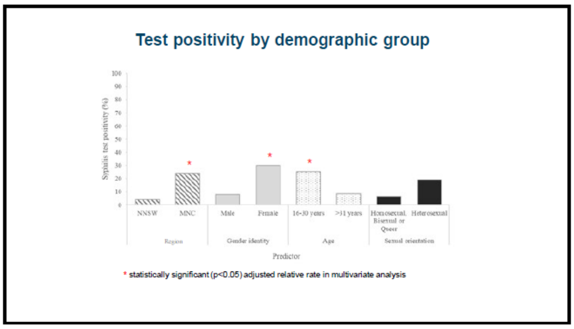


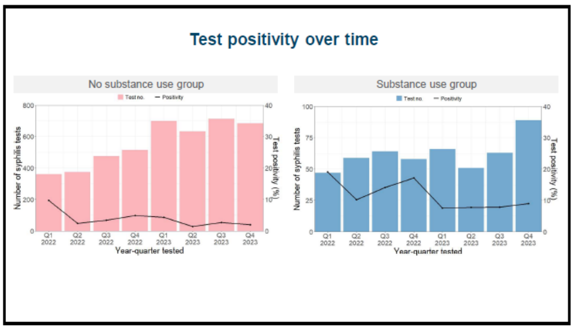


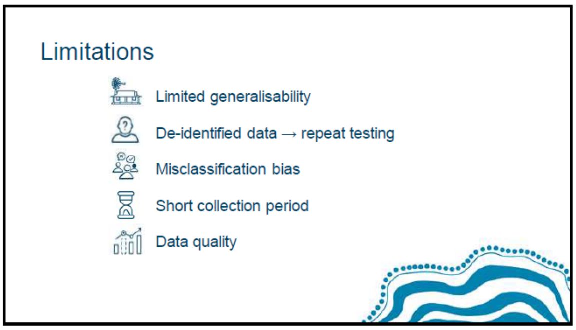

Test positivity by substance use group

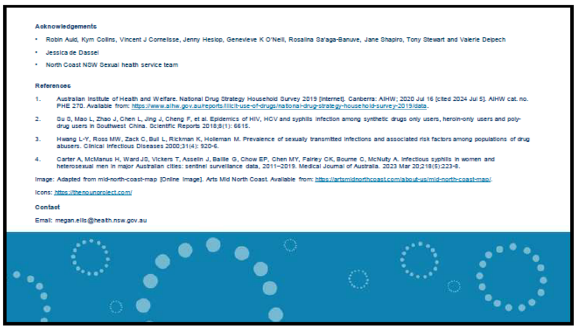
Substance use	Total tests, N = 4952	Positive tests, N =213	Test positivity	Relative rate	95% CI	p-value
No substance use	4,455	157	3.52%	Ref		
Substance use	497	56	11.27%	3.20*	2.34, 4.31	<0.001








Limitations
Limited generalisability
De-identified data → repeat testing
Misclassification bias
Short collection period
Data quality


Acknowledgements
• Robin Auld, Kym Collins, Vincent J Cornelisse, Jenny Heslop, Genevieve K O'Neill, Rosalina Sa'aga-Banuve, Jane Shapiro, Tony Stewart and Valerie Delpech
• Jessica de Dassel
• North Coast NSW Sexual health service team
References
1. Australian Institute of Health and Welfare. National Drug Strategy Household Survey 2019 [Internet]. Canberra: AIHW; 2020 Jul 16 [cited 2024 Jul 5]. AIHW cat. no. PHE 270. Available from: https://www.aihw.gov.au/reports/illicit-use-of-drugs/national-drug-strategy-household-survey-2019/data.
2. Su S, Mao L, Zhao J, Chen L, Jing J, Cheng F, et al. Epidemics of HIV, HCV and syphilis infection among synthetic drugs only users, heroin-only users and poly-drug users in Southwest China. Scientific Reports 2018;8(1): 6615.
3. Hwang L-Y, Ross MW, Zack C, Bull L, Rickman K, Holleman M. Prevalence of sexually transmitted infections and associated risk factors among populations of drug abusers. Clinical Infectious Diseases 2000;31(4): 920-6.
4. Carter A, McManus H, Ward JS, Vickers T, Asselin J, Baillie G, Chow EP, Chen MY, Fairley CK, Bourne C, McNulty A. Infectious syphilis in women and heterosexual men in major Australian cities: sentinel surveillance data, 2011–2019. Medical Journal of Australia. 2023 Mar 20;218(5):223-8.
Image: Adapted from mid-north-coast-map [Online image]. Arts Mid North Coast. Available from: https://artsmidnorthcoast.com/about-us/mid-north-coast-map/.
Icons: https://thenounproject.com/
Contact
Email: megan.ellis@health.nsw.gov.au

Chapter III

Investigation of an acute public health problem

Investigation of a gastrointestinal illness outbreak in attendees of a Tweed Heads birthday dinner, March 2024

CHAPTER CONTENTS

PROLOGUE

This chapter details the investigation of a gastrointestinal outbreak among attendees to a birthday dinner on 8 March 2024 in a restaurant in Tweed Heads. The investigation was performed by staff at North Coast Population and Public Health (NCPPH), in collaboration with the NSW Food Authority, local shire council and the Ministry of Health.

My role

As a member of the outbreak investigation team, I was involved from the start to the conclusion of this outbreak. I attended all team meetings, formed the case definition and was actively involved in developing a standardised interview questionnaire. I interviewed five people among the cohort. I liaised with pathology to follow up and discuss case results including typing. I also helped to prepare the line list and performed data cleaning and analysis including generation of the epidemiological curve. Finally, I wrote the Situation Report (SITREP) and updated it as the outbreak progressed.

Lessons learnt

This is the first foodborne outbreak I have been involved in. It was a great opportunity to revise and practice the steps of an outbreak I learnt during MAE course block. I experienced the difficulties of dealing with recall bias when interviewing people about their food history exposure, especially when they have preconceived opinions about the cause of their illness. The main lesson I learnt was that outbreaks are often not as neat and straightforward as the ones I learned about in lectures or published in journals. We often do not get to find out the source and method of transmission. I was unfamiliar with yersiniosis prior to this outbreak, and it was interesting reading the literature on the epidemiology, clinical presentation and microbiology of this pathogen which aided the development of the hypothesis generating questionnaire and report write up.

During this investigation, I experienced the challenges associated with intergovernmental communication and performing an investigation involving multiple bodies (including Ministry of Health, NSW food authority, public health staff and the local shire council) who have their own competing priorities which can lead to delays and possible miscommunication.

Public health implications

Due to limited laboratory, epidemiological and environmental evidence, we were unable to confirm the aetiological agent and source of this gastrointestinal outbreak. This highlights the obstacles of foodborne investigation including: small sample sizes limiting epidemiological analyses, difficulties obtaining stool samples, delays in public health unit notification leading to recall bias and limited accuracy and availability of environmental testing.

Investigating potential yersiniosis outbreaks poses further challenges due to the limited and mixed evidence regarding common foodborne sources, accuracy of detection methods and pathogenicity of different strains. This demonstrates the need for further research into yersiniosis. Since biotype 1A has been shown to be the most common type in Queensland[1], it is important that we improve our understanding of the pathogenic potential of these strains and consider the public health impact.

MAE course requirements

The project fulfilled the MAE core course requirement "Investigation of an acute public health problem".

Acknowledgements

I would like to thank all of the outbreak team members including Robin Auld, Genevieve O'Neill, Jessica de Dassel, John Turahui and Phoebe Nicholls. I would also like to acknowledge my academic supervisors Professor Tony Stewart and Dr Rosalina Sa' aga-Banuve for their input into the report write up.

Abbreviations

ACT	Australian Capital Territory
AR	Attack rate
HREC	Human Research Ethics Committee
LHD	Local Health District
MAE	Master of Philosophy in Applied Epidemiology
NCPPH	North Coast Population and Public Health
NSW	New South Wales
NSWFA	New South Wales Food Authority
PCR	Polymerase Chain Reaction
pYV	Virulence plasmid (plasmid of Yersinia virulence)
Y. enterocolitica	Yersinia enterocolitica
95% CI	95% confidence

ABSTRACT

Yersiniosis is a globally occurring foodborne disease, predominantly caused by the zoonosis bacteria *Yersinia enterocolitica*. Cases are normally sporadic, but outbreaks have previously been reported. On 12 March 2024, North Coast Population and Public Health was asked to investigate a gastrointestinal illness outbreak involving birthday dinner attendees at a Tweed Heads restaurant on 8 March 2024 following the detection of *Yersinia enterocolitica* and reports of other illness in the group.

A case was defined as any person who attended restaurant X on 8 March who either developed symptoms of gastrointestinal illness (probable case) or had pathology confirming Yersinia enterocolitica infection (confirmed case).

We performed a retrospective cohort study which involved telephone interviews of the birthday party attendees. Of the 16 attendees, the case attack rate was 50%. Three stool samples were taken, of which only one was positive for *Yersinia enterocolitica*. Epidemiological analysis found that none of the food items consumed by attendees at restaurant X were clearly associated with gastrointestinal illness. Environmental assessment was also unable to provide insights into the cause of the outbreak. There were no known complaints from other attendees of the restaurant of foodborne illness.

Overall, we were unable to identify the source of the outbreak though our investigation suggested that it was unlikely associated with an exposure at restaurant X. While *Yersinia enterocolitica* was linked to this outbreak, due to limited evidence we were unable to confirm if this was the causal agent or a coincidental finding. Since the outbreak was likely concentrated to birthday party attendees and secondary transmission did not occur, no further public health interventions were required.

INTRODUCTION

Yersiniosis is a gastrointestinal disease caused by the gram-negative, zoonotic bacteria *Yersinia enterocolitica* (*Y. enterocolitica*) and rarely *Yersinia pseudotuberculosis*.[2] The incubation period is 1 to 11 days, however faecal shedding can continue for over two months.[3, 4] Common symptoms include diarrhoea, abdominal pain, vomiting, nausea and fever.[5] Asymptomatic infection can also occur.[6] Duration of diarrhoea can range from a few days to a few weeks and can be watery and bloody, especially in children.[7] Other clinical manifestations of yersiniosis include pseudoappendicitis syndrome, arthritis, pharyngitis and erythema nodosum.[7] Infants, immunocompromised and those with iron overload are at increased risk of sepsis which is potentially fatal.[5] Investigation involves a stool sample polymerase chain reaction (PCR) and culture.[1] For most cases the infection is self-limiting requiring supportive care, for non-complicated infection antibiotics (typically aminoglycosides or trimethoprim-sulfamethoxazole) are only recommend in rare instances.[5]

Y. enterocolitica has been isolated in a range of domestic and wild animals, with pigs being the main reservoir.[8] Transmission to humans is predominantly foodborne, however transmission via pet contact and blood transfusion can also occur.[9] Person-to-person transmission is rare but has been reported previously.[10] *Y. enterocolitica* has been isolated in a large range of foods, including pork, milk (raw and pasteurised), seafood and beef.[9] Occupational pig contact or consumption of pork products, especially raw or undercooked, has been identified as a major risk factor.[11] Yersiniosis cases are normally sporadic instead of relating to an outbreak.[12] In 2014 a *Y. enterocolitica* outbreak linked to Norwegian military bases involving 133 confirmed cases was thought to be due to fresh salad products.[13] In the United States, an outbreak of *Y. enterocolitica* occurred at a youth summer camp in 2019 involving 109 cases and was attributed to milk which had been pasteurised onsite at a small dairy.[14] Consumption of untreated drinking water has also been identified as a risk factor.[11]

Yersiniosis has been reported globally.[8] It was the third most commonly reported foodborne zoonotic disease in Europe in 2021.[15] In New Zealand, yersiniosis notifications have increased over the past decade, with the majority of these being sporadic with an unknown source.[16]

In Australia, due to low incidence rates and lack of identified outbreaks prior to 2001, Yersiniosis is currently only notifiable in selected jurisdictions including the Australian Capital Territory (ACT), Queensland, Western Australia, South Australia and the Northern Territory. It is not notifiable nationally or in New South Wales (NSW) and Victoria which are the states with the largest populations. In the 2020 Queensland Foodborne surveillance report, *Y. enterocolitica* notification rate was 11.4 per 100,000 persons.[1] Cases were diagnosed through a mix of culture and PCR, with biotype 1A the most common (65%).[1] All age groups were impacted, with the 70 years and over age group having the highest notification rate (15.2 per 100,000 persons).[1] Females had a higher proportion of notifications (65%) and seasonal trends were found with peaks during the warmer months.[1] Most of the literature on Yersiniosis in Australia is about the animal disease, the only possible human yersiniosis outbreak published in Australia found by the author occurred in ACT in 2009, involving a confirmed 10-month-old case and two family members who were symptomatic but had negative test results.[17] Takeaway BBQ/ roast pork was thought to be potentially the source; however, this was unable to be confirmed.[17]

On 12 March 2024, NSW Food authority (NSWFA) received a complaint about an alleged Yersinia foodborne illness from a restaurant in Tweed Heads ('restaurant X'). The complainant reported that seven people attending a birthday dinner at restaurant X on 8 March 2024 developed gastrointestinal illness approximately 28 to 86 hours post-event. They reported that one alleged case attended a private hospital on 10 March 2024 where Yersiniosis infection was identified in a stool sample by PCR and culture. At the time of notification to NSWFA the cases identified a salad eaten at restaurant X as responsible for their illness, as it was the common item across all meals eaten by the alleged cases. NSWFA notified the NSW Ministry of Health One Health branch who informed North Coast Population and Public Health (NCPPH) and requested further investigation be performed.

METHODS

Epidemiological investigation

A retrospective cohort study was performed. The cohort included any person who attended the birthday dinner on 8 March 2024 and consumed food at restaurant X.

Case definitions

A <u>confirmed case</u> was defined as any person who attended restaurant X on 8 March 2024 who had who had a *Y. enterocolitica* infection detected in a stool sample by PCR and/or culture.

A <u>probable case</u> was defined as any person who attended restaurant X on 8 March 2024 and developed any symptoms of gastrointestinal illness (such as diarrhoea, abdominal cramps, vomiting or nausea) following consumption of the food; without other causes identified.

Individuals in the cohort were interviewed over telephone using a questionnaire developed by the MAE scholar and communicable disease team members based on the Queensland health Yersiniosis hypothesis generating questionnaire. This included a 3-day food diary, 5-day high priority food trawler and environmental exposures screen. To assess risk, individual's past medical history, age and occupation were recorded. Finally, clinical history including symptom onset and type, exposure to unwell individuals, medical review, investigations and treatments were assessed. Interviews were performed on 13 and 14 March 2024, 5 to 6 days after the birthday dinner.

Univariate analysis was performed for each food menu item to generate relative risk and 95% confidence intervals (95% CI). A two-tailed Fischer exact test was performed to determine p-values. Exposure was considered statistically significant if the 95% CI did not cross 1.0 and p-value was <0.05. Data analysis was performed in Microsoft Excel 365 (Microsoft Corporation, 2011) and using the GraphPad QuickCalcs Website[18].

Environmental health investigation

NSWFA requested Tweed Shire Council environmental health team conduct a basic food risk strategies inspection.

Laboratory investigation

Pathology was performed for three of the cases. The first case attended a private hospital on 12 March 2024 and had a stool sample performed by Sullivan Nicolaides Pathology (SNP). NCPPH organised stool sample testing for two additional cases on 15 and 20 March 2024 by Queensland Medical Laboratory (QML) and SNP. All of the stool samples were tested by multiplex PCR and culture, investigating for common enteric bacterial, parasitic, and viral pathogens (including *Entamoeba histolytica*, Giardia species, Dientamoeba species, Cryptosporidium species, Blastocystis species, *Yersinia enterocolitica*, Campylobacter species, Shigella species, Salmonella species, Aeromonas species, norovirus, rotavirus and adenovirus). When indicated, positive samples were sent to Queensland Health Scientific Services for typing.

Ethical approval

This study was conducted as an outbreak investigation under the NSW *Public Health Act 2010.* Ethical considerations for this project were approved by the Australian National University HREC under protocol 2017/909 “Request for waiver of consent for use of data in research for Master of Philosophy in Applied Epidemiology students for Outbreak Investigation and Surveillance in Public Health projects.”

Results

Epidemiological investigation

There were 16 attendees to the birthday dinner. Interviews were completed by public health staff for all attendees (response rate = 100%). One attendee provided information on behalf of her 16-year-old son. Of the attendees, 6.3% (1/16) met the confirmed case definition and 43.8% (7/16) met the probable case definition, resulting in a confirmed and probable case attack rate of 50% (8/16).

Of the eight cases (confirmed and probable), median age was 52 years (range 18 to 82 years) and the male to female gender ratio was 1:1. Two of the cases (25%) were high risk, one was immunocompromised and the second was elderly (aged over 75 years). However, neither reported complications from the illness.

Medical attention was sought in 75% (6/8) of cases at a general practice or emergency department, all of these cases were prescribed antibiotics however one decided not to take it (Table 1). None of the cases required hospital admission. Diarrhoea was reported in all cases (8/8) while vomiting, fever, abdominal cramps and joint/ muscle aches were reported in 75% (6/8) of the cases.

Table 1. Severity of illness of cases attending the birthday dinner (N=8), by medical review, antibiotic prescription and reported symptoms, North Coast NSW, 2024

	Cases (N=8)	%
Severity		
Sought medical attention	6	75
Hospitalisation	0	0
Antibiotics prescribed	6	75
Symptoms		
Diarrhoea	8	100
Bloody stools	0	0
Vomiting	6	75
Fever	6	75
Abdominal cramps	6	75
Joint/ muscle aches	6	75
Rash	0	0

Earliest symptom onset was 00:00 on 10 March 2024, 28 hours after eating at restaurant X. Although it is difficult to establish trends due to low case numbers, we can see a peak in cases (31.3%, 5/8) on 10 March 2024 and all cases' symptom onset occurred within a four-day period (Figure 1).

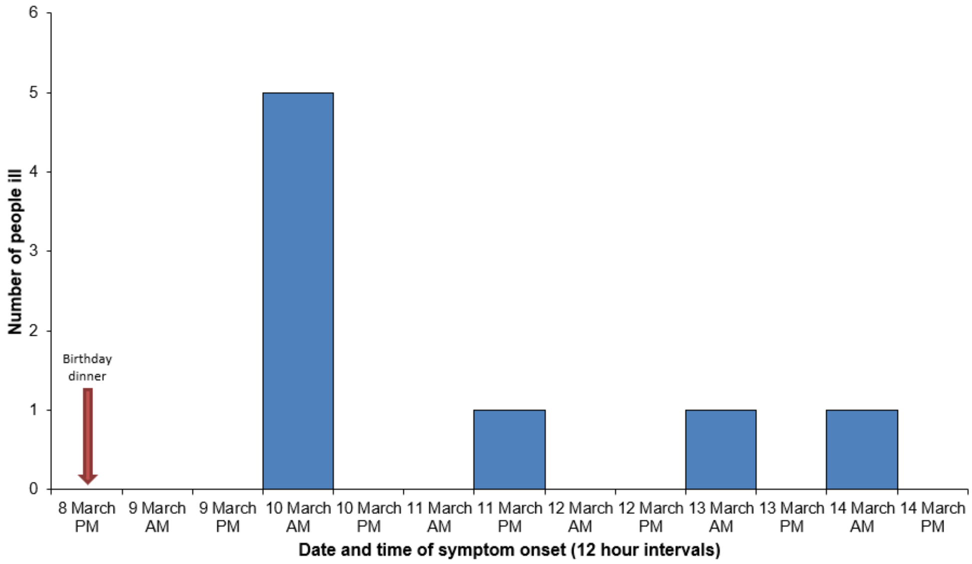


Figure 1. Epidemiological curve of case symptom onset date and time (in 12-hour intervals) (N = 8) following a birthday dinner, North Coast NSW, 2024

The cases all belonged to two families. Family A was comprised of three cases living in the same household. Family B included five cases living in two separate households. Excluding their own family members, cases denied contact with other attendees of the birthday party for at least six months prior to the event. The birthday dinner involved two tables, involving a mix of cases and non-cases in both.

Univariate analysis showed that none of the food consumed by the cohort at restaurant X were associated with illness (p>0.05 for all food exposures) (Table 2). Analysis was limited by low sample size and the broad range of foods consumed.

Table 2. Univariate analysis of risk factors for gastrointestinal illness following a birthday dinner, North Coast NSW, 2024 (AR% = attack rate)

Food consumed	Exposed			Unexposed			Results		
	Cases	Total	AR%	Cases	Total	AR%	Relative risk	95% CI	p-value
Caesar salad with prawns	1	1	100	7	15	46.7	2.14	1.25-3.68	1.00
Calamari	1	1	100	7	15	46.7	2.14	1.25-3.68	1.00
Cheeseburger	0	1	0	8	15	53.3	0		
Chicken burger	1	1	100	7	15	46.7	2.14	1.25-3.68	1.00
Chicken parmigiana	1	1	100	7	15	46.7	2.14	1.25-3.68	1.00
Chicken Schnitzel	2	4	50	6	12	50	1.00	0.32-3.10	1.00
Nourish bowl	0	1	0	8	7	114.3	0		
Salt and pepper squid	2	3	66.7	6	13	46.2	1.44	0.54-3.90	1.00
Steak	1	4	25	7	12	58.3	0.43	0.07-2.50	1.00
Side chips	7	14	50	1	1	100	0.50	0.23-4.40	1.00
Side salad	6	10	60	2	6	33.3	1.80	0.52-6.22	0.61
Side salad dressing	5	7	71.4	3	9	33.3	2.14	0.76-6.04	0.32
Sweet potato fries	5	11	45.5	3	5	60	0.76	0.29-1.99	1.00
Aioli	5	11	45.5	3	5	60	0.76	0.29-1.99	1.00
Krispy Kreme donut	3	4	75	5	11	45.5	1.65	0.70-3.90	0.57

The food diary and high-risk food trawler were unable to identify any foods outside the birthday dinner that were common between cases that may have caused illness. No common or high-risk yersiniosis environmental exposures were reported.

Environmental health investigation

Restaurant X has a capacity of over 150 people. Tweed Shire Council environmental health team inspected the venue on 13 March 2024 and found some issues with temperature control which were addressed. Environmental samples were not collected. NSWFA did not perform any further inspections of the premises.

Laboratory investigation

The first case tested on 10 March 2024 (symptom onset 10 March 2024, symptomatic at time of collection) had a positive result for *Y. enterocolitica* on faecal PCR and culture. Typing showed that it was "biotype 1A non-typeable". The second case tested on 15 March 2024 (symptom onset 14 March 2024, symptomatic at time of collection) returned a negative PCR and culture faecal specimen. The final case tested on 20 March 2024 (symptom onset 10 March 2024, asymptomatic at time of collection) also had a negative result. None of the cases had been commenced on antibiotic treatment when samples were collected.

Public health response

All attendees to the birthday dinner were contacted by public health. Those that were asymptomatic were advised to monitor for symptoms for two weeks after the event and contact public health if they developed symptoms. The final case's symptom onset was on 14 March 2024, 124 hours after eating at restaurant X and 96 hours after the onset of symptoms in the first case (Figure 1). No further complaints of foodborne illness were received by NSWFA in relation to restaurant X, suggesting that this was an isolated incident. After discussion with NSWFA, the decision was made to declare the incident over on 20 March 2024.

Discussion

We investigated an outbreak of gastrointestinal illness involving a large proportion of birthday dinner attendees at a Tweed Heads restaurant in March 2024. We concluded that the outbreak was unlikely due to a food exposure at restaurant X. Due to limited evidence we were unable to confirm whether *Y. enterocolitica* was the causal agent of the outbreak.

Yersiniosis has a complex epidemiology and the source of infection in humans is often unknown.[19] Even in countries with higher incidence rates of yersiniosis, outbreaks are rare.[12] Unfortunately when small outbreaks do occur, due to the limited evidence available it makes it difficult to identify the source.[20] Furthermore there are often difficulties isolating *Y. enterocolitica* from clinical, environmental and food sources.[19]

Epidemiological evidence was unable to demonstrate an association between any of the foods consumed at restaurant X and gastrointestinal illness in this cohort. Analysis was limited by the small sample and the large variety of meals ordered by the cohort, however this also suggests that a shared food source at restaurant X was unlikely. Yersiniosis is commonly due to consumption of pork[11], aside from bacon in one case's Caesar salad there was no other meals consumed by this cohort at restaurant X containing pork products. While it is possible that contamination occurred due to poor hygiene practices, we would expect to have been notified of more cases outside of this cohort in other attendees of the venue.

Salad has previously been reported as the likely source of large *Y. enterocolitica* outbreaks overseas.[13] While salad was a common food consumed by cases, it was also consumed by many of the controls and univariate analysis showed that it did not pose a statistically significant risk. Furthermore, since salad is a common food at the restaurant (it is served as side with most of the main dishes) if there was contamination, we would expect to see a much larger outbreak in restaurant X attendees.

NSWFA and NCPPH were not informed of other diners at restaurant X reporting gastrointestinal illness. Since restaurant X is a large, busy venue if it was the source of the outbreak, we would expect to have received foodborne illness complaints from other venue patrons or staff. However, we also must consider that many people do not notify when they develop gastrointestinal illness, so it is possible that there were other cases that we were unaware. The lack of convincing evidence of the source of the outbreak in this cohort at restaurant X and decreased capacity at the NCPPH, due to low staffing levels and its recent response to a possible measles outbreak, meant that further contact of a broader range of diners was not deemed warranted, especially as it may unfairly pose a risk to the reputation of the premises.

Due to the high attack rate in this cohort and the close proximity of case' symptom onset (four-day window) this suggest that it was likely a single source outbreak with no secondary transmission in the cohort. Although restaurant X was reported by the cases as the only interaction of the birthday party attendees in the past six months, it should be noted that all of the cases belonged to only two families, across three households. Therefore, it is highly possible that a separate common exposure could have been the source of the outbreak linking the two families. A limitation of this study was recall bias; all the interviewers noted that many cases could only provide a limited food history for events outside the birthday dinner. This could be because interviews were conducted five to six days later or because cases were fixated on restaurant X being the cause of the outbreak.

Aside from issues with temperature control, environmental health investigation did not find any other potential sources for the outbreak. While temperature changes may have contributed to the outbreak this was unlikely to have to have had a major impact as *Y. enterocolitica* is psychrophilic and is able to replicate at temperatures ranging from 0 to 44°C.[3]

As per the Centers for Disease Control and Prevention (CDC*) Guidelines for foodborne disease outbreaks*[15] we were unable to confirm that *Y. enterocolitica* was the aetiological agent of this outbreak. The guidelines require isolation of organism from the clinical specimen from two or more ill persons OR isolation of pathogenic strain of organism from epidemiologically implicated food.[21] Since a potential food source was not found, environmental swabs were not performed; however, even if testing did occur this would be unlikely to be fruitful as isolates of *Y. enterocolitica* are difficult to detect.[22]

Laboratory evidence revealed only one stool sample was positive for *Y. enterocolitica*. Unfortunately, only three samples were collected. We were unable to get further samples as many cases were on antibiotic treatment and their symptoms had resolved. It is unusual that the two samples were negative on both PCR and culture as *Y. enterocolitica* can be excreted in faeces from two weeks to over two months.[4] Furthermore, the second case tested was symptomatic when the stool sample was collected, therefore we would expect them to be shedding high levels of enteric pathogen. A meta-analysis of multiplex PCR tests for gastroenteritis pathogens found that the test had high diagnostic accuracy for all pathogens except for *Y. enterocolitica*.[23] Although *Y. enterocolitica* had good specificity (1.00, 95% CI 0.99-1.00) the sensitivity was low (0.48, 95% CI 0.31-0.65).[23] Therefore, it is possible that these two cases had a false negative result.

The incubation period of *Y. enterocolitica* ranges from 1 to 11 days which matches the symptom onset of cases after the birthday dinner;[3] however, it is unusual that the majority of cases developed symptoms only around 30 hours after the dinner as *Y. enterocolitica* incubation is typically three to seven days.[13] While symptoms including fever, diarrhoea, vomiting, abdominal pain and joint/ muscles aches reported by cases are typical for *Y. enterocolitica* they are also seen in most enteric diseases making it difficult to differentiate the likely causal agent. For example, cryptosporidiosis has a similar clinical syndrome to yersiniosis and there has been a 32.3% rise in cryptosporidiosis notifications from 2022 to 2023 in Australia.[24] Although stool samples were negative for cryptosporidiosis it is possible that another gastrointestinal pathogen that is not routinely tested and has similar clinical presentation was the causal agent.

The one positive pathology sample for *Y. enterocolitica* was revealed to be biotype 1A non-typeable. Biotype 1A strains are classified as non-pathogenic as they do not have the markers associated with virulence plasmid (pYV) and traditional chromosomal virulence genes.[9] They also have widespread occurrence in different environments, foods and asymptomatic animals.[9] While it is a debated topic, there is a growing body of evidence suggesting that biotype 1A strains can cause gastrointestinal illness in humans, however further research is required.[25-28]

It was interesting to find that the 75% of cases were prescribed antibiotic treatment. Only two cases were classified as high risk, none reported complications and only three cases had an investigation performed. Yersiniosis is usually self-limiting and antibiotic treatment is typically only recommended in immunocompromised patients or those suffering from septicaemia or invasive infection.[29] A population-based study of Yersiniosis cases in Germany found that 37% of cases were prescribed antimicrobials, however they were unable to find an association between antimicrobial treatment and severity of illness or probable post-infectious complications.[30] Antibiotics have previously been shown to not significantly reduce duration of enteritis.[31] This raises the issue of unnecessary antibiotic prescribing and risk of antimicrobial resistance.

CONCLUSION

The results of the investigation into a gastrointestinal illness outbreak amongst birthday dinner attendees was inconclusive. Based on epidemiological evidence and environmental health assessment it is unlikely that the source of the outbreak occurred at restaurant X and we were unable to confirm the aetiological agent. This study demonstrates the challenges and limitations associated with foodborne investigations.

REFERENCES

1. Queensland Health. Enhancing Foodborne Disease Surveillance Across Australia - OzFoodNet Annual Report, 2020. Brisbane (AU): Queensland Health; 2021 May.
2. Galindo CL, Rosenzweig JA, Kirtley ML, Chopra AK. Pathogenesis of Y. enterocolitica and Y. pseudotuberculosis in Human Yersiniosis. Journal of pathogens. 2011;2011(1):182051.
3. Bottone EJ. Yersinia enterocolitica: revisitation of an enduring human pathogen. Clinical Microbiology Newsletter. 2015;37(1):1-8.
4. Barton M. Pathogens in Milk| Yersinia enterocolitica. Encyclopedia of Dairy Sciences (Second Edition): Academic Press; 2011. p. 117-23.
5. Aziz M, Yelamanchili VS. Yersinia Enterocolitica. In: StatPearls. StatPearls Publishing, Treasure Island (FL); 2023. PMID: 29763012.
6. Tompkins D, Hudson M, Smith H, Eglin R, Wheeler J, Brett M, et al. A study of infectious intestinal disease in England: microbiological findings in cases and controls. Communicable Disease and Public Health. 1999;2(2):108-13.
7. Bottone EJ. Yersinia enterocolitica: the charisma continues. Clinical microbiology reviews. 1997;10(2):257-76.
8. Riahi SM, Ahmadi E, Zeinali T. Global prevalence of Yersinia enterocolitica in cases of gastroenteritis: A systematic review and meta-analysis. International journal of microbiology. 2021;2021(1):1499869.
9. Sabina Y, Rahman A, Ray RC, Montet D. Yersinia enterocolitica: mode of transmission, molecular insights of virulence, and pathogenesis of infection. Journal of pathogens. 2011;2011(1):429069.
10. Morse DL, Shayegani M, Gallo RJ. Epidemiologic investigation of a Yersinia camp outbreak linked to a food handler. American journal of public health. 1984;74(6):589-92.
11. Guillier L, Fravalo P, Leclercq A, Thébault A, Kooh P, Cadavez V, et al. Risk factors for sporadic Yersinia enterocolitica infections: a systematic review and meta-analysis. Microbial Risk Analysis. 2021;17:100141.
12. Drummond N, Murphy BP, Ringwood T, Prentice MB, Buckley JF, Fanning S. Yersinia enterocolitica: a brief review of the issues relating to the zoonotic pathogen, public health challenges, and the pork production chain. Foodborne pathogens and disease. 2012;9(3):179-89.
13. MacDonald E, Einöder-Moreno M, Borgen K, Brandal LT, Diab L, Fossli Ø, et al. National outbreak of Yersinia enterocolitica infections in military and civilian populations associated with consumption of mixed salad, Norway, 2014. Eurosurveillance. 2016;21(34):30321.
14. Gruber JF, Morris S, Warren KA, Kline KE, Schroeder B, Dettinger L, et al. Yersinia enterocolitica outbreak associated with pasteurized milk. Foodborne Pathogens and Disease. 2021;18(7):448-54.
15. European Centre for Disease Prevention and Control (ECDC). Yersiniosis Annual Epidemiological Report for 2021. Stockholm: ECDC; 2022 December.
16. Rivas L, Strydom H, Paine S, Wang J, Wright J. Yersiniosis in New Zealand. Pathogens. 2021;10(2):191.
17. Group OW. OzFoodNet Quarterly Report, 1 July to 31 September 2009. Communicable Diseases Intelligence Quarterly Report. 2009;33(4):426-32.
18. QuickCalcs: Analyse a 2x2 contingency table [Internet]. GraphPad; 2024 [cited 2024 Mar 20]; Available from: https://www.graphpad.com/quickcalcs/contingency1/.

19. Fredriksson-Ahomaa M, Stolle A, Korkeala H. Molecular epidemiology of Yersinia enterocolitica infections. FEMS Immunology & Medical Microbiology. 2006;47(3):315-29.

20. Lake R, Hudson A, Cressey P. Risk profile: Yersinia enterocolitica in pork. Inst Env Sci Res Limited. 2004;1:48.

21. Centers for Disease Control and Prevention (CDC). Guidelines for COnfrming Cause of Foodborne Disease Outbreaks [Internet]. Atlanta (GA): CDC; 2015 [updated 2015 Oct 15; cited 2024 Apr 04]. Available from: https://www.cdc.gov/foodsafety/outbreaks/investigating-outbreaks/confirming_diagnosis.html.

22. Bari ML, Hossain MA, Isshiki K, Ukuku D. Behavior of Yersinia enterocolitica in Foods. Journal of pathogens. 2011;2011(1):420732.

23. Chang L-J, Hsiao C-J, Chen B, Liu T-Y, Ding J, Hsu W-T, et al. Accuracy and comparison of two rapid multiplex PCR tests for gastroenteritis pathogens: a systematic review and meta-analysis. BMJ Open Gastroenterology. 2021;8(1):e000553.

24. Department of Health and Aged Care. National Communicable Disease Surveillance Dashboard [Internet]. Canberra (AU): Department of Health and Aged Care; 204 [updated 2024 Apr 9; cited 2024 Apr 9]. Available from: https://nindss.health.gov.au/pbi-dashboard/.

25. Tennant SM, Grant TH, Robins-Browne RM. Pathogenicity of Yersinia enterocolitica biotype 1A. FEMS Immunology & Medical Microbiology. 2003;38(2):127-37.

26. Singh I, Virdi JS. Production of Yersinia stable toxin (YST) and distribution of yst genes in biotype 1A strains of Yersinia enterocolitica. Journal of Medical Microbiology. 2004;53(11):1065-8.

27. Bhagat N, Virdi JS. The enigma of Yersinia enterocolitica biovar 1A. Critical Reviews in Microbiology. 2011;37(1):25-39.

28. Batzilla J, Heesemann J, Rakin A. The pathogenic potential of Yersinia enterocolitica 1A. International Journal of Medical Microbiology. 2011;301(7):556-61.

29. Fàbrega A, Vila J. Yersinia enterocolitica: pathogenesis, virulence and antimicrobial resistance. Enfermedades infecciosas y microbiologia clinica. 2012;30(1):24-32.

30. Rosner BM, Werber D, Höhle M, Stark K. Clinical aspects and self-reported symptoms of sequelae of Yersinia enterocolitica infections in a population-based study, Germany 2009–2010. BMC infectious diseases. 2013;13:1-8.

31. Hoogkamp-Korstanje J. Antibiotics in Yersinia enterocolitica infections. Journal of Antimicrobial Chemotherapy. 1987;20(1):123-31.

Chapter IV

Analysis of a public health dataset

Epidemiology of Q fever notifications in North Coast New South Wales, 2014–2023

CHAPTER CONTENTS

PROLOGUE

Study rationale

Q fever is highly prevalent in the northern region of New South Wales (NSW) and southern Queensland. The high number of notifications in North Coast NSW could be linked to its regional location and substantial agricultural industry. However, public health staff have noted an increase in cases with “non-traditional” risk factors, such as native animal exposure, suggesting that the epidemiology of Q fever may be more complex and multifactorial than previously thought. Previous Q fever epidemiological studies have been performed in the neighbouring Queensland and Hunter New England regions; this will be the first study focusing on Q fever notifications in North Coast NSW. We hope that by examining the epidemiology of cases over the past decade we will be able to improve our understanding of the impact of this disease and identify priority groups that public health interventions can target.

My role

I was involved in discussions about project ideas for this chapter and supported the idea of a Q fever data analysis. I prepared the protocol, data analysis plan and ethics application. I performed all data cleaning and analysis, including statistical analysis with assistance from ANU statistician Dr Alice Richardson. Finally, I wrote the chapter with input from my supervisors.

Lessons learnt

This study allowed me to practice and develop my data analysis skills. It gave me the opportunity to improve my coding in R including data cleaning, geospatial mapping, age standardisation and data visualisation. I have learnt a lot about statistical methods with the guidance of Dr Richardson, including methods to perform this in R. A major lesson I learned from this project was that sometimes data analysis is hindered by the limitations of the dataset. Although I had initially been ambitious regarding ideas about figures, I learnt that you must consider the size of the sample, quality of the data and ask yourself whether the additional figures will help answer the study’s aims.

I enjoyed learning about a disease that impacts primarily regional populations, especially learning about the burden of disease and how complex the epidemiology can be. I was amazed to learn about the barriers associated with Q fever vaccination administration, despite it being manufactured in Australia and the evidence that it is an effective public health intervention. This highlighted to me the disadvantages regional and rural populations face.

Public health implications

This study contributes to our understanding of Q fever's epidemiology and impact in the North Coast NSW region. We hope these findings will help increase awareness of Q fever amongst both clinicians and community members, which may lead to increased screening and earlier diagnosis. If commenced early enough, antibiotic treatment may reduce the risk of long-term complications associated with Q fever.

This was a hypothesis-generating project that may be used to design future case-control or cohort studies to gain a better understanding of risk factors. Future studies could also have a closer examination of the burden of Q fever in hospital settings and the economic costs associated with this.

This study has important implications for the public health unit, it suggests that more work needs to be done to improve data quality and demonstrates the difficulty of following up on notified cases and contacting clinicians to obtain case histories. A review of the NSW Health Q fever dataset containing state-level notification data may be beneficial, to improve the quality of data while also capturing the broad range of risk factors contributing.

Finally, this study shows that we need to consider strategies to reduce the ongoing high rates of Q fever in North Coast NSW. We hope our findings can guide future public health interventions including educational programs and vaccine campaigns. This study demonstrates that Q fever public health interventions cannot be focused only on high-risk occupation settings, instead, we must consider expanding programs to the broader community, especially those residing in areas with increased native animal and environmental exposure.

MAE course requirements

This chapter fulfills the MAE requirement for an analysis of a public health dataset.

Acknowledgements

I am very grateful to Dr Alice Richardson, ANU statistical support network statistician, for providing statistical advice for this project. I would also like to thank Dr Joanne Taylor, University of Newcastle School of Medicine and Public Health, for her fantastic input during project development and for providing an independent peer review report required for HREA. I acknowledge my field and academic supervisors Prof Tony Stewart, Dr Rosalina Sa'aga-Banuve, Robin Auld and Genevieve O'Neill for their project guidance and insightful feedback. Finally, I would like to thank the NCPPH communicable disease for their collection of Q fever notification data that was used in this analysis.

ABBREVIATIONS

°C	Degrees Celsius
ABS	Australian Bureau of Statistics
AIR	Australian Immunisation Register
CDNA	Communicable Diseases Network Australia
CI	Confidence interval
C. burnetii	Coxiella burnetii
ERP	Estimated resident population
LFT	Liver function test
LGA	Local government area
LHD	Local health district
MNC	Mid North Coast
NNSW	Northern NSW
NSW	New South Wales
SAPHaRI	Secure Analytics for Population Health Research and Intelligence

ABSTRACT

Introduction

Q fever is a zoonotic disease with a complex epidemiology and substantial public health impact. It is caused by the gram-negative bacteria *Coxiella burnetii*. Human infection commonly occurs by breathing in dust contaminated by infected animal faeces, urine, milk, and birth products. North Coast NSW has a substantial livestock industry and one of the highest incidences of Q fever in NSW. This study examined Q fever epidemiological trends in North Coast NSW.

Methods

Q fever notification data was extracted from the NSW Notifiable Conditions Information Management System. Notifications in North Coast residents between 2014 and 2023 were analysed, which included examination of geographical distribution, risk factors and severity of illness.

Results

There were 577 confirmed Q fever notifications between 2014 and 2023. Notifications were predominantly in males (72.8%) and those aged 50−74 years (56.0%). Nearly half of the cases were hospitalised (49.0%) and around 90% were symptomatic, however, less than 1% had a self-reported history of Q fever vaccination. Animal exposure was reported in 60.5% of cases, while a large proportion of cases did not report a high-risk occupation (32.1%). Q fever notification rate in the region did not significantly change over the study period. Increased notification count appeared to be associated with the warmer months with greater rainfall.

Conclusion

Notifications of Q fever in North Coast NSW are high and rates have not improved over the past decade. Many notifications did not have the "traditional" Q fever risk factors and self-reported vaccine coverage was poor, this suggests that we need to consider expanding the current vaccination and community awareness campaigns.

INTRODUCTION

Q fever has been reported worldwide, except for New Zealand.[1] It became a notifiable condition in all Australian states and territories in 1977.[1] It is a zoonotic disease caused by the pathogen *Coxiella burnetii*, an intracellular Gram-negative bacterium.[2] While there is a wide range of reservoirs for *C. burnetii*, including both domestic and wild animals, it is primarily seen in sheep, cattle and goats.[3] In Australia, exposure to kangaroos is often reported.[4] Human transmission is mainly via inhalation of contaminated aerosols from animal secretions.[5]

The clinical severity of Q fever infection can vary from flu-like symptoms to severe illness. While the majority of cases are asymptomatic (around 60% of those with primary infection) it can also lead to hospitalisation and death.[2] Around 2% of acute Q fever cases require hospitalisation mainly due to complications such as pneumonia and hepatitis.[6, 7] Chronic Q fever is a serious condition that can occur one month to several years after primary infection due to ongoing infection and can manifest as endocarditis, osteoarticular infections and vascular infections.[8] A previous study by Million et al.[9] examining the long term outcomes of patients with Q fever endocarditis reported a 10-year mortality of 19%.

Since 1989 there has been a Q fever vaccine available for humans which is only available in Australia (Q-vax).[3] The Australian Immunisation Handbook recommends Q fever vaccination for people 15 years and over whose work puts them in contact with animal products or high-risk animals (sheep, cattle and goats) or who live in rural and remote areas.[10] The vaccine has an estimated efficacy of 93%, unfortunately, it is not funded by the government and needs to be purchased privately.[11] In addition, pre-vaccination screening is required to reduce the risk of a severe hypersensitivity reaction in those with a previous infection.[8] Previously, Q-fever immunisations could be reported to the Australian Q fever Register which was privately owned and funded by the Australian Meat Processor Corporation.[12] However, in April 2024 this was replaced by the Australian Immunisation Register (AIR).[12]

Due to declining rates of vaccine uptake the Australian government funded the National Q Fever Management Program in 2001.[13] This program provided free Q-vax immunisations to abattoir workers, sheep, dairy and beef cattle farmers and their employees and relatives who worked on a farm.[13] After the introduction of this program there was a corresponding drop in national notification rates between 2002 and 2006, with the greatest decline seen in young adult males.[13] The program was time-limited and ceased in 2006, with a subsequent rise in Q fever notifications seen from 2009.[14]

Since 2010 in NSW, surveillance datasets have provided enhanced data for each Q fever notification, including information on occupation, animal exposures and place of acquisition. This resulted in a substantial improvement in Q fever risk factor data quality, with the proportion of cases with unknown exposure sources decreasing.[4] Despite the improvements in data quality many notifications do not have a clear source of infection suggesting other unknown factors may contribute.[4]

Historically rurality has been a key risk factor for Q fever,[4,15,16] however, emerging research suggests this may no longer be the case.[17, 18] A recent epidemiological analysis of Q fever in Wide Bay Queensland identified an unexpected increase in cases in urban areas since 2018.[18] This has been hypothesized to have occurred due to the expansion of urban areas, with farmland rezoned to make way for housing estates. [18]

Due to the nature of disease transmission, Q fever has been traditionally associated with occupations involving livestock exposure.[5] However, over the past few decades in Australia evidence has been conflicting suggesting that risk pathways may be more complicated than initially thought. Historically, abattoir work has been repeatedly identified as an at-risk occupation[5, 19], however, emerging research suggests this may no longer be the case.[6, 18, 20] A 2015 review of nationally notified data found that while occupations involving livestock were most frequently reported by cases, the next most reported occupation group was "no known risk occupation" suggesting that other factors contribute to the Q fever risk profile in Australia and that workplace vaccination programs should be reviewed, possibly expanded and more research needs to be conducted to identify any common risk factors in this "no known risk occupation" group.[14]

A comparison of Q fever notifications in the Wide Bay region of Queensland, before and after 2017 found a substantial difference in risk factors.[18] Q fever notifications reported over 2013−2017 had a greater proportion of high-risk occupations (e.g. 12% hunt or butcher animals and 6.1% work in livestock transport) while notifications reported over 2018−2022 frequently reported mowing, gardening and land clearing exposure (17% of cases).[18] These studies suggest that we should consider broader environmental exposure pathways when considering risk factors for Q fever. Recent climate conditions should also be considered as there is currently mixed evidence for its contribution, while some researchers suggest persistent dry and windy conditions may contribute to increased transmission others suggest it may be more linked to rainfall.[18, 21]

North Coast NSW is situated on the southern border of Queensland and has a substantial livestock industry. It encompasses two local health districts (LHDs): Mid North Coast (MNC) and Northern NSW (NNSW). North Coast NSW experienced a significant expansion of urban areas in recent years due to substantial population growth since the emergence of COVID-19. In 2022, North Coast NSW had the second-highest number of Q fever notifications in NSW (n=51), behind only Hunter New England LHD (n=56).[22]

This was the first Q fever study performed in North Coast NSW. It aimed to review the epidemiological trends of Q fever notifications in North Coast NSW to improve our understanding of factors contributing to Q fever acquisition and guide local public health interventions. As evident from the disparity of evidence in the literature, risk factors for Q fever are complex and evolving, therefore we hoped to provide an updated and focused review of current local trends.

Aim and objectives

This study aimed to examine the epidemiology of Q fever in North Coast NSW region between 2014 and 2023.

The objectives of the study were to:

- Determine count and age-standardised incidence rates of Q fever notifications in North Coast NSW residents, including breakdown by local government area (LGA) and LHD.
- Compare Q fever notification count and rates by key demographic and exposure variables.
- Examine severity of disease at time of notification, by determining the number of cases. presenting with symptomatic disease and/or requiring hospitalisation (acknowledging that this is not an indication of the disease burden in the region as those with asymptomatic disease are less likely to be diagnosed and notified).
- Identify trends in Q fever incidence rates over time, including hospitalisation, seasonal and annual trends.

METHODS

Study design

A retrospective observational study was performed. The study population included individuals notified, by laboratory or clinician, to NSW Health with confirmed Q Fever who were residents of NNSW or MNC LHDs, between 1 January 2014 and 31 December 2023.

Definitions

Case definitions are those defined in the *Q fever Communicable Disease Network Australia (CDNA) National Guidelines for Public Health Units*.[8] A confirmed case of Q fever requires laboratory definitive evidence (detection of *C. burnetii* by nucleic acid testing or significant increase in antibody level to Phase II antigen in paired sera tested in parallel in absence of recent Q fever vaccination or detection of *C. burnetii* by culture) or laboratory suggestive evidence (detection of specific IgM in the absence of recent Q fever vaccination) and clinical evidence (clinically compatible disease).

Data collection

Q fever notification data was extracted from the NSW Notifiable Conditions Information Management System (NCIMS) on 14 March 2024 as a spreadsheet in Microsoft Excel (Microsoft Office 2013; WA, USA). Data was limited to confirmed notifications, with MNC or NNSW listed as the jurisdiction and with notification dates ranging from 1 January 2014 to 31 December 2023. NCIMS data fields extracted included: age, gender, geographical location, symptoms, hospitalisation, vaccination status, place of acquisition, high-risk occupation and animal contact exposure.

Historical climate data was obtained from the Australian Bureau of Meteorology, Climate Data Online webpage.[23] Data was extracted from the 15 weather stations in the North Coast NSW region which had climate data collected during the study period (Ballina airport, Byron Bay, Casino airport, Coolangattta, Dorrigo, Evans head, Grafton airport, Grafton research station, Harwood island, Kempsey airport, Lismore airport, Lower Bucca, Uralba, Yamba and Yarras). The average monthly rainfall (mm), mean daily wind run (km), maximum wind gust (km/hour) and maximum daily temperature (degrees Celsius (°C)) for the 15 stations were calculated using Microsoft Excel (Microsoft Office 2013; WA, USA).

LHD and LGA estimated resident population (ERP) data were extracted from the NSW Secure Analytics for Population Health Research and Intelligence (SAPHaRI) portal, based on the Australian Bureau of Statistics (ABS) census and projected population data.[24, 25] NSW health concordance files were used to ensure LGA populations only captured those living within the North Coast NSW borders (MNC and NNSW LHD).

Data analysis

Data analysis was performed using R statistical software (v.4.3.1; R Core Team 2023).[26] Descriptive analysis included counts, proportions and notification rates.

To calculate annual notification rates, ERP was used as the denominator data. To determine the notification rate over multiple years, the total number of notifications for that period was divided by the summed ERP for the period. Since 2023 ERP was not available at the time of data collection, projected 2023 data was used to represent the denominator for that year.

We also determined age-standardised notification rates for each LHD using the direct method. This was performed with the R package PHEindicatormethods (version 2.0.2, Anderson et al., 2024), utilising the 2001 Standard Australia Population dataset.[27] To compare MNC versus NNSW LHD notification rates we conducted a two-sample test of proportions.

Univariate analysis involving Poisson regression to generate notification rate ratios and 95% confidence intervals (95% CI) was performed for the age and sex variables. Rates used ERP size as an offset. Results were considered statistically significant if the p-value was less than 0.05.

To investigate the trend in notification rate over time we fitted a generalised linear model with Poisson outcome and log(population) as the offset. To investigate the effect of month we fitted a generalised linear model with Poisson outcome as before.

Ethical approval

The protocol was approved by the NSW Population and Health Services Research Ethics Committee (Ethical Approval Number 2023/ETH02586) and the Australian National University Human Research Ethics Committee (Ethics Approval Number H/2023/1436).

RESULTS

Demographics

A total of 577 confirmed Q fever notifications in North Coast NSW were recorded on NCIMS between 2014 to 2023 (average annual notification rate of 11.1 per 100,000 persons). Of these notifications, 315 (54.6%) resided in NNSW and 262 (45.4%) resided in MNC at the time of notification. The age-standardised annual notification rate for NNSW was 10.5 per 100,000 persons (95% CI 9.31−11.8) while for MNC LHD it was 12.3 per 100,000 persons (95% CI 10.8−14.0). There was a statistically significant difference in the proportion of Q fever notifications by LHD ($p = 0.045$, MNC = 262/ 2,153,765, NNSW = 315/3,045,252).

Figure 1 displays the geographical distribution of notifications over the combined 10-year study period by LGA. Clarence Valley had the highest number of notifications for the study period (17.0%, n=98/577), followed by Coffs Harbour (14.2%, n=82/577). However, the annual notification rate was greatest in Kyogle (51.2 per 100,000 persons), followed by Bellingen (32.2 per 100,000 persons). Tenterfield was not included in the figure as only a part of this region belongs to the North Coast NSW region and the population is small (n= 410), there were four cases over the study period.

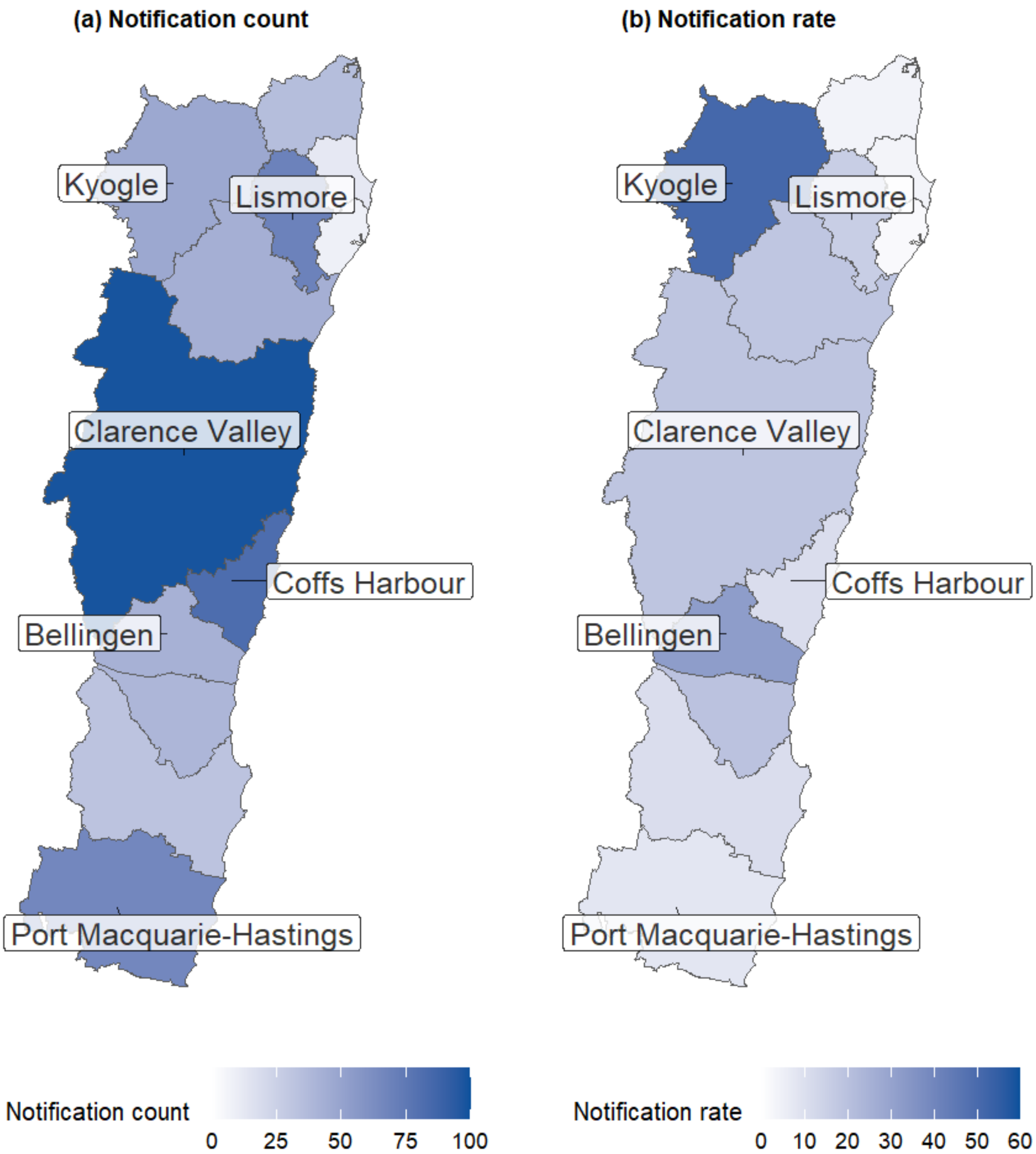


Figure 1. Geographical distribution of Q fever notifications in North Coast NSW, by local government area, (a) notification count and (B) average annual notification rate per 100,000 persons, 2014–2023.

Risk factors

Table 1 summarises the risk factors of notified cases. The majority of notifications were acquired in NSW (78.5%, n= 453/577). Q fever notifications were predominantly in males (72.8%, n= 420/577) and those aged 50–74 years (56.0%, n= 323/577) (Table 1). Over the study period, the Q fever notification rate was 2.79 times greater in males compared to females (95% CI 2.33–3.36, p <0.001). Compared to the 0–24 years age group, the notification rate was greatest in those aged 50–74 years (IRR 5.89, 95% 4.35–8.18, p<0.001) followed by those aged 25–49 years (IRR 4.15, 95% CI 3.01–5.84, p<0.001) and those aged 75 years and over (IRR 1.88, 95% CI 1.18–2.95, p=0.007).

The majority of Q fever notifications in North Coast NSW did not report a high-risk occupation (32.1%, n = 185/ 577). The most common high-risk occupation reported was a farmer (24.6%, n= 142/577). A large proportion of notifications had an unknown occupation (27.6%, n=159/577) or “other” high-risk occupation (13.3%, n=77/577) which was not further described.

Animal exposure was reported in 60.5% (n=349/577) of notified cases. Of these notifications, farm animals were the most common exposure (52.7%, n= 184/349), followed by native animals (23.8%, n=83/349) and then exposure to only animal discharges or tissues (12%, n=42/349). One-third of notifications had unknown animal exposure (n=194/577).

Table 1. Q fever notifications in North Coast NSW, by risk factor, 2014–2023.

Characteristic	N = 577
Gender	
Female	157 (27%)
Male	420 (73%)
Age group	
0–24	44 (7.6%)
25–49	178 (31%)
50–74	323 (56%)
75+	32 (5.5%)
Place of acquisition	
Acquired in NSW	453 (79%)
Acquired in Australia outside NSW	<5
Acquired outside Australia	<5
Unknown	118 (20%)
Vaccinated	
Yes	<5 (0.7%)
No	412 (71%)
Unknown	161 (27.9%)
High risk occupation	
Abattoir Worker	9 (1.6%)
Farmer	142 (25%)
Grazier	<5
Stock Yard Worker	<5
Veterinarian/ Veterinary Nurse	<5
Other	77 (13%)
No high-risk occupation	185 (32%)
Unknown	159 (28%)
Any animal exposure	
Farm animals	184 (31%)
Native animals	83 (14%)
Faeces	16 (2.7%)
Animal discharges or tissues (including birth products)	42 (7.2%)
Other animal or animal product	34 (5.8%)
No animal-related risk exposures	34 (5.8%)
Unknown	194 (33.1%)

Vaccination

Less than 1% of cases (n=4) had a history of Q fever vaccination, however, a large proportion had an unknown vaccination history (27.9%, n=161/577). For all the cases who were classified as vaccinated, this was self-reported and not confirmed on health records. The median duration of time between Q fever vaccination and notification was 11.5 years (range 3−26 years). The majority of those vaccinated had a high-risk occupation (75%, n=3/4).

Disease severity

Around 90% of cases were symptomatic, the most commonly reported symptoms and/or signs were fever (82.8%, n=478/577), lethargy (77.3%, n=447/577) and abnormal liver function test (LFT) (71.1%, n=410/577) (Table 2). Nearly half of the cases required hospitalisation (48.9%, n=282/577). Endocarditis was reported in 2.3% (n=13/577) of notifications and unknown in 51% (n=294/577). A large proportion of notified cases reported "other" symptoms (57.5%, n=332/577), with further details on the symptoms they experienced included in the notification form.

Table 2. Q fever notifications in North Coast NSW, by clinical characteristics, 2014−2023

	Number of notifications (N = 577)		
	Yes	No	Unknown
Severity			
Hospitalised	282 (49%)	232 (40%)	63 (11%)
Symptomatic	519 (90%)	2 (0.3%)	56 (9.7%)
Symptom type			
Abnormal LFT	410 (71%)	33 (5.7%)	134 (23%)
Chills	399 (69%)	39 (6.8%)	139 (24%)
Malaise	393 (68%)	34 (5.9%)	150 (26%)
Fever	478 (83%)	15 (2.6%)	84 (15%)
Lethargy	447 (77%)	13 (2.3%)	118 (20%)
Headache	379 (66%)	56 (9.7%)	142 (25%)
Endocarditis	13 (2.3%)	270 (47%)	294 (51%)
Other	332 (58%)	40 (6.9%)	205 (36%)

Trends over time

Despite some variance in notification count, the annual Q fever notification rates for North Coast NSW remained fairly stable between 2014 and 2023 (Figure 2). The notification rate was estimated to be falling by 2% per year but the decline was not statistically significant (RR = 0.98, 95%CI 0.95−1.0, p=0.086). Of note, the population of North Coast increased by around 7% over the study period.

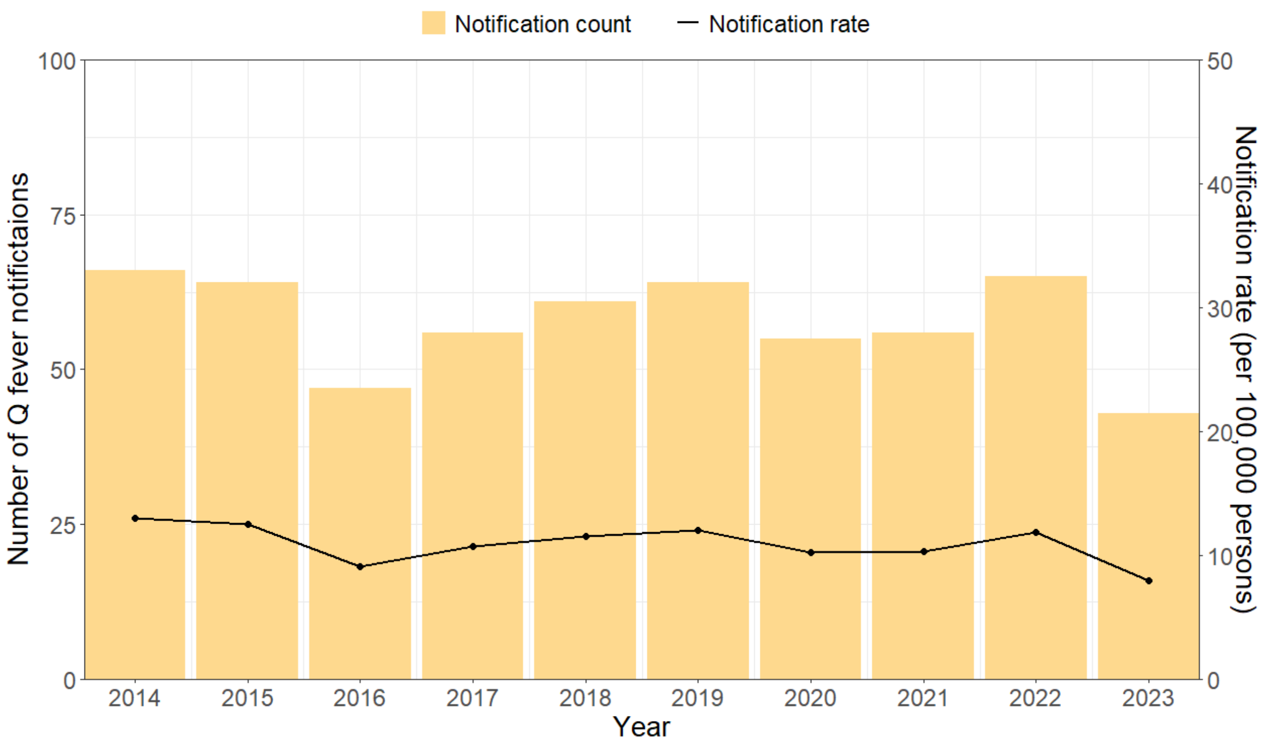


Figure 2. Q fever annual notification count and notification rate in North Coast NSW, 2014–2023

Figure 3 shows the number of Q fever notifications that were hospitalised each year of the study period and the annual hospitalisation rate. Overall, the hospitalisation rate for notified cases was stable between 2014 and 2020, with a small rise in 2022 and drop in 2021 and 2023.

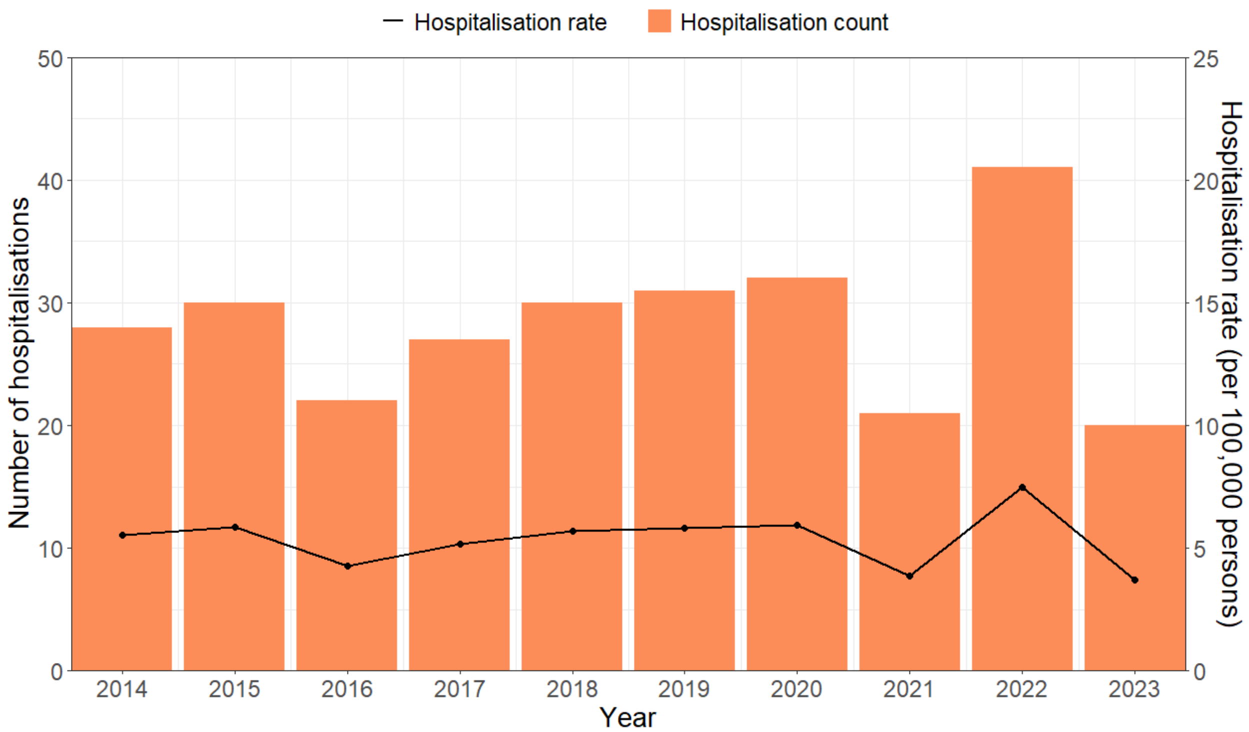


Figure 3. Q fever annual hospitalisation count and rate for notified cases in North Coast NSW, 2014–2023

There was no substantial change in Q fever annual notification rate over the study period for males or females (Figure 4). Notification rates were greater in males every year (Figure 4).

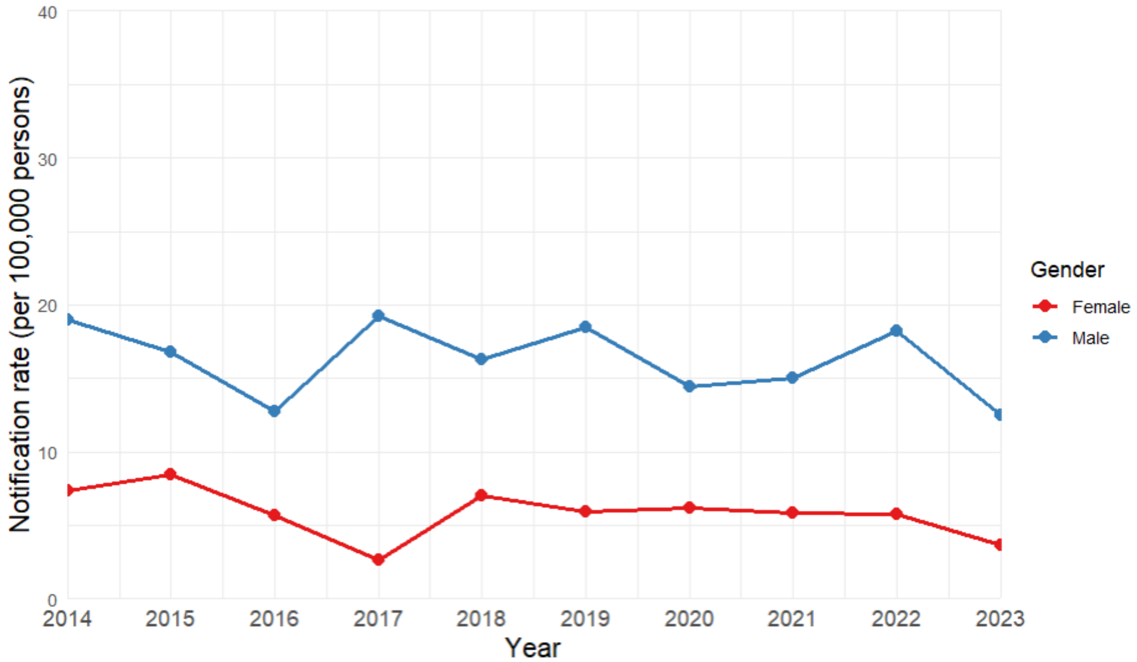


Figure 4. Q fever annual notification rate in North Coast NSW, by gender and year, 2014–2023

Q fever notification rates were consistently highest in the 50–74 year age group from 2014 and 2023 (Figure 5). The 75+ age group notification rate increased six-fold between 2017 and 2021 (from 1.86 per 100,000 persons to 11.66 per 100,000 persons), overtaking both the 25–49 and 50–74 year age groups. However, it substantially decreased in 2022 (Figure 5).

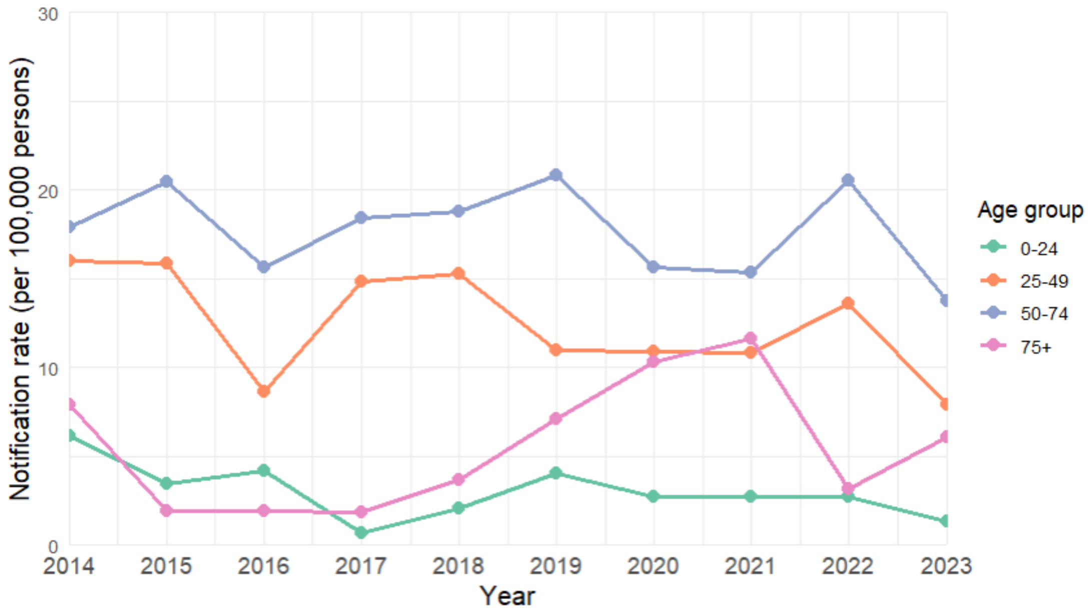


Figure 5. Q fever annual notification rate in North Coast NSW, by age group, 2014–2023

Figure 6A shows the total number of Q fever notifications over the 10-year study period, by month of notification date. To investigate the effect of month we fitted a generalised linear model with Poisson outcome as before (Appendix 1). September was used as the baseline as it was the month with the lowest notification count. The effect 'month' was significant ($X^2 = 42.2$, df = 11, $p < 0.001$). Follow-up tests of significance of individual months showed that the months with significantly more cases than baseline were December ($p = 0.025$), January ($p < 0.001$), February ($p < 0.001$), March ($p = 0.003$) and May ($p = 0.004$).

Historical climate trends for North Coast NSW by month can be seen in Figures 6B and 6C. The months with higher notifications of Q fever generally corresponded with the months with greater rainfall and warmer temperatures (Figures 6A and 6B). There was no obvious trend found between Q fever notification count and daily wind run or maximum wind gust speed (Figures 6A and 6C).

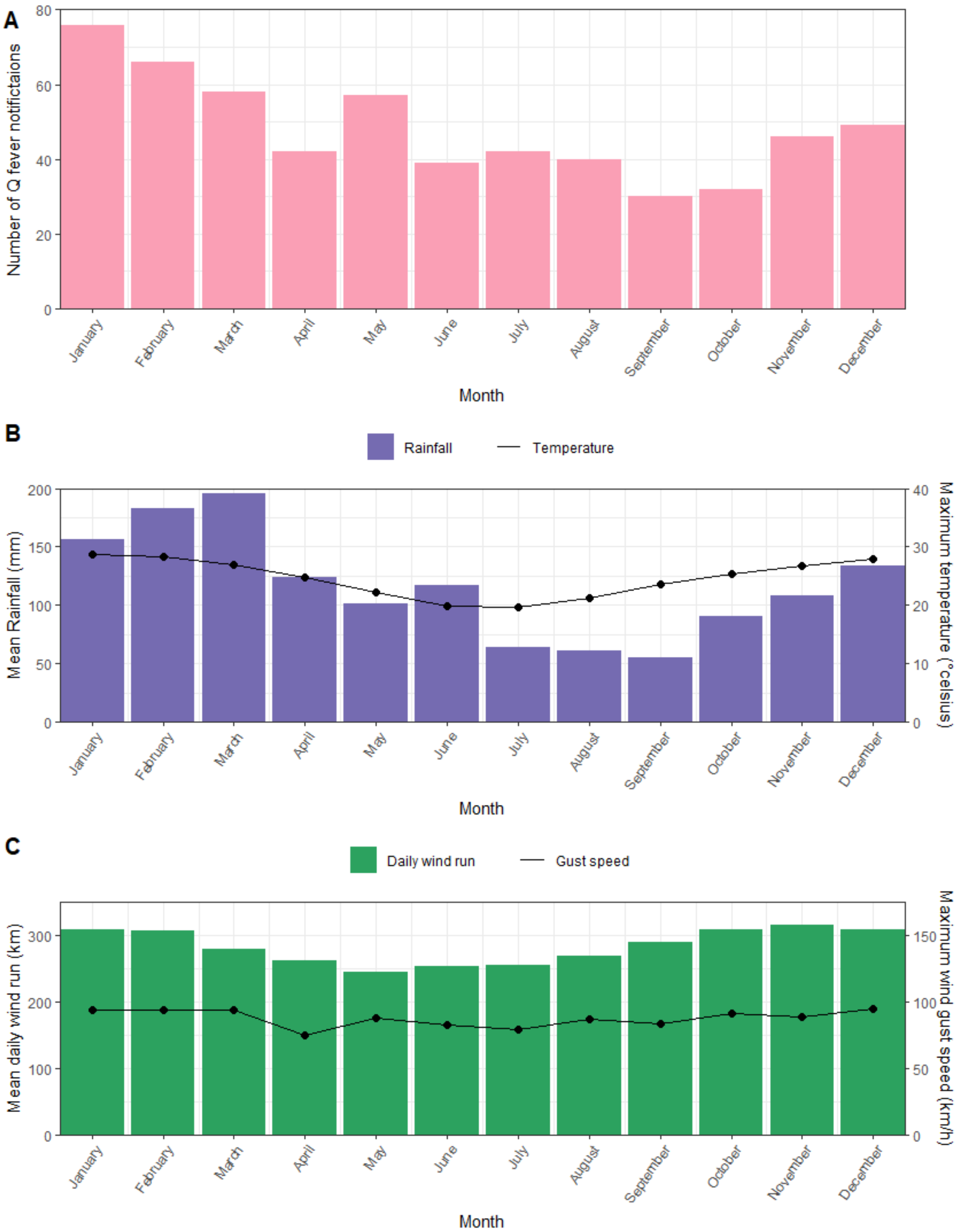


Figure 6. Q fever notification and climate in North Coast NSW, by month. (A) Q fever notification count, 2014–2023. (B) Mean rainfall (mm) and maximum temperature (°Celsius). (C) Mean daily wind run (km) and maximum wind gust speed (km/hour)

DISCUSSION

This study examined the epidemiology of Q fever notifications in North Coast NSW over the past decade. We found that notified cases of Q fever often suffer from substantial disease and very few had a history of vaccination. A large proportion of cases reported animal exposure but did not report a high-risk occupation, however, our analysis was limited by the large quantity of unknown data.

Risk factors

We found that males and those aged 50−74 years had significantly higher rates of Q fever. This is consistent with previous studies.[14, 28] While the male predominance could be attributed to increased occupational animal and environmental exposure, it is unclear why older people are at increased risk. Only the 75+ year age group had a substantial change over time, with a large increase from 2017 to 2021. Our findings were consistent with a previous Queensland study which found that the average age of notified cases increased over time, while the proportion of females remained relatively constant.[29] However, it is interesting that only this older age group had a clear rise in notification rate over time, the reason for this trend is out of the scope of this paper and will hopefully be explored in future studies.

Only 40% of notifications reported a high-risk occupation and a third of these had an occupation not listed in the dataset. Suggesting that other occupations or non-occupational exposure could be stronger risk factors. Previous studies in Queensland and the Netherlands found that fewer Q fever cases than expected reported high-risk occupations and suggested that environmental exposure, through land clearing, mowing and residing close to farms, increased the risk of transmission.[18] In the past, North Coast NSW lost large expanses of rainforest due to land clearing for the logging and dairy industry. More recently, agricultural and urban development have resulted in further land clearing and proximity of houses close to areas with grassland or replacing previous farmland. In 2018−2021, around 9,000 hectares of vegetation were cleared in the North Coast region.[30] We should also consider people who have hobby farms, as they may be exposed to the same animal and/ or environmental risks as those with high-risk occupations but may not be captured by this data field.

This study was unable to examine environmental exposures as it is not included in the NSW health Q fever dataset. A previous study examining Q fever notifications in Queensland found that 82% of notifications between 2013 and 2017 were exposed to environmental exposures.[29] The most common environmental exposure was “exposure to dust from paddocks or animal yards” followed by “live/ work within 300 m of bush/ scrub/ forest area”.[29] Environmental sampling performed in Queensland detected *C. burnetti* DNA in 2% of soil and 6.9% of atmospheric dust samples.[31] *C. burnetti* is highly resistant to adverse environmental conditions and can remain in the soil for up to 5 months.[32] This suggests that non-direct animal exposure and other environmental factors should be considered when assessing Q fever risk and that we should consider expanding the NSW dataset to include factors similar to those used by Queensland.

Animal exposure was identified as a common risk factor among notified cases, with farm animal exposure being the most frequently reported. Native animal exposure was reported in nearly a quarter of those reporting animal exposure. Over the past decade, increasing urban developments and density of kangaroos in urban green spaces have led to a rise in kangaroo-related incidents (such as road collisions and attacks) around the Coffs Harbour Northern Beaches region of North Coast NSW.[33] In Queensland, *C. burnetti* DNA has previously been revealed in a variety of native animal blood, urine and faecal samples.[31] A review of Q fever patients in an endemic region of north Queensland revealed that macropod and possum exposure was reported significantly more than cattle exposure (69,8%, 66.7% and 23.8%, respectively).[34]

Vaccination

We found very few notified cases had been vaccinated, and all these cases were individuals with high-risk occupations. Similarly, a review of NSW Q fever notifications between 2001 and 2010 found that 1.2% of notified cases had prior vaccination.[35] This could reflect the effectiveness of Q-vax as those protected from Q fever infection via vaccination would not be notified. Previous research suggests that Q-vax has an efficacy greater than 93%.[11] The duration of immunity is less clear, it has previously been estimated to be at least 5 years[36], though immune responses to *C. burnetti* have been shown in people who had been vaccinated over 10 years prior.[37]

Alternatively, the lower vaccination rate seen in North Coast NSW Q fever notifications may also reflect the poor vaccine coverage in this area. Barriers to vaccination included lack of awareness, poor health literacy (including lack of perceived risk), access to trained healthcare staff as well as financial and time constraints associated with the vaccine and screening process.[13, 38, 39] Additionally, vaccination status was self-reported only and unknown in a large proportion of cases. This emphasises the difficulties with recording Q fever vaccination status, however, this should improve with the introduction of the Q fever vaccine to AIR in April 2024 and the closure of the previous Australian Q Fever Register which was owned by the Australian Meat Processor Corporation.[12] However, AIR will not include vaccination or natural immunity status information prior to 15 April 2024 unless the individual organised for a vaccine provider to report this information.[12] By having Q fever vaccine records in AIR, this will make this information more accessible to clinicians which should hopefully simplify the pre-vaccination process.

Clinical characteristics

The study showed that notified cases of Q fever experienced considerable illness. Nearly half of the cases require hospital admission, which is greater than the rate of 40% reported in Queensland.[29] This also suggests that Q fever can result in considerable healthcare costs.

We found that 90% of cases notified during the study period were symptomatic. Our results were consistent with a Victorian review of Q fever notifications, which found that 94% of cases between 2004 and 2013 reported symptoms.[40] Since asymptomatic cases are unlikely to be diagnosed and notified to public health and the literature suggests that the majority of cases are asymptomatic, this suggests that Q fever is highly prevalent in this region.[2] Serosurvey studies can provide us further indication of previous Q past exposure and epidemiology of the disease, a study by Gidding et al.[28] estimated that the national Q standardised seroprevalence for Australia was above 5% which also suggested that notification rates were likely well under true incidence rates.

Due to the mix of vague symptoms Q fever presents with, even cases presenting with symptomatic disease may not be tested and diagnosed by clinicians due to the broad differential list and lack of awareness of the disease. This may result in patients not being given appropriate antibiotic treatment and may lead to the development of complications that are not appropriately screened for. Of concern, we found that over 2% of cases were diagnosed with endocarditis which can cause substantial morbidity and mortality. Finally, we found that 58% had other symptoms that were not included in the NSW health Q fever dataset suggesting that many cases may not have the classical Q fever clinical fever presentation and that the form may need to be expanded to enable greater granularity of the clinical presentation.

Geographical distribution

Kyogle was identified as the region with the highest notification rate of Q fever. This could be due to multiple factors. Firstly, agriculture is the largest industry in Kyogle, with livestock slaughtering the greatest commodity. Secondly, the estimated resident population of Kyogle for 2023 was 9,468 and the population density was only 2.6 persons per square km.[41] Harris et al.[21] previously demonstrated that acute Q fever cases in Northern Queensland were more likely to live in sparsely populated areas with increased wildlife. Finally, Kyogle has an older population with a median age of 52 years[42], compared to 38 years in Australia[43], and older age is a risk factor for Q fever.[14]

Change over time

When examining annual temporal trends, we did not find a significant change in the Q fever rate for North Coast NSW over the study period. While it is reassuring that rates are not increasing it also suggests that public health interventions are not currently occurring to effectively improve rates.

There was no substantial trend seen in the hospitalisation rate over time for notified cases. The variations seen between 2021 and 2023 are likely related to the COVID-19 pandemic which may have impacted health seeking behaviour and access to services. Furthermore, there was a backlog of Q fever notifications when public health staff were prioritising the surge in COVID-19 cases.

Climate

Notifications for Q fever were greatest from December to May (excluding April). However, it should be noted that we analysed Q fever notification date which is likely delayed from the actual disease onset date and the predisposing factors contributing to disease transmission. A systematic review of the acute Q fever incubation period reported a median incubation period of 18 days with 95% of cases likely occurring 7 to 32 days post-exposure, therefore the delay likely has minimal impact on our interpretation of seasonal trends.[44]

North Coast NSW's climate is a mix of subtropical along the coast and temperate in the uplands.[45] Months of increased notifications correspond to the Australian summer and autumn seasons and are associated with warmer weather and high rainfall. Although December to February also had higher mean daily wind runs, we could not see an obvious trend between wind data and Q fever notification count. This is inconsistent with previous suggestions that Q fever is associated with dry and windy conditions.[18]

A previous epidemiological study performed in North Queensland found a seasonal peak of Q fever in May which for this region was immediately after the wet season.[21] However, a more recent study of an endemic region of North Queensland by Sivabalan et al.[34] found a peak in cases in summer, they also reported that case numbers were associated with higher rainfall however this was not statistically significant. It was suggested that higher rainfall could contribute to increased wildlife which leads to a rise in human acute Q fever cases.[21] This is especially relevant to macropods (including native kangaroos and wallabies) which are herbivores and rely on vegetation growth brought upon by the wet season.[21]

In the United States, Q fever notifications season trends are thought to be linked with animal activity. It was suggested that the peak in cases during the spring-summer months (April to July) was linked to the animal birthing season and period of increased outdoor activity.[46, 47] This was not seen in our study, the calving season in NSW is year-round though tends to be reduced in the summer months January to February which is when we saw a peak in Q fever cases.

Limitations

A major limitation of this study was the high proportion of unknown or missing data fields. This could be due to a range of reasons including inability to contact the case or notifying clinician, poor recall from the case or clinician or public health staff not asking for the information. Of note, the study period included the COVID-19 pandemic when public health and clinical staff were not able to prioritise the collection of this data. This study involved a retrospective analysis of routinely collected data, therefore we were limited to the data fields provided on NCIMS and unable to follow up on the missing data. Notification counts were relatively low which limited analysis of data and interpretation of trends.

Data was de-identified and there was no linkage to other health datasets, therefore subsequent health service admissions and morbidity data may not be included in our dataset. Furthermore, hospitalisation count and rate were likely underreported as the data is limited to cases that were notified to the public health unit.

Our findings may not be generalised to other areas as North Coast NSW is a regional area with substantial native and agricultural industry presence. In addition, cases analysed were those notified to the public health unit, we likely only captured individuals with substantial illness presenting to healthcare centres therefore we are unable to determine the overall burden of this disease in the community. Notification data only included those who reside in the North Coast NSW region, therefore those who visited this region and had a local exposure were not included in our analysis.

CONCLUSION

Q fever notification rate has remained high in North Coast NSW over the past decade. This has caused a substantial healthcare burden and calls for increased public health intervention. Our study has shown that we cannot target only those with traditional high-risk occupations when designing vaccination and public awareness campaigns. We must consider the various opportunities for wildlife exposures including indirect transmission through the environment and the factors that influence this, such as climate and housing development. Our study was restricted by the large quantity of “other” or “unknown” data suggesting that more needs to be done to improve data quality, such as expanding the NSW dataset (especially for the occupational, environmental and animal related exposure fields), which could improve our understanding of the epidemiology of this disease and help shape our public health response.

REFERENCES

1. Maurin M, Raoult Df. Q fever. Clinical microbiology reviews. 1999;12(4):518-53.
2. Angelakis E, Raoult D. Q fever. Veterinary microbiology. 2010;140(3-4):297-309.
3. NSW Government. Q fever NSW Control Guidelines for Public Health Units. [Internet]. Sydney: NSW government; 2012 [updated 2019 Jun 6; cited 2024 May 5]. Available from: https://www.health.nsw.gov.au/Infectious/controlguideline/Documents/qfever.pdf.
4. Clutterbuck H, Eastwood K, Massey PD, Hope K, Mor SM. Surveillance system enhancements for Q fever in NSW, 2005-2015. Communicable Diseases Intelligence. 2018;42(1):S2209-6051.
5. Eastwood K, Graves SR, Massey PD, Bosward K, Hutchinson P. Q fever: A rural disease with potential urban consequences. Australian Journal of General Practice. 2018;47(3):112-6.
6. Ergas D, Keysari A, Edelstein V, Sthoeger ZM. Acute Q fever in Israel: clinical and laboratory study of 100 hospitalized patients. IMAJ-RAMAT GAN-. 2006;8(5):337.
7. Cutler SJ, Bouzid M, Cutler RR. Q fever. Journal of Infection. 2007;54(4):313-8.
8. Communicable Diseases Network Australia. Q fever CDNA National Guidelines for Public Health Units. [Internet] Canberra (AU): Communicable Diseases Network Australia; 2018 [updated 2018 Nov; cited 2024 Apr]. Available from: https://www.health.gov.au/resources/publications/q-fever-cdna-national-guidelines-for-public-health-units?language=en
9. Million M, Thuny F, Richet H, Raoult D. Long-term outcome of Q fever endocarditis: a 26-year personal survey. The Lancet infectious diseases. 2010;10(8):527-35.
10. Department of Health and Aged Care. Australian Immunisation Handbook: Q Fever [Internet]. Canberra (AU): Department of Health and Aged Care; 2024 [cited 2024 May 28]. Available from: https://immunisationhandbook.health.gov.au/contents/vaccine-preventable-diseases/q-fever.
11. Woldeyohannes SM, Perkins NR, Baker P, Gilks CF, Knibbs LD, Reid SA. Q fever vaccine efficacy and occupational exposure risk in Queensland, Australia: A retrospective cohort study. Vaccine. 2020;38(42):6578-84.
12. Department of Health and Aged Care. Addition of Q fever vaccines to the Australian Immunisation Register [Internet]. Canberra (AU): Department of Health and Aged Care; 2024 [cited 2024 May 23]. Available from: https://www.health.gov.au/news/addition-of-q-fever-vaccines-to-the-australian-immunisation-register#:~:text=From%2015%20April%202024%2C%20vaccination,to%20the%20Australian%20Immunisation%20Register.&text=The%20Australian%20Immunisation%20Register%20(AIR,to%20all%20people%20in%20Australia.
13. Gidding HF, Wallace C, Lawrence GL, McIntyre PB. Australia's national Q fever vaccination program. Vaccine. 2009;27(14):2037-41.
14. Sloan-Gardner T, Massey P, Hutchinson P, Knope K, Fearnley E. Trends and risk factors for human Q fever in Australia, 1991–2014. Epidemiology & Infection. 2017;145(4):787-95.
15. Gidding HF, Faddy HM, Durrheim DN, Graves SR, Nguyen C, Hutchinson P, et al. Seroprevalence of Q fever among metropolitan and non-metropolitan blood donors in New South Wales and Queensland, 2014–2015. Medical Journal of Australia. 2019;210(7):309-15.
16. Karki S, Gidding HF, Newall AT, McIntyre PB, Liu BC. Risk factors and burden of acute Q fever in older adults in New South Wales: a prospective cohort study. Medical Journal of Australia. 2015;203(11):438e.1-e.6.

17. Tozer S, Lambert S, Sloots T, Nissen M. Q fever seroprevalence in metropolitan samples is similar to rural/remote samples in Queensland, Australia. European journal of clinical microbiology & infectious diseases. 2011;30:1287-93.
18. Roughan M, Hodge E, Khan A, Chor J. Evolving epidemiology of Q fever in Wide Bay. Communicable Diseases Intelligence. 2023;47.
19. Rahaman MR, Milazzo A, Marshall H, Bi P. Spatial, temporal, and occupational risks of Q fever infection in South Australia, 2007–2017. Journal of Infection and Public Health. 2020;13(4):544-51.
20. Proboste T, Clark NJ, Tozer S, Wood C, Lambert SB, Soares Magalhães RJ. Profiling risk factors for household and community spatiotemporal clusters of Q fever notifications in Queensland between 2002 and 2017. Pathogens. 2022;11(8):830.
21. Harris P, Eales K, Squires R, Govan B, Norton R. Acute Q fever in northern Queensland: variation in incidence related to rainfall and geographical location. Epidemiology & Infection. 2013;141(5):1034-8.
22. Communicable Diseases Branch and Centre for Epidemiology and Evidence NSW Health. Q fever notifications in NSW residents 2023 [Available from: https://www1.health.nsw.gov.au/IDD/#/QF.
23. Commonwealth of Australia, Bureau of Meteorology. Climate Data Online [Internet]. Canberra (AU): Bureau of Meteorology; 2024 [cited 2024 Apr 15]. Available from: http://www.bom.gov.au/climate/data/index.shtml.
24. ABS Customised Data Services, received 7 November 2023. Estimated Resident Population (ERP) based on the 2021 Census. 2011-2021 Final, 2022 Preliminary.
25. NSW Department of Planning and Environment, 2022 CPA Population and Dwelling projections, recieved 26 May 2022 by email.
26. R Core Team (2023). R: A Language and Environment for Statistical Computing. Internet]. Vienna, Austria. https://www.R-project.org/.
27. Australian Bureau of Statistics. Australian Standard Population 2001. 2001.
28. Gidding H, Peng C, Graves S, Massey P, Nguyen C, Stenos J, et al. Q fever seroprevalence in Australia suggests one in twenty people have been exposed. Epidemiology & Infection. 2020;148:e18.
29. Tozer S, Wood C, Si D-m, Nissen M, Sloots T, Lambert S. The improving state of Q fever surveillance. A review of Queensland notifications, 2003-2017. Communicable Diseases Intelligence. 2020;44.
30. NSW Government, Department of Climate Change, Energy, the Environment and Water. 2021 NSW Vegetation clearing report. [Internet]. Sydney (AU): NSW Government; [updated 2024 Apr 23; cited 2024 Jul 19]. Available from: https://www.environment.nsw.gov.au/topics/animals-and-plants/native-vegetation/landcover-science/2021-nsw-vegetation-clearing-report.
31. Tozer S, Lambert S, Strong C, Field H, Sloots T, Nissen M. Potential animal and environmental sources of q fever infection for humans in q ueensland. Zoonoses and public health. 2014;61(2):105-12.
32. Woldehiwet Z. Q fever (coxiellosis): epidemiology and pathogenesis. Research in veterinary science. 2004;77(2):93-100.
33. Henderson T, Rajaratnam R, Vernes K. Population density of eastern grey kangaroos (Macropus giganteus) in a periurban matrix at Coffs Harbour, New South Wales. Australian Mammalogy. 2017;40(2):312-4.

34. Sivabalan P, Saboo A, Yew J, Norton R. Q fever in an endemic region of North Queensland, Australia: A 10 year review. One Health. 2017;3:51-5.

35. Lowbridge CP, Tobin S, Seale H, Ferson MJ. Notifications of Q fever in NSW, 2001–2010. New South Wales public health bulletin. 2012;23(2):31-5.

36. Marmion B, Ormsbee R, Kyrkou M, Wright J, Worswick D, Izzo A, et al. Vaccine prophylaxis of abattoir-associated Q fever: eight years' experience in Australian abattoirs. Epidemiology & Infection. 1990;104(2):275-87.

37. Kersh GJ, Fitzpatrick KA, Self JS, Biggerstaff BJ, Massung RF. Long-Term immune responses to Coxiella burnetii after vaccination. Clinical and Vaccine Immunology. 2013;20(2):129-33.

38. Sellens E, Norris JM, Dhand NK, Heller J, Hayes L, Gidding HF, et al. Q fever knowledge, attitudes and vaccination status of Australia's veterinary workforce in 2014. PloS one. 2016;11(1):e0146819.

39. Rahaman MR, Marshall H, Milazzo A, Crabb D, Bi P. Q fever prevention and vaccination: Australian livestock farmers' knowledge and attitudes to inform a One Health approach. One Health. 2021;12:100232.

40. Bond KA, Franklin L, Sutton B, Stevenson M, Firestone S. Review of 20 years of human acute Q fever notifications in Victoria, 1994–2013. Australian veterinary journal. 2018;96(6):223-30.

41. Australian Bureau of Statistics. Regional Population, 2022-23: Population estimates and components by LGA, 2022 to 2023 [Internet]. Canberra: ABS; 2024 Mar 26 [cited 2024 Jul 1]. ABS cat. no. 3218.0. Available from: https://www.abs.gov.au/statistics/people/population/regional-population/latest-release.

42. Australian Bureau of Statistics. Kyogle: 2021 Census All persons QuickStats [Internet]. Canberra: ABS; [cited 2024 Jul 1]. Available from: https://abs.gov.au/census/find-census-data/quickstats/2021/LGA14550.

43. Australian Bureau of Statistics. Australia: 2021 Census All persons QuickStats [Internet]. Canberra: ABS; [cited 2024 Jul 1]. Available from: https://www.abs.gov.au/census/find-census-data/quickstats/2021/AUS.

44. Todkill D, Fowler T, Hawker J. Estimating the incubation period of acute Q fever, a systematic review. Epidemiology & Infection. 2018;146(6):665-72.

45. NSW Government Environment and Heritage. NSW North Coast bioregion. [Internet]. Sydney (AU): NSW Government Environment and Heritage; 2023 [updated 2023 Nov; cited 2024 Sep 3]. Available from: https://www.environment.nsw.gov.au/topics/animals-and-plants/biodiversity/bioregions/bioregions-of-nsw/nsw-north-coast.

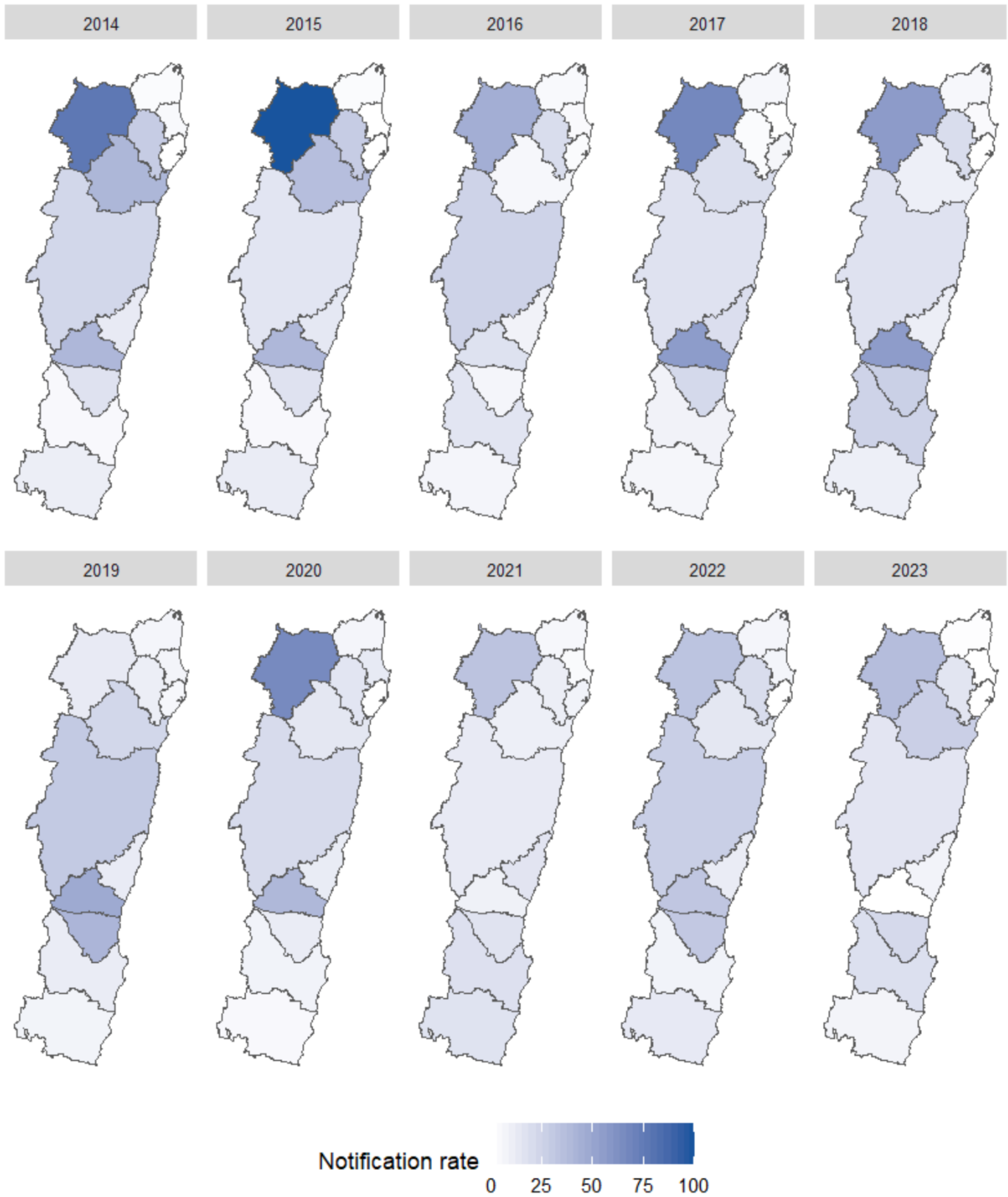
46. Kaufman HW, Chen Z, Radcliff J, Batterman HJ, Leake J. Q fever: an under-reported reportable communicable disease. Epidemiology & Infection. 2018;146(10):1240-4.

47. Centers for Disease Control and Prevention. Q Fever in the United States [Internet]. Atlanta (GA): Centers for Disease Control and Prevention; 2021 [updated 2021 August 6; cited 2024 May 7]. Available from: https://www.cdc.gov/qfever/stats/index.html.

APPENDICES

Appendix A. Effect of month on Q fever notifications, generalised linear model with Poisson outcome Coefficients, North Coast NSW, 2014-2023

Month	Estimate	Standard Error	z-value	p-value
Intercept	-12.1	0.182	-66.2	<2e-16
January	0.93	0.22	4.31	0.00001*
February	0.79	0.22	3.58	0.0003*
March	0.66	0.22	2.93	0.003*
April	0.34	0.23	1.41	0.16
May	0.64	0.23	2.85	0.004*
June	0.26	0.24	1.08	0.28
July	0.34	0.24	1.41	0.16
August	0.28	0.24	1.19	0.23
September	-	-	-	-
October	0.06	0.25	0.25	0.80
November	0.43	0.23	1.82	0.07
December	0.49	0.23	2.12	0.03*



Appendix B. Geographical distribution of Q fever in North Coast NSW over time, by annual Q fever notification rate per 100,000 persons, by local government area (LGA) and year, 2014–2023

Chapter V
Evaluation of a surveillance system

Evaluation of the residential aged care facility acute respiratory infection outbreak surveillance system in North Coast NSW

CHAPTER CONTENTS

PROLOGUE

Study rationale

Elderly people are a vulnerable group for acute respiratory infections (ARI), evidenced by the greater hospitalisation and mortality rates seen in this population. Residential aged care facilities (RACF) are high-risk venues for ARI outbreaks due to the proximity of residents and their susceptibility to severe disease. These outbreaks can be difficult to contain and can have detrimental impacts on both residents and staff. An important aspect of RACF outbreak management is the early detection and notification of ARI outbreaks to the local public health unit.

There is often a lot of focus on the epidemiology of individual ARI disease notification trends across a whole population, for example, at a regional or state level. However, we must also monitor changes at an outbreak level, as this provides an indication of disease transmission in this priority population and the ability of health staff to effectively respond to and control outbreaks.

Although the COVID-19 pandemic is no longer a public health emergency, Australia is still experiencing high rates of ARIs, especially during the winter periods. Other diseases have also required increased public health resources, such as the rising number of syphilis, pertussis and cryptosporidium cases. We evaluated the North Coast NSW RACF ARI outbreak surveillance system to identify strengths and weaknesses of the system during its operation in the pandemic and post-pandemic period and used this to develop recommendations to guide its improvement in the future.

My role

Using the Centers for Disease Control and Prevention surveillance system evaluation guidelines, I prepared a concept note for the evaluation. I reviewed state and national guidelines on RACF ARI outbreak response and created a flow chart showing the local system's process. I wrote the survey questions, built the survey on REDCap, and liaised with the Primary Health Network to request their assistance with its distribution to RACF staff. I wrote the interview questions and performed semi-structured interviews with public health staff. I extracted, cleaned and analysed all the qualitative and quantitative data. Finally, I drafted this chapter and developed recommendations based on the evaluation findings for dissemination to stakeholders.

Lessons learnt

I had a great experience completing this project, as I enjoyed interacting with the RACF and public health unit (PHU) staff and had the opportunity to gain various new skills. This project gave me the opportunity to learn a lot about surveillance systems and the evaluation process, an area I did not have any experience in prior to the MAE program.

I was introduced to REDCap and after attending training sessions I built my first operational survey for this project using the platform. This was my first time performing prospective data collection and analysis. I performed semi-structured interviews with the public health staff and learned about the benefits and challenges associated with collecting and analysing qualitative data. I learned about the different ways to analyse surveillance system attributes and how the attributes are closely linked to each other. This evaluation gave me a deeper appreciation of the challenges associated with developing and running a surveillance system during a pandemic and how it evolves as resources and priorities change over time.

Public health implications

This was the first local evaluation of the RACF ARI outbreak surveillance system in North Coast NSW. The findings of this evaluation show that while the surveillance system has numerous strengths, it may not be sustainable and there are areas for improvement. We suggest a separate evaluation of the uses of the surveillance data by internal and external stakeholders. The results of this can be used to guide the development of well-defined objectives and improvements, which will optimise the finite public health resources available, consider the current health landscape and involve the valuable input of RACF and PHU staff. This will then help improve the system's simplicity, timeliness, acceptability and usefulness.

MAE course requirements

This chapter fulfils the requirements "Evaluate a surveillance system or other health information system" and "Analysis of a public health dataset".

Acknowledgements

I would like to acknowledge the amazing work the NCPPH communicable disease team, COVID-19 teams, LHD and PHN partners, and RACF staff have done in ARI outbreak management in RACFs over the past few years. I am especially grateful to those who contributed to this evaluation and provided feedback. Thank you to the Healthy North Coast Primary Health Network, for their support with survey distribution and providing resources. I would like to acknowledge Dr Jessica de Dassel for her feedback when designing the stakeholder survey. Thank you to my incredible supervisors Dr Rosalina Sa'aga-Banuve, Genevieve O'Neill, Robin Auld and Prof Tony Stewart, for sharing their wisdom and supporting me through all the ups and downs of this project.

ABBREVIATIONS

ARI	Acute respiratory infection
BAU	Business as usual
CD	Communicable disease
CDC	Centers for Disease Control and Prevention
CDNA	Communicable Diseases Network Australia
COVID-19	Coronavirus disease 2019
HREC	Human research ethics committee
IPAC	Infection prevention and control
IQR	Interquartile range
IT	Information technology
LHD	Local health district
MNC	Mid North Coast
N/A	Not applicable
NCIMS	Notifiable Conditions Information Management System
NCPPH	North Coast Population and Public Health
NSW	New South Wales
NNSW	Northern New South Wales
PCR	Polymerase chain reaction
PHU	Public health unit
PVP	Predictive value positive
OMT	Outbreak management team
RACF	Residential Aged Care Facility
RAT	Rapid antigen test
REDCap	Research Electronic Data Capture
RSV	Respiratory Syncytial Virus

ABSTRACT

Background

Residential aged care facilities (RACFs) are susceptible to outbreaks of acute respiratory infections (ARI), which include COVID-19, influenza and respiratory syncytial virus. This can lead to severe impacts on both the residents and staff exposed. The surveillance of ARI outbreaks in RACFs is an important aspect of public health outbreak response. This was the first evaluation of the North Coast NSW RACF ARI outbreak surveillance system. It aimed to assess the system's attributes and identify areas where improvements could be made.

Methods

Evaluation of the RACF ARI outbreak surveillance system followed the *Updated Guidelines for Evaluating Public Health Surveillance Systems* developed by the Centers for Disease Control and Prevention. We reviewed the RACF ARI outbreak guidelines and the local PHU surveillance process. To assess the system's attributes using stakeholder feedback, we performed semi-structured interviews with public health unit staff and invited local RACF staff to perform an online survey. Finally, we performed a descriptive analysis of North Coast NSW RACF ARI outbreak notification data.

Results

From 1 January 2022 to 31 December 2023, there were 309 RACF ARI outbreaks notified to the North Coast NSW public health unit. Of the 80 RACFs in this region, only one RACF did not report an ARI outbreak during this period, suggesting the system has good acceptability and representativeness. Staff shortages were identified as a major issue impacting outbreak surveillance and management, however, despite the challenges brought by the COVID-19 pandemic the system showed good flexibility likely due to the increased experience of RACF staff, public health support and usefulness of the outbreak guidelines. Overall, stakeholders were generally satisfied with the current surveillance system, however, there were concerns with the administrative burden and sustainability of the system due to evolving financial and public health priorities.

Conclusion

Based on the findings of this evaluation, we suggest an in-depth assessment of the uses of the surveillance system's outputs which could be used to establish clearly defined objectives. We recommend improving the simplicity and timeliness of the system by reviewing the data captured by the system and exploring the feasibility of using a more automated system. Finally, we suggest reviewing the role of public health staff in outbreak response and consider changing them to a more passive outbreak surveillance role with more focus being placed on outbreak preparedness strategies.

INTRODUCTION

Acute respiratory infections

Acute respiratory infections (ARI) are common infections caused by respiratory viruses such as COVID-19, influenza, and respiratory syncytial virus (RSV). [1] They are defined by the presence of recent or worsening acute respiratory symptoms including sore throat, runny nose, nasal congestion and breathing difficulties with or without other symptoms (Box 1). [2] The virus is spread primarily through droplet or aerosol transmission and tends to follow a seasonal pattern with peaks during autumn and winter. [1, 3]

Public health importance

The impact of ARI can range from asymptomatic infection to severe illness causing significant morbidity and death. [1] While uncommon, complications from ARI can include pneumonia, sepsis, sinusitis, bacterial co-infection and exacerbation of comorbid medical conditions. [4]

Chen and Kirk performed a national survey in 2008–2009 to identify the period prevalence of ARI in Australia. [3] They extrapolated that there were 68.9 million cases of ARI in Australia annually, with an estimated incidence of 3.2 cases of ARI/ person per year. [3]

The recent COVID-19 pandemic has played a significant impact on ARI prevalence in the community. In NSW, there have been over 4 million cases of COVID-19 reported since the pandemic began in 2020. [5] In 2022, the burden of COVID-19 was estimated to be 151,400 disability-adjusted life years lost and it was the third leading cause of death in Australia (5.2% of all deaths). [6]

The National 2023 influenza season summary produced by the Department of Health and Aged Care (Australia) reported 242,296 notifications of laboratory-confirmed influenza and 376 influenza-related deaths reported in the 2023 influenza season (9 April to 15 October 2023). [7] Similar to previous years, influenza-associated mortality was greatest in the 85 years and older age group (3.46% case fatality rate). [7]

RSV became a nationally notifiable disease in July 2021 and notifiable in NSW in September 2022. In 2023, there were 128,109 cases of RSV nationally, of this around 18% of notifications were in those aged 65 years and over. [5] NSW had the second highest rate of influenza in 2023 in Australia (behind South Australia) at 559 notifications per 100,000 persons. [5]

ARI outbreaks in RACFs

On 20 June 2023, there were over 190,000 people residing in residential aged care facilities (RACFs) in Australia, the majority were aged 85 years and over. [8] RACFs are high-risk venues for ARI outbreaks due to multiple reasons. Firstly, residents are typically elderly and have multiple medical comorbidities making them more vulnerable to acquiring severe illness and complications. Secondly, the risk of transmission is greater due to the shared living environment, increased healthcare staff contact and frequent entry of visitors to the facilities. [9] A meta-analysis of the impact of COVID-19 on RACF residents globally, between December 2019 and November 2021, reported resident hospitalisation rates of 29.1%, case fatality rates of 22.7% and mortality rates of 15.8%.[10] However, rates have likely varied a lot over time due to changes in circulating COVID-19 variants, public health policies and vaccination rates. In Australia, since the pandemic began in 2020 there have been over 22,000 outbreaks in RACFs, resulting in over 220,000 resident and 120,000 staff cases nationally. [11] As at 30 June 2022, 29% of all COVID-19 related deaths in Australia were in people living in RACFs. [11, 12]

Due to this risk, it is important that outbreaks are detected and responded to rapidly and appropriately by RACF staff. In December 2020, the Australian Government mandated RACFs to appoint an on-site nurse as an infection prevention and control (IPAC) lead to ensure the RACF would be adequately able to respond to and prevent infectious diseases and in July 2023 all RACFs were required to have a registered nurse on-site and on duty 24 hours a day, 7 days a week. [13, 14] In NSW, the Australian Government Department of Health and Aged Care together with NSW Health supports RACFs with the management of ARIs. RACF staff are advised to follow the national guidelines, *National Outbreak Management Guideline for Acute Respiratory Infection (including COVID-19, influenza and RSV) in Residential Aged Care Homes*[1] and local NSW Health guidelines, *Guidance for residential aged care facilities on the public health management of acute respiratory infections (including COVID-19, influenza, and respiratory syncytial virus).* [2] Box 1 outlines the definitions of ARI and ARI outbreaks in RACFs as per these guidelines. Please note that although ARI can be caused by a broad range of pathogens, this paper will focus on ARI's caused by the pathogens listed in the ARI outbreak definition i.e. COVID-19, influenza and RSV (Box 1).

Box 1: Case and outbreak definitions

The definitions for ARI and ARI outbreaks in RACF are consistent with the Australian Government Department of Health and Aged Care, *National Guidelines for the Prevention, National Outbreak Management Guideline for Acute Respiratory Infection (including COVID-19, influenza and RSV) in Residential Aged Care Homes*. [1]

ARI is defined as:

- Recent onset of new or worsening acute respiratory symptoms: cough, breathing difficulty, sore throat, or runny nose/nasal congestion with or without other symptoms (see below).
- Other symptoms include:
  - Headache, muscle aches (myalgia), fatigue, nausea or vomiting and diarrhoea. Loss of smell and taste and loss of appetite can also occur with COVID-19.
  - Fever (≥37.5°C) can occur, however is less common in elderly individuals.
  - In the elderly, other symptoms to consider are new onset or increase in confusion, change in baseline behaviour, falling, or exacerbation of underlying chronic illness (e.g., increasing shortness of breath in someone with congestive heart failure).

An ARI outbreak in a RACF is declared when 2 or more residents test positive within a 72-hour period for:

- COVID-19 or
- Influenza or
- RSV.

Surveillance system evaluation

The World Health Organization (WHO) defines public health surveillance as “the continuous and systematic collection, orderly consolidation and evaluation of pertinent data with prompt dissemination of results to those who need to know, particularly those who are in a position to take action”. [15] It is important to evaluate public health surveillance systems to ensure that they are effective, optimise resources and adapt well to changing health landscapes.

The purpose of this evaluation was to assess the North Coast NSW RACF ARI outbreak surveillance system and aspects of the outbreak management response. It focused only on the regional public health unit (PHU) and RACF surveillance response occurring in North Coast NSW, we acknowledge that this is only one arm of the larger RACF ARI outbreak surveillance occurring nationally and we did not evaluate the Commonwealth surveillance system. The evaluation covered ARI outbreaks notified between 1 January 2022 to 31 December 2023 (inclusive).

The objectives of the evaluation were to:

1. Identify the objectives and processes involved in the operation of the system
2. Assess the usefulness and attributes of the system
3. Based on the evaluation findings, produce recommendations to improve the surveillance system.

METHODS

The evaluation was performed using the *Updated Guidelines for Evaluating Public Health Surveillance Systems* developed by the Centers for Disease Control and Prevention (CDC). [16]

Attributes were assessed through the combination of analysis of outbreak notification data and stakeholder feedback (Table 1). Survey and interview questions were developed based on the CDC guidelines (Table 1, Appendix A and Appendix B). The survey was created in REDCap (Research Electronic Data Capture) and distributed to RACF staff in North Coast NSW via email by the Healthy North Coast (Primary Health Network) Healthy Ageing Coordinator. The survey was also promoted at Mid North Coast (MNC) and Northern NSW (NNSW) local health district (LHD) RACF cross-sector meetings.

All public health officers currently involved in RACF ARI outbreak response in the North Coast NSW PHU were invited over email to participate in individual semi-structured interviews about their experiences and feedback on the system, this was performed virtually over Microsoft Teams (Microsoft Office 2013; WA, USA).

RACF ARI outbreak notification data was used to analyse the surveillance system, this was extracted by the research team from the NSW Health Notifiable Conditions Information Management System (NCIMS). Data cleaning and analysis were performed using Microsoft Excel (Microsoft Office 2013; WA, USA) and R software (v.4.3.1; R Core Team 2023). Notifications were filtered to the facility "RACF", classification "Outbreak", managing PHU "Lismore" or "Port Macquarie", condition "Influenza", "COVID-19" or "RSV" and date PHU / office made aware of the outbreak between "1/1/2022" and "31/12/2023" (inclusive).

A list of RACFs in North Coast NSW, which was used as a denominator when assessing the representativeness attribute, was created by combining RACF lists provided by the Healthy North Coast Primary Health Network and the PHU.

Table 1. Attributes assessed in evaluation, by measurement and data source

Attribute	Definition[16]	Measurement	RACF staff survey	PHU staff interview	NCIMS data analysis
Simplicity	Reflects the system's structure and ease of use.	Stakeholders' confidence and resources needed to perform steps of outbreak response, including data collection and transfer. Training required to use the system.	X	X	
Timeliness	The speed between steps of RACF ARI outbreak detection, notification and management.	Delay between outbreak occurrence and PHU notification. Time spent by RACF staff performing outbreak steps. PHU staff time required for operating the system. Descriptive analysis of outbreak durations.	X	X	X
Stability	Availability and reliability of the system.	Identify obstacles impacting the system including IT issues and staff shortages. Assess the level and frequency of impact.	X	X	
Flexibility	System's ability to adapt to changing information needs or operating conditions, with minimal resources.	Ability to cope with increased notifications. Impact of staff changes and changes to guidelines and policies on the system. Factors impacting the system's ability to adapt to changes.	X	X	
Representativeness	System's ability to accurately describe the occurrence of ARI RACF outbreaks over time by place and person.	Geographical distribution of RACFs reporting outbreaks. Participation of RACFs reporting outbreaks. Frequency of outbreaks reported over time, compared to national trends. Breakdown of outbreaks by pathogen type.	X		X
Data Quality	Completeness and validity of the data.	Proportion of missing data for key data fields. Errors in the data.			X
Sensitivity	Proportion of ARI outbreaks in NCNSW RACFs that were detected by the system.	Unable to calculate, perceived sensitivity measured based on feedback from RACF and PHU staff on not reporting outbreaks.	X	X	
Predictive value positive	The proportion of reported RACF ARI outbreaks that are true ARI outbreaks.	Unable to calculate, perceived based on experience from PHU staff receiving incorrect outbreak notifications.		X	
Acceptability	The willingness of RACF and PHU staff to participate in the surveillance system.	Stakeholder participation in surveillance system. Stakeholder views on the system.	X	X	X
Usefulness	Ability to prevent and control RACF ARI outbreaks. Meet the objectives of stakeholders.	Stakeholder views on the system's ability to meet objectives. Impact of system failing.	X	X	

Ethical considerations

Ethical considerations for this project were approved by the Australian National University HREC under protocol 2017/909 "Request for waiver of consent for use of data in research for Master of Philosophy in Applied Epidemiology students for Outbreak Investigation and Surveillance in Public Health projects."

RESULTS

Description of the surveillance system process

Figure 1 shows the RACF ARI outbreak surveillance system in North Coast NSW, based on the NSW Health and Australian Government Department of Health and Aged Care guidelines previously mentioned. [1, 2] Of note, RACF's outbreak response may vary from the process shown in this figure based on their unique circumstances and local procedures.[1]

When a RACF resident develops symptoms consistent with ARI the RACF should immediately respond by isolating the resident, implementing IPAC measures and performing a respiratory panel PCR and/ or COVID-19 (or combination if available) rapid antigen test (RAT). [2] If the result is positive for COVID-19, influenza or RSV they should follow the steps outlined in their outbreak management plan, perform a risk assessment of residents and staff contacts and respond appropriately. [2]

An ARI outbreak should be declared if two or more residents test positive for either COVID-19, influenza or RSV within 72 hours. [2]. Closure of outbreaks typically occurs at least seven days after the last known transmission. The decision to declare an outbreak closed should occur after consultation with the PHU. [2]

The role of the PHU is to respond to case notifications, perform a risk assessment and provide advice on the screening and management of cases, staff and residents. [17]

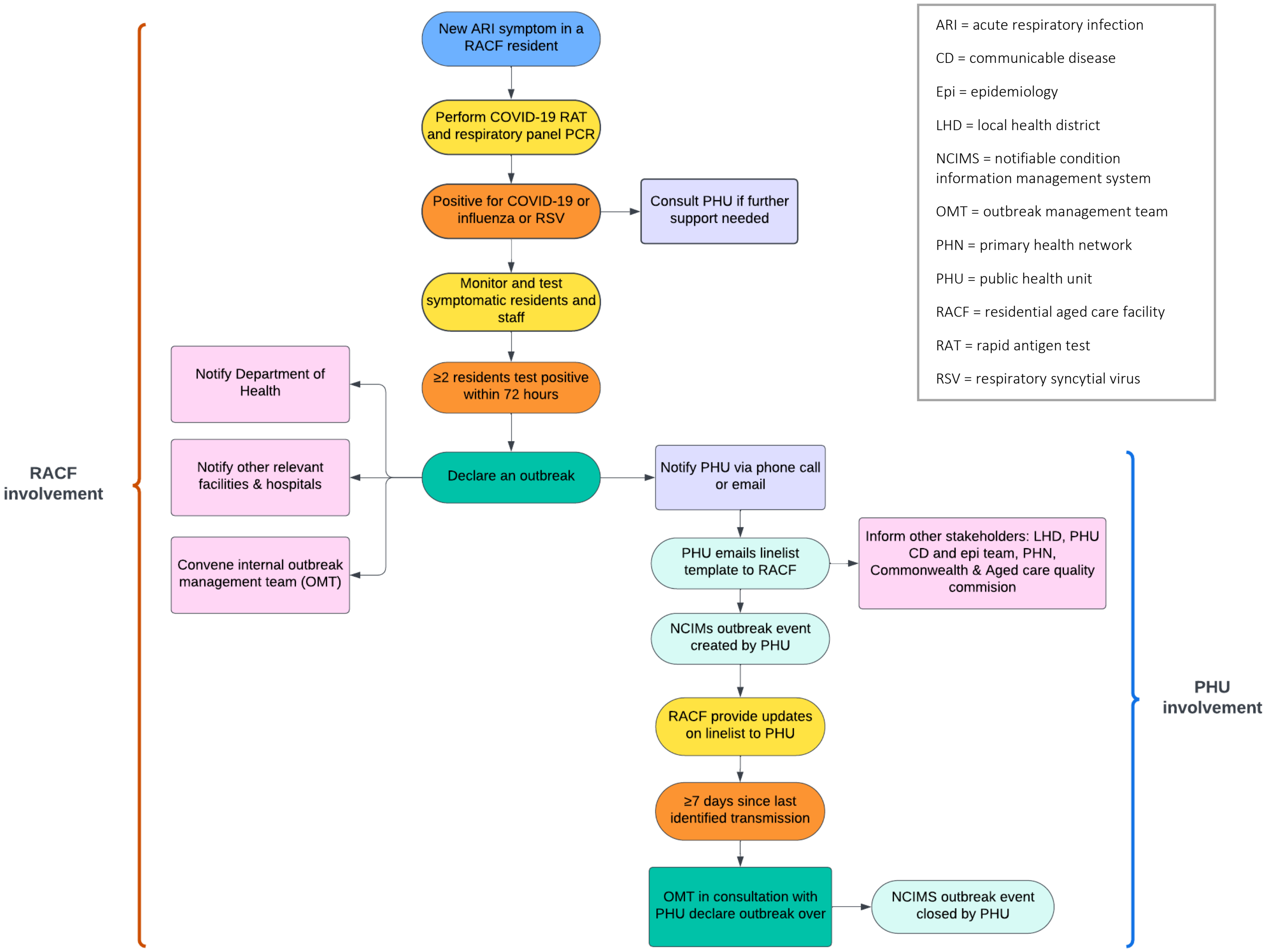


Figure 1. Flowchart of the North Coast NSW RACF ARI outbreak surveillance system

Evaluation stakeholders

All PHU staff involved in ARI RACF outbreak response at the time of data collection agreed to be interviewed for the evaluation (n=6/6). Experience in RACF ARI outbreak management ranged greatly, half of the team began during the COVID-19 pandemic while the remaining staff had previous influenza RACF outbreak experience, with some having two decades worth of experience.

Thirty RACF staff across North Coast NSW completed the evaluation survey. The majority of RACF respondents worked in both clinical and non-clinical roles (55.2%, n=16/29) (Figure 2). West Kempsey was the most commonly reported RACF location (n=5), followed by Coffs Harbour (n=4) (Figure 3).

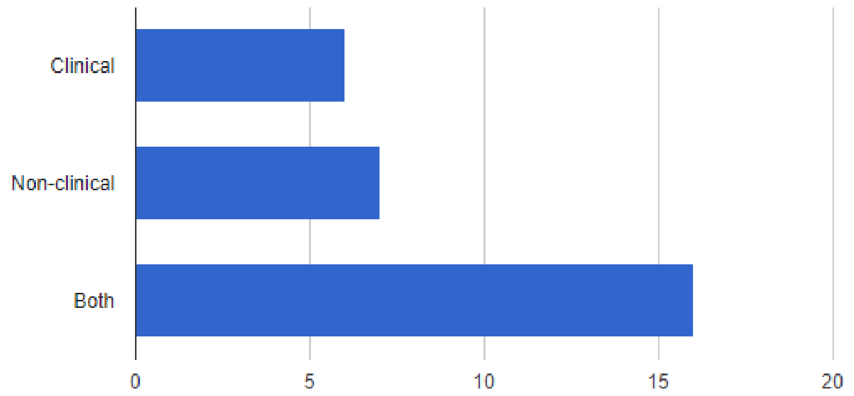


Figure 2. Role of RACF staff survey respondents by RACF postcode (N=29)

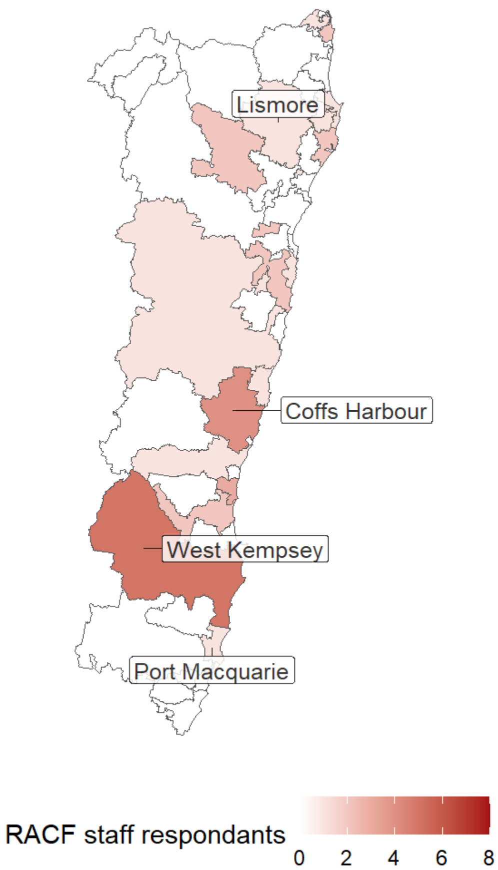


Figure 3. Distribution of RACF staff survey respondents in North Coast NSW by RACF postcode (N=28)

Objectives

There are currently no specified objectives for the North Coast NSW regional RACF ARI outbreak surveillance system. At the Commonwealth level, the objective of RACF ARI outbreak surveillance is included in the *Australian National Surveillance Plan for COVID-19, Influenza and RSV*, which is a "national framework for the collection, analysis, and reporting of health-related data to inform public health decision making and national policy responses to these viral respiratory diseases in Australia".[18]

The surveillance objective is to "Monitor outbreaks in RACFs" which is indicated by "Counts of COVID-19, influenza and RSV outbreaks in RACFs" and reported in the Department of Health and Aged Care Website: COVID-19 Reporting. [18]

There are also general influenza and COVID-19 national guidelines for PHUs which have objectives relating to RACF outbreak surveillance. The *Seasonal Influenza Infection CDNA National guidelines for Public Health Units*[19] surveillance objectives include:

1. Determine, monitor and report the number of cases and geographical spread of influenza
2. Detect outbreaks in high-risk settings and trigger appropriate control measures
3. Identify and characterise influenza epidemics and stage in the community
4. Determine the severity of disease to inform appropriate disease control measures and health service planning
5. Facilitate further typing of influenza strains circulating in the community to inform vaccine development
6. Determine resistance patterns of influenza circulating in the community to inform antiviral treatment recommendations
7. Better understand the epidemiology of the disease through the collection, collation and analysis of data
8. Facilitate further studies, where necessary, to investigate the epidemiology, clinical features, and vaccine effectiveness. [19]

The *Coronavirus Disease 2019 (COVID-19) CDNA National Guidelines for Public Health Units*[20] surveillance objectives are to monitor:

1. SARS-CoV-2 activity in Australia
2. the virological and genetic characteristics of SARS-CoV-2
3. epidemiological and clinical characteristics of COVID-19 (including severity and mortality)
4. outbreaks in high-risk settings and population groups to inform response
5. public health intervention effectiveness and health care system impact and capacity associated with COVID-19. [20]

PHU staff were asked to define what they considered were the objectives of the North Coast NSW RACF ARI outbreak surveillance system. Responses included:

1. Support and guidance for RACFs to reduce ARI transmission in residents and staff and reduce negative outcomes
2. Monitor the epidemiology of ARI outbreaks in RACFs in North Coast NSW
3. Provide information to IPAC to inform risk assessments in clinical settings

4. Promote communication and partnership between the PHU and RACF.

Simplicity

The majority of RACF staff respondents felt confident completing all steps of the outbreak process (Figure 4). There were only a few people who reported feeling not confident at all about completing Commonwealth requirements and preparing the line list for public health (Figure 4).

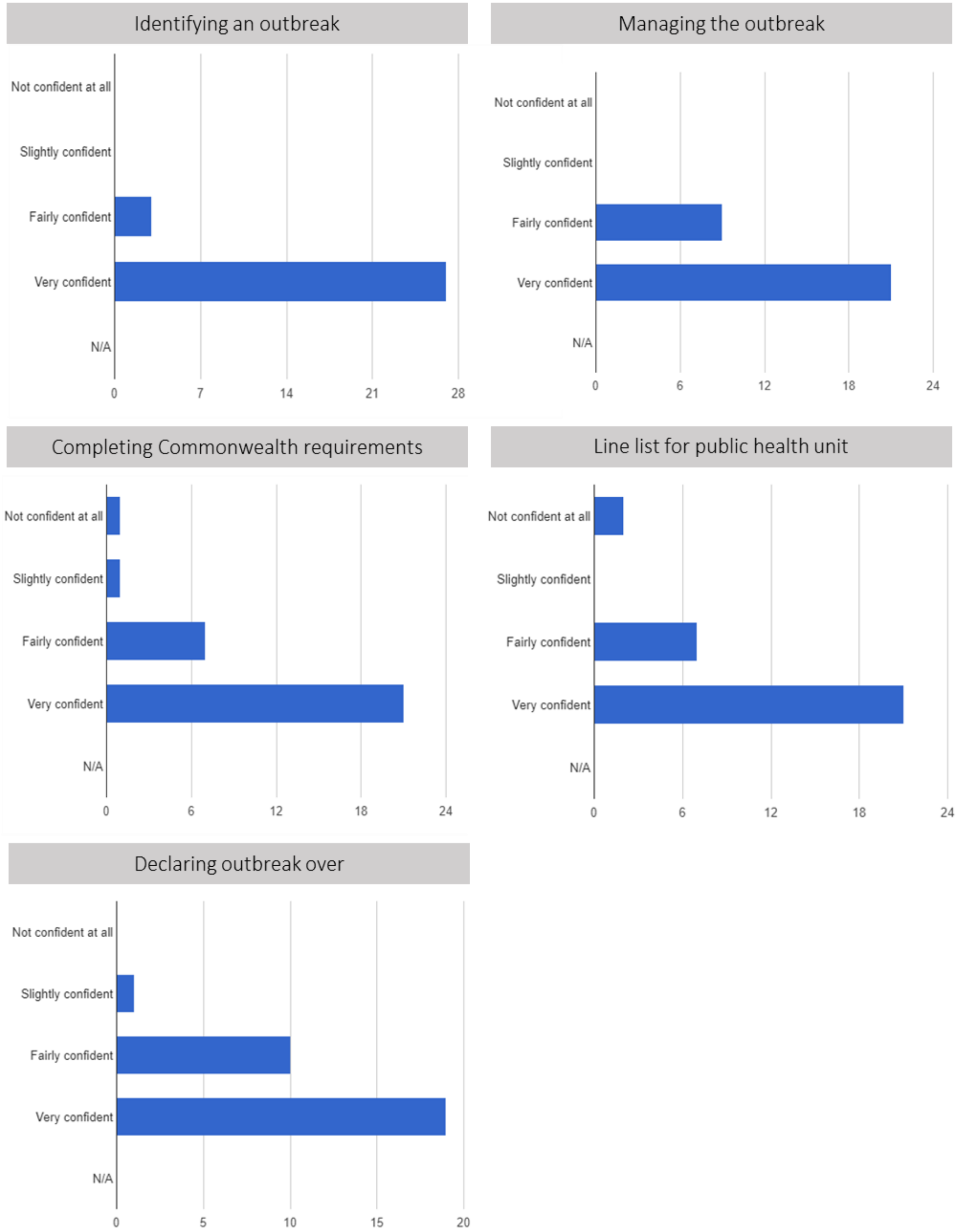


Figure 4. RACF staff survey response, confidence in performing different steps of the acute respiratory infection outbreak response (N=30)

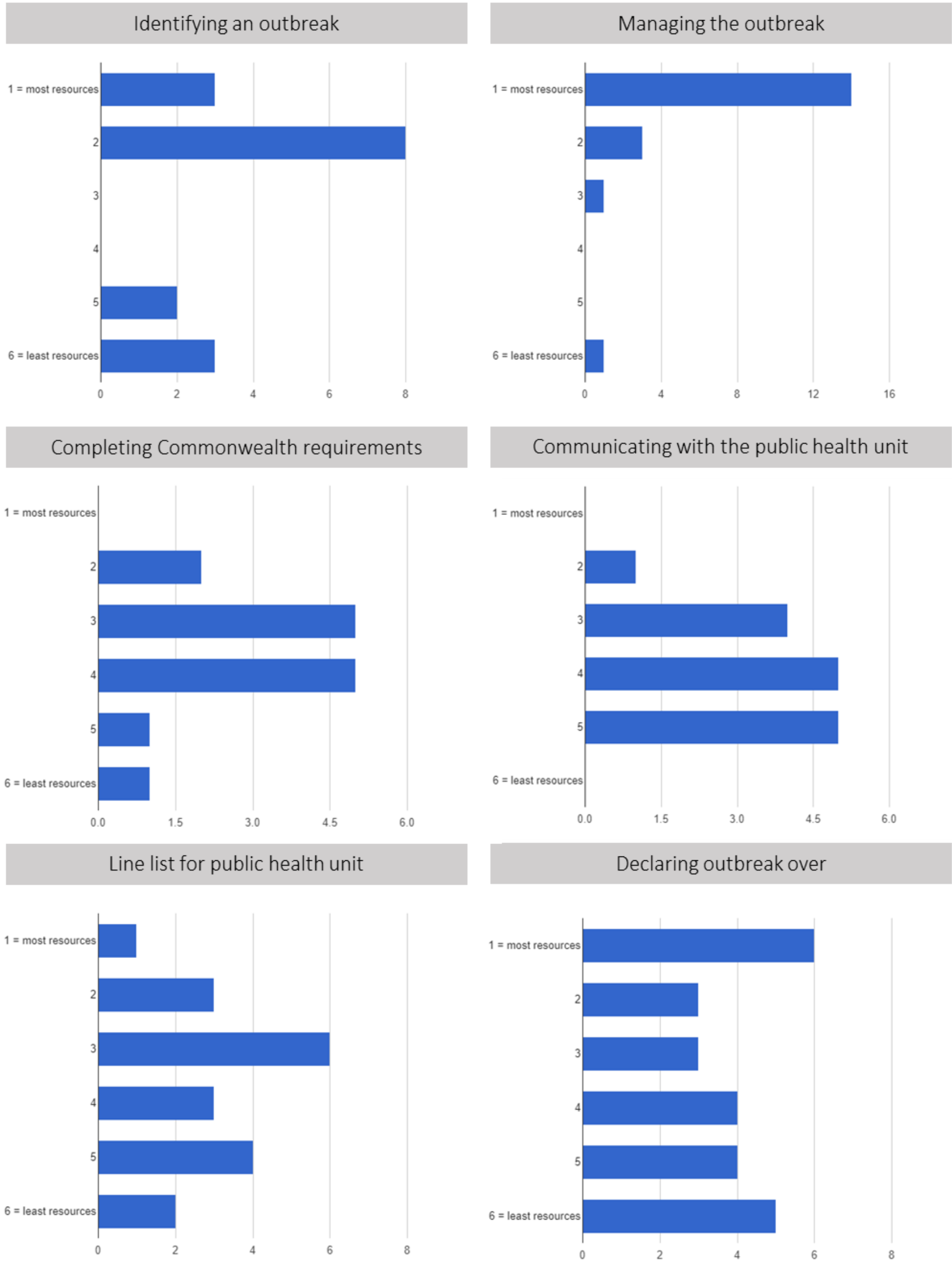


Figure 5. RACF staff survey responses, rank outbreak management steps based on resources required to complete them (e.g. Staffing, time, IT infrastructure, equipment etc.) (N=14–25)

Figure 5 shows the RACF staff survey response for the exercise "Rank outbreak management steps based on resources required to complete it". The majority of respondents ranked "Managing the outbreak" as the step requiring the most resources (n=14). A large proportion of people also listed "Identifying an outbreak" as requiring more resources compared to other steps (n=11). In contrast, "Declaring outbreak over", "Communicating with the PHU" and "Line list for PHU" had very mixed rankings listed by respondents.

PHU staff who started RACF ARI outbreak management work during the COVID-19 pandemic reported receiving minimal training, they were given a brief training session with an experienced public health officer and then it was mainly self-learning on the job and using online resources. This was understandable, due to the urgent demands brought by the pandemic. In contrast, PHU staff who had longstanding experience reported they received formal training in the form of an in-person, multiday workshop on various outbreak topics which they found very beneficial.

When PHU staff were questioned on the simplicity of data collection and transfer from RACFs there were mixed responses. A few members reported that communication over email and phone calls was easy, a good way to have rapport and they had no concerns. A couple reported issues with RACFs using outdated line lists with different data fields. Others reported that they had issues getting the line lists, especially information on the onset date of the last case, which delayed closing the outbreak. This was a problem as they often did not have the capacity to chase the RACF for this information.

Timeliness

Around two thirds (69.3%, n=214/309) of outbreaks were reported to the PHU on the day the outbreak was recognised. Of the 76 outbreaks with delayed notification, the median delay was 2 days (IQR 1–4 days, range 1–30 days). The remaining outbreaks (n=19) had an invalid duration entered.

Tables 2 and 3 show the hours spent by RACF staff performing different steps of the outbreak process. There was a wide range of responses for each step. Overall, most steps took the majority of respondents 1 to 2 hours to complete, however managing an outbreak required the most hours (median 4 hours per day).

Table 2. RACF staff survey responses, total hours spent on each outbreak step

Step in the outbreak process	Total responses	Range (hours)	IQR (hours)	Median (hours)
Identifying an outbreak	29	0.5–48	1–3	2
Commonwealth reporting requirements	29	0.5–24	1–3	2
Declaring an outbreak over	29	0.5–72	1–2	1

Table 3. RACF staff survey responses, hours per day spent on each outbreak step

Step in the outbreak process	Total responses	Range (hours)	IQR (hours)	Median (hours)
Managing an outbreak	29	2–24	2–10	4
Communicating with the public health unit	27*	0.5–3	1–1	1
Line list for public health unit	27*	0.5–4	1–2	1

*One response was removed as an invalid number was provided

During the time of PHU staff interviews (August 2024), there had been an increase in the number of outbreaks notified likely due to the winter period. All six staff members interviewed were involved in ongoing RACF ARI outbreak response; however, the majority of this work was assigned to one staff member. This "outbreak" worker spent around four hours daily on RACF ARI outbreak management during peak periods, which went down to around two hours in quieter periods. Other team members were each responsible for around two to three outbreaks at each time, which would generally take only a few hours total each week enabling them to focus on other CD work. However, these numbers would vary depending on staffing and outbreak levels.

The majority of PHU staff identified the initial steps of outbreak management as the most time consuming. In particular, gathering information from the RACF (such as line lists) to confirm the outbreak met the required criteria. One commented, "*They've* [RACFs] *done it before, it's just time consuming, it's not hard*".

There were 273 outbreaks with outbreak closure dates reported, enabling us to calculate the duration between notification and closure of the outbreak. Duration of outbreaks ranged from 4 to 63 days, median outbreak duration was 18 days (interquartile range (IQR) 12–26 days). As seen in Figure 6, the majority of outbreaks lasted 11 to 30 days.

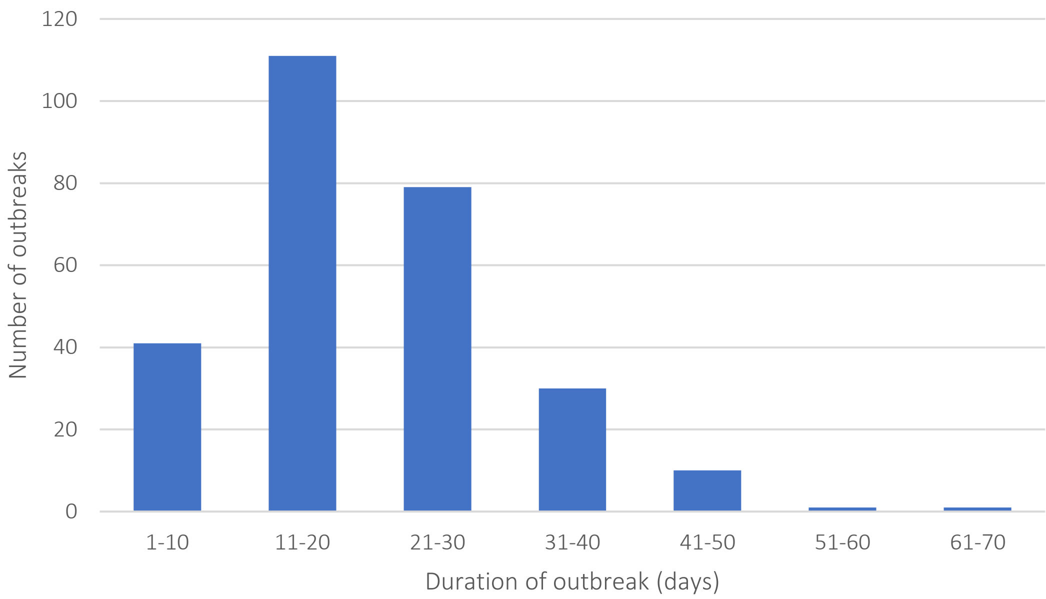


Figure 6. Frequency of RACF ARI outbreaks in North Coast NSW, by outbreak duration (N=273),

Stability

The large majority of RACF staff respondents reported that they experienced obstacles to outbreak management and surveillance (83%, n=25/30). Staff shortages were the most commonly reported factor (70%, n=21/30) (Figure 7). Other barriers identified included: testing issues, the amount of information collected for the PHU and lack of training/ confidence in managing the outbreak (Figure 7). IT issues can include problems accessing and using computers/ tablets, internet, email and software applications such as Microsoft Excel. Very few RACF staff reported IT issues, however one commented that technical issues impacted their ability to enter data leading to delays in closing an outbreak and incorrect information being entered.

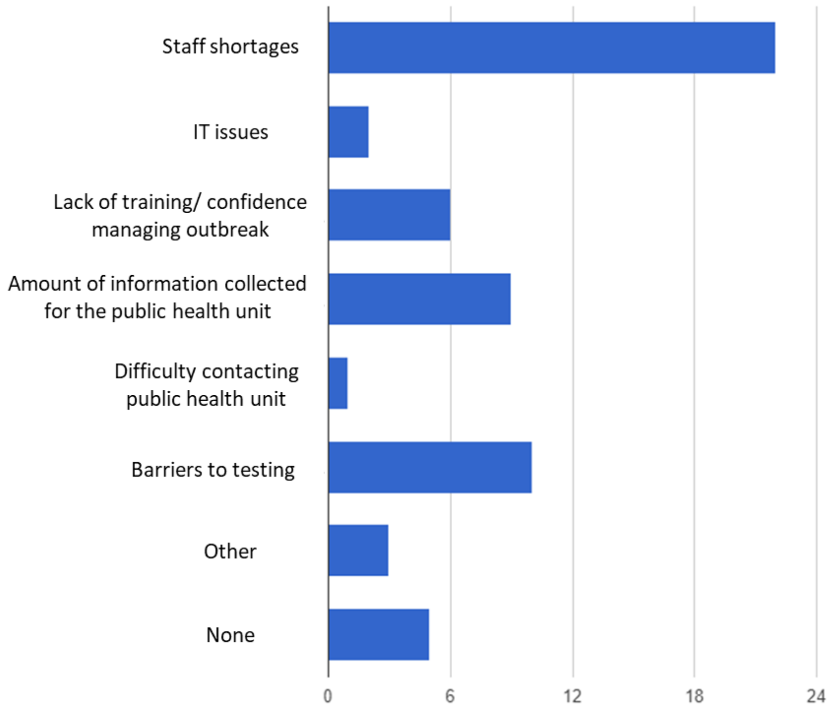


Figure 7. RACF staff survey responses, factors impacting respondent's ability to manage outbreak (N=30)

PHU staff did not identify IT issues as a factor that impacted the stability of the system, interviewees reported that on the rare chance delays did occur it would be minimal and not lead to any consequences.

Flexibility

The RACF ARI outbreak surveillance system underwent numerous changes over the two-year evaluation period, the majority related to the COVID-19 pandemic which began in 2020. The PHU adapted to these changes by adjusting its staffing capacity in response to shifting priorities. From 2020 to early 2023, additional surge workforce staff were able to assist with outbreak management. From mid-2023 to 2024 although the emergency response had ended, the PHU was able to provide additional staffing to assist with outbreak response over the busy winter period. In addition, PHU interviewees reported that there was a shift from the PHU proactively communicating and overseeing RACF management to the onus being placed back on the RACF to update the PHU, which saved them time and resources. All interviewees reported that these strategies generally worked well. When asked about the impact of these changes on data quality, the response was mixed with some reporting that some RACFs would be lost to follow up and others reporting no change.

The COVID-19 pandemic also led to many national and state level policy and guideline changes regarding RACF ARI outbreaks impacting both RACF and PHU staff. One staff member commented that in the early days of the pandemic "*We were joking, if you don't like the policy just wait 20 minutes*". While these changes were initially reported by interviewees as challenging to keep on top of and required staff to remind RACFs of the changes, they became less frequent and were no longer seen as an issue. The last guideline change was September 2024 which came one year after the previous version.

When asked to identify factors that support outbreak management response, answers from RACF staff included: surge workforce, PHU and Healthy North Coast Primary Health Network support and resources, IPAC leads, refresher training after each outbreak, outbreak meetings as well as clear outbreak management policies and guidelines. Experience was also reported by quite a few respondents as beneficial, with one respondent writing "*Staff are not as frightened now. We have had several outbreaks and they are not so daunting*".

Representativeness

Of the 309 outbreaks notified in the evaluation period, 147 (47.6%) were from MNC LHD and 162 were from NNSW LHD (52.4%). The RACF suburbs with the highest number of ARI outbreaks reported were Port Macquarie (n=45), followed by Coffs Harbour (n=28) (Figure 8).

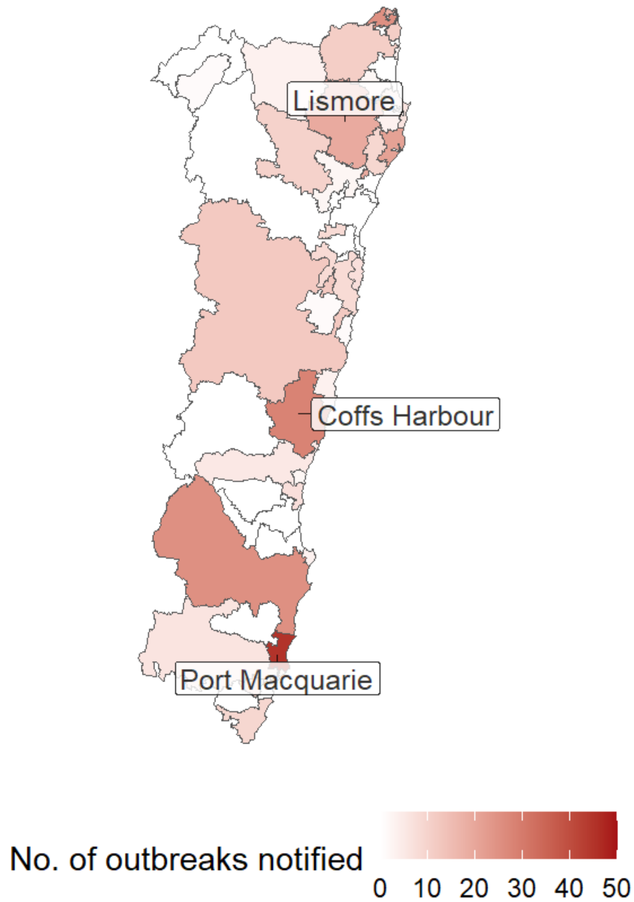


Figure 8. Spatial distribution of RACF ARI outbreaks reported in North Coast NSW, January 2022 to December 2023, by RACF postcode (N=309)

Out of the 80 RACFs in North Coast NSW identified by the research team, only one did not have any ARI outbreaks notified to the PHU during the study period (a total of 98.8% represented in the surveillance system).

When examining RACF ARI outbreaks notified to the PHU during the evaluation period, we found that 96.1% (n=297/309) were COVID-19, 1.94% (n=6/309) were influenza and 1.94% (n=6/309) were RSV.

Figure 9 shows outbreak trends over the evaluation period. We can see peaks every six months, around July and December each year. Peaks were greater in 2022 compared to 2023. In comparison to national COVID-19 RACF outbreak trends (Figure 10) [21], we can see similar six monthly peaks with a general decline over the 2 years.

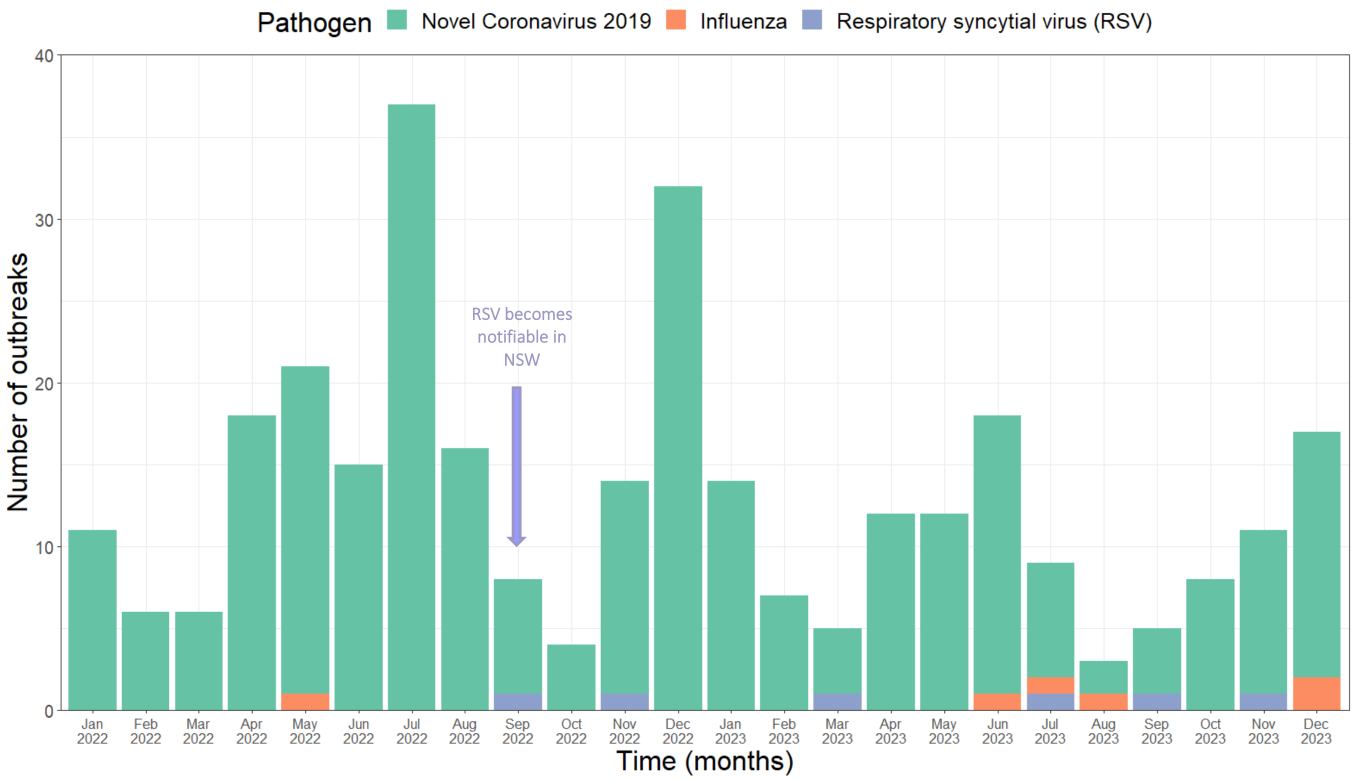


Figure 9. North Coast NSW RACF acute respiratory infection outbreak count over time, January 2022 to December 2023, by pathogen (N=309)

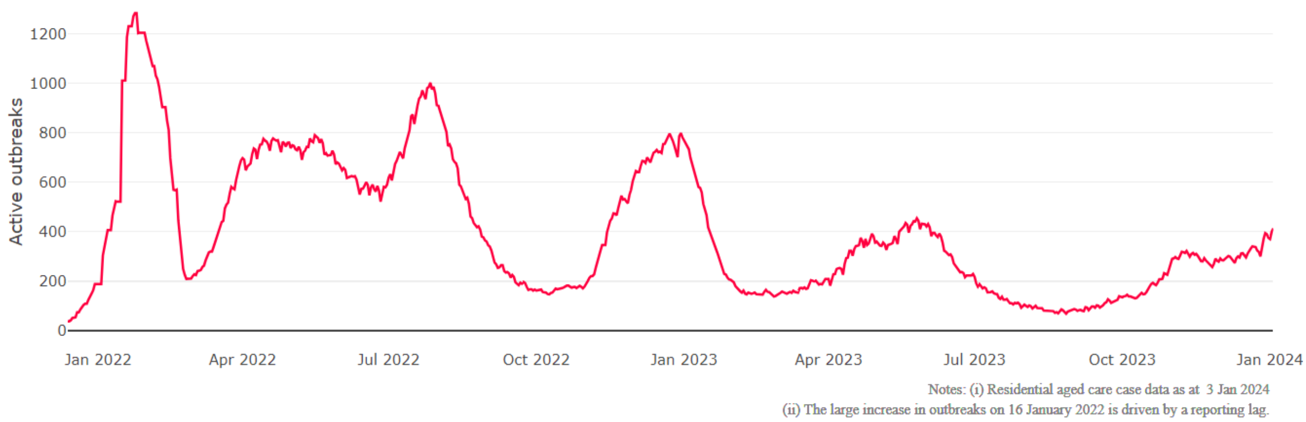


Figure 10. National COVID-19 outbreak trends in RACFs. Source: Department of Health and Aged Care[21]

Data quality

Table 4 below shows the completeness of key NCIMS data fields. The majority of fields had less than 50% missing and all compulsory data fields did not have any missing data. Items with high proportions of missing data included vaccination related data (88.7%), laboratory confirmed non-staff cases (77%), hospitalisation (68.3%) and mortality (64.4%).

While performing data analysis for this evaluation, the research team incidentally found many errors in the NCIMS dataset. For example, a Sydney RACF incorrectly had NNSW (Lismore) as the jurisdiction.

There were also around 20 incidences where the author found that the date was incorrectly entered for outbreak exposure and/ or closure, leading to negative outbreak durations.

Table 4. Completeness of key NCIMS reporting form variables for RACF ARI outbreaks in North Coast NSW, 1 January 2022 to 31 December 2023 (N=309)

Items	Proportion of missing data
Full name*	0%
Facility name (where appropriate)	26.9%
Facility suburb / town (where appropriate)	27.8%
Facility type	25.9%
Condition*	0%
Date PHU / office made aware of outbreak*	0%
Date the outbreak / exposure was recognised*	0%
Date outbreak / exposure closed	11.3%
Managing PHU / office*	0%
Number at risk of illness - Non-staff	25.9%
Number laboratory confirmed - Non-staff	77%
Date of onset for first Non-staff	18.8%
Number hospitalised - Non-staff	68.3%
Number died - Non-staff	64.4%
Number vaccinated prior to outbreak (if applicable) - Non-staff	88.7%

*Compulsory fields in the online NCIMS notification form

Sensitivity

We were unable to calculate the sensitivity of the surveillance system at detecting ARI outbreaks in RACFs in North Coast NSW as we did not have access to another data source to use as a comparison. However, we were able to get an indication based on the feedback from RACF and PHU staff. In the RACF staff survey question "Have you ever not reported an (ARI) outbreak to the public health unit due to these or other factors*?",* 93.3% (n=28/30) of participants responded "No" while only 3.3% (n=1/30) responded "Yes" and 3.3% (n=1/30) responded "Unsure/ rather not say".

PHU staff were asked “In your opinion, are there likely to be outbreaks of ARI in RACFs which are either undetected or not notified to the PHU?”. Overall, the consensus was that RACF staff were effectively identifying and notifying ARI outbreaks. Generally, PHU staff believed COVID-19 outbreaks were well detected and notified but were less confident that all influenza outbreak notifications were captured as RACF staff may just be performing COVID-19 rapid antigen tests (RAT) instead of a complete respiratory panel. A few pointed out that the PHU epidemiology team provided a safety net by notifying the CD team if multiple influenza notifications were notified in the location of a RACF, and when this occurred in the past it was often found to not meet outbreak criteria.

Predictive value positive

We were unable to calculate predictive value positive (PVP) as we did not have the additional data needed to calculate this. However, it is unlikely there would be many false positives as PHU CD staff confirm with the RACFs if a notification meets outbreak criteria before recording it in NCIMS.

During the interviews with PHU staff, we asked them about their experience receiving incorrect outbreak notifications from RACF ARI outbreaks. The response from interviewees was consistent: it was an uncommon occurrence. While there were often emails informing the PHU of a single case (exposure) it was often the RACF just giving the PHU the extra warning for a possible future outbreak and they were aware it did not meet outbreak criteria.

Acceptability

A surveillance system with high acceptability involves operators who follow guidelines and report all health events in a timely and accurate manner.[16] It is closely linked to the previously discussed timeliness, simplicity and data quality attributes. There was very good participation of nearly all RACFs reporting ARI outbreaks to the PHU (98.8%, see Representativeness section) and the majority notified the PHU on the day or outbreak detection (69.3%, see Timeliness section).

As previously mentioned (see Simplicity section), a few PHU staff reported issues receiving updates from RACF staff on the outbreak even when they proactively contacted the RACF staff to chase this information. One interviewee commented “*They* [the RACF staff] *know what they're doing. I think a part of the reluctance to call back is because they don't see the point in it*.”

PHU staff were asked to rate the surveillance system on a scale of 0–10 (a higher score being more positive). The majority of interviewees (66.7%, n=4/6) rated it 4–6 with one stating “*I don't think it's a zero or you know a low number, but I think we could probably improve it quite a bit*”. One thought the system works fine but commented that “*I think we overreport too much. We're reporting to the Commonwealth. On top of that reporting to the Ministry and you know reporting locally, yet aged care* [facilities] *are reporting already*". There was also the comment "*It's really clunky, it's really admin heavy*".

In contrast, a couple of interviewees rated it 8–9 with one stating *"I really don't have trouble with NCIMS, and I think it's our local policies and procedures that we have in place here... it's a pretty easy process because they're there and we have our guidelines*".

When RACF staff were asked about their opinion of the outbreak processes in their workplace, 71.4% (n=20/28) reported feeling happy while 25% (n=7/28) believed it could be better (Figure 11). The majority felt that the current process for interactions with the PHU were adequate, 46.7% (n=14/30) believed no changes were required and 36.7% (n=11/30) responded that only some changes should be implemented (Figure 12).

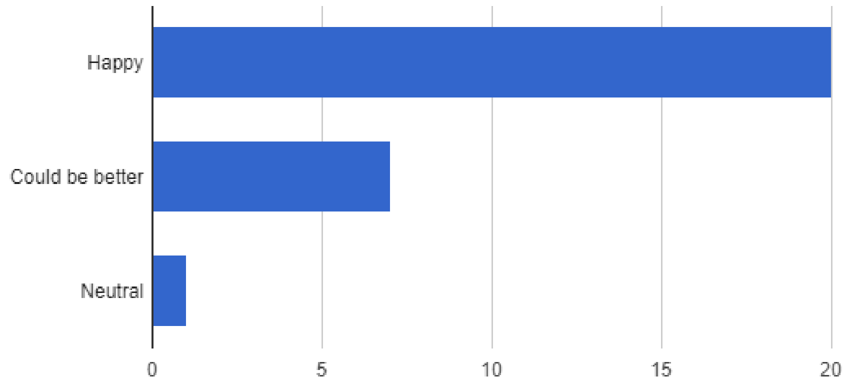


Figure 11. RACF staff survey responses, how do you feel about the outbreak processes in place at your workplace? (N=28)

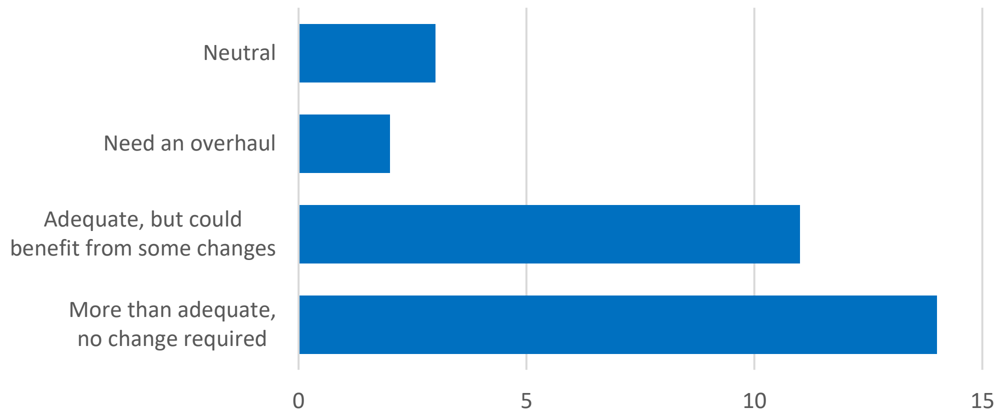


Figure 12. RACF staff survey responses, how do you feel about the outbreak processes in place for your interactions with the public health unit? (N=30)

Usefulness

When asked if the North Coast NSW surveillance system was meeting the objectives they suggested, PHU staff generally agreed that it helped inform IPAC and was useful for reporting and monitoring purposes. There was mixed response from PHU staff regarding its ability to support and guide RACF staff with ARI outbreak management to reduce transmission. One PHU interviewee stated "*I think it should be so that we can support them* [RACF staff] *to reduce transmission, like amongst residents and staff and reduce the risk of the outbreak and reduce the negative health outcomes. That's what I think it should be for, but I don't think that's what it is for. Otherwise, It just seems very much monitoring, like it's a numbers game really. That's what I think its purpose is at the moment."*

In contrast, another interviewee stated "*Oh yeah, absolutely the support and guidance are there… you know for every manager I speak to; you know I say: "Look you guys know what you're doing I'm not here to tell you what to do. I'm just here to guide you and support you along the way" and they go: "But that means the world to us". So, they are appreciating still that guidance and when you think, you know, they're probably over us by now but they're certainly not. So, I feel that it is a great thing to still have that correspondence and communication and partnership with them – absolutely.*"

In response to the question "What do you think is the role of the PHU during an outbreak?", providing advice and support to the RACFs was listed by 78.6% of RACF staff respondents (n= 22/28). Other suggestions included data collection, escalating concerns to NSW Health (state level), assessing risk, access to IPAC resources as well as to provide updates on current practices and what is happening with community transmission. One member wrote, "*Advice re* [regarding] *risks and fresh eyes to advise on if anything should be attended. Just running by an independent expert body promotes confidence*".

When provided with the hypothetical situation of the system falling apart, the consensus from PHU staff was that it would not have a detrimental impact on public health. Common themes were that RACFs were well experienced and independent and, unless new staff were involved, PHU support was not required. While the PHU may monitor and be concerned about a spike in numbers, it was unlikely to impact public health action and there were other indicators of disease activity such as hospitalisations, intensive care unit admissions and mortality data. One interviewee expressed concern that RACFs may become less accountable. A few people mentioned that while the system was important during the pandemic, it has become less relevant. One stated: "*I think we were really useful to them* [RACF staff] *initially in COVID and I think the times past now, they know what to do…. what I would like is, sure they can let us know and then reach out if they need help. So, a service where they can use us if they need help, but not where we're just doing it for the sake of doing it and we're not* *actually assisting*". A couple of interviewees mentioned if the system ended this would actually be beneficial to PHU staff as would free up their time and allow them to focus on other notifiable diseases.

A few comments were made by RACF staff regarding the usefulness of the current outbreak surveillance system. One respondent stated "*It has become easier but still a lot of work managing this on top of other commitments. It would be nice if we could just get on with life now and it not be so hard in Aged Care where our workload is forever increasing.*" Similarly, another wrote "*COVID outbreaks should be BAU* [business as usual]*, the compliance requirements need to be lessened*." There were also questions about the current value of the PHU in outbreak management. It was suggested that we need to focus on other areas of RACF/PHU ARI outbreak response not just surveillance, "*Working together to achieve together is the answer, we are seeing increased vaccination challenges with community attitudes seemingly changing. Helping us message the importance of preparation and preparedness is important*".

DISCUSSION

Summary of findings

The RACF ARI outbreak surveillance system in North Coast NSW has undergone many changes over the past few years, this evaluation found that it has many strong attributes; however, there are also areas that can be improved. In addition, we need to consider if the current level of response involved in the surveillance system process is an optimal and sustainable use of resources.

The surveillance system was found to have generally good simplicity and timeliness for RACF staff. A contributor to this was the extensive experience RACF staff had during the COVID-19 pandemic, which was reflected by their confidence in performing outbreak process steps. Managing the outbreak was identified as the step that took the most time and resources, which is understandable as this step involves many time-consuming components such as implementing IPAC measures and managing cases and contacts.

For PHU staff, the initial notification and collection of information relating to the outbreak takes up the most time and resources due to the heavy admin and back and forth nature of this step which lowered the simplicity and timeliness of the system. There was mixed feedback on the communication between PHU and RACF, many staff had no concerns while others had issues chasing line list information. Generally, PHU and RACF found the system's processes and guidelines easy to follow, suggesting good simplicity.

The majority of RACF staff reported experiencing factors that impacted the stability of the surveillance system. The most common obstacle was staff shortages, this was a major issue during the pandemic due to staff being sick and needing to isolate or suffering from burnout. Issues with IT did not majorly impact the stability of the system for both RACF and PHU staff. This has implications as technological platforms will likely be utilised to improve the surveillance system in the future, reducing manual data entry and transfer.

The flexibility of the system was heavily tested during the pandemic, however, we found that it generally adapted well to changing conditions. Although there were many changes during the pandemic, over time guideline updates became less frequent and RACF reported feeling more experienced and benefited from the ongoing support from the PHU, Healthy North Coast Primary Health Network and IPAC staff.

As the number of ARI outbreaks declined and RACF staff became more experienced the PHU staff became less involved in proactively following up outbreaks. This was generally reflected to have gone well, especially as PHU resources and priorities shifted. Based on the data available, the participation of RACF in reporting outbreaks to PHU was excellent. In addition, the majority of outbreaks were reported on the day of the outbreak suggesting good acceptability and timeliness. Our trends were also consistent with national trends, suggesting that we are likely not missing a large proportion of outbreaks. Unsurprisingly, the majority of outbreaks were reported in large towns due to the density and size of RACFs in these areas. Finally, both RACF and PHU staff felt confident that ARI outbreaks were being captured by RACF staff in the system. This suggests that if PHU staff were to have less involvement in outbreak management it is unlikely to have a detrimental impact on the operating and output of the system.

We found that the majority of outbreaks notified during the study period were COVID-19 and there were few influenza and RSV outbreaks. As suggested by staff, this could be due to the easy availability of COVID-19 RATs, compared to respiratory panel PCR and combined RAT testing. It could also be due to RSV only becoming notifiable in NSW in September 2022, and there may have been a delay in RACF staff becoming familiar with the policy change and aware to notify these outbreaks to the PHU. While it would not have impacted our data since it was after the study period, it will be interesting to see the impact of the RSV vaccines on outbreak count as two vaccines were approved by the Therapeutic Goods Australia (TGA) for adults aged 60 years and over earlier this year (private only). [22]

Over the past couple of years, the PHU has had the capacity to have additional staffing for RACF ARI outbreak work during the busy winter period and when there were unexpected staff shortages.

However, due to funding constraints, it is unclear how sustainable this strategy will be in the future suggesting other strategies need to be considered.

The majority of outbreak's duration was 11–20 days, since outbreaks can generally only be closed 7 days after the last case tested positive or was isolated this suggests that most outbreaks are controlled within a few days to a couple of weeks suggesting effective management by the RACF staff, however, many factors contribute to this measure. [23] Compulsory data variables had 100% completeness; this is likely due to the requirement for staff to provide information in order to submit the data entry form on NCIMS. PHU staff reported that RACF staff sometimes used different versions of line lists, this may explain the variations in data completeness and suggests that communication of a standardised line list with key data fields may need to be distributed and promoted to RACFs by the PHU. Non-compulsory fields on hospitalisation, mortality and vaccination had high rates of missing data. While this information could be found from alternate data sources, it would be useful to have this information at an outbreak level so we can better characterise outbreaks (including epidemiological and clinical characteristics), assess the effectiveness of control measures and determine health care service response capacity, which could be used to guide public health decision making and policy.[24] Quite a few data entry errors were picked up by the research team which suggests there may be issues with data validity. While they were unlikely to have had any consequence on outbreak management or outcomes, this shows that there might be some value in utilising calculated field checks in NCIMS, for example, a check to ensure that the duration of outbreak is greater than zero.

Overall, PHU and RACF staff generally thought that the surveillance system was effective at monitoring ARI outbreak levels in North Coast NSW RACFs, however, there were concerns about the quantity of administrative duties involved, over-reporting and the usefulness of the system in reducing disease transmission. It was expressed by a few PHU staff that since RACF staff have become well experienced in the process the current PHU involvement is unnecessary and resources would be better diverted to other communicable disease activities, with more responsibility and trust put on RACF staff to report and perform outbreak management processes. Some PHU staff did not feel like they were making a substantial difference in helping RACF staff. However, others received feedback from RACF staff that they preferred the extra support, and it kept them accountable. During this time when other diseases pose a larger public health threat and health services are undergoing substantial financial and resource constraints, we may need to reconsider the feasibility to continue giving this level of support and resources. There are other indicators and measures of ARI outbreak transmission in RACF communities and with staff burnout a major issue we must reduce unnecessary duties and processes for both RACF and PHU staff. Furthermore, if a few further outbreaks are not notified to the PHU, based on our findings it seems unlikely to substantially impact public health action.

Strengths and limitations of evaluation

The benefit of this evaluation was that it involved the views of stakeholders directly involved in operating the system, the RACF and PHU staff. In both the survey and interviews, respondents had opportunities to openly provide comments and feedback. We also were able to see the impact of drastic changes experienced during the system's operation throughout the COVID-19 pandemic, which was a great test of its flexibility and stability.

It would have been beneficial to get stakeholder feedback at the state or commonwealth level, especially from individuals who provide input for the guidelines and policies related to RACF ARI outbreaks. The distribution and use of the data collected in this surveillance system was out of the scope of this evaluation but would be a valuable measure to assess the system's usefulness and acceptability in the future.

Feedback from PHU staff was limited as it only involved six people and only involved current staff, not those who operated the system earlier in the study period. Similarly, the 30 respondents to the RACF survey may not adequately represent the views of the many RACF staff in North Coast NSW. Our findings may not reflect the experience of stakeholders in other regions, especially those in more remote or metropolitan areas with different resource levels.

Finally, our analysis was limited by incomplete data and since we did not have access to another dataset to compare the NCIMS outbreak notification to, we were limited in our ability to assess the PVP and sensitivity attributes.

Recommendations

Based on the findings of this evaluation, the following recommendations are suggested:

1) Evaluate the distribution and use of information collected by the surveillance system

PHU staff should consider evaluating the distribution of the surveillance system outputs and how the data collected informs public health action at a district level. This information could then guide the development of objectives (Recommendation 2) and allow us to reduce the collection of unnecessary information, reducing the workload for the system operators. This will involve consultation with stakeholders including: PHU staff, the Ministry of Health, RACF staff, clinicians as well as organisations such as the Healthy North Coast Primary Health Network. Ideally, this evaluation would be repeated as the system undergoes upgrades and public health priority changes.

2) Determine objectives for the North Coast NSW RACF ARI outbreak surveillance system

It is important that the system has clearly defined surveillance objectives developed, that are agreed by stakeholders and consider the system's priorities and resources available. These objectives should be focused on the local public health unit and RACF ARI outbreak response, as opposed to the national Commonwealth surveillance system. This will aid improvements that PHU staff can make to the local system and allow more comprehensive evaluation in the future.

3) Involve RACF and PHU staff when developing changes to the surveillance process, consider the formation of a working group

Many RACF and PHU staff were very interested in providing feedback on the system and expressed interest in getting involved in improvements made to the system. Half of the RACF staff survey respondents (n=14/28) were happy to be contacted to provide further feedback on the surveillance system in the future and 58.6% (n=17/29) expressed interest in joining a potential working group to contribute feedback to a new system. This will ensure that changes to the system will improve work for staff operating the system, increasing the acceptability of the system and reducing the risk of encountering unforeseen challenges. We propose a working group involving RACF, PHU and Healthy North Coast Primary Health Network staff to develop this process.

4) Review the role of PHU staff in RACF ARI outbreak response

We suggest reducing the PHU's active involvement in RACF ARI outbreak surveillance. Especially during periods of increased outbreak activity when the PHU is unable to obtain surge staff or when other communicable diseases are prioritised, it would be useful for the RACF staff to be able to operate the surveillance system independently, without relying on PHU input and feedback. Based on this evaluation, it appears that the RACF are experienced and reliable at detecting and notifying outbreaks. While there is a risk that there may be missed outbreaks or not all the information may be communicated, we believe that this is unlikely to significantly impact public health action. However, it would be important to ensure that the PHU staff are still available as needed for RACF staff to consult with if they do require assistance, especially with changing staff, guidelines or atypical outbreak scenarios.

As suggested by a RACF staff member, the PHU staff could transfer their focus from outbreak surveillance to preparedness. PHU staff could provide regular ARI outbreak training sessions for RACF staff on topics such as outbreak detection and completing line list information, which will be useful for new RACF staff but also provide an opportunity for experienced staff to refresh their skills and become familiar with updates to guidelines. Another important aspect of outbreak preparedness is promoting vaccination of residents, staff and visitors. [2] In September 2024, 17.9% of RACFs in the North Coast Primary Health Network had a resident COVID-19 vaccination coverage of 50% or below for the previous 12 months (any dose number administered) and only 28.2% of RACFs had COVID-19 vaccination rates of 80–100%.[25] In the neighbouring Hunter New England LHD, a review of RACF outbreak prevention and response preparedness identified low staff vaccination rates in some facilities as a weakness in outbreak prevention.[26] The PHU could get more involved in providing targeted vaccination education to staff and residents, in particular addressing concerns and confusion regarding vaccine safety and frequency.

5) Reduce manual entry and transfer of data by utilising a more automated system

We suggest that the PHU invest resources into setting up an automated system to enter and transfer data. For example, other jurisdictions have used REDCap or Microsoft Forms to send out surveys to the RACF staff during an outbreak to collect data. It could also automatically send out reminders and be used as a method to receive updates on the outbreak and its closure, therefore reducing the time spent by PHU staff on RACF ARI outbreak surveillance. It may also be helpful for RACF staff as it should be a more streamlined process and make data entry easier. Recently, Sydney LHD developed and implemented a novel web-based app (FluCARE), a feasibility pilot study found it to be useful, safe and acceptable for detecting and responding to influenza and COVID-19 outbreaks. [27]

However, we must consider the impact these changes will have on the partnership between RACF and PHU teams, as the current communication method provides an opportunity for education, moral support and improved relationships which may contribute to improved outbreak management and outcomes. [23] We should also consider the staff's willingness and ability to learn a new system. Reassuringly, we found that very few PHU and RACF staff experienced IT issues with the recent system. In the RACF survey, 89.7% (n=26/29) stated they would find an online survey tool acceptable, with 6.9% (n=2/29) being neutral and only one person (3.4%) being against this. Finally, recommendations should recognise future updates to the notifiable diseases management database.

CONCLUSION

Overall, this evaluation found that the North Coast NSW RACF ARI outbreak surveillance system generally had good simplicity, timeliness, IT stability, flexibility, acceptability and representativeness. However, with the changing economic and public health disease landscape we need to reconsider the surveillance objectives and usefulness of the current system in North Coast NSW. We should consider moving to a more automated system, decreasing the level of information collected and reducing the active involvement of the PHU in outbreak surveillance so that resources can be directed elsewhere. When developing improvements, we must ensure that we gain the input of RACF and PHU staff and maintain the strong relationship built between these parties during the pandemic. We should also engage other stakeholders to better understand the uses of the surveillance system outputs to guide the development of local objectives and enable us to improve the usefulness and acceptability of the system.

References

1. Australian Government Department of Health and Aged Care. Communicable Diseases Network Australia: National Outbreak Management Guideline for Acute Respiratory Infection (including COVID-19, influenza and RSV) in Residential Aged Care Home [Internet]. Canberra (AU): Australian Government Department of Health and Aged Care; 2024 June [cited 2024 Sep 9]. Available from: https://www.health.gov.au/sites/default/files/2024-06/national-guideline-for-the-prevention-control-and-public-health-management-of-outbreaks-of-acute-respiratory-infection-in-residential-aged-care-homes.pdf.
2. NSW Health. Guidance for residential aged care facilities on the public health management of acute respiratory infections (including COVID-19, influenza, and respiratory syncytial virus) [Internet]. Canberra (AU): NSW Health; 2024 Sep 5 [cited 2024 Sep 9]. Available from: https://www.health.nsw.gov.au/Infectious/covid-19/Documents/racf-ari-guidance.pdf.
3. Chen Y, Kirk M. Incidence of acute respiratory infections in Australia. Epidemiology & Infection. 2014;142(7):1355-61.
4. Thomas M, Bomar PA. Upper respiratory tract infection. StatPearls Publishing. 2018.
5. Australian Government Department of Health and Aged Care. National Communicable Disease Surveillance Dashboard [Internet]. Canberra (AU): Australian Government Department of Health and Aged Care; 2024 Sep (2024 Sep 13). Available from: https://nindss.health.gov.au/pbi-dashboard/.
6. Australian Institute of Health and Welfare. COVID-19 [Internet]. Canberra: Australian Institute of Health and Welfare, 2024 Jul 16 [cited 2024 Sep. 13]. Available from: https://www.aihw.gov.au/reports/australias-health/covid-19.
7. Australian Government Department of Health and Aged Care. Australian Influenza Surveillance Report – 2023 End of Season Summary [Internet]. Canberra (AU): Australian Government Department of Health and Aged Care; 2024 [cited 2024 Aug 20]. Available from: https://www.health.gov.au/sites/default/files/2023-12/aisr-2023-national-influenza-season-summary.pdf.
8. Australian Government Australian Institute of Health and Welfare (GEN Aged Cared data) [Internet]. People using aged care. Canberra (AU): Australian Institute of Health and Welfare; 2024 Apr [cited 2024 Oct 08]. Available from: https://www.gen-agedcaredata.gov.au/topics/people-using-aged-care.
9. Lansbury LE, Brown CS, Nguyen-Van-Tam JS. Influenza in long-term care facilities. Influenza and other respiratory viruses. 2017;11(5):356-66.
10. Zhang J, Yu Y, Petrovic M, Pei X, Tian Q-B, Zhang L, et al. Impact of the COVID-19 pandemic and corresponding control measures on long-term care facilities: a systematic review and meta-analysis. Age and Ageing. 2023;52(1):afac308.
11. Australian Government Department of Health and Aged Care. COVID-19 outbreaks in Australian residential aged care facilities [Internet]. Canberra (AU): Australian Government Department of Health and Aged Care; 2024 Sep [cited 2024 Aug 28]. Available from: https://www.health.gov.au/resources/collections/covid-19-outbreaks-in-australian-residential-aged-care-facilities.
12. Australian Institute of Health and Welfare (AIHW). Older Australians [Internet]. Canberra (AU): Australian Institute of Health and Welfare (AIHW); 2024 Jul 2 [cited 2024 Oct 17]. Available from: https://www.aihw.gov.au/reports/older-people/older-australians/contents/aged-care?s/page/5/page/2/&s/page/5/page/5/&s/page/5/&s/page/9/&s/page/582/&utm_medium=Email+&utm_campaign=Elena%2Fpage%2F2%2F&utm_source=Signature.

13. Australian Government Department of Health and Aged Care. Infection Prevention and Control Leads [Internet]. Canberra (AU): Australian Government Department of Health and Aged Care; 2024 Sep [cited 2024 Oct 18]. Available from: https://www.health.gov.au/our-work/infection-prevention-and-control-leads.

14. Australian Government Aged Care Quality and Safety Commission. 24/7 registered nurse coverage and care minutes in residential aged care [Internet]. Canberra (AU): Australian Government Aged Care Quality and Safety Commission; 2023 Jun 27 [cited 2024 Oct 22]. Available from: https://www.agedcarequality.gov.au/resource-library/247-registered-nurse-coverage-and-care-minutes-residential-aged-care.

15. World Health Organization. Public health surveillance [Internet]. World Health Organization [cited 2024 Sep 10]. Available from: https://www.emro.who.int/health-topics/public-health-surveillance/index.html.

16. German RR, Lee L, Horan J, Milstein R, Pertowski C, Waller M, et al. Updated guidelines for evaluating public health surveillance systems. MMWR Recomm Rep. 2001;50(1-35).

17. NSW Health. Protocol to support joint management of a COVID-19 outbreak in one or more residential aged care facility (RACF) in NSW Version 6.0. 2022.

18. Australian Government Department of Health and Aged Care. Australian National Surveillance Plan for COVID-19, Influenza, and RSV [Internet]. Canberra (AU): Australian Government Department of Health and Aged Care; 2024 Apr 17 [cited 2024 Oct 21]. Available from: https://www.health.gov.au/sites/default/files/2024-04/australian-national-surveillance-plan-for-covid-19-influenza-and-rsv_1.pdf.

19. Communicable Diseases Network Australia. Seasonal Influenza Infection CDNA National Guidelines for Public Health Units [Internet]. Canberra (AU): Communicable Diseases Network Australia; 2019 Jul [cited 2024 Oct 18]. Available from: https://www.health.gov.au/sites/default/files/documents/2022/06/influenza-infection-flu-cdna-national-guidelines-for-public-health-units.pdf.

20. Australian Government Department of Health and Aged Care. Coronavirus Disease 2019 (COVID-19) CDNA National Guidelines for Public Health Units [Internet]. Canberra (AU): Australian Government Department of Health and Aged Care; 2024 Jul [cited 2024 Oct 18]. Available from: https://www.health.gov.au/sites/default/files/2024-06/coronavirus-covid-19-cdna-national-guidelines-for-public-health-units_0.pdf.

21. Australian Government Department of Health and Aged Care. COVID-19 outbreaks in Australian residential aged care facilities – 4 January 2024. [Internet]. Canberra (AU): Australian Government Department of Health and Aged Care; 2024 Jan 5 [cited 2024 Aug 22]. Available from: https://www.health.gov.au/resources/publications/covid-19-outbreaks-in-australian-residential-aged-care-facilities-4-january-2024?language=en. Figure 1, National Outbreak Trends in Aged Care, p. 2.

22. Natonal Centre for Immunisation Research and Surveillance (NCIRS). Evaluation of and expected access to new RSV vaccines and long-acting monoclonal antibody (mAB) in Australia as at 13 September 2024 [Internet]. Canberra (AU): NCIRS; 2024 Sep [cited 2024 Oct 21] Available from: https://ncirsorgau/sites/default/files/2024-09/Evaluation%20and%20expected%20access%20to%20new%20RSV%20vaccines%20and%20long acting%20monoclonal%20antibody%20%28mAB%29%20in%20Australia%20as%20at%2013%20September%202024pdf.

23. Tennant E, Fletcher S, Kakar S, Najjar Z, Lord H, Clark P, et al. Factors associated with adverse outcomes during influenza outbreaks in aged care facilities. Australian and New Zealand Journal of Public Health. 2020;44(1):65-72.

24. Merritt TD, Dalton CB, Kakar SR, Ferson MJ, Stanley P, Gilmour R. Influenza outbreaks in aged care facilities in New South Wales in 2017: impact and lessons for surveillance. 2021.

25. Australian Government Department of Health and Aged Care. Residential aged care residents COVID-19 vaccination rates [Internet]. Canberra (AU): Department of Health and Aged Care; 2024 [updated 2024 Sep; cited 2024 Oct 8]. Available from: https://www.health.gov.au/resources/publications/residential-aged-care-residents-covid-19-vaccination-rates-0?language=en.

26. Latta R, Massey PD, Merritt T, Eastwood K, Islam F, Durrheim DN. Outbreak management in residential aged care facilities-prevention and response strategies in regional Australia. Australian Journal of Advanced Nursing, The. 2018;35(3):6-13.

27. Quinn E, Hsiao KH, Johnstone T, Gomez M, Parasuraman A, Ingleton A, et al. Protecting Older Adult Residents in Care Facilities Against Influenza and COVID-19 Using the Influenza Communication, Advice and Reporting (FluCARE) App: Prospective Cohort Mixed Methods Study. JMIR Formative Research. 2023;7(1):e38080.

APPENDICES

Appendix A: PHU staff semi-structured interview questions

No.	Question	Attributes
1	How long have you been involved in RACF ARI public health outbreak response? (*Try to get start and end date*)	
2	How much training did you require before you were comfortable performing your role in RACF outbreak management?	Simplicity, timeliness, flexibility
3	How much time do you spend on RACF ARI outbreak response each week? (*If easier can convert to hours per day or per month*)	Timeliness, simplicity
4	What steps in RACF ARI outbreak management take the longest time and why?	Timeliness, simplicity
5	How does the system cope during periods of staff changes and spikes in cases? *Prompts*: a. What strategies do you have in place to respond in periods where you have an increase in outbreaks? b. Loss of PPR team –how this impacted process	Flexibility, stability
6	How did data quality get impacted during this period?	Data quality, flexibility
7	Can you think of any other factors which have impacted the functioning of the system e.g., IT issues, RACF staff & policy changes?	Stability, flexibility
8	How simple is the collection of information from RACFs? What are the obstacles?	Simplicity, acceptability
9	In your opinion, are there likely to be outbreaks of ARI in RACFs which are either undetected or not notified to the PHU?	Sensitivity, acceptability
10	In your experience, how often are RACF ARI outbreaks incorrectly notified (if ever)? (*false positive*)	PPV, simplicity
11	What do you think are the objectives of the PHU/ RACF ARI outbreak system?	Usefulness

12	Do you think these objectives are being met by the current system? Why?	Usefulness
13	Can I get your rating on the overall RACF ARI outbreak process? 10 being its perfect, 0 being terrible system we need an overhaul. Explain why you chose this number.	Acceptability, usefulness
14	What do you think would happen if the system fell apart? *Prompt* How would this impact: a. RACF staff b. Cases + contacts – does it prevent further cases c. PHU	Usefulness
15	Any other feedback or final comments on the process you would like to make?	

Appendix B: RACF staff online survey

AAA

NSW GOVERNMENT

North Coast Population & Public Health Directorate

Aged care facility staff survey on the acute respiratory infection outbreak system

The purpose of this survey is to evaluate the public health acute respiratory infection outbreak system at aged care facilities in North Coast NSW. This project is being conducted by North Coast Population and Public Health (NCPPH) and Australian National University (ANU). You are invited to participated in this survey because you are a staff member at an aged care facility in North Coast NSW.

Your participation in this survey is voluntary, if you participate in the survey you may withdraw at any time. The survey should take approximately 5-10 minutes. Your responses will be confidential, and you do not have to provide identifying information such as your name or workplace unless you wish to be contacted further. All survey responses will be securely stored and accessed by only the research team. Only aggregated, non-identifiable information will be published. The results of this survey will be used for scholarly purposes and to improve the current public health outbreak surveillance system.

If you have any questions about this survey, please contact Dr Megan Ellis via email megan.ellis@health.nsw.gov.au. This project has been approved by ANU HREA under protocol 2017/909.

Thank you!

What is your role during outbreaks at your aged care facility?

What is the postcode of the aged care facility where you work?

If you work at more than one aged care facility, please enter all the postcodes

On a scale of one to five, how confident do you feel completing the following outbreak management steps?

	Not confident at all	Slightly confident	Fairly confident	Very confident	N/A
Identifying an outbreak	○	○	○	○	○
Managing the outbreak	○	○	○	○	○
Completing the Commonwealth Department of Health reporting requirements	○	○	○	○	○
Completing the line list for the public health unit	○	○	○	○	○
Declaring an outbreak over	○	○	○	○	○

Rank the following outbreak management steps based on the resources required to complete it (e.g. staffing, time, IT infrastructure, equipment etc.)
(1 = most resources, 6 = least resources)

(One selection allowed per column)	1 = most resources	2	3	4	5	6 = least resources
Identifying an outbreak	○	○	○	○	○	○
Managing the outbreak	○	○	○	○	○	○
Completing the Commonwealth Department of Health reporting requirements	○	○	○	○	○	○

Communicating with the public health unit	○	○	○	○	○	○
Completing the line list for the public health unit	○	○	○	○	○	○
Declaring an outbreak over	○	○	○	○	○	○

During an outbreak, how many hours do you spend on each outbreak step?

	Approximate number of hours (in total)
Identifying an outbreak	
Completing the Commonwealth Department of Health reporting requirements	
Declaring an outbreak over	

During the outbreaks, on average how many hours per day do you spend on:

	Approximate number of hours per day
Managing the outbreak	
Communicating with the public health unit	
Completing the line list for the public health unit	

Which of these factors have negatively impacted your ability to manage outbreaks?

- Staff shortages
- IT issues (e.g., internet connection issues, computer systems down)
- Lack of training and/or confidence with management of an outbreak
- The amount of information you are asked to collect for the public health unit
- Difficulty contacting the public health unit
- Barriers to testing (e.g., no pathology forms, no RATs or swabs on site, no doctors available to order the tests, pathology company unable to visit the site to collect samples)
- Other - please specify
- None

Select all that apply

Have you ever not reported an outbreak to the public health unit due to these or other factors?

Yes

	No
	Unsure/ rather not say
What factors have supported your outbreak management response?	
What do you think is the role of the public health unit during an outbreak?	
How do you feel about the outbreak processes in place at your workplace?	Happy
	Could be better
	Neutral
How do you feel about the outbreak processes in place for your interactions with the public health unit?	More than adequate, no changes required
	Adequate, but could benefit from some changes
	Need an overhaul
	Neutral
Would you be happy to be contacted by the public health unit research team to provide further feedback on the outbreak process?	Yes
	No

The public health unit is considering changing the way outbreaks are reported, so that aged care facility staff would complete a simple online survey (the link to the survey would be provided by email).

Would this be acceptable to you?

Yes

Neutral

No

When the public health unit looks at building a new system for managing outbreaks would you be interested in joining a working group to contribute your feedback to the new system?

Yes

No

If you wish to share anything else with the public health unit on outbreak processes, please add it here.

Submit

Powered by REDCap

Chapter VI

Teaching experience

Lessons from the field and teaching to first year sessions

CHAPTER CONTENTS

MAE TEACHING ACTIVITIES

The Master of Philosophy in Applied Epidemiology (MAE) program requires scholars to perform two teaching activities. Firstly, scholars must conduct and participate in lessons from the field session with their fellow 2023–2024 cohort members. Secondly, they must prepare and conduct an epidemiology training session for the first-year MAE scholars. This chapter outlines my experience completing these requirements, including the valuable lessons I learned

ABBREVIATIONS

DBS	Dry blood spot
LFF	Lessons from the field
MAE	Master of Philosophy in Applied
PoCT	Point of care testing

LESSONS FROM THE FIELD

Lessons from the field (LFF) provides an opportunity for MAE scholars to present and discuss case studies, using the experiences they have gained from their unique field placements and backgrounds. My LFF group included five scholars, however, one scholar was unable to participate in my session as they were on leave.

Based on my experience in the “SERCO hepatitis C dry blood spot (DBS) sub-study” (Chapter 1) and previous experience working clinically in drug and alcohol, I decided to present on “Point-of-care test (PoCT) validation in a prison setting”.

Learning objectives for the session were to:

1. Consider the health concerns and inequalities faced by prison populations.
2. List some of the strengths and limitations of PoCT and understand how they are beneficial in certain settings.
3. Identify potential obstacles and risks involved in performing data collection in a prison setting and how to best mitigate these.
4. Perform sensitivity and specificity calculations.

I prepared the learning outcomes, lesson plan, background information, worksheet, presentation slides and facilitated the videoconference session. I used a range of government resources when researching and preparing the presentation.[1,2,3]

In the case study, scholars were asked to perform a study evaluating a new hepatitis C PoCT in a private prison setting. Before the videoconference, participants were asked to complete a worksheet involving 13 questions.

The session was broken up into four sections:

(1) Background information: focused on prisoner health, hepatitis C and PoCT.

(2) Planning of the study: included engaging stakeholders, challenges of data collection in a prison setting and methods to promote the study to participants.

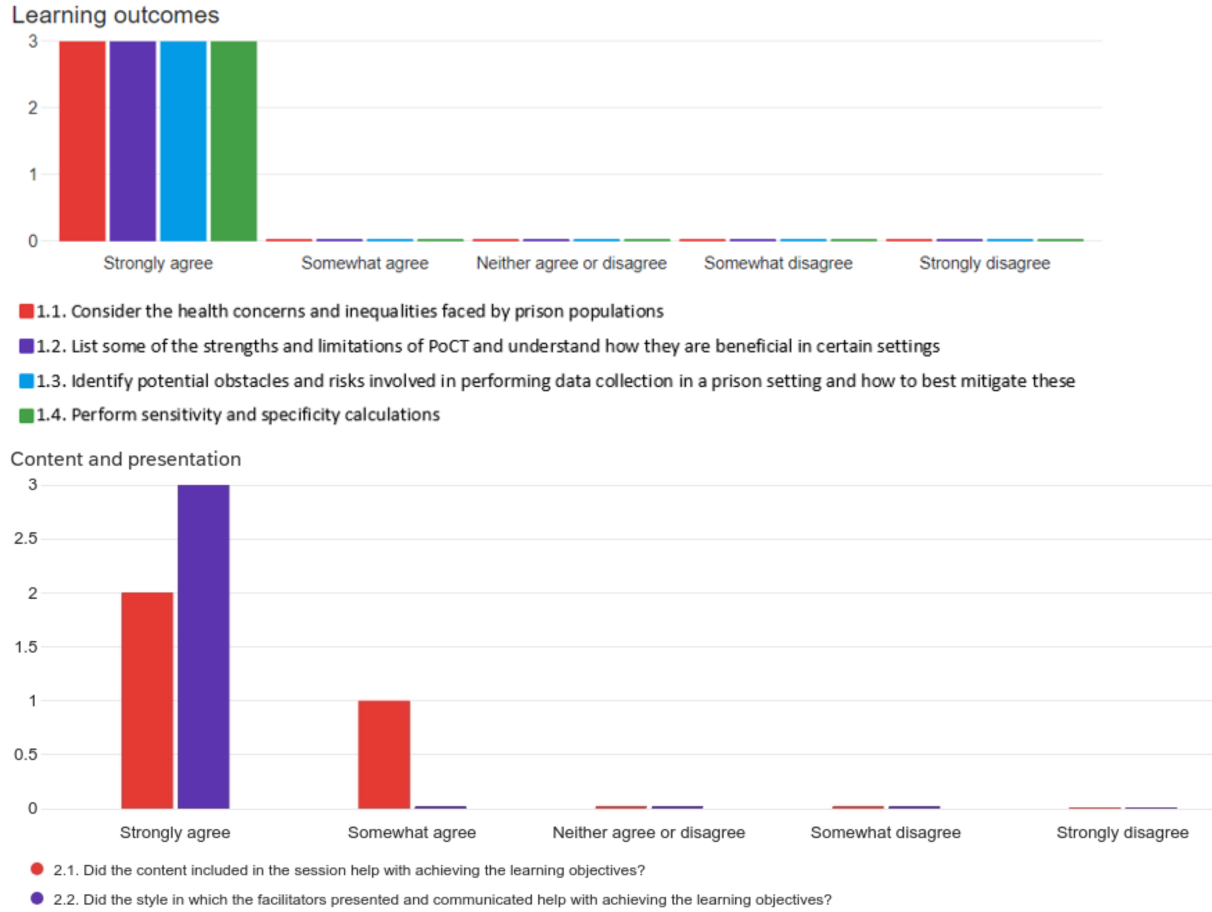
(3) The activation: included discussion of the ethical considerations associated with prison research, informed consent, screening questions, risks and issues that can occur during data collection and strategies to prevent this.

(4) Analysis of results: included sensitivity and specificity calculations as well as considerations regarding repeating the study.

During the videoconference session we worked through the case study, going over the answers from the worksheet and I also provided additional insights from my own experience. It was also an opportunity for my peers to ask me questions about the case study and topics covered. Slides from the presentation are shown in Appendix A.

Participants completed a feedback survey at the end of my teaching session regarding the learning outcomes, content and delivery of the session. Overall, I received very positive feedback (Figure 1). I also included a free text box for additional comments (Figure 1) and participants gave me verbal feedback that the session was enjoyable and a good learning experience about topics they were unfamiliar with.

I really enjoyed preparing and delivering this session. I think it helped to progress the case study chronologically, from the planning to data collection to analysis phase. Being able to draw from my own experience and provide personal anecdotes was a useful teaching skill and engaged the group. In the future, I would provide a summary of hepatitis C or provide links to useful resources in the background session of the worksheet as there were members who were not familiar with the disease; however, I adapted by having a slide which provided an overview of this topic during the videoconference and answered any additional questions they had about the disease. I was impressed with some of the ideas and responses provided by group members in their worksheets and included this in my presentation. This was my first time using Qualtrics to create the feedback survey, I was pleased to see how simple it was to use and would utilise it again in the future.



3.1. Please provide any additional comments or feedback on this session

This was an interesting and well-presented topic!

This was fantastic. The topic was very engaging. I learnt a lot. It would be good for the MAE staff to do a session on vulnerable populations (ft. Meg for a case study). I also liked doing the specificity and sensitivity analyses with a real life example. Everything was explained well and at the level of understanding suitable for a LFF.

Very good presentation on the requirements of HEP C testing within prison settings

Figure 1. Participant feedback results from my lessons from the field (LFF) session (taken from Qualtrics)

TEACHING TO FIRST YEAR SCHOLARS

As part of my MAE teaching requirements, I prepared and presented a teaching session to the first-year MAE cohort students in February 2024. My cohort divided into four groups and we each presented a 90-minute session on a topic of our choice. Based on our own unique field placement experiences my group decided to present on "Public health in different contexts".

Learning objectives for the session were to:

1. Describe public health in different geographical settings (including metropolitan, regional, remote and global settings).
2. Explain challenges and opportunities associated with public health responses in these geographical settings.
3. Discuss the political, cultural, economic and social considerations in conducting public health responses in these geographical settings.

In this lesson my group provided examples of public health topics in metropolitan, regional, rural and overseas settings. This included discussion of geography, demography, climate, industries, priority populations, resources and major health concerns. We then had the students participate in a group activity where they discussed the opportunities and challenges they would expect in a measles outbreak in their allocated setting. Based on my experience in North Coast NSW I presented the regional part of the presentation with my colleague from Hunter New England public health unit. I also helped facilitate the group activity and provided the conclusion for the session.

We prepared an online feedback form that the students were asked to complete on the conclusion of our presentation. The results of this survey are shown below (Figure 2). Overall, we received very positive feedback on both the structure, presentation and content of the session. We were concerned that when doing the group activity the groups would focus on the negative "challenges" associated with each context, however we were impressed to find that they instead focused on the many opportunities and benefits. On reflection, to improve this session I think it would have been beneficial at the start to ask the students to reflect on their own previous experiences working in different contexts. Our session went for longer than originally planned and we did not factor in time for questions at the end, if I was to plan this session again I would ensure that 10 minutes were allocated for this. I think it would have also been more engaging if we provided more personal examples of our experience in our context, instead of mainly providing factual information on the setting.

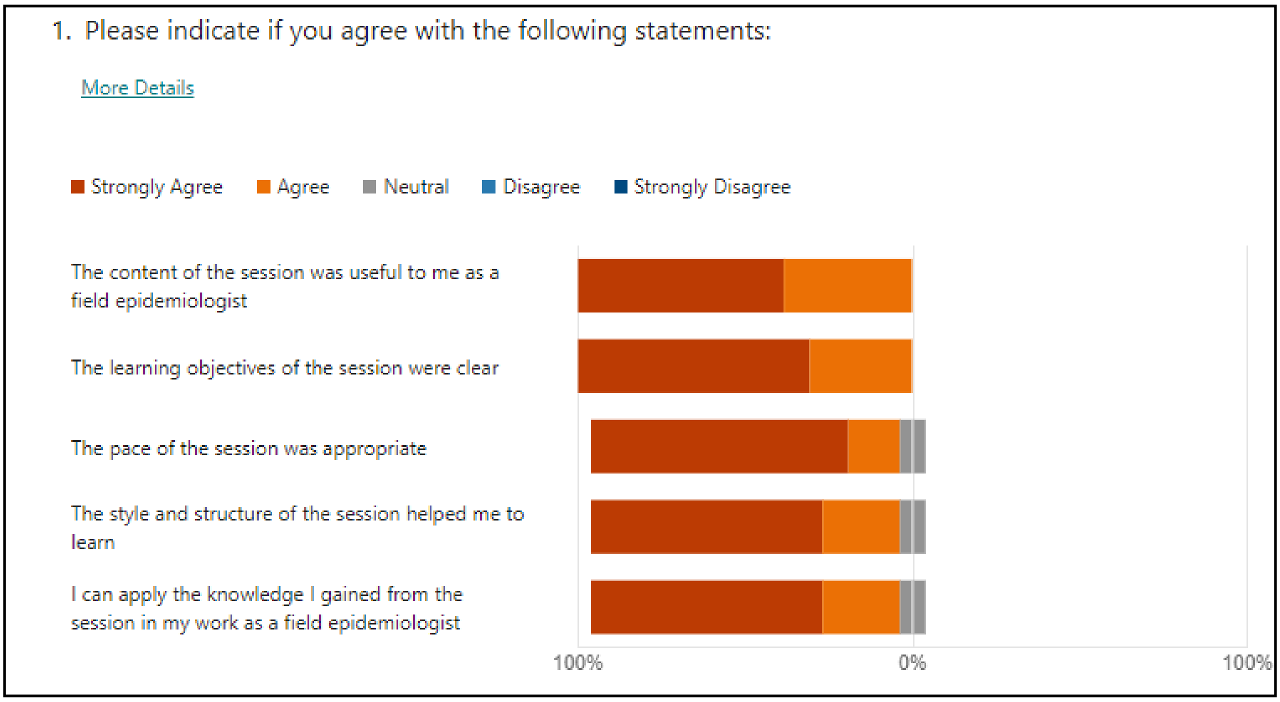


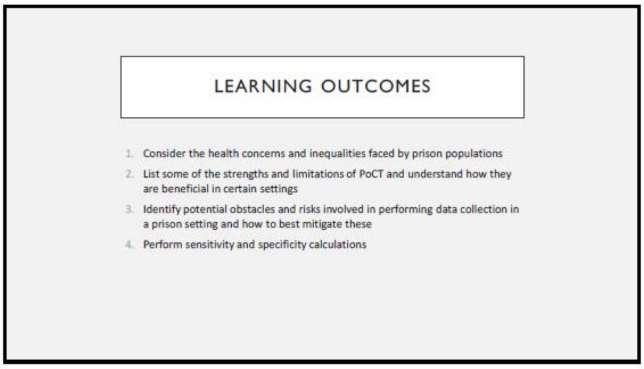
Figure 2. Participant feedback results from the teaching first year scholars' session

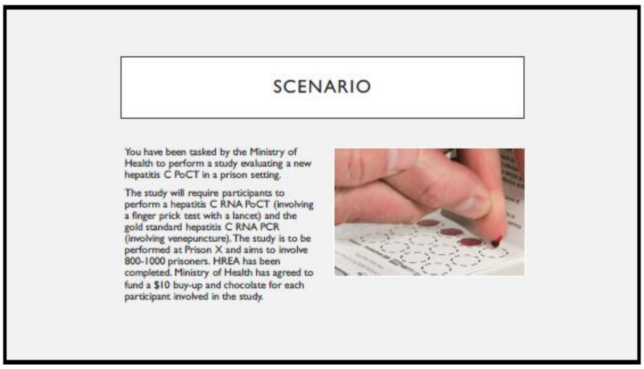
REFERENCES

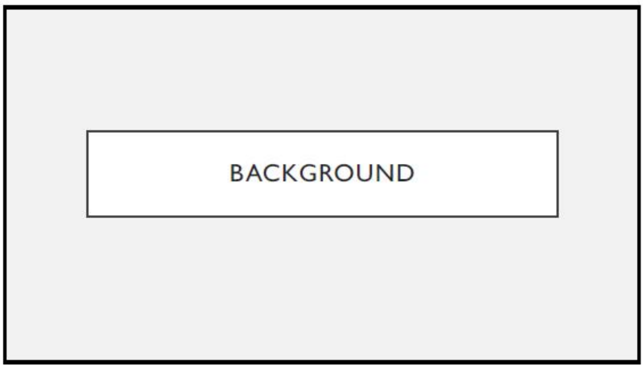
1. Australian Institute of Health and Welfare. Adults in prison [Internet]. Canberra: Australian Institute of Health and Welfare, 2023 [cited 2024 Apr 25]. Available from: https://www.aihw.gov.au/reports/australias-welfare/adults-in-prison.
2. Australian Government Department of Health. Requirements for point of care testing. [Internet]. Canberra (AU): Australian Government Department of Health; 2015 [updated 2021, cited 2024 April 15]. Available from: https://www.safetyandquality.gov.au/sites/default/files/2022-08/tier_4_requirements_for_point_of_care_testing_second_edition_2021.pdf.
3. Basit H, Tyagi I, Koirala J. Hepatitis C – StatPearls [Internet]. NIH: National Library of Medicine. 2023 Mar 26 [cited 2024 Apr 5]. Available from: https://www.ncbi.nlm.nih.gov/books/NBK430897/.

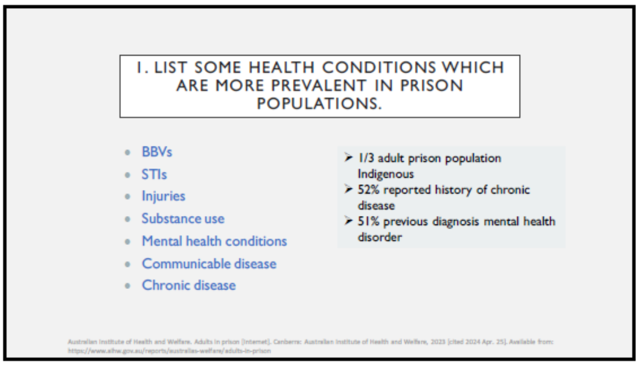
APPENDIX

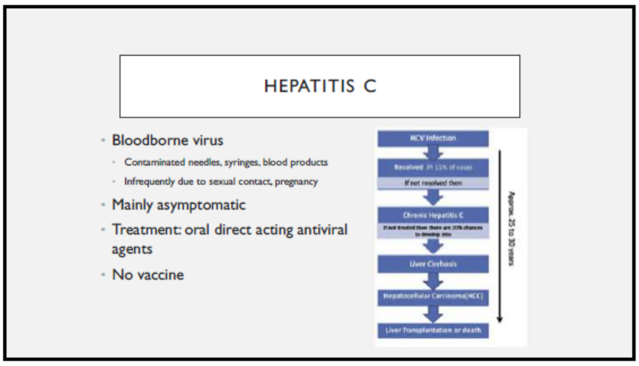
APPENDIX A: LFF slides











2. WHY ARE PRISON POPULATIONS AT HIGHER RISK OF HEPATITIS C?

- IVDU
- Tattoos
- Shared needles
- Shared razors, toothbrushes
- Poor healthcare engagement before incarceration (lower rates of screening, treatment, follow-up)
- Higher Indigenous population

3. LIST SOME ADVANTAGES AND DISADVANTAGES OF POINT OF CARE TESTING?

Advantage	Disadvantage
• Generally cheaper • Easy to use • Less training required (don't need to be clinical/ path staff) • Rapid results enable quick response • More accessible – no additional appt or travel required • Smaller sample, less invasive • Can be used in a wide range of settings • Less steps involved	• Lower accuracy • Overutilisation & inappropriate use • Poorer documentation • Increased risk human error e.g. data entry, test handling & interpretation • May incur cost to patient if not under MBS + require additional confirmatory testing if positive

4. WHY IS POCT SCREENING BENEFICIAL FOR PRISON SETTINGS?

- High-risk population
- Mass testing of large population – reduce transmission
- Less training required of staff, don't require additional specialist staff to travel into prison
- Don't rely on path lab, no centrifuge or cold chain transportation required
- Rapid diagnosis is useful due to high turnover of prisoners as they are transferred/ released
- Many prisoners have poor veins due to ++ IVDU

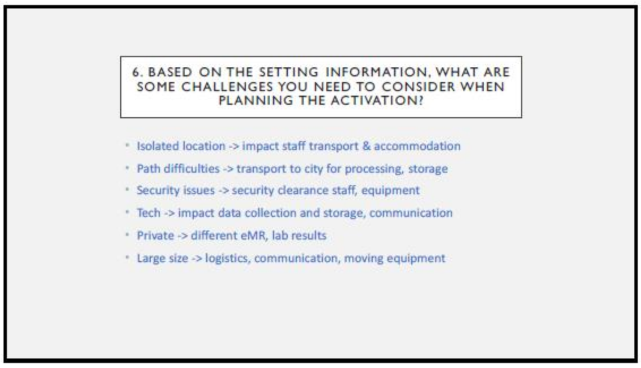
PLANNING

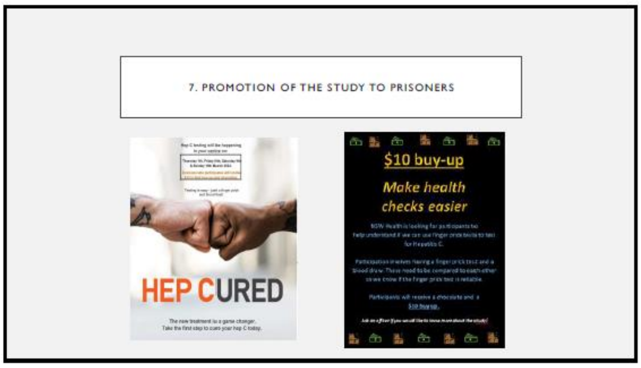
5. WHICH STAKEHOLDERS WOULD YOU ENGAGE DURING THE PLANNING STAGE OF THE PROJECT?

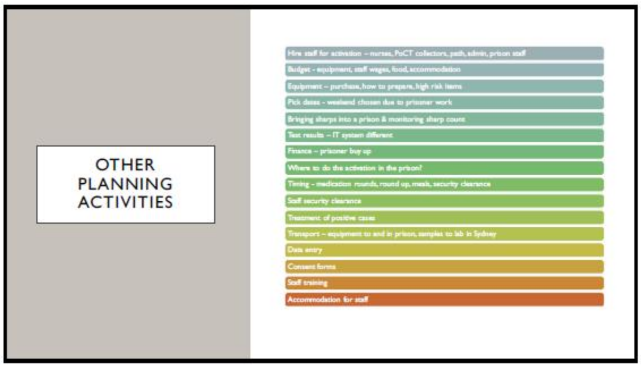
- Ministry of health
- Prison team (health, logistics, security teams)
- Staff involved in activation (e.g. clinical staff)
- Pathology
- Relevant community organisations e.g. Hepatitis Australia
- Justice Health public health unit
- PHU staff

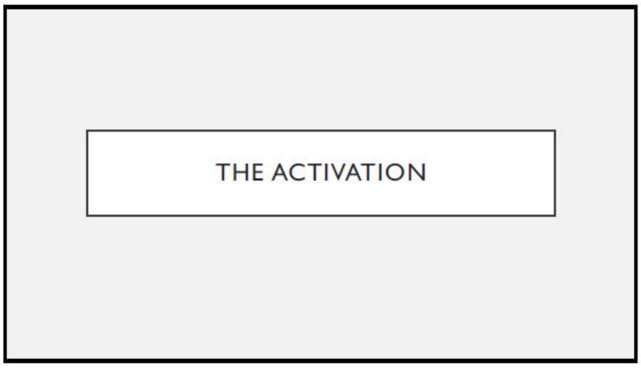
SETTING

The study will be conducted at Prison X, a 1500 capacity maximum-security private prison. It is 90,000 square metres complex based in a rural location. The nearest town (Town X, population 2000) is a 30-minute drive and the closest city is 5 hours drive or 1 hour plane flight away. The prison has its own health centre and staff. While there is a centrifuge available, pathology has to be transported to a small lab in Town X for testing (limited capacity). Phones and laptops are not allowed to be brought into the prison.

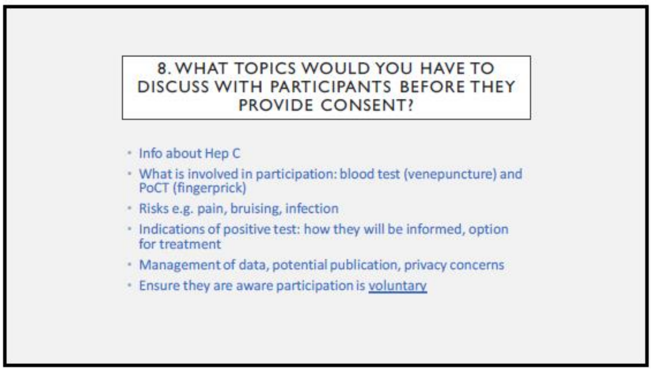

6. BASED ON THE SETTING INFORMATION, WHAT ARE SOME CHALLENGES YOU NEED TO CONSIDER WHEN PLANNING THE ACTIVATION?
Isolated location -> impact staff transport & accommodation
Path difficulties -> transport to city for processing, storage
Security issues -> security clearance staff, equipment
Tech -> impact data collection and storage, communication
Private -> different eMR, lab results
Large size -> logistics, communication, moving equipment

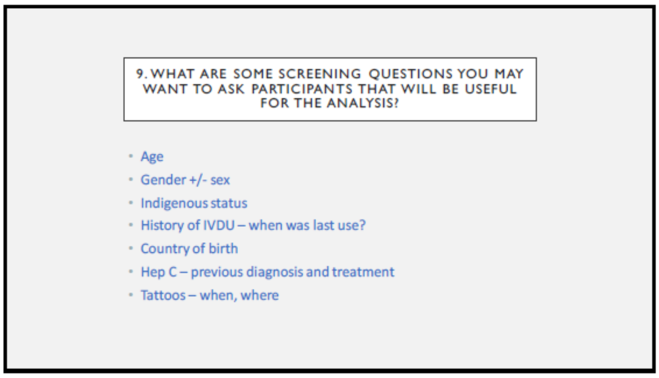

7. PROMOTION OF THE STUDY TO PRISONERS
HEP CURED
The new treatment is a game changer.
Take the first step to cure your hep C today.
$10 buy-up
Make health checks easier
NSW Health is looking for participants to help understand if we can use finger prick tests to test for Hepatitis C.
Participation involves having a finger prick test and a blood draw. These need to be compared to each other so we know if the finger prick test is reliable.
Participants will receive a chocolate and a $10 buy-up.

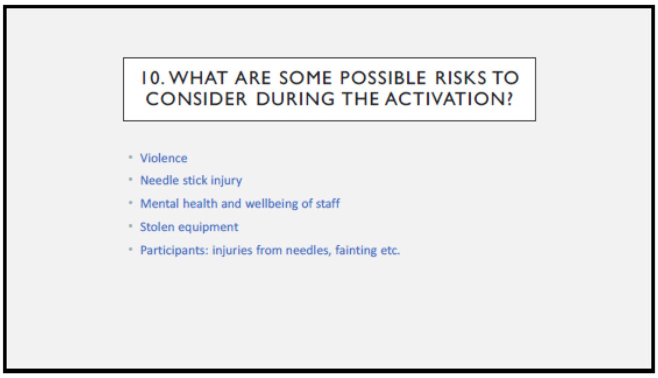

OTHER PLANNING ACTIVITIES
Hire staff for activation – nurses, PoCT collectors, path, admin, prison staff
Budget - equipment, staff wages, food, accommodation
Equipment – purchase, how to prepare, high risk items
Pick dates – weekend chosen due to prisoner work
Bringing sharps into a prison & monitoring sharp count
Test results – IT system different
Finance – prisoner buy up
Where to do the activation in the prison?
Timing - medication rounds, round up, meals, security clearance
Staff security clearance
Treatment of positive cases
Transport – equipment to and in prison, samples to lab in Sydney
Data entry
Consent forms
Staff training
Accommodation for staff

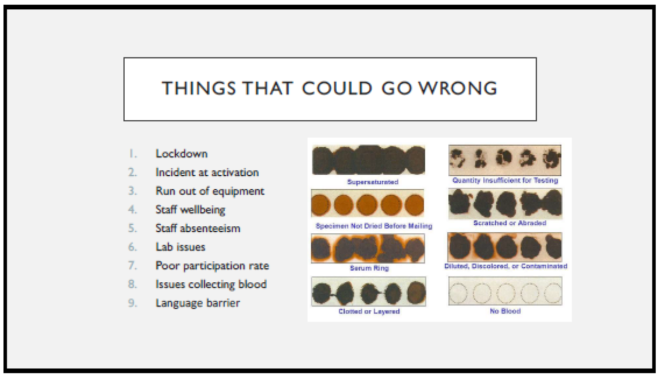

THE ACTIVATION


ETHICS OF PRISON RESEARCH
Vulnerable "captive population"
Benefit to risk ratio
Money incentive
Holmesburg prison experiments
Philadelphia prisoners used as human guinea p
TRIBUNE SPECIAL REPORT
Experiments scar former inmates
Dollars lured former i

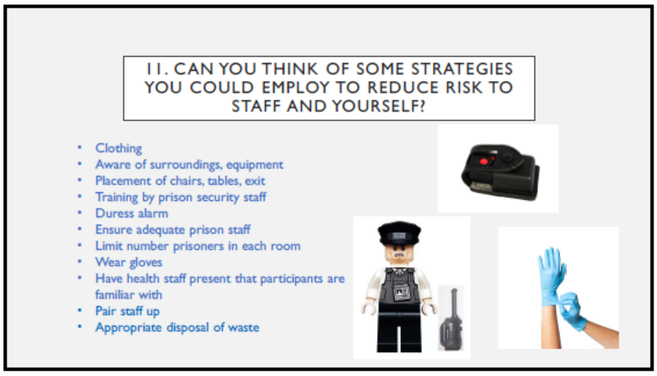

8. WHAT TOPICS WOULD YOU HAVE TO DISCUSS WITH PARTICIPANTS BEFORE THEY PROVIDE CONSENT?
Info about Hep C
What is involved in participation: blood test (venepuncture) and PoCT (fingerprick)
Risks e.g. pain, bruising, infection
Indications of positive test: how they will be informed, option for treatment
Management of data, potential publication, privacy concerns
Ensure they are aware participation is voluntary

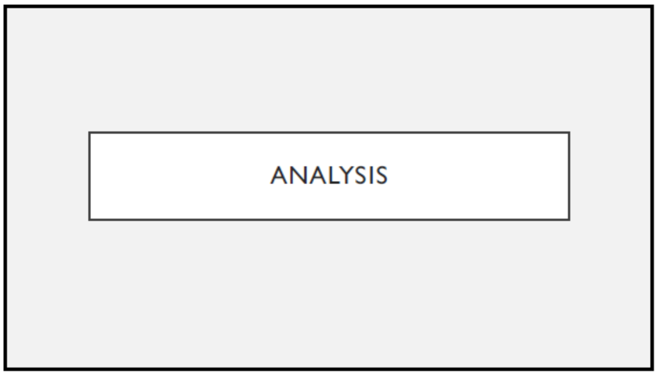

9. WHAT ARE SOME SCREENING QUESTIONS YOU MAY WANT TO ASK PARTICIPANTS THAT WILL BE USEFUL FOR THE ANALYSIS?
Age
Gender +/- sex
Indigenous status
History of IVDU – when was last use?
Country of birth
Hep C – previous diagnosis and treatment
Tattoos – when, where

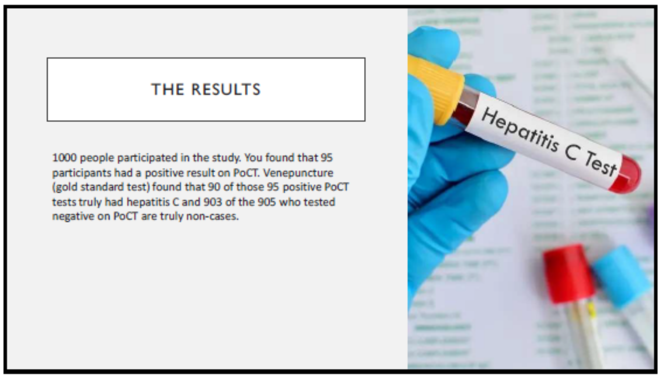

10. WHAT ARE SOME POSSIBLE RISKS TO CONSIDER DURING THE ACTIVATION?
Violence
Needle stick injury
Mental health and wellbeing of staff
Stolen equipment
Participants: injuries from needles, fainting etc.

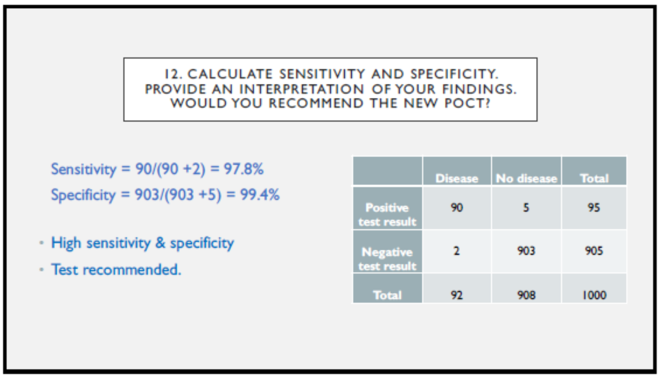

THINGS THAT COULD GO WRONG
1. Lockdown
2. Incident at activation
3. Run out of equipment
4. Staff wellbeing
5. Staff absenteeism
6. Lab issues
7. Poor participation rate
8. Issues collecting blood
9. Language barrier
Supersaturated
Quantity Insufficient for Testing
Specimen Not Dried Before Mailing
Scratched or Abraded
Serum Ring
Diluted, Discolored, or Contaminated
Clotted or Layered
No Blood


WHICH OF THESE ITEMS DO YOU NEED TO MONITOR CLOSELY FOR THEFT?

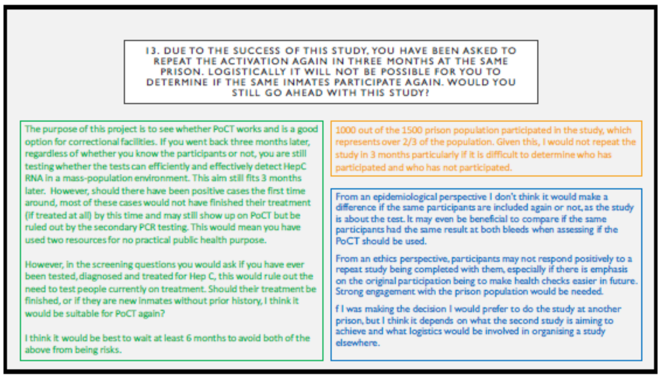

11. CAN YOU THINK OF SOME STRATEGIES YOU COULD EMPLOY TO REDUCE RISK TO STAFF AND YOURSELF?
Clothing
Aware of surroundings, equipment
Placement of chairs, tables, exit
Training by prison security staff
Duress alarm
Ensure adequate prison staff
Limit number prisoners in each room
Wear gloves
Have health staff present that participants are familiar with
Pair staff up
Appropriate disposal of waste

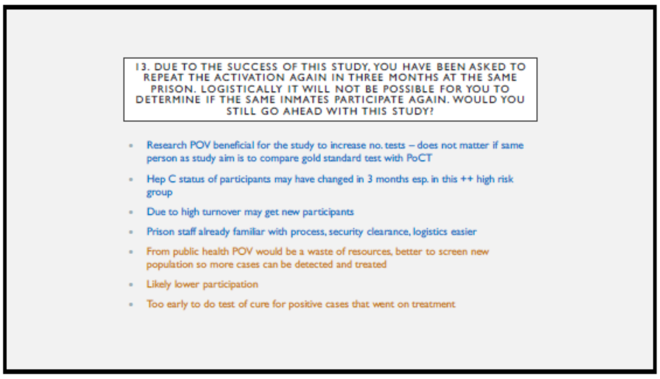

ANALYSIS

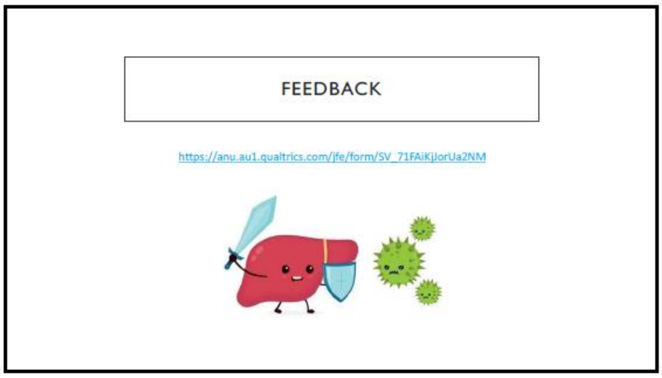

THE RESULTS
1000 people participated in the study. You found that 95 participants had a positive result on PoCT. Venepuncture (gold standard test) found that 90 of those 95 positive PoCT tests truly had hepatitis C and 903 of the 905 who tested negative on PoCT are truly non-cases.
Hepatitis C Test

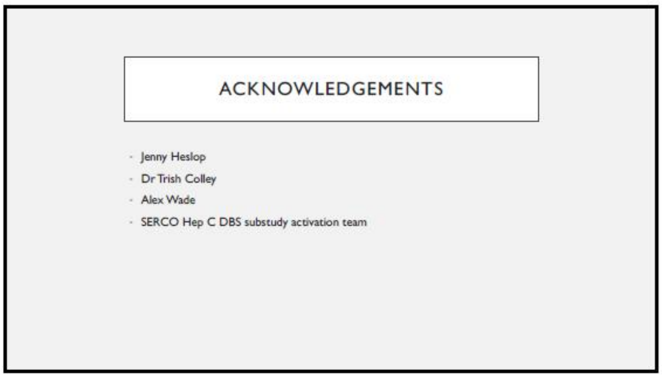

12. CALCULATE SENSITIVITY AND SPECIFICITY. PROVIDE AN INTERPRETATION OF YOUR FINDINGS. WOULD YOU RECOMMEND THE NEW POCT?
Sensitivity = 90/(90 +2) = 97.8%
Specificity = 903/(903 +5) = 99.4%
High sensitivity & specificity
Test recommended.

	Disease	No disease	Total
Positive test result	90	5	95
Negative test result	2	903	905
Total	92	908	1000


13. DUE TO THE SUCCESS OF THIS STUDY, YOU HAVE BEEN ASKED TO REPEAT THE ACTIVATION AGAIN IN THREE MONTHS AT THE SAME PRISON. LOGISTICALLY IT WILL NOT BE POSSIBLE FOR YOU TO DETERMINE IF THE SAME INMATES PARTICIPATE AGAIN. WOULD YOU STILL GO AHEAD WITH THIS STUDY?
The purpose of this project is to see whether PoCT works and is a good option for correctional facilities. If you went back three months later, regardless of whether you know the participants or not, you are still testing whether the tests can efficiently and effectively detect HepC RNA in a mass-population environment. This aim still fits 3 months later. However, should there have been positive cases the first time around, most of these cases would not have finished their treatment (if treated at all) by this time and may still show up on PoCT but be ruled out by the secondary PCR testing. This would mean you have used two resources for no practical public health purpose.
However, in the screening questions you would ask if you have ever been tested, diagnosed and treated for Hep C, this would rule out the need to test people currently on treatment. Should their treatment be finished, or if they are new inmates without prior history, I think it would be suitable for PoCT again?
I think it would be best to wait at least 6 months to avoid both of the above from being risks.
1000 out of the 1500 prison population participated in the study, which represents over 2/3 of the population. Given this, I would not repeat the study in 3 months particularly if it is difficult to determine who has participated and who has not participated.
From an epidemiological perspective I don't think it would make a difference if the same participants are included again or not, as the study is about the test. It may even be beneficial to compare if the same participants had the same result at both bleeds when assessing if the PoCT should be used.
From an ethics perspective, participants may not respond positively to a repeat study being completed with them, especially if there is emphasis on the original participation being to make health checks easier in future. Strong engagement with the prison population would be needed.
f I was making the decision I would prefer to do the study at another prison, but I think it depends on what the second study is aiming to achieve and what logistics would be involved in organising a study elsewhere.


13. DUE TO THE SUCCESS OF THIS STUDY, YOU HAVE BEEN ASKED TO REPEAT THE ACTIVATION AGAIN IN THREE MONTHS AT THE SAME PRISON. LOGISTICALLY IT WILL NOT BE POSSIBLE FOR YOU TO DETERMINE IF THE SAME INMATES PARTICIPATE AGAIN. WOULD YOU STILL GO AHEAD WITH THIS STUDY?
Research POV beneficial for the study to increase no. tests – does not matter if same person as study aim is to compare gold standard test with PoCT
Hep C status of participants may have changed in 3 months esp. in this ++ high risk group
Due to high turnover may get new participants
Prison staff already familiar with process, security clearance, logistics easier
From public health POV would be a waste of resources, better to screen new population so more cases can be detected and treated
Likely lower participation
Too early to do test of cure for positive cases that went on treatment


FEEDBACK
https://anu.au1.qualtrics.com/jfe/form/SV_71FAiKJlorUa2NM


ACKNOWLEDGEMENTS
Jenny Heslop
Dr Trish Colley
Alex Wade
SERCO Hep C DBS substudy activation team

[End of thesis]