Applied Epidemiology on the Gold Coast, Queensland Australia, 2023-2024

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

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Queensland Health

2023-2024

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Acknowledgement of Country

Jingeri jimbelung,

I would like to acknowledge and pay my respects to the Traditional Owners on whose lands I have been honoured to live, study, work, and connect with throughout my MAE journey; the Ngunnawal and Ngambri peoples, as well as the Kombumerri, Wangerriburra, Bullongin, Minjungbal and Birinburra peoples of the Yugambeh Language Region.

Originality Statement

I hereby declare that this submission is my own work and to the best of my knowledge it contains no materials previously published or written by another person, or substantial proportions of material which have been accepted for the award of any other degree or diploma at the Australian National University (ANU) or any other educational institution, except where due acknowledgement is made in the text. Any contribution made to this research by others, who I worked with at the Gold Coast Public Health Unit, Gold Coast Hospital and Health Service, Queensland Health, ANU or elsewhere, is explicitly acknowledged in the thesis. I also declare that the intellectual content of this thesis is the product of my own work, except to the extent that assistance from others in the project's design and conception or in style, presentation, or linguistic expression is acknowledged.

Victoria Marriott

25 October 2024

Acknowledgements

My Master of Philosophy, Applied Epidemiology (MAE) experience has truly been a team effort. I am thankful for the many people who have supported and inspired me over the past 22 months both professionally and personally.

I would firstly like to thank the Gold Coast Public Health Unit (GCPHU) and the National Centre for Epidemiology and Population Health (NCEPH) at the Australian National University (ANU) for facilitating my MAE program. To my field supervisors Dr Fiona May (Figure 1) and Ian Hunter, thank you for your guidance and for sharing your knowledge of both epidemiology and public health. Fiona, your confidence in my abilities has taught me independence and has prepared me for my career after the MAE, and for that, I will be forever grateful. I would also like to acknowledge the broader GCPHU for making me feel welcomed from the moment I started my placement, particularly Chrissy and Jacquie. Your unwavering positivity and support for my success has been incredibly uplifting. To my academic supervisor Dr Amalie Dyda, thank you for always reminding me that I was capable of succeeding, especially during moments of doubt. Your mentorship and encouragement have kept me on track and motivated.

My MAE experience would not have been the same without the lifelong friendships I made along the way. Thank you to the 2023-24 MAE cohort for the constant laughs, professional support, and social connection. I will always cherish our course blocks (Figure 2-4), especially the lunchtime sports and the infamous Carolina Reaper cohort study.

Thank you to my network of family and friends who have been a part of this journey. Thank you to Abby, Hollie, and Bella for cheering me on and keeping me accountable from afar. Thank you to Nanna Peg for being my biggest fan. Your genuine interest in my thesis and my work as an epidemiologist has been an incredible source of support, reinforcing my decision to pursue this path and reminding me of its importance to the community.

Finally, I would like to share my appreciation for my partner, Dan. Thank you for selflessly moving to Queensland with me to support my education and career without hesitation. Your eagerness to learn about my work means the world to me, and at this point, you probably know more about public health than any other electrician. Despite facing an incredibly challenging year, you never stopped supporting me. Thank you for always being by my side.

Figure 1. (Left to right) Dr Fiona May with Victoria, August 2024.

Figure 2. 2023-24 MAE cohort and MAE Director Dr Tony Stewart, Course Block 1, Canberra, March 2023.

Figure 3. 2023-24 MAE cohort and ANU staff in traditional Fijian attire gifted by scholar Dr Daniel Faktaufon, First SAFETYNET Scientific Conference, Canberra, September 2023.

Figure 4. 2023-24 MAE cohort 'Awards Night' celebrating our last course block together, Course Block 3, Canberra, February 2024

Acronyms

ABHS	Alcohol-based Hand Sanitiser
AIR	Australian Immunisation Register
ANU	Australian National University
CCC	Childcare Centre
CDC	Communicable Disease Control
CDB	Communicable Diseases Branch
CIT	Community Immunisation Team
CBS	Community-based Surveillance
ED	Emergency Department
EDIS	Emergency Department Information System
EH	Environmental Health
GSSS	Gastrointestinal Syndromic Surveillance System
GCHHS	Gold Coast Hospital and Health Service
GCPHU	Gold Coast Public Health Unit
GCSHS	Gold Coast Sexual Health Service
GCUH	Gold Coast University Hospital
HP	Health Promotion
HHS	Hospital and Health Service
HBCIS	Hospital Based Corporate Information System
ieMR	Integrated Electronic Medical Records
IARC	International Agency for Research on Cancer
ICD-10	International Classification of Diseases 10th Revision
ISP	Immunisation Service Provider
JEV	Japanese Encephalitis Virus
LFF	Lessons From the Field
MIS	Management Information Systems
MAE	Master of Philosophy (Applied Epidemiology)
NCEPH	National Centre for Epidemiology and Population Health
NIP	National Immunisation Program
NCD	Non-communicable Disease
NNSW	Northern New South Wales
NoCS	Notifiable Conditions System

OCT	Outbreak Control Team
PPE	Personal Protective Equipment
PCR	Polymerase Chain Reaction
PHREDSS	Public Health Rapid, Emergency, Disease and Syndromic Surveillance
PHU	Public Health Unit
RACH	Residential Aged Care Home
SEIFA IRSAD	Socio-Economic Index for Areas – Index of Relative Socio-economic Advantage and Disadvantage
SHRF	Sexual Health Research Fund
STI	Sexually Transmissible Infection
SOP	Standard Operating Procedure
SNOMED CT	Systematized Medical Nomenclature for Medicine–Clinical Terminology
URN	Unique Record Number
VPD	Vaccine Preventable Disease

Abstract

From February 2023 to December 2024, I completed my Master of Philosophy (Applied Epidemiology) (MAE) field placement with the Gold Coast Public Health Unit (GCPHU). In this thesis, I present the projects and additional experiences I completed during my placement.

My core projects are outlined in chapters two through four and include a combined data analysis and epidemiological study investigating the effect of a single SMS reminder on the timely uptake of childhood immunisations; an outbreak investigation of gastroenteritis after a local dance rehearsal; and an evaluation of the GCPHU Gastrointestinal Syndromic Surveillance System (GSSS). By completing these projects, the GCPHU has developed a greater understanding of local childhood immunisation coverage, identified gaps in community outbreak management, and provided recommendations to Queensland Health on the implementation of syndromic surveillance at the 2032 Brisbane Olympic and Paralympics Games.

Chapters five and six describe my teaching experiences and additional public health activities. These include introducing my MAE cohort to non-communicable disease clusters; teaching the 2024 first-year MAE cohort about One Health in Australia; instigating and delivering sexual health promotion at youth events on the Gold Coast; developing public health communication material for the community; improving the GSSS enhanced data collection; and establishing an enhanced surveillance system for triaging pertussis notifications.

My work in this thesis not only satisfies the competencies of the MAE program but also continues to inform routine public health activities undertaken by the GCPHU.

Contents

Chapter I - Introduction

Master of Philosophy (Applied Epidemiology) experience

Field placement overview

I completed my field placement with the Epidemiology and Data team at the Gold Coast Public Health Unit (GCPHU)(Figure 1.1). The GCPHU operates within the broader Gold Coast Hospital and Health Service (GCHHS). The GCHHS is one of 16 hospital and health services (HHS) across Queensland, all statutory bodies funded by the Queensland Government to provide public health services to our communities. The GCHHS is the southern-most HHS in Queensland, servicing a population of over 640,000 people.

Figure 1.1. Gold Coast Public Health Unit staff, 2024

The GCPHU is comprised of five core functions which work collaboratively to promote health, prevent disease, and manage risk:

- Communicable Disease Control (CDC) – to investigate, manage and prevent the spread of communicable diseases across the Gold Coast community.
- Community Immunisation (CIT) – to improve immunisation rates and minimise the spread of vaccine-preventable diseases by delivering free community immunisation clinics and the school immunisation program.
- Environmental Health (EH) – to minimise the risk to human health from environmental hazards such as air, soil, water, lead, mosquitoes, and poisons through community investigations, risk assessments and audits.
- Epidemiology and Data (Epi and Data) – to collect, analyse and interpret public health data to understand the cause of disease and inform public health action.
- Health Promotion (HP) – to improve individual and community health agency and outcomes by co-creating initiatives to promote health and prevent disease.

During my placement I had two field supervisors, Dr Fiona May (2014-15 MAE alumni) as my primary supervisor, and Ian Hunter as my secondary field supervisor until his retirement in early November 2023. As part of the Epi and Data team, I contributed to routine epidemiological activities including cleaning, analysing, and reporting surveillance, operational and vaccine coverage data on a weekly, monthly, or ad hoc basis. I also evaluated the GCPHU's childhood immunisation SMS reminder program (Chapter II), and provided epidemiological support to outbreak control teams, such as descriptive and analytical insights during a large gastroenteritis outbreak on the Gold Coast (Chapter III). Throughout my placement I supported the execution of the Gold Coast's Gastrointestinal Syndromic Surveillance System (GSSS) and evaluated its case-identification process to improve local gastroenteritis surveillance and inform planning for the 2032 Brisbane Olympic and Paralympic Games (Chapter IV). In addition to supporting routine epidemiological tasks, I coordinated and chaired the GCPHU research forum, initiated a partnership with the Gold Coast Sexual Health Service (GCSHS) to promote positive sexual health behaviours among the Gold Coast youth community, developed a letter notifying residential aged care homes about the risk of listeriosis (Chapter VI), developed an enhanced surveillance system for pertussis using REDCap (Chapter VI), and redeveloped the GCPHU website content to be more accessible (Chapter VI).

Throughout my placement, Fiona and Ian also encouraged me to collaborate with all GCPHU teams to gain a comprehensive understanding of public health and the operations of a public health unit. This involved attending regular CDC and EH team meetings to observe discussions and learn about their daily responsibilities including responding to vaccine cold chain breaches or enforcing the *Tobacco and Other Smoking Products Act 1998,* respectively. I also used these meetings to actively seek practical public health experience, such as when an EH officer took me into the field to conduct mosquito surveillance by setting and collecting traps. Overall, my field placement with the GCPHU was a well-rounded, practical experience that allowed me to learn and develop key public health skills.

Summary of degree requirements

All major and minor MAE competencies have been addressed throughout the projects and activities documented in this thesis (Table 1.1).

Table 1.1. Master of Philosophy (Applied Epidemiology) competencies and their corresponding thesis chapter.

Competency	Chapter 2	Chapter 3	Chapter 4	Chapter 5	Chapter 6
Investigation of an acute public health problem or threat		✓			
Design and conduct an epidemiological study	✓				
Analysis of a public health dataset	✓				
Evaluation of a surveillance system			✓		
Literature review	✓				
Lay summary					✓
Conference presentation	✓		✓		
Peer-reviewed publication	✓				
Teaching field epidemiology				✓	

Combined data analysis and epidemiological study – Chapter II

Design and conduct an epidemiological study

The Australian Government has a national immunisation target of 95% for children aged five years or younger. This target aims to achieve herd immunity and mitigate the effects of vaccine preventable diseases (VPD). The Gold Coast consistently falls short of this target at all age milestones (one, two and five years of age) often ranking among Australia’s poorest regions for childhood immunisation coverage.

To improve childhood immunisation coverage and timeliness the GCPHU initiated an SMS reminder program in mid-January 2023 targeting new parents at four weeks post-birth to encourage timely immunisations from six weeks of age. In collaboration with my supervisors, I designed a before-and-after quality improvement study to investigate the effect of the SMS program and identify whether the program should continue.

Analysis of a public health data set

In completing the before-and-after study, I linked and analysed three public health datasets to investigate the effect of a single SMS reminder on childhood immunisation uptake and timeliness on the Gold Coast. These included the birth records from the Gold Coast University Hospital (GCUH) to identify study participants, Queensland immunisation records captured in the Australian Immunisation Register (AIR) to determine participant immunisation status, and GCUH SMS delivery receipts to separate participants into relevant study groups e.g., before or after the SMS was introduced. Descriptive and analytical findings identified that the SMS did not significantly improve the overall uptake or timeliness of the two-month immunisations on the Gold Coast as both outcomes were already high. Disparities in immunisation uptake were identified across demographic groups with mothers aged less than 20-years, First Nations children, and children living in both low and high socio-economic areas significantly less likely to complete the two-month schedule. While First Nations children were more than twice as likely to receive additional National Immunisation Program (NIP) immunisations (meningococcal B vaccine) after the introduction of the SMS, an interrupted time series analysis identified this was due to a policy change which increased immunisation access. These results led the GCPHU to investigate at what point coverage rates drop between two and 12 months, and to explore how the SMS could be modified to enhance immunisation uptake among different sociocultural groups.

Investigation of an acute public health problem or threat – Chapter III

In late 2023, I investigated an outbreak of gastroenteritis at a local Gold Coast dance studio. During a rehearsal, two dance students vomited on a shared dance floor. Within 48 hours over 100 rehearsal attendees reported gastrointestinal illness, one of which tested positive for norovirus genotype II. This event resulted in one of the largest ever reported point-source outbreaks of viral gastroenteritis on the Gold Coast.

During this outbreak, my role was to coordinate the epidemiological response. I developed a case definition, conducted case interviews, collated and analysed survey responses, and presented my findings to the GCPHU Outbreak Control Team to guide any public health action. My findings indicated that being in the room when the vomiting occurred did not significantly increase the risk of illness, but rather improper cleaning practices and the continued use of the shared space likely contributed to the spread of disease. These results supported providing educational resources to the dance school on how to effectively clean up vomit to prevent transmission, especially when viral gastroenteritis is suspected.

Evaluation of a surveillance system – Chapter IV

In the lead up to the 2018 Gold Coast Commonwealth Games, the GCPHU developed the Gastrointestinal Syndromic Surveillance System (GSSS). The aim of the system was to identify and interrupt the spread of gastrointestinal illness using early signal detection and enhanced follow up. As part of the *Queensland Health 2023-2032 Public Health Roadmap,* it was recommended that Queensland Health Communicable Disease Branch (CDB) consult with GCPHU on the evaluation and possible statewide extension of the GSSS in preparation for the 2032 Brisbane Olympic and Paralympic Games (2032 Games).

In 2023, MAE scholar Kirsty Nichols evaluated the enhanced surveillance component of the GSSS. This is where SMS surveys are sent to individuals who present to the emergency department with gastrointestinal illness with the aim of identifying any common exposures for public health follow up. To complete the GSSS evaluation, I was responsible for assessing the initial signal detection component of the system which informs the enhanced follow up. The evaluation found that the patient identification component of the GSSS is not representative enough to provide insightful data on gastrointestinal disease in the community, nor is it specific enough to identify instances of disease consistently and accurately. Additionally, the visualisation platform that hosts the GSSS data is outdated and at risk of being decommissioned by the GCHHS. Upon completion, all aspects of the evaluation including any recommendations were combined in an internal report for the GCPHU to action, and for the CDB to consider for their 2032 Games planning.

Literature review – Chapter II

I completed a comprehensive literature review investigating the use and impact of SMS reminders on childhood immunisation uptake and timeliness as part of my combined data analysis and epidemiological study.

Lay summary – Chapter VI

I prepared the following communication materials for non-scientific audiences:

- A one-page letter to advise affected Gold Coast Residential Aged Care Homes about a recent food recall linked to listeriosis infection, and how to keep their residents safe.
- Updated and accessible GCPHU website content for the public health research and training, and epidemiology and data subpages.

Conference presentation – Chapters II and IV

I prepared and delivered the following conference presentations relating to my MAE projects:

Short Oral (six minutes):

- A single SMS to improve childhood immunisation: A before-and-after quality improvement study, Communicable Diseases and Immunisation Conference, 11-13 June 2024, Brisbane Australia.
- *Implementation of enhanced surveillance at mass gathering events*, Communicable Diseases and Immunisation Conference, 11-13 June 2024, Brisbane Australia.

Long Oral (15 minutes):

- Syndromic surveillance: Identifying and interrupting the spread of infectious diseases at mass gathering events, 2nd Western Pacific Mass Gathering Events and Health Symposium, 24-25 June, Gold Coast Australia.

Peer-reviewed publication – Chapter II

I prepared an advanced manuscript for my combined data analysis and epidemiological study - A single SMS to improve childhood immunisation: A before-and-after quality improvement study, Gold Coast, Australia. At the time this thesis was submitted, the manuscript had been prepared for submission to the *Australian and New Zealand Journal of Public Health* for peer review.

During my placement with the GCPHU, I also contributed to the following manuscripts and quality improvement reports as a co-author:

- Fillman G, Bladen T, Mak C, May F, Alexander K, Slinko V, et al. Enhancing childhood immunisation coverage rates in Gold Coast SA3s Broadbeach-Burleigh and Coolangatta. Gold Coast Public Health Unit, Gold Coast Hospital and Health Service, Queensland Health. 2024 (Internal report).
- Ona A, Colbran C, Slinko V, Jurd S, Hunter I, May F, et al. Tailored Immunisation Program (TIP) in Northern Gold Coast Region. Gold Coast Public Health Unit, Gold Coast Hospital and Health Service, Queensland Health. 2024. (Draft manuscript).

Teaching field epidemiology – Chapter V

As part of the MAE *Lessons from the Field* competency, I introduced my allocated peer group to the concept of non-communicable disease clusters, specifically cancer clusters, and how to approach them as a public health unit epidemiologist. I also participated in the following peer-review sessions:

- Geographic mapping in R, by Dr Bhavi Ravindran
- Animal disease investigations in low resource settings, by Michaela Gilbert
- Point of care test validation in a prison setting, by Dr Megan Ellis
- Generating case timeline visuals in R, by Aaron Osborne

Additionally, during my final MAE course block, I prepared, delivered, and evaluated a field epidemiology teaching module alongside four of my peers, Michaela Gilbert, Elaine Ung, Marie Heloury, and Tiana Mahncke. We introduced the 2024 MAE cohort to the concept of a One Health response, using the 2022 incursion of Japanese Encephalitis in Australia as a case study.

Coursework

I completed all course requirements for the MAE program:

- Outbreak Investigation (Summer Session, 2023)
- Public Health Surveillance (Summer Session, 2023)
- Research Design and Methods (Winter Session, 2023)
- Analysis of Public Health Data (Winter Session, 2023)
- Issues in Applied Epidemiology (Summer Session, 2024)

Chapter II – Data analysis & epidemiological study

A single SMS to improve childhood immunisation: A before-and-after quality improvement study, Gold Coast Australia, 1 January 2018 to 31 December 2023

Contents

Prologue

This chapter details my combined epidemiological study and data analysis project, a before-and-after quality improvement study looking at whether a single SMS can improve timely immunisation uptake for children born on the Gold Coast. This chapter addresses the following competencies:

- Literature review,
- design and conduct an epidemiological study,
- analysis of a public health dataset,
- conference presentation, and
- peer-reviewed publication.

My role

In 2023, the Gold Coast Public Health Unit (GCPHU) implemented a quality improvement project that aimed to improve childhood immunisation rates on the Gold Coast. This involved sending a single SMS reminder to new parents, four weeks after birth, to remind them that their child was eligible for vaccination from six weeks of age (the SMS project). My role was to develop and lead a research study to assess the impact of the SMS project on the uptake and timeliness of childhood immunisations on the Gold Coast, ultimately influencing whether the SMS should continue.

To prepare for this research project, I performed a literature review (Appendix A), and developed a project concept note and accompanying data analysis plan. These documents outlined the background, aim, statistical methods and expected outputs of the project and helped to plan how, when, and why this project would be executed. As part of my concept note, I included a comprehensive literature review exploring how SMS reminders have been utilised around the world to support increased childhood immunisation uptake. This allowed me to understand the current landscape and identify any literature gaps which would be addressed by my research. Once my supervisors approved this suite of documents, I used them to support my ethics application with the Gold Coast Hospital and Health Service Human Research Ethics Committee (GCHHS HREC). This application involved seeking a waiver of consent, as this project required linking secondary data sets and it would not be feasible to retrospectively contact all participants to seek their consent.

Once I had received ethical approval and a waiver of consent, I obtained three datasets for linkage and analysis. The Gold Coast University Hospital (GCUH) provided two datasets; a complete record of all babies born at GCUH between 1 January 2018 and 31 December 2023, and the delivery receipts for all SMSs sent as part of the SMS project after implementation on 27 January 2023 until 31 December 2023. I extracted the final dataset from the Australian Immunisation Record (AIR), a complete immunisation history for all children with a Medicare address located in Queensland. Under guidance from my supervisors and the Gold Coast Hospital and Health Service (GCHHS) biostatistician Dr Ian Hughes, I successfully linked and deidentified all three datasets using Stata18 before performing both descriptive and analytical analyses.

To ensure any updates or outcomes from this study were widely disseminated throughout this project timeline, I presented the findings at; the Communicable Disease and Immunisation Conference, Brisbane July 2024 (Appendix B), the Queensland Health Statewide Public Health Unit Immunisation Forum, July 2024, and the Gold Coast Hospital and Health Service Research Grand Rounds, August 2024. In addition, I have prepared this chapter in the format of an advanced manuscript for publication, with the intended journal being the Australian Journal of Public Health Australia and New Zealand.

Key reflections

This was the most challenging yet rewarding project I completed during my MAE experience. There are three key elements of this project which I would like to reflect upon; navigating the ethics pathway, performing data linkage, and the importance of biostatistics support.

Course block taught me that the ethics approval process can be long and complicated, however this can be improved if you complete your application thoroughly the first time. This was the case for my ethics experience. Because I had already completed a data analysis plan and research concept note, I was able to reuse most of the content to complete the ethics application and submit it in a timely manner. However, I underestimated the time needed for data custodian approval and a consent waiver, which delayed the start of the project. Fortunately, starting this project early in my MAE program meant these delays were not detrimental. From this experience, I've learned the importance of initiating the ethics process as early as possible.

As this project utilised First Nations data to identify local strengths and gaps in immunisation, I worked with the GCHHS First Nations Equity Team to ensure the results were presented in a culturally appropriate way, and that they would be shared with the local community to support public health action and education. GCHHS First Nations Equity Program Manager, Paula Rankmore, who was involved in the development of the SMS, provided key guidance around including meningococcal B data in the overall First Nations coverage rates. Although this inclusion led to a decrease in total coverage rates, it supported the transparent dissemination of data. Data transparency is an essential requirement under the Gold Coast Health Equity legislation to ensure accountability and action to promote healthier futures for the First Nations community of the Gold Coast. Throughout the project, I provided regular updates to the Gold Coast Immunisation Collaborative Group. This group is made up of both internal and external stakeholders and includes membership from the GCHHS First Nations Health Equity Team, Kalwun, a local Aboriginal and Torres Strait Islander Community Controlled Health Organisation, and Waijungbah Jarjums, a local health service supporting First Nations families through pregnancy, birth and childhood. By providing regular updates, this group were able to use the findings to inform their routine immunisation activities. After the MAE, I will continue to disseminate and explore the meaning of the results in collaboration with Paula and the Gold Coast Immunisation Collaborative Group.

For this project I had to link three datasets, two from the GCHHS and the other from the AIR. A significant challenge for me was determining how to ethically link the First Nations status of each child between the GCHHS and AIR datasets. I was concerned that if I were to use an algorithm to derive First Nations status, I would be removing the individual's right to self-identify. The *National best practice guidelines for data linkage activities relating to Aboriginal and Torres Strait Islander people: 2012* (1) recognise that there is no one-size-fits-all approach, but rather the researcher should investigate what data linkage method is best for their dataset/s. After consulting the guidelines, the GCHHS First Nations Equity Program Manager Paula Rankmore, and my MAE colleague Toni White at the Institute for Urban Indigenous Health who was working on a similar data linkage project, I used what was determined to be the most trusted data set as a single source of truth, the GCHHS birth dataset. This dataset was more complete than the AIR dataset and it had very few blank or 'Unknown/Unstated' variables. Additionally, each time a person presents to the hospital they have the opportunity to update how they choose to identify, compared to Medicare which has recognised the under-identification for First Nations status in their database.(2) This experience underscored the need to carefully consider not only technical aspects of data linkage but also the broader ethical implications, ensuring that the methods used align with best practices and respect the rights of the individuals represented in the data.

Throughout this project I was supported by epidemiologists and biostatisticians who guided me through the data analysis component. After linking the three datasets in Stata18, I conducted various statistical tests to assess the impact of the SMS reminder on childhood immunisation uptake. Preliminary findings suggested that First Nations children were more than twice as likely to receive the meningococcal B vaccine after receiving the SMS. However, Dr. Ian Hughes and his biostatistics student Boni recommended we perform an interrupted time series analysis, which later revealed that the statewide policy change to include the meningococcal B vaccine on the NIP in July 2020, not the SMS, was the primary driver of the increased uptake. Ian and Boni's oversight prevented me from misinterpreting the results.

Public health impact

The SMS did not have a significant impact on the uptake or timeliness of two-month childhood immunisations. This project highlighted the need for further research on the behaviours and attitudes towards both SMS reminders in a local context. Additionally, this project identified that overall, Gold Coast childhood two-month immunisation coverage rates are far higher than previously considered, prompting the need for further qualitative research on immunisation attitudes and behaviours between two months and one year, when immunisation coverage is assessed, and rates are known to decline.

Acknowledgements

I would like to thank my supervisors Dr Fiona May, Ian Hunter, Dr Amalie Dyda and associate supervisor Dr Emma Field for their insight, guidance, and most of all patience throughout this combined epidemiological study and data analysis project. Thank you to Christobel Mak and Jacqueline Pittaway for transferring your knowledge on navigating the AIR and interpreting the National Immunisation Schedule. Thank you to Dr Ian Hughes and Boni Hsu for providing ongoing biostatistical advice and support. Thank you to Paula Rankmore for your guidance and support in the development of this project as well as the dissemination of results to First Nations people across the Gold Coast.

Finally, this SMS project is only but a small part in the GCPHU's efforts to improve immunisation rates on the Gold Coast. I would like to thank Annie Hackett, Linda Menton and the whole GCPHU Community Immunisation Team for not only conceptualising the SMS initiative, but all your consistent hard work in promoting and delivering immunisations across the Gold Coast community.

Draft manuscript

A single SMS to improve childhood immunisation: A before-and-after quality improvement study, Gold Coast Australia, 1 January 2018 to 31 December 2023

Authors

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Abstract

Objective

To investigate the effect of a single SMS reminder on the timeliness and uptake of National Immunisation Program (NIP) two-month immunisations for live children born at the Gold Coast University Hospital (GCUH) between 1 January 2018 and 31 December 2023.

Methods

A before-and-after investigation using linked datasets: GCUH birth records from the Queensland integrated electronic Medical Record (ieMR); SMS delivery receipts from the GCUH Hospital Based Corporate Information System (HBCIS); and immunisation records reported to the Australian Immunisation Register (AIR). Chi-squared tests and multivariable logistic regression analyses were used to explore immunisation timeliness and uptake across time periods as well as to identify any demographic associations or potential interactions. A Poisson regression interrupted time series analysis evaluated the longitudinal effect of the SMS on immunisation uptake.

Results

A total of 26,408 participants were included: 22,364 in the pre-SMS cohort, and 4,044 in the SMS cohort. The SMS did not significantly increase the uptake (92.6% pre-SMS, 92.4% post-SMS, p=0.703) or timeliness (96.4% pre-SMS, 96.0% post-SMS, p=0.944) of two-month immunisations in the overall birth cohort. The significant increase in First Nations children receiving the meningococcal B vaccine (p<0.000, OR 2.76, 95%CI 1.99-3.80) following the

introduction of the SMS reminder is more likely attributable to the policy change that added the vaccine to the NIP, rather than the SMS intervention itself.

Conclusions

The overall uptake and timeliness of two-month immunisations for children born on the Gold Coast remain high. Our findings reinforce the mixed impact of SMS reminders on childhood immunisation rates. Developing a best-practice approach for SMS reminders is needed to ensure more consistent results across contexts.

Implications for public health

Despite strong uptake at two months of age, community immunisation rates on the Gold Coast continue to be lower than the rest of the state when assessed at one, two, and five-years of age. Further consumer research is needed to understand this decline and its causes.

Introduction

The Australian National Immunisation Program (NIP) is a national initiative that provides free immunisations to eligible individuals from birth through to adulthood. To achieve herd immunity and reduce the impact of vaccine preventable diseases (VPD), Australia has a NIP coverage target of 95% for children aged five years or younger.(1) This target is monitored by assessing NIP coverage rates for children at one, two, and five years of age.(1) The Gold Coast region in the state of Queensland consistently fails to meet this target and remains one of Australia's poorest performing regions for childhood immunisation coverage.(2)

In 2019, prior to the SARS-CoV-2 pandemic (the pandemic) the Gold Coast reported 92.4% of 1-year olds, 89.1% of 2-year olds, and 91.7% of 5-year olds were fully immunised.(3) These rates were well below the national (94.3%, 90.2%, and 94.3%),(3) and Queensland coverage rates (94.2%, 91.9%, and 94.4%).(4) The same year, the Gold Coast region had the lowest coverage of two doses of measles-mumps-rubella vaccine (78.2%) and the second lowest coverage four doses of diptheria-tetanus-acellular pertussis containing vaccine (78.8%) in Australia, leaving the Gold Coast population particularly vulnerable to preventable diseases.(3) After the pandemic, Gold Coast immunisation rates for NIP vaccines have decreased further, a phenomenon witnessed across Australia and the globe.(2, 5-7) In 2023, only 88.5% of 1-year olds (-3.9%), 87.6% of 2-year olds (-1.5%), and 89.6% (-2.1%) of 5-year olds on the Gold Coast were fully immunised.(2) While both national (92.8% (-1.5%), 90.8% (+0.6%), and 93.3% (-1.0%)),(2) and Queensland coverage rates (92.5% (-1.7%), 90.8% (-1.1%), and 92.9% (-1.5%))(4) also faced a decline after the pandemic, the gap between Gold Coast coverage rates and the rest of the country continued to widen. As our local childhood immunisation rates continue to decline, it is imperative to explore contemporary solutions that aim to protect our community against VPDs.

If a child misses, or is late to receive their first immunisations, it is a strong predictor that they will not complete their full immunisation schedule (8-10). A northern Queensland study by Hanna et al. (8) investigated immunisation uptake in local pre-school-aged children to identify any factors associated with failure to immunise by the two-year milestone. After reviewing over 600 immunisation records, they established that if a child receives their first immunisations on-time, the child would be more likely to be fully immunised by two years of age compared to the children who were late, or missed their first immunisations (OR 10.3, 95%CI 5.2-20.9). These findings were reinforced in the national ecological study by Hull et al. (9) who when reviewing retrospective data from the Australian Childhood Immunisation Register (ACIR), found that the strongest predictor of low or no uptake of measles and pertussis immunisations across Australia between 1996 and 1998 was the failure to receive any immunisations on time, by three months of age. A follow up national observational study conducted in 2001 by Hull et al. (10) used ACIR data to look at the timeliness of all routine immunisations across all milestones in children born in Australia. This study found that immunisation delays become more frequent in later doses, reinforcing the need for interventions to improve timeliness and support full schedule completion.

International literature suggests that prospective SMS reminders are a cost-effective method to improve timely childhood immunisation uptake, particularly among hard-to-reach populations.(11-17) Two recent studies in Queensland showed a positive association between SMS reminders and immunisation timeliness and schedule completion in First Nations populations. Manderson et al. (18) studied the impact of new SMS reminders across five immunisation milestones in regional Queensland and witnessed an increase in the number of children immunised on time compared to the control group across all milestones except 12 months. Similarly, a randomised control trial (RCT) across two First Nations primary health centres in southern Queensland (19) found that an SMS reminder was effective in improving immunisation timeliness in children at three and five months of age, but not beyond seven months, and that these results further improved when the SMS was paired with an educational intervention.

However, while some local research has shown positive outcomes, it is highly likely that the impact of an SMS is influenced by the specific context in which the intervention is delivered.(20, 21) A systematic review of 30 RCTs by Currie et al. (22) found that while SMS reminders were generally effective in improving uptake and/or timeliness in both low- and high-income countries, outcomes were greater when a financial incentive was included, when there was a specific educational message about the vaccine, or when the message was targeted at a population with already high social acceptability of immunisation. They also identified that without a way to confirm if recipients received the SMS or understood its contents, it is difficult to determine whether behaviour change can be attributed to the SMS alone. Furthermore, it remains unclear which components of the SMS initiatives, e.g., the financial incentive, educational message, or the timely reminder alone, is the primary driver of action as there is limited mixed-methods research in this field.

Overall, most SMS immunisation reminder studies have returned mixed results with no consistent indicators for when SMS reminders are most effective.(15, 19, 22, 23) To the best of our knowledge, this is the first immunisation SMS reminder study specific to the Gold Coast context.

SMS intervention

On 27 January 2023, the Gold Coast Public Health Unit (GCPHU) in partnership with the Gold Coast University Hospital (GCUH) under the banner of the Gold Coast Hospital and Health Service (GCHHS), implemented a quality improvement project that aimed to increase childhood immunisation rates on the Gold Coast. A single, opt-out SMS (Box 2.1) was sent to parents of live children four weeks after birth, reminding them of their child's NIP eligibility from six weeks of age. The SMS content was personalised, contained actionable health information, and was delivered using the official 'Gold Coast Health' Alpha-Tag to promote legitimacy. This study evaluates the effectiveness of the SMS reminder.

> *Hello JANE, your baby (DOB: 01-Jan-2023) will be eligible for free vaccinations under the National Immunisation Program from six weeks of age. On-time vaccination is the most effective way to protect your baby from serious diseases. No appointments are required; visit our website to find a community immunisation drop-in clinic near you www.health.qld.gov.au/immunisegc or contact your GP.*

Box 2.1. SMS childhood immunisation reminder – SMS content example

Methods

A before-and-after quality improvement study was undertaken to identify changes in the Gold Coast NIP two-month childhood immunisation coverage and timeliness after the SMS was implemented. All data was obtained from secondary sources.

Data sources and data linkage

The GCUH is the largest public hospital on the Gold Coast and captures over 70% of all local births annually.(24) Demographic details for all public, live births at GCUH from 1 January 2018 to 31 December 2023 were extracted from the Queensland integrated electronic Medical Record (ieMR). Data from private hospitals and home births were unavailable.

An SMS was sent to each parent who had consented to receive general hospital messaging at the time of their child's birth. SMS delivery records and parent demographic data from 27 January 2023 to 31 December 2023 were obtained from the GCUH Hospital Based Corporate Information System (HBCIS). The HBCIS database is integrated with ieMR and uses the same source data.

The cost of the SMS program was calculated by multiplying the number of SMSs delivered by the cost of a single message, $0.15. No additional funds were required to complete this project.

Immunisation records were acquired through the Australian Immunisation Register (AIR). The AIR is a national database that records immunisations in Australia. It holds information on which vaccines an individual has received, the date they received them, and who administered them. Vaccines given internationally, or any vaccine exemptions can also be recorded in the AIR by a recognised vaccination provider.(25) Demographic and immunisation history data for individuals born between 1 January 2018 and 31 December 2023 with a Medicare address in Queensland were accessed through an AIR-011A – Due/Overdue Report – by Locality.(26)

To investigate whether vaccine uptake or timeliness was affected by socioeconomic inequalities, a child's relative socio-economic advantage and disadvantage (IRSAD SEIFA quintile) was calculated based on their postcode reported at birth and assessed against the Australian Bureau of Statistics Socio-Economic Index of Relative Socio-economic Advantage and Disadvantage 2021 Postal Area datacube.(27) This measure uses a variety of data on economic and social factors within a geographical region to calculate a broad measure of advantage and disadvantage.

Data linkage was performed by GCPHU Epidemiologists using Stata18 (StataCorp, LP, College Station, Texas).(28) All records in the birth dataset were given a project-specific identifier, before being matched with the SMS records. As newborns may not have a registered name after birth, the birth dataset was matched to the SMS records primarily using birth parent first name, last name, and date of birth, followed by child date of birth, and first name and last name if available. This combined dataset was then linked to the AIR data using child first name, last name, date of birth and sex. Several thousand records were unable to be matched with the AIR data due to missing data, specifically children registered in AIR as 'Baby Of', or children who had since moved interstate and were no longer in the Queensland AIR-011A dataset. After the linkage was performed, all records were deidentified before analyses. The demographic variables, including First Nations status of the child, were obtained from the original birth dataset.(29)

Measures of coverage and timeliness

The NIP Schedule identifies at which age NIP vaccines are to be given to ensure safe delivery and optimal protection against select diseases.(30) This study focused on all of the diseases covered by the vaccines given from six weeks and due at two-months (diphtheria, tetanus, pertussis, hepatitis B, polio, Haemophilus influenzae type b, pneumococcal disease, rotavirus, and meningococcal B for First Nations children), not just those that are assessed at the one-year milestone (does not include rotavirus or meningococcal B). As the NIP Schedule is subject to change, each child was assessed against the Queensland two-month schedule applicable when they reached six weeks of age (Appendix A). For the descriptive analysis, if a child had received all recommended vaccines as per their NIP Schedule they were deemed 'fully immunised'. If they had received some, but not others, they were categorised as 'partially immunised', and if they had not received any NIP vaccines, they were 'never immunised'. For the analytical investigation, participants were classified as either 'complete', those who were deemed fully immunised, or 'incomplete' for those who were partially or never immunised.

From 1 July 2020, First Nations children in Queensland were eligible to receive a free meningococcal B vaccination from six weeks of age as part of their two-month schedule under the NIP.(31) In this program, children born prior to 1 July 2020 were eligible to receive a catch-up vaccine if they were still under two-years of age. For this study, First Nations children born on or after 1 August 2018 were considered 'fully immunised' if they received a meningococcal B vaccine as well as all other recommended NIP vaccines. If these children received all regular NIP vaccines except for meningococcal B, they were considered 'partially immunised'. If a First

Nations child was born before 1 August 2018, the meningococcal B vaccine was not included in their uptake assessment.

As per the *Australian Immunisation Register: National due and overdue rules for immunisation*, (32) an immunisation record was considered 'on-time' if the child had received the valid dose within 30 days of their due date, and 'delayed' if they received the valid course on, or after 30 days past their due date. To describe the dataset, a child was deemed 'all on-time' if they had received all recommended vaccines on-time. If they had received some vaccines on-time, but were late for others, they were considered 'partially on-time', and if they had not received any vaccines on-time, they were 'all delayed'. For the regression analyses, timeliness was only assessed if the child had received their full schedule and were considered either 'on time' or 'delayed'.

Because the meningococcal B rollout included a three-year catch-up period and did not follow the traditional rules for due and overdue, timeliness for meningococcal B uptake was not assessed in this study.

Statistical analyses

All analyses were performed using Stata18.(28) Descriptive statistics were used to summarise the study population and assess the frequency and distribution of key categorical variables including: immunisation status, timeliness of uptake, sex at birth, First Nations status, maternal age at delivery, and IRSAD SEIFA quintile.

Chi-squared tests were used to explore immunisation uptake and timeliness independently before and after the implementation of the SMS. Multivariable logistic regression analyses were performed to identify associations between immunisation uptake, timeliness, and demographic variables which returned a p value of ≤ 0.05. Interaction analyses were undertaken to see if two or more variables influenced immunisation uptake.

A Poisson regression interrupted time series analysis was conducted to evaluate the longitudinal effect of the SMS on the uptake of all two-month childhood immunisations and the meningococcal B uptake independently. Timeliness was not assessed in the time series analyses.

Results

Between 1 January 2018 and 31 December 2023, there were 31,250 live births at the GCUH. Of the births that occurred after the introduction of the SMS (n=4,726), 98% of parents (n=4,636) received the SMS immunisation reminder as part of their post-hospital care, costing the GCHHS a total of $695.40 in SMS fees.

A total of 26,529 births (85%) were able to be linked with the SMS and AIR datasets. The remaining 4,721 births (15%) were unable to be linked with AIR. Of those, 1,707 (36%) did not have a name recorded against the child at birth and were unable to be matched in the AIR, and the remaining 3,014 births (73%) were likely unmatched due to a Medicare address outside of Queensland, or a change in name between birth and time of first immunisation. There were 121 births that occurred after the introduction of the SMS that did not receive the reminder message due to opting out of hospital communication. These births were excluded from the analysis (Figure 2.1).

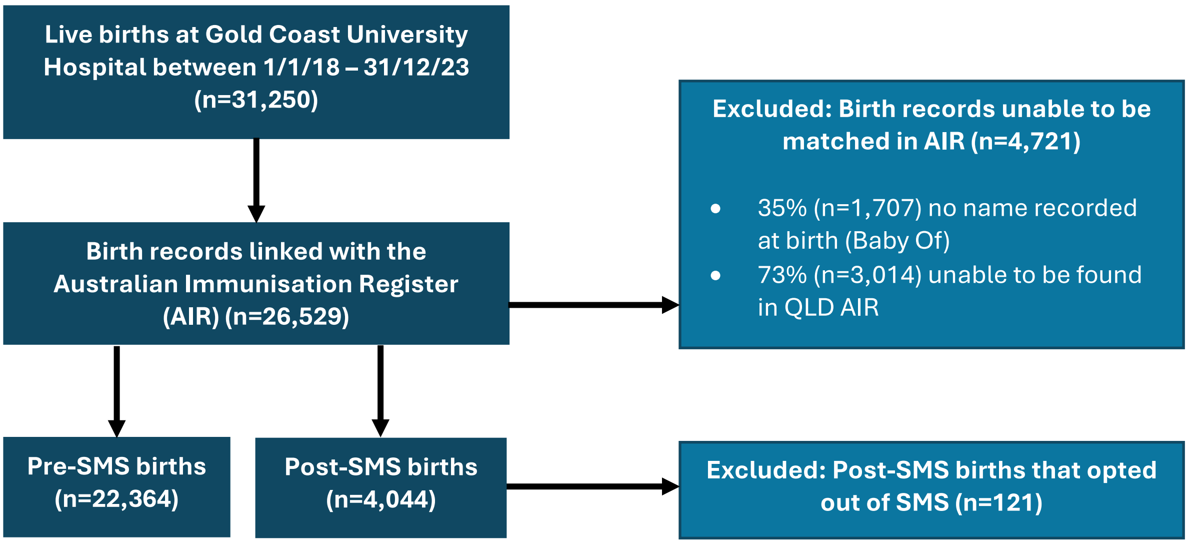

Figure 2.1. Inclusion and exclusion criteria

Characteristics of sample

A total of 26,408 linked records were included in this analysis (Table 2.1), 22,364 (84.7%) in the pre-SMS cohort, and 4,044 (15.3%) in the SMS cohort. Immunisation uptake was high for the pre-SMS (92.6%) and the SMS cohort (92.4%), both only slightly behind the national coverage target of 95%. Both groups were extremely timely in receiving their immunisations, with 96.4% of the pre-SMS group and 96.0% of the SMS group receiving their full schedule on time. Approximately half of each cohort were born male (51.6% pre-SMS, 49.8% SMS), the most reported maternal age group for both cohorts was 30-34-years, and the median IRSAD SEIFA quintile score for each cohort was 3. There was a higher proportion of First Nations children in the SMS cohort (6.0%) compared to the pre-SMS cohort (4.4%).

Table 2.1. Demographic characteristics and immunisation status of study participants by SMS intervention group.

Characteristics	Intervention Group				P value
	Pre-SMS		SMS		
	n	%	n	%	
Child immunisation status					
Fully immunised	20,710	92.6	3,738	92.4	0.042
Partially immunised	1,611	7.2	290	7.2	
Never immunised	43	0.2	16	0.4	
Timeliness of immunisation uptake					
All on time	21,559	96.4	3,881	96.0	0.071
All delayed	686	3.1	131	3.2	
Partially on time	92	0.4	16	0.4	
Unimmunised	43	0.2	16	0.4	
Sex at birth					
Male	11,537	51.6	2,014	49.8	0.002
Female	10,824	48.4	2,026	50.1	
First Nations status of child					
Aboriginal and/or Torres Strait Islander	994	4.4	242	6.0	0.000
Not Aboriginal or Torres Strait Islander	21,363	95.5	3,794	93.8	
Unknown	7	<0	8	0.2	
Maternal age					
<20 years	396	1.8	56	1.4	0.001
20-24 years	2,851	12.8	457	11.3	
25-29 years	6,674	29.8	1,163	28.8	
30-34 years	7,611	34.0	1,397	34.5	
35-39 years	3,977	17.8	787	19.5	
40+ years	855	3.8	184	4.6	
IRSAD SEIFA quintile of child postcode					
1 – most disadvantaged	212	0.9	34	0.8	0.097
2	2,134	9.5	373	9.2	
3	10,720	47.9	1,948	48.2	
4	9,083	40.6	1,668	41.2	
5 – most advantaged	151	0.7	17	0.4	
Unknown	64	0.3	4	0.1	
TOTAL	**22,364**	**84.7**	**4,044**	**15.3**	

Both before and after the SMS, children living in the most disadvantaged (SEIFA quintile 1 and 2) and most advantaged (SEIFA quintile 5) areas were statistically less likely to complete their two-month immunisation schedule than those living in areas corresponding to SEIFA quintile 3 or 4 (Table 2.2). SEIFA index had no significant impact on immunisation timeliness for those who completed their full schedule.

When analysing maternal age at delivery, mothers aged less than 20-years or between 20-24-years were statistically less likely to complete their child's immunisation schedule compared to those aged 40-years and over both before and after the SMS was introduced (Table 2.2). For First Nations children, maternal age did not significantly impact schedule completion. Maternal age was also associated with immunisation timeliness. Mothers aged 20-39-years were more likely to immunise their children on time compared to those aged over 40-years (Table 2.2). Maternal age did not significantly impact the timeliness of immunisation uptake for First Nations children.

Female births were less likely to complete their full schedule (OR 0.94) but more likely to be on time (OR 1.1) compared males, however these results were not statistically significant (p=0.225, 95% CI 0.86-1.04, p=0.514, 95% CI 0.86-1.36 respectively) (Table 2.2).

Table 2.2. Multivariable logistic regression analysis of factors associated with immunisation uptake and timeliness.

Characteristic		Uptake			Timeliness[1]		
		Adjusted odds ratio (OR)	95% confidence interval (CI)	P value	Adjusted odds ratio (OR)	95% confidence interval (CI)	P value
Sex[2]	Male	REF	-	-	REF	-	-
	Female	0.94	0.86-1.04	0.225	1.08	0.86-1.36	0.514
First Nations Status of child[2]	Not Aboriginal or Torres Strait Islander	REF	-	-	REF	-	-
	Aboriginal and/or Torres Strait Islander	0.03	0.27-0.35	<0.000	0.63	0.32-1.24	0.182
Maternal age (years)[2]	40+	REF	-	-	REF	-	-
	35-39	1.13	0.87-1.46	0.368	2.20	1.33-3.63	0.002
	30-34	1.20	0.93-1.53	0.154	1.82	1.16-2.87	0.010
	25-29	1.00	0.79-1.29	0.939	2.38	1.48-3.82	0.000
	20-24	0.66	0.51-0.86	0.002	2.31	1.34-3.98	0.003
	<20	0.41	0.29-0.58	<0.000	1.01	0.46-2.20	0.987
SEIFA quintile[2,3]	5	0.49	0.32-0.77	0.002	0.45	0.16-1.23	0.120
	4	1.02	0.93-1.13	0.661	1.14	0.89-1.45	0.316
	3	REF	-	-	REF	-	-
	2	0.81	0.69-0.94	0.007	0.93	0.63-1.37	0.707
	1	0.61	0.41-0.91	0.015	0.91	0.29-2.89	0.878

[1]Timeliness was only assessed if the individual had completed their full two-month schedule.
[2] Children recorded at birth with 'other' or 'unknown' were excluded from this analysis due to small counts.
[3] Most socio-economic advantage (5) to most socio-economic disadvantage (1) according to Socio-Economic Indexes for Areas (SEIFA), Australia, 2021.

Timeliness and coverage

The SMS did not significantly increase the uptake (p=0.703) or the timeliness (p=0.944) of two-month immunisations in the overall birth cohort (Table 2.3). The uptake of NIP vaccines in First Nations children increased by four percentage points, however the increase was not statistically significant (p=0.205) and was unlikely to be because of the SMS. When looking at additional NIP vaccines, First Nations children were more than twice as likely (p=0.000, OR 2.76, 95% CI 1.99-3.80) to receive a meningococcal B immunisation if they received an SMS, increasing uptake from 16.9% pre-SMS to 35.9% (Table 2.3).

Table 2.3. Proportion of immunisation uptake and timeliness before and after the implementation of the SMS reminder.

Characteristic	Pre-SMS n	Pre-SMS %	SMS n	SMS %	Change in percentage points	P value	OR (95% CI)
Whole population							
2-month schedule complete[1]	20,710	92.60	3,738	92.43	-0.17	0.703	0.98 (0.86-1.11)
On time[2]	20,458	98.78	3,692	98.77	-0.01	0.944	0.99 (0.72-1.39)
Non-Indigenous children							
2-month schedule complete[3]	20,328	95.16	3,629	95.65	+0.49	0.187	1.12 (0.94-1.33)
On time[2]	20,083	98.79	3,585	98.79	0.00	0.971	0.99 (0.72-1.41)
First Nations children							
2-month schedule complete[3]	375	37.73	101	41.74	+4.01	0.205	1.18 (0.88-1.59)
On time[2]	368	98.13	99	98.02	-0.11	0.941	0.94 (0.18-9.43)
Meningococcal B uptake	168	16.90	87	35.95	+19.05	<0.000	2.76 (1.99-3.80)

[1]Complete schedule: diphtheria, tetanus, pertussis, hepatitis B, polio, *Haemophilus influenzae* type b, pneumococcal disease, rotavirus.
[2]Only children who had completed their two-month schedule were assessed for timeliness.
[3]Includes the additional meningococcal B NIP vaccine available to all First Nations children.

Non-Indigenous children were 32 times more likely to complete their two-month immunisation schedule (diphtheria, tetanus, pertussis, hepatitis B, polio, *Haemophilus influenzae* type b, pneumococcal disease, rotavirus) compared to First Nations children (p<0.000, OR 32.10, 95%CI 28.22-36.51) (diphtheria, tetanus, pertussis, hepatitis B, polio, *Haemophilus influenzae* type b, pneumococcal disease, rotavirus, and meningococcal B). While there was no significant association between SMS receipt and immunisation uptake for First Nations children, an interaction effect was observed that positively influenced immunisation rates when factoring in maternal age at delivery. Immunisation schedule completion in First Nations children with mothers aged 25-29-years increased from 36% (95%CI 0.30-0.41) to 55% (95%CI 0.43-0.66) after receiving the SMS. Immunisation uptake was timely for both First Nations and non-Indigenous children, with no significant difference between groups before or after the intervention.

When investigating the interaction between the SMS and immunisation uptake between subgroups, the probability for mothers under 20-years to complete their child's schedule dropped significantly from 86.1% (95%CI 0.83-0.90) to 67.9% (95%CI 0.56-0.80), indicating a negative association between the SMS and immunisation completion for this group. For older mothers, probabilities remained high and mostly unchanged. The SMS had very little effect on the uptake across socioeconomic groups, however there was a negative association between the SMS and uptake for children living in the areas of greater disadvantage with the probability of completion dropping from 89.2% (95%CI 0.85-0.93) to 85.2% (95%CI 0.73-0.97).

Interrupted time series analyses

The interrupted time series analysis did not reveal any evidence of seasonality in immunisation uptake based on the month of birth. Immunisation rates remained consistently high across all months, indicating that birth timing did not influence the likelihood of children receiving their full immunisation schedule.

The interrupted time series analysis for meningococcal B uptake revealed that while the there was a significant association (p<0.000, OR 2.76, 95%CI 1.99-3.80) between the SMS intervention and receiving the meningococcal B vaccine, the true increase occurred (p=0.002, incidence rate ratio [IRR] 17.90, 95% CI 2.81-113.89) in July 2020 when the vaccine became widely available through the NIP (Figure 2.2). This indicates that the policy change, rather than the SMS intervention alone, was the primary driver behind the observed rise in immunisation rates over the study period.

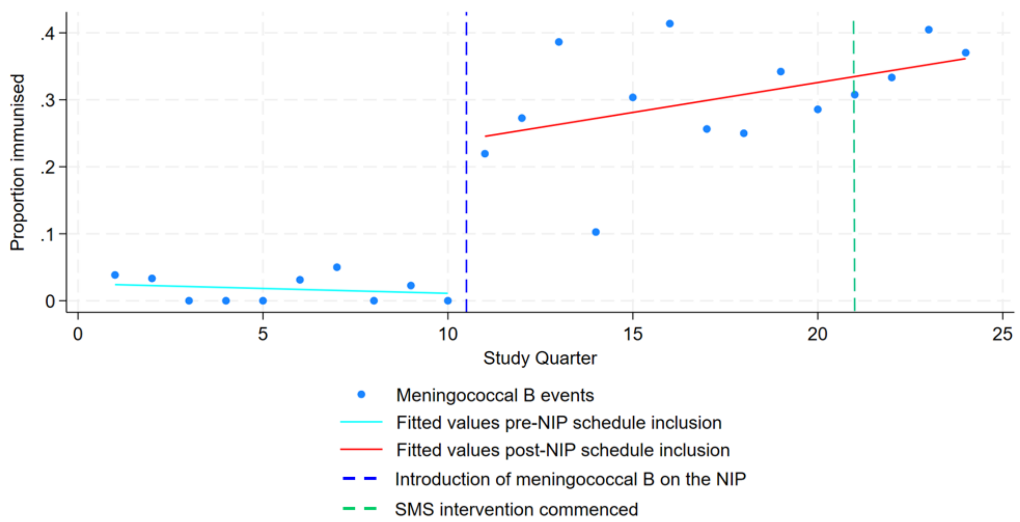

Figure 2.2. Interrupted time series of meningococcal B uptake in First Nations children by study quarter.

Discussion

Prior to this study, the GCPHU had only routinely assessed NIP coverage rates for Gold Coast children at one, two and five years of age as per the national immunisation coverage targets. These assessments consistently indicated that the Gold Coast had amongst the lowest childhood immunisation coverage in the country, (33) leading to the assumption that low coverage would be an issue from birth. However, consistent with the results from the recent central Queensland study by Manderson et al. (18) this study identified that childhood immunisation uptake at the two-month milestone for children born on the Gold Coast is high compared to what is reported at the one-year milestone. Additionally, this study found that childhood uptake was largely on time regardless of whether an individual received the SMS intervention. Our findings reinforce existing literature that SMS reminders have mixed results in improving the uptake and timeliness of early childhood immunisations, particularly in a context where immunisations are largely on time and baseline coverage is already high.(15, 34, 35) Additional insights could be gained by examining coverage data for all children with a Medicare address on the Gold Coast and conducting an interrupted time series analysis. This would allow us to identify when, between the ages of two and 12 months, and beyond, do children on the Gold Coast begin to miss timely immunisations. Furthermore, this analysis could reveal whether children who were not born locally are disproportionately contributing to the decline in coverage rates. Such findings would prompt qualitative research to explore barriers preventing timely immunisation in this group and could also indicate specific areas where SMS reminders might be more effective in improving coverage.

Despite Australia reporting relatively high overall childhood immunisation coverage rates, social inequities continue to drive disparities in uptake across the country. First Nations children, children born to mothers under 20-years of age, or children living in areas of lower relative socio-economic disadvantage are significantly less likely to complete their immunisation schedules.(36-38) Arat et al. (36) analysed the measles, mumps, rubella immunisation data for over 1.1 million children across Western Australia (WA) and New South Wales (NSW) between 2002 and 2011, and found that while the average immunisation coverage was high (92.5% in WA, 93.2% NSW), the coverage in First Nations children was between 8-10 percentage points lower, 3-5 percentage points lower for children born to mothers aged less than 20-years, and 1-4 percentage points lower in the most disadvantaged socioeconomic groups. Our study supports this evidence as we identified a 10-percentage point deficit in immunisation uptake between children with mothers under 20-years and older age groups, and a 54-percentage point deficit between schedule completion in First Nations children compared to non-First Nations children after the introduction of the SMS.

Several Australian qualitative studies analysing tailoring immunisation program (TIP) delivery have attempted to explain these disparities with common barriers to immunisation including accessing culturally safe services, financial or geographical access to services, or existing knowledge on immunisation.(36, 39-42) A qualitative research synthesis by Thomas et al. (40) reviewing five TIP papers in NSW between 2016-2020 found that children were likely to fall behind on their immunisations due to competing priorities at home such as food security, domestic violence issues, or mental health needs, or because accessing available services were costly or confined to restricted operating hours, resulting in families having to choose between loss of income or not immunising their children. These barriers disproportionately affect those in lower-socioeconomic areas. The study also reinforced the importance of cultural safety to support First Nations families with immunisation and that racism in healthcare is a major barrier to accessing immunisation services. While our study also identified that those living in the most advantaged socioeconomic areas are also less likely to complete their immunisation schedule, this is often due to the clustering of conscientious objectors, combined with the thinking, feeling, and social influence of others and their perceived education around disease, rather than access barriers.(36, 43, 44) This suggests parental choice plays a greater role in lower uptake rates in these communities.(45, 46) While our study has identified gaps in immunisation coverage, to effectively design public health interventions that address these gaps, we need to better understand the social, economic, cultural, and geographical barriers affecting children born on the Gold Coast.

The low uptake of the additional meningococcal B vaccine in First Nations children diluted the overall immunisation coverage results for this group, resulting in an unjust representation of First Nations immunisation uptake on the Gold Coast. Immunisation coverage reports in Australia do not routinely include all diseases covered at milestones such as rotavirus, nor do they include any of the additional vaccines available to First Nations children or children with specified medical risk conditions. Excluding this data can be seen as misleading and could potentially overinflate true population coverage as it is not representative of the NIP schedule. Prior to this study, the GCPHU did not know meningococcal B uptake was low for local First Nations children as it is not calculated in the first-year age milestone. This study has prompted local health services to investigate why meningococcal B uptake is notably lower than the other childhood immunisations. Impacting factors may include whether immunisation service providers (ISPs) and caregivers are aware of the additional NIP vaccines, what diseases they prevent and why they are important, as well as whether ISPs carry adequate stock of these vaccines to service their communities. Most importantly, ISPs must know how to ask patients if they identify as Aboriginal and/or Torres Strait Islander in a culturally appropriate way to ensure they are offering what is available to each child as per their NIP schedule. Understanding the reasons behind the low uptake will assist to develop educational strategies and information to ensure First Nations families are supported to complete the full NIP schedule.

Furthermore, First Nations children in Australia are disproportionately affected by invasive meningococcal disease serogroup B, with First Nations children four-times more likely to acquire the disease than non-First Nations children.(47, 48) While First Nations children who received the SMS were statistically more likely to receive the additional meningococcal B vaccine added to the NIP in 2020, the interrupted time series identified this coincided with the policy change that occurred on 1 July rather than the implementation of the SMS. After the vaccine became widely available for Queensland First Nations children in 2020, there has been an increase in government and non-government media to promote immunisation which may have caused the gradual increase in uptake over the study period. In 2024, the meningococcal B vaccine was added to the NIP for all infants aged six weeks to 12 months, for children aged 12 months to two years as a catch up, and for adolescents aged 15 to 19-years.(49) Further data will be needed to understand how this policy change has influenced the overall uptake and timeliness of the two-month schedule for both First Nations and non-First Nations children.

A key limitation of this study is that the SMS intervention had only been in effect for less than a year at the time of analysis. Although this cannot provide insight into long-term outcomes, the large sample size ensures sufficient statistical power to detect meaningful short-term effects. These early findings provide a foundation for evaluating the intervention's initial impact, allowing for future research to expand on longitudinal trends as the NIP and SMS continue to evolve. The exclusion of participants due to unmatched hospital and Queensland AIR records, as well as the inability to analyse private birth data may have led to an underrepresentation of certain groups in the sample population, affecting the external validity and generalisability of the results, but not the reliability of the results within the included study population.

Furthermore, reminders that provide additional educational information or tailored immunisation advice have shown to be more effective in improving immunisation uptake and timeliness than a simple SMS.(19, 22) In 2025, the first Australian National Vaccination Insights project (50) identified that parents and caregivers want more tailored, and easily accessible educational information and campaigns about immunisation and the diseases they defend against.(51) The SMS in this study contains a general statement on the benefit of immunisation as well as details on how to access services, but no additional educational information. While a positive interaction effect was observed for young First Nations mothers, the SMS did not significantly improve overall uptake or timeliness of childhood immunisations, consistent with existing domestic and international literature. This reinforces that generic messaging may be insufficient to drive behavioural change, especially in populations with diverse subgroups. Amending the SMS content to contain educational information may improve results, particularly if it was tailored to the needs and preferences of specific subgroups identified by this analysis. To determine what educational content parents would value, qualitative research is needed to explore recipient perspectives and inform culturally and contextually relevant, co-designed educational messaging, rather than relying on a generic, one-size-fits-all approach.

While the SMS intervention did not lead to significant improvements in overall immunisation uptake or timeliness in children born at Gold Coast public hospitals, community anecdotes indicate that many parents appreciate immunisation reminders.(52-54) This positive feedback, combined with the existing high immunisation coverage rates suggests that there may be underlying barriers to immunisation that the SMS alone cannot address. To identify these barriers, it is essential to understand the immunisation coverage landscape beyond children born at public hospitals locally. Analysing coverage data for all vaccines including rotavirus and meningococcal B, for all children living on the Gold Coast will help pinpoint gaps in coverage, identify opportunities for qualitative research on local barriers, and enhance public health efforts to improve immunisation overall.

Acknowledgements

The authors would like to thank the GCPHU Community Immunisation Team, particularly Annie Hackett and Linda Menton for their continual efforts to improve local immunisation coverage through the coordination of free community clinics and conceptualisation of the SMS intervention. Thank you to Dr Ian Hughes and Boni Hsu for supporting the biostatistical element of this project. Thank you to the Gold Coast Hospital and Health Service Health Equity Team for your guidance and support in the development of this project as well as the dissemination of results to First Nations people across the Gold Coast. We would also like to thank the GCHHS Data Operations Unit for the collation and provision of birth and SMS data for this study.

Ethics

This project was conducted as part of the first author's Master of Philosophy (Applied Epidemiology) through partnership between the National Centre for Epidemiology and Population Health, Australian National University and the Gold Coast Public Health Unit, Queensland Health.

Ethics approval was obtained from the Gold Coast Hospital and Health Service Human Research Ethics Committee (LNR HREC/2023/QGC/97907). This project also received mutual recognition from the Australian National University Human Research Ethics Committee (H/2024/1075).

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Manuscript appendix

Appendix A – Diseases covered in the Queensland National Immunisation Program 2018-2023

	Age	Disease	All children	First Nations children
Children born on or after 1 August 2018	**2 Months (from 6 weeks)**	Diphtheria, tetanus, pertussis, hepatitis B, polio, haemophilus influenzae type b	✓	
		Pneumococcal	✓	
		Rotavirus	✓	
		Meningococcal B		✓
Children born prior to 1 August 2018	**2 Months (from 6 weeks)**	Diphtheria, tetanus, pertussis, hepatitis B, polio, haemophilus influenzae type b	✓	
		Pneumococcal	✓	
		Rotavirus	✓	

Appendix A – Literature review process

Aim:

To understand the prevalence and impact of existing SMS reminders as a childhood immunisation intervention.

Question:

What is the current evidence surrounding the effectiveness of SMS reminders on childhood immunisation coverage and timeliness?

Methods:

I initially consulted an Information Access Coordinator from the Australian National University, Melinda Burrows, to assist in the development and refinement of appropriate search terms and review techniques. After working with Melinda, in June 2023 I searched ProQuest, PubMed, Scopus and Web of Science for peer-reviewed papers using the following:

> (CHILD* OR INFANT* OR TODDLER OR BABY OR KID*) AND (VACCIN* OR INOCULAT* OR IMMUNI*) AND (SMS OR "TEXT MESSAGE" OR MESSAGE OR "SINGLE MESSAGE SERVICE") AND (INFORM* OR DIRECTIVE OR MEMO OR REMIND* OR ALERT) AND (TIMELI* OR "ON TIME" OR PROMPT OR "UP TO DATE" OR PUNCTUAL OR OPPORTUN*) AND (UPTAKE OR ACCEPT* OR RECEPTIV* OR COVERAGE OR RATE)

Using the inclusion and exclusion criteria in Table 1, I was able to further refine the literature for review. The timeframe for inclusion was set as five years (2018-2023) as prior to this time there appeared to be minimal publications on the topic. This may be due to the technological advancements of SMS services including cost and access.

Table 1. Inclusion and exclusion criteria utilised in the literature search, 28 June 2023.

Criterion	Inclusion	Exclusion
Year	2018-2023	Published prior to 2018
Language	English	All other languages
Location	All countries	N/A
Intervention type	SMS only	All other interventions e.g., email, phone call, letter etc.
Immunization type	All other immunisations	COVID-19
Incentives	No incentives offered	Incentives offered e.g., monetary
Methodology	Systematic reviews Meta analysis Observational studies Randomized control trials	Reviews Opinions/letters
Publication status	Peer reviewed	Pre-prints Grey literature

Search results:

The initial search returned 915 articles. After duplicates (n=314) were removed, 574 articles were reviewed by their titles and abstracts using the inclusion and exclusion criteria. From here, 56 papers progressed to a full review, where 10 articles remained thereafter. Using the snowballing method, two additional articles were identified in the references of the remaining 10 papers. A total of 12 studies were identified in the literature review and were utilised to inform my combined data analysis and epidemiological study (Figure 1).

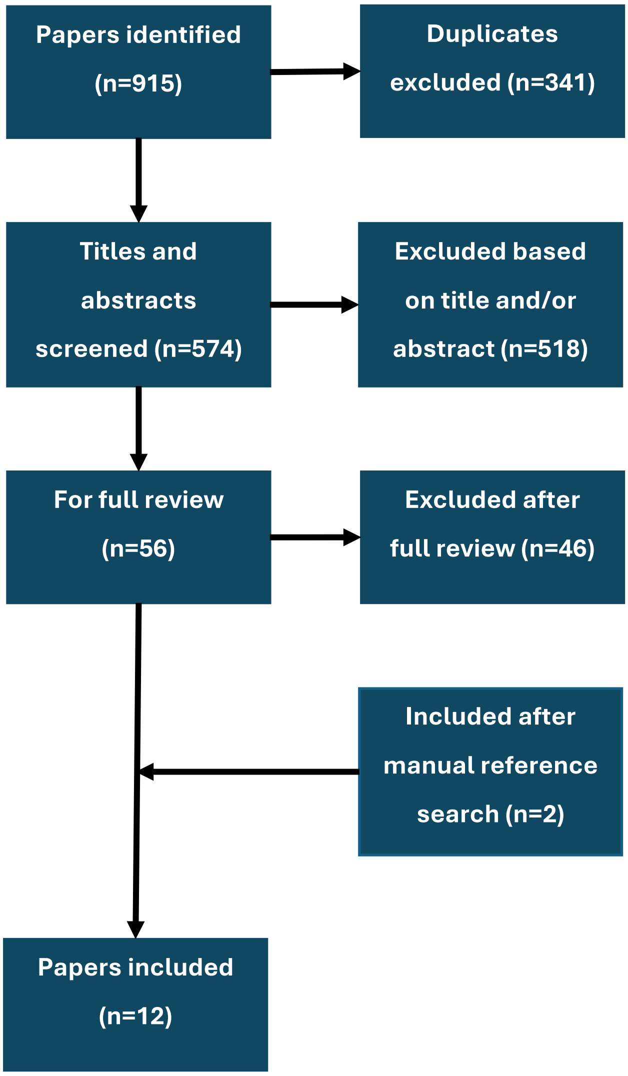
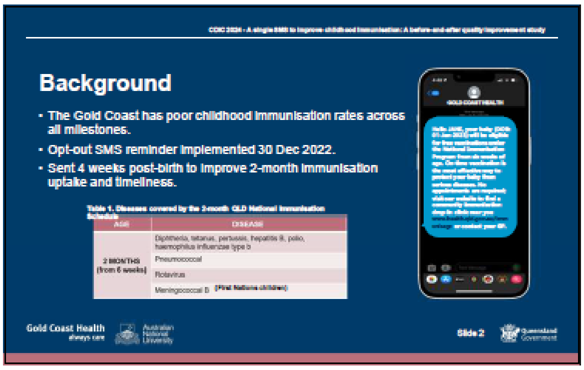
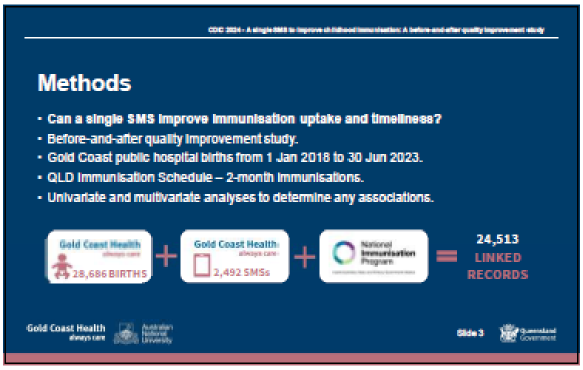
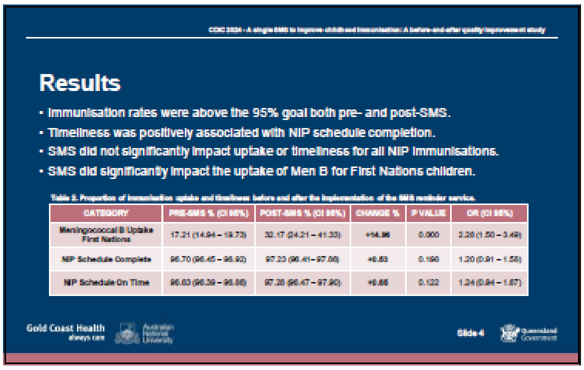


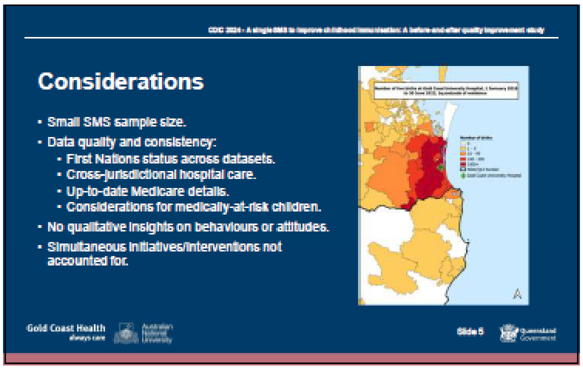
Figure 1. Summary of literature review process

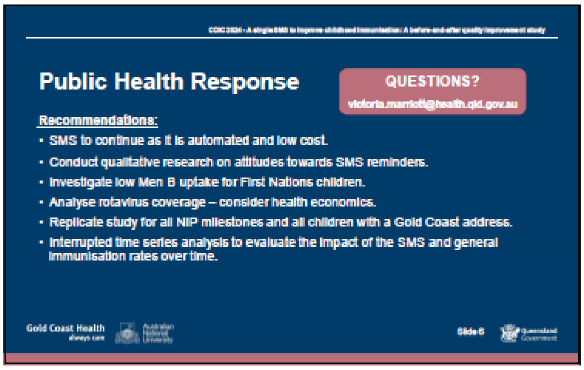
Appendix B – Project slides from CDIC 2024











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Chapter III – Outbreak investigation

Vomit on the dancefloor

Contents

Prologue

This chapter outlines an outbreak investigation I led during my field placement with the Gold Coast Public Health Unit (GCPHU). The following MAE competency is addressed in this chapter:

- Investigation of an acute public health problem or threat

My role

In late 2023, there was an outbreak of gastroenteritis at a local Gold Coast dance studio. My role was to oversee the epidemiological response. I developed a case definition, completed case interviews, collated and analysed survey responses, and presented this information to the GCPHU Outbreak Control Team (OCT) to guide the public health response.

Key reflections

Coordinating the epidemiological investigation was a fantastic opportunity to test and showcase my skills acquired throughout the MAE Program. I was confident to interview cases and perform relevant analyses, however I was challenged by the concept of collecting data for data's sake which occurred in this instance. In response to the outbreak, the dance school distributed a case survey and requested only symptomatic individuals complete it. Aspiring to perform a neat cohort study, I wanted to ask all rehearsal attendees to complete the survey, regardless of symptoms. However, my supervisors identified that collecting additional data on those without the outcome, or non-cases, would not change the public health response. By this point in the investigation, the public health risk had been effectively managed, no additional cases had been identified and communication with the school had been finalised. This situation highlighted the importance of collecting data only when it serves a clear public health purpose.

Public health impact

This investigation underscores the importance of educating non-childcare settings about gastrointestinal illness, and infection prevention and control. Environments like the affected dance school may not follow, or be aware of, the national *Staying Healthy: Preventing Infectious Diseases in Early Childhood Education and Care Services* guidelines, as they focus more on providing skills or services rather than primarily caring for children. This oversight puts these facilities at significant risk of spreading infectious diseases. Promoting non-traditional care settings to utilise these guidelines will help protect individuals and mitigate disease transmission.

Acknowledgements

The whole GCPHU team were essential throughout this outbreak response. I would like to individually thank Communicable Disease Control nurses Moira Dore and Fiona Vosti, as well as Environmental Health Officer Chloe Hyland for liaising with complainants, and Advanced Epidemiologist and my MAE Field Supervisor Dr Fiona May for epidemiological guidance. I would also like to acknowledge my academic supervisor Dr Amalie Dyda for her feedback provided on this chapter.

Abstract

Background

An outbreak of gastroenteritis was investigated by the Gold Coast Public Health Unit (GCPHU) when an anonymous phone call reported 80 persons unwell after attending a one-day children's dance rehearsal held on 26 November 2023.

Methods

A probable case was an individual who attended the rehearsal on 26 November 2023 and reported gastrointestinal symptoms within two days of the rehearsal. A confirmed case was an individual who met the probable definition and had laboratory confirmation of norovirus. The dance studio performed active case finding and surveyed symptomatic individuals before the GCPHU was notified on 28 November 2023. To verify reported events, the GCPHU interviewed several staff and rehearsal attendees. The GCPHU Gastrointestinal Syndromic Surveillance System supported passive case finding. Collated data were used to conduct descriptive analyses and a retrospective cohort study, and to calculate risk ratios. A faecal sample was collected from a single case who was symptomatic at the time of investigation. No active case finding, or environmental testing was performed by the GCPHU.

Results

A total of 287 dancers, teachers and volunteers attended the rehearsal across two rooms, Studio A and Studio B. Two dancers vomited in Studio A during the rehearsal and an additional seven dancers attended while symptomatic despite having experienced symptoms in the days leading up to the event. In total, there were nine attendees who were reportedly symptomatic during the rehearsal. After the rehearsal, the dance studio continued operating before closing on 29 November for a deep clean under the advice of 13HEALTH.

The survey identified 99 symptomatic individuals who met the case definitions (98=probable, 1=confirmed). After excluding non-susceptible persons (n=7), 181 rehearsal attendees did not have the outcome and were considered non-cases.

Amongst the cases, 58% (57/99) were dancers and 92% (91/99) were female. The median age for dancers was four years (range: 2-7 years) and the median age for volunteers and teachers was 18 years (range: 11-50 years). The median incubation period was within one day (range <1-2 days) of rehearsal and the median duration of illness was two days (range 1-4 days). Vomiting was the most reported symptom (98%; 96/99) followed by diarrhoea (38%; 37/99). Six individuals reported presenting to an emergency department due to their illness. The faecal sample collected was positive for norovirus genotype II.

Being exposed to the vomit in Studio A did not significantly increase the risk of developing gastroenteritis compared to those in Studio B (risk ratio [RR], 0.77; (95% confidence interval [95% CI], -0.56 – 1.06). The overall attack rate was 35% (99/280).

Conclusion

This outbreak was characterised by the failure to exclude unwell dance students from class and poor infection prevention and control practices. This investigation reinforces the importance of educating all institutional settings on preventing and managing gastrointestinal illnesses, specifically those who care for young children.

Introduction

Noroviruses are recognised as the leading cause of gastrointestinal illness across all age groups internationally.(1) In the 2000s it was estimated that noroviruses cause upward of 1.8 million cases of gastroenteritis in Australia per year.(2) Despite this, a single case of norovirus is not nationally notifiable in Australia,(3) leading to potential underrepresentation of its true incidence in the community.

In Queensland, it is a legislative requirement under the *Public Act 2005* to notify two or more associated cases of food or waterborne gastrointestinal illness, or a single case in a food handler. In 2023, Queensland investigated 10 foodborne outbreaks that met this legislative requirement, norovirus was the causative agent for one (10%) of these outbreaks. Norovirus is often underreported because its transmission is more commonly person-to-person through the faecal-oral route, or contact with aerosolised virus, than contact with contaminated food or water.(4, 5) In 2023, Queensland reported 135 non-foodborne enteric outbreaks, 77% (n=104) were attributed to norovirus with a total of 2,581 cases identified and 108 persons hospitalised.(6)

Norovirus outbreaks are often detected in institutional settings where people spend a lot of time in close proximity and share spaces or objects such as childcare centres (CCC) and residential aged care homes.(4, 7-10) Outbreaks can be difficult to control due to the low infectious dose of noroviruses (≤18 virions),(11) short incubation period (often 12-48 hours), high viral titres (10^5-10^{11} virions per gram of faeces) and prolonged viral shedding (median of four weeks and up to eight weeks),(12-15) environmental stability on surfaces, and their resistance to common cleaning products.(16) While in Queensland there is no legal requirement for these facilities to notify non-food or waterborne gastrointestinal outbreaks, it is recommended that staff contact their local public health unit to assist in the management of a suspected norovirus outbreak.(17, 18) This study describes a point-source norovirus outbreak that occurred at a dance school on the Gold Coast, Queensland, Australia in 2023.

On 28 November 2023, the Gold Coast Public Health Unit (GCPHU) received an anonymous phone call reporting multiple individuals with gastroenteritis. All individuals had reportedly attended a children’s one-day dance rehearsal on 26 November 2023 where two young dancers vomited on the dancefloor during the event. This alert initiated a formal investigation to identify the cause, manage any risk and prevent further illness.

Methods

Communicable Disease Control investigation

Staff from the GCPHU Communicable Disease Control (CDC), Environmental Health (EH) and Epidemiology teams conducted unstructured phone interviews with two dance school staff members on 28 November 2023, and two rehearsal attendees on 29 November 2023. The staff members were identified for interview as they were the key contacts for both the rehearsal event and general facility and were able to action recommendations identified by the GCPHU. The rehearsal attendees were identified for interview as their families both submitted complaints to the GCPHU and were open to communication. The aim of these interviews was to understand the context of the dance rehearsal event, investigate the cause and spread of illness, and provide education as necessary.

One of the interviewed rehearsal attendees provided a faecal sample for laboratory testing on 6 December 2023. This sample was tested for viral pathogens through a private pathology laboratory by polymerase chain reaction (PCR) using the Seegene Allplex GI-Virus PCR assay. No environmental samples were collected.

Epidemiological investigation

A probable case was defined as an individual who attended the dance rehearsal and reported vomiting and/or diarrhoea within two days (19) after the rehearsal. A confirmed case was defined as an individual who met the probable case definition and had laboratory confirmation of norovirus.

Prior to reporting the outbreak to the GCPHU, the dance school independently developed a Microsoft Forms survey (questions available at Appendix A) to collect information from symptomatic dance school members. Asymptomatic individuals were asked not to complete the survey. The survey requested demographic details, symptom profile, onset date, daily symptom reports between 25-29 November 2023 inclusive, hospitalisation status, as well as whether they were in Studio A, Studio B, or both studios throughout the rehearsal. The survey data was provided to the GCPHU on 29 November 2023 through a Google Sheets file to assist the investigation under section 90 of the *Queensland Public Health Act (2005)*. No additional active case finding was conducted by the GCPHU due to delayed involvement in the investigation and because the dance school alerted the GCPHU to any new cases reported by their community for the duration of the outbreak. The GCPHU decided not to pursue additional data collection as it was considered duplicative and risked straining the relationship with the dance school during the investigation.

The GCPHU Gastrointestinal Syndromic Surveillance System (GSSS) utilises emergency department presentation data and follow up surveys to identify common exposures and interrupt the spread of gastrointestinal illness throughout the community. Over the course of the outbreak, the GSSS survey data was monitored for any mention of the dance rehearsal as a form of passive surveillance.

Of the cases who reported requiring hospital care after the rehearsal, hospitalisation status was verified through the Queensland Integrated Electronic Medical Record (ieMR).

Utilising the survey data, descriptive analyses were conducted using Excel and analytical investigations were performed using Stata18 (StataCorp, LP, College Station, Texas).(20) Attack rates (AR), relative risk (RR) and the associated 95% confidence intervals (CI 95%) were calculated for each dance studio and rehearsal status (e.g., student or staff) to identify any relationship between vomit exposure and infection.

Results

A total of 287 junior dancers, staff and volunteers attended the rehearsal on 26 November 2023. The dance school advised that two studios were utilised throughout the day; dancers aged 0-5 years (n=125) used Studio A, with dancers aged 5-6 years (n=75) used Studio B. Staff and volunteers (n=87) were split between the two studios, with some individuals spending time across both studios throughout the rehearsal.

Communicable Disease Control investigation

Data collected in the four telephone interviews revealed that several children reportedly attended routine dance classes in the days leading up to the rehearsal while symptomatic with gastroenteritis. The survey revealed that seven individuals were unwell prior to the rehearsal and attended the rehearsal while symptomatic.

During the rehearsal, two dancers reportedly vomited on the dancefloor of Studio A on separate occasions. These two dancers did not report experiencing symptoms prior to the rehearsal in the survey. After both incidents, rehearsal paused while senior students cleaned up the vomit. It is unknown whether the two dancers remained onsite for the rest of the day or if they were sent home.

When questioned about the environmental cleaning practices used during the rehearsal, staff stated that the students used gloves, masks, and a bleach-based cleaner when cleaning up the vomit as that was understood to be best practice. However, interviews with senior students contradicted this statement, stating they used towels and a generic disinfectant spray, and that no personal protective equipment (PPE) was provided. Staff reported that the affected area of the room was not used for the rest of the rehearsal, but it was not clarified whether only part of the room was sectioned off, of if the entire room was vacated. Contrary to the staff statement, the students indicated Studio A was still in use after the vomit was cleaned up and that children were required to sit and move on the floor as part of their dance routines.

Each studio provided alcohol-based hand sanitiser (ABHS), but use was not monitored. The studios also shared bathrooms, some without soap provided. All attendees brought and consumed their own food.

Staff reported that within two days of the rehearsal, over 100 dancers and staff were absent from routine class due to gastrointestinal illness. At this point, the school sought guidance from 13HEALTH, Queensland's health advice phone line, who recommended the school close until further notice and that an appropriate deep clean was performed. The dance school reopened a few days later and they were not alerted to any further cases.

Based on the clinical nature of reported illnesses and preliminary descriptive epidemiology, the GCPHU OCT hypothesised the outbreak was caused by norovirus. This was confirmed on 7 December 2023 when the sample collected from a case returned a positive PCR for norovirus genotype II.

To support the dance school in understanding the current outbreak and preventing future transmission events, the CDC team provided dance staff with the *Queensland Health Viral or Suspected Viral Gastroenteritis Outbreaks fact sheet for Directors and Staff of Early Childhood Education and Care Services*.(19) This fact sheet provides education for care service institutions on the actions required during a viral gastroenteritis outbreak, including the importance of hand hygiene, exclusion and environmental cleaning.

Epidemiological investigation

A total of 118 surveys were completed by symptomatic individuals. Four of the responses were duplicate records and were removed. Of the 114 symptomatic individuals who completed the survey, 99 respondents (87%) met either the probable or confirmed case definition (98=probable, 1=confirmed), 13 respondents (11%) were excluded from the study as they did not meet the case definition; they either did not attend the rehearsal due to existing illness (n=4), attended the rehearsal while already symptomatic and were not at risk of illness (n=7), or did not attend the rehearsal and developed symptoms outside the study period (n=2). The remaining two respondents (2%) were deemed secondary cases as while they attended the rehearsal, their symptom onset date (29 November 2023) was later than other cases, and ongoing known contact with primary cases on 26-29 November 2025 indicated they most likely acquired their infection in subsequent dance classes. These two respondents were classified as non-cases for this statistical analysis component of this study (Figure 3.1).

After excluding the seven individuals who attended the rehearsal while already symptomatic, there were a total of 280 individuals who were deemed susceptible to illness at the rehearsal. Of these, 99 (35%) were cases, and the remaining 181 individuals (65%) were considered non-cases resulting in a total attack rate of 35% (n=99/280).

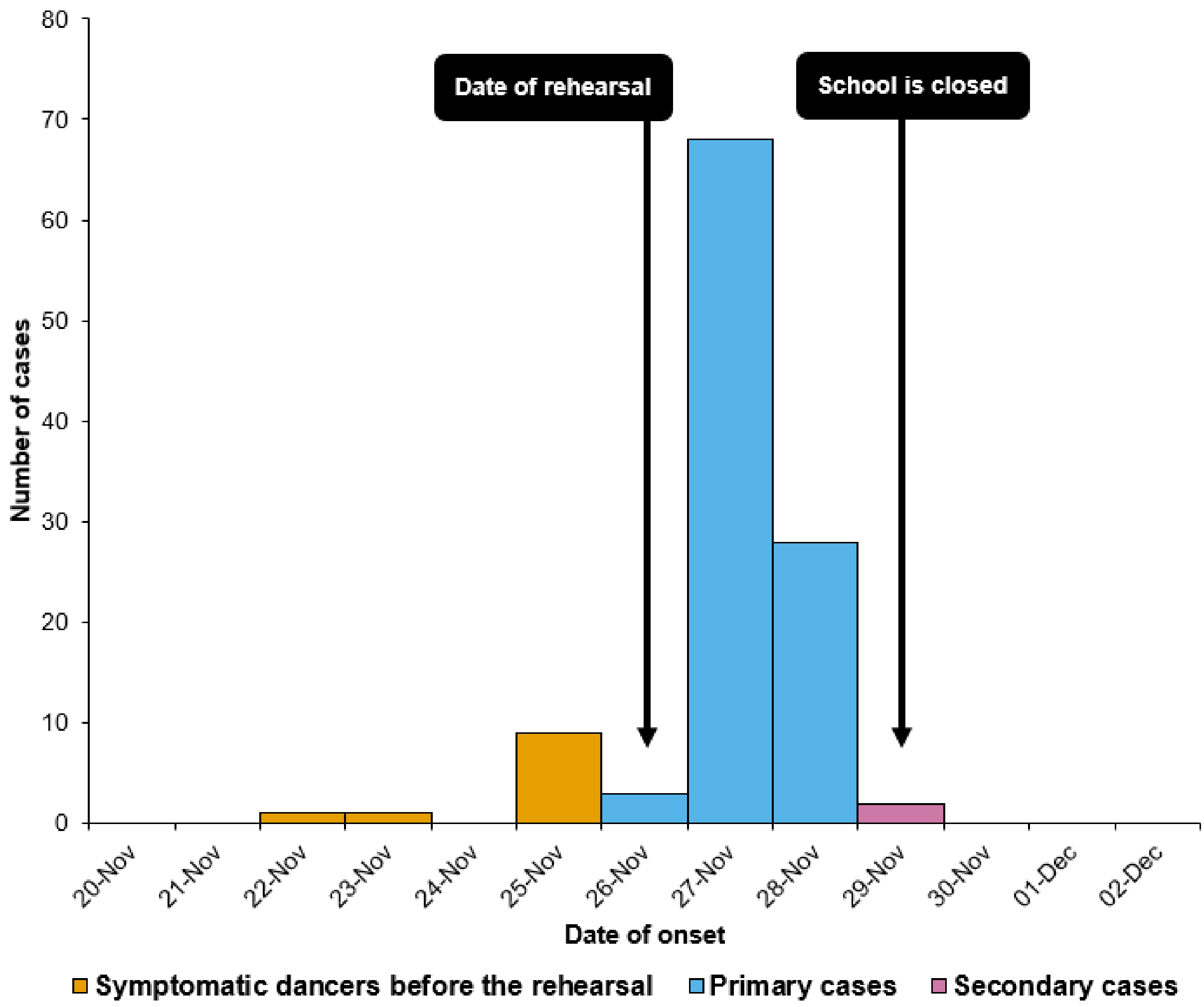

Figure 3.1. Epidemic curve of gastrointestinal cases associated with the dance rehearsal outbreak by symptom onset date, Gold Coast, Queensland Australia, November 2023.

Age was available for 92% (91/99) of cases. The median age was seven years (range: 2-50 years; interquartile range: 4-18 years) and 92% (91/99) of cases were female (Table 3.1).

Vomiting was the most reported symptom (98%; 96/99) followed by diarrhoea (38%; 37/99). The median incubation period was within one day (range 1-2 days) of the rehearsal. The median duration of illness was two days (range 1-4 days) (Table 3.1).

The day after the rehearsal, 41% (n=41) of cases attended routine classes before the facility was temporarily closed and deep cleaned. Of these, 33 cases (80%) reported symptoms on the day of their class attendance, however it is unknown at what time their symptoms started so we cannot confidently say if they were symptomatic during the class. The combination of potentially symptomatic attendees and ongoing contact with contaminated surfaces from the prior rehearsal likely resulted in the two recorded secondary cases.

Six cases (6.1%) reported in the dance school survey that they presented to an emergency department due to their condition (Table 3.1). The GCPHU was able to verify two presentations using ieMR. These two cases were sent a routine SMS survey from the GCPHU as part of the GSSS. While both cases responded to the GSSS survey, neither provided any additional details of their exposure at the dance school. The GSSS did not identify any new cases associated with the outbreak. Of the two verified reports, neither had a faecal sample collected during their presentation.

Table 3.1. Characteristics of cases associated with the dance rehearsal gastrointestinal outbreak (n=99), Gold Coast, Queensland Australia, November 2023.

Demographic characteristics	Cases n=99 (%)
Gender	
Male	8 (8.1%)
Female	91 (91.9%)
Age group	
<10	57 (57.6%)
10-19	30 (30.3%)
20-29	8 (8.1%)
30+	4 (4.0%)
Studio	
Studio A only (exposed)	55 (55.6%)
Studio B only (not exposed)	37 (37.4%)
Studio A & B – staff and volunteers (exposed)	7 (7.1%)
Symptom profile	
Vomiting ONLY	63 (61.6%)
Diarrhoea ONLY	2 (2.0%)
Both vomiting and diarrhoea	36 (36.4%)
Severity of illness	
Presentation to Emergency Department	6 (6.1%)

Being directly exposed to the vomit in Studio A did not increase the risk of developing gastroenteritis. For those exposed, the risk of illness was 23% lower (RR 0.77, 95% CI 0.56 – 1.06) than those unexposed, however this result is not statistically significant (p = 0.1130) (Table 3.2).

Dancers who utilised either Studio A or B were at similar risk of illness (RR 1.67 and 1.69 respectively) (Table 3.3). Teachers and volunteers who utilised both studios had a significantly lower risk of illness (RR 0.17, 95% CI 0.08-0.35) compared to the dancers who only used Studio A or B (Table 3.3).

Table 3.2. Relative risk of gastrointestinal illness among dance rehearsal attendees by exposure to vomit, Gold Coast, Queensland Australia, November 2023.

Case definition	Exposed (Studio A)	Unexposed (Studio B)	Total	RR (95% CI)	P value
Cases	62	37	99	0.77 (0.56-1.06)	0.1130
Non cases	130	51	181		
Total	**192**	**88**	**280**		

Table 3.3. Attack rate and relative risk of gastrointestinal illness among dance rehearsal attendees by studio usage, Gold Coast, Queensland Australia, November 2023.

Studio	Studio cases	Studio non-cases	AR	Cases outside the studio	Non-cases outside the studio	RR	P value	95% CI
A (n=120)	55	65	45.8%	44	116	1.67	0.0015	1.21-2.29
B (n=73)	37	36	50.7%	62	145	1.69	0.0014	1.24-2.30
A & B (n=87)	7	80	8.0%	92	101	0.17	0.0000	0.08-0.35

Discussion

This investigation describes the rapid spread of gastrointestinal illness in a non-traditional childcare setting. While only one positive norovirus sample was detected, this event was characteristic of norovirus due to the short but rapid spread of disease and consistent clinical presentation of cases. We hypothesise that the inadequate exclusion of symptomatic children before the rehearsal, combined with the on-site vomiting episodes, insufficient hand washing facilities and cleaning practices resulted in a large point-source outbreak with secondary transmission. Rectifying these issues is crucial for preventing future outbreaks.(4, 17, 21, 22)

Noroviruses are extremely resilient and require specific cleaning agents to reduce environmental contamination.(9, 16, 23) Dance staff failed to follow the appropriate PPE and cleaning guidelines at the rehearsal. This practice not only put the individual who was cleaning the vomit at risk of infection, but all others who utilised the space. With norovirus transfer documented from primary surfaces to hands and then to secondary surfaces,(5, 17, 23-25) it is possible that transmission may have occurred through several routes; inhalation of aerosolised vomit particles, person-to-person contact with those already symptomatic, and contact with primary and secondary contaminated surfaces such as the floor in Studio A and the shared bathrooms. This is highlighted by the lack of statistical association between being in Studio A or B and the risk of developing gastrointestinal symptoms despite Studio A having the primary vomit exposure.

One of the common spaces utilised by attendees were the bathrooms. With no soap available in the bathrooms, rehearsal attendees would not have been able to perform effective hand hygiene. While ABHS was available at the rehearsal, usage was not mandatory nor was it monitored by staff. Additionally, ABHS has proven largely ineffective against non-enveloped virus transmission and should not be relied upon during outbreaks of viral gastroenteritis.(26-29) To reduce the risk of disease transmission, it is recommended that care facilities provide liquid hand soap and encourage regular hand washing.(4)

Dance students were disproportionately affected by gastrointestinal illness compared to the staff and volunteers throughout this outbreak despite all sharing the same spaces. This is likely influenced by the fact that older children and adults have a better understanding of disease transmission and the importance of protective behaviours, such as hand hygiene, compared to young children.(23, 30-32) Additionally, the children participating in the rehearsal had greater direct exposure to the contaminated space as they were required to sit and move on the floor as part of their dance routines. It must also be noted that 92% of cases were reported as female.

When looking at dance participation across Australia, females make up 91% of child participants (0-14-years) and 89% of adult participants (15-years and older).(33) As such, the gender breakdown in this outbreak is likely due to the context of the event.

In the lead up to the rehearsal, at the rehearsal, and in the days following, several students attended the dance school while symptomatic or recovered but potentially still infectious. In Australia, individuals with gastrointestinal disease like norovirus are strongly recommended to exclude themselves from care services for at least 48 hours after symptoms cease.(17) This recommendation is essential as individuals can continue to shed high levels of virus for several days after they have recovered, increasing the risk of secondary transmission.(34, 35) Transmission in this outbreak reportedly stopped when the dance school closed for 72 hours, and all social and environmental contact ceased. Although the closure effectively controlled the spread of disease, it highlighted the economic and social burden of noroviruses,(30, 36) with productivity loss and absenteeism among staff, students, and parents. Despite conflicts between institutions and parents on the execution of exclusion policies,(17, 37) adopting an evidence-based policy is necessary to reduce the economic and social burden of disease as well as prevent further illness transmission.

There are several limitations in this investigation's design and execution, largely due to the delayed involvement of the GCPHU. Although the dance school's digital survey was thorough, it lacked data validation and epidemiological rigour resulting in incomplete, and invalid records as well as limited data points for analysis. For example, the survey asked for symptom onset date but did not request time of onset, nor did they ask for symptom details in the days after the studio had closed for cleaning. Due to the sudden nature and accelerated spread of viral gastroenteritis such as norovirus, without accurate information on the timing of illness it is difficult to know whether the cases in this study can be confidently attributed to the rehearsal alone, whether exposure occurred during routine class in the days prior, or if secondary transmission with rapid onset took place after the rehearsal. Additionally, the survey only included symptomatic individuals, preventing the execution of a complete cohort study as non-symptomatic individuals could not be verified. In the end, the GCPHU chose not to conduct their own survey and instead used the count of attendees, minus the case numbers, as a measure to account for those without the outcome, or non-cases. This decision was made as the initial survey had a high response rate and a second survey risked causing fatigue among responders resulting in a poor response rate. By using the available data, the GCPHU acknowledged the likely underrepresentation of disease, including onward household transmission, and potential for information bias regarding the delineation between those with the outcome and those without.

Another limitation of this study is that the four phone interviews were conducted using unstructured interviews. Despite unstructured interviews promoting authentic discussion, this approach meant the GCPHU forgot to clarify certain aspects of the outbreak, such as the size of the studios and the length of the rehearsal which may have assisted with understanding transmission risk. Additionally, some respondents provided contradicting accounts of the rehearsal events, namely staff suggesting appropriate cleaning protocol was followed, and students denying this claim, this may indicate a level of cognitive bias with staff concerned about any potential repercussions and students attributing blame for their illness. While interviews were conducted in a timely manner, some respondents were still unsure on the order of events, the availability of hand hygiene products, or what cleaning products were utilised, suggesting a level of recall bias. While the poor recall did not impact the health protection advice provided, it did prove difficult to confirm a timeline of events.

Despite these limitations, this outbreak highlights the value of community-based surveillance (CBS) and community engagement during a public health response. Community-based surveillance involves community members collecting and reporting public health information, which helps to detect and manage outbreaks that might be missed by traditional surveillance methods.(38) Not only does CBS empower communities, it can also be more timely and effective than government-led efforts due to the on-the-ground presence and strong rapport among community members.(39, 40) In this outbreak, the dance school's development, communication and distribution of the survey likely facilitated quick data collection and a high response rate. The GCPHU should consider actively involving community in future outbreaks and epidemiological research where appropriate.

Conclusion

As norovirus is not a nationally notifiable condition in Australia, outbreaks in non-traditional care facilities such as the affected dance school are most likely underreported and under resourced. This investigation highlights the importance of educating non-traditional childcare institutions on the role of their local public health unit in assisting with infection control, and the implementation of the national *Staying Healthy: Preventing Infectious Diseases in Early Childhood Education and Care Services* guidelines.

Ethics

This project was approved by the Australian National University Human Research Ethics Committee, protocol 2017/909. All data in this project has been managed in accordance with the *Queensland Public Health Act 2005* and the *Public Health Regulation 2018*.

Appendix A – Microsoft Forms case survey questions designed by the dance school.

1. Email address:
2. Name, Initial (e.g., "Example, AN"):
3. Gender (select)
    a. Female
    b. Male
    c. Other
4. Date of birth (DD/MM/YYYY)
5. Status (select)
    a. Staff
    b. Student
    c. Volunteer
6. Person's Age group (select)
    a. 15/u Performance Team
    b. 15/u Performance Team, Full time/Part-time/Academy
    c. 15/u Performance Team, Senior Performance Team
    d. 15/u Performance Team, Senior Performance Team, Full time/Part-time/Academy
    e. 15/u Performance Team, Senior Performance Team, Full time/Part-time/Academy, Staff/Helper
    f. Full time/Part-time/Academy
    g. Full time/Part-time/Academy, Staff/Helper
    h. Junior or 10/u Performance Team
    i. Mini or 6/u Performance Team
    j. Mini or 6/u Performance Team, Pre-Junior or 8/u Performance Team
    k. Preschool (Ready Set Dance, Ready Set Ballet, Ready Set Acro)
    l. Preschool (Ready Set Dance, Ready Set Ballet, Ready Set Acro), Pre-Junior or 8/u Performance Team
    m. Senior Performance Team
    n. Senior Performance Team, Full time/Part-time/Academy
    o. Senior Performance Team, Full time/Part-time/Academy, Staff/Helper
    p. Senior Performance Team, Staff/Helper

    q. Staff/Helper

7. Date of onset of illness (DD/MM/YYYY)

8. Did the person have symptoms on:

- a. 25/11/2023
    - i. Clear
    - ii. Diarrhoea
    - iii. Vomiting
    - iv. Diarrhoea & Vomiting
- b. 26/11/2023
    - i. Clear
    - ii. Diarrhoea
    - iii. Vomiting
    - iv. Diarrhoea & Vomiting
- c. 27/11/2023
    - i. Clear
    - ii. Diarrhoea
    - iii. Vomiting
    - iv. Diarrhoea & Vomiting
- d. 28/11/2023
    - i. Clear
    - ii. Diarrhoea
    - iii. Vomiting
    - iv. Diarrhoea & Vomiting
- e. 29/11/2023
    - i. Clear
    - ii. Diarrhoea
    - iii. Vomiting
    - iv. Diarrhoea & Vomiting

9. Has the person been hospitalised for gastro since 25/11/2023? (select)

- a. Yes
- b. No

10. What days did the person attend the dance school, select all that apply:

- a. Friday 24/11
- b. Saturday 25/11

c. Sunday 26/11
d. Monday 27/11

11. Did the person attend the dance rehearsal on Sunday 26/11?

a. No - was not required to be there
b. No - was supposed to be but unavailable (reason other than sickness)
c. No - was supposed to be but was sick
d. Yes - a mini student (studio B)
e. Yes - a preschool student (studio A)
f. Yes - as a staff/helper with both age groups (studio A & B)
g. Yes - as staff/helper in the mini room (studio B)
h. Yes - as staff/helper in the preschool room (studio A)

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Chapter IV – Surveillance evaluation

Evaluating Part A of the Gold Coast Gastrointestinal Syndromic Surveillance System

Contents

Prologue

In this chapter I evaluate and provide recommendations for the signal detection component of the Gold Coast Public Health Unit's (GCPHU) Gastrointestinal Syndromic Surveillance System (GSSS). This chapter addresses the following competencies:

- Evaluate a public health surveillance system, and
- conference presentation.

My Role

In preparation for the 2018 Gold Coast Commonwealth Games (the Games), the GCPHU developed the GSSS to help identify and interrupt the spread of gastrointestinal illness. The GSSS operates in two parts; Part A, gastroenteritis signal detection, and Part B, enhanced follow up. After the Games, the GSSS continued as a legacy system and supported the routine detection of community gastroenteritis outbreaks on the Gold Coast. The GSSS ran for five years before 2023 MAE scholar Kirsty Nichols evaluated Part B of the system. My role was to complete the GSSS evaluation by assessing Part A to both improve the GSSS locally, and to present the combined evaluation to the Queensland Health Communicable Diseases Branch (CDB) to inform planning for the 2032 Brisbane Olympic and Paralympic Games (2032 Games).

To evaluate Part A, the signal detection element of the GSSS, I followed the United States Centers for Disease Control and Prevention's *Updated Guidelines for Evaluating Surveillance Systems*.(1) Throughout the evaluation, my responsibilities included:

- Designing the evaluation,
- conducting stakeholder interviews,
- analysing system data and interview responses to inform assessments on simplicity, stability, flexibility, acceptability, PPV, data quality, representativeness, and timeliness, and
- delivering internal recommendations to the GCPHU and a report summary to the CDB.

I presented the results of my evaluation at the 2024 Communicable Diseases and Intelligence Conference as a short six minute oral (Appendix A), and at the 2nd Western Pacific Mass Gathering and Health Symposium as a long 15-minute oral. I also presented my findings to the Queensland Alliance for Environmental Health Sciences 2032 Games Special Interest Group and the Queensland Health Data Visualisation Working Group at their request.

Key Reflections

As part of my routine work at the GCPHU, my role was to perform the daily GSSS process from start to finish as needed. This included downloading the gastroenteritis source data, sending the SMS survey to cases, exporting, cleaning and analysing the survey data in Stata18, identifying any common exposures and liaising with the GCPHU CDC and EH teams when public health action was required. By being an end user of this surveillance system, evaluating its performance was quite straightforward. I was familiar with the stakeholders involved at each step of the process, how the data was sourced and analysed, and the system's limitations. From my experience, I was able to identify specific recommendations for improvement. However, these insights represented my perspective and other users may have differing or additional opinions. For example, prior to this evaluation I would have said the system was inflexible as changes seemed to take a considerable amount of time, suggesting a level of technical difficulty. However, after interviewing the staff who maintain the dashboard, it became clear that while changes are technically straightforward, they are often hindered by approval pathways and competing priorities. This evaluation highlighted the importance of conducting a comprehensive, user-informed assessment to ensure the system and its limitations are accurately described and recommendations reflect the perspective of all users.

This project highlighted the importance of regular project evaluations. When the GCPHU attempted to update the signal detection coding as per the Part B evaluation recommendations, it was discovered that changes to the GSSS dashboard, while theoretically simple to perform, were no longer in scope as the dashboard was flagged for decommission, which had not been previously communicated to the GCPHU users. The inability to update the syndrome coding meant the system was failing to accurately detect instances of gastroenteritis, impacting the ability to perform enhanced surveillance and identify community outbreaks. It took six months to resolve the coding issue because the external consultant developers were primarily focused on creating the new replacement dashboards, leaving the GCPHU without a functional dashboard. Once resolved, retrospective data analysis revealed that 1,181 instances of gastroenteritis were missed during the six-month period where the GSSS coding had failed. Should the GSSS have been evaluated after its initial implementation and updated on an annual or bi-annual basis thereafter, these issues may have been rectified sooner with fewer delays and missed opportunities for public health action.

Throughout this evaluation, I was fortunate enough to engage with, and learn from, many different internal and external stakeholders. As part of my initial research into syndromic surveillance systems, I came across the New South Wales Health (NSW Health) Public Health Rapid, Emergency, Disease and Syndromic Surveillance (PHREDSS) system. The PHREDSS system was initially developed to identify public health threats associated with the 2003 Rugby World Cup. Using hospital and ambulance data, PHREDSS can identify disease trends across nine detailed syndrome groups. With PHREDSS running for over 20 years, I wanted to learn from NSW Health to see how I could improve the GSSS. After meeting the PHREDSS team to discuss our system's similarities and differences, strengths and weaknesses, I came away with a better understanding of how syndromic surveillance could be applied beyond gastrointestinal illness and a realisation on how valuable it is to share our learnings with our colleagues. This sentiment was also expressed at the 2nd Western Pacific Mass Gathering and Health Symposium where I presented this evaluation project. Internationally, health agencies are renown for not sharing or publishing their learnings, particularly around mass gathering surveillance systems. As mass gathering events become larger, and as our international disease landscape evolves, it is imperative that we share our surveillance evaluations after large international events such as the Olympic and Paralympic Games to promote best practice and keep our communities safe.

Public Health Impact

The GSSS is a legacy system that continues to have a significant impact on public health actions undertaken by the GCPHU. While no outbreaks were detected at the Games, the GSSS allowed public health officials to determine if the incidence of gastroenteritis was above a standard threshold and if required, deliver public health messaging. Scaled down for daily use, the GSSS consistently identifies multiple community outbreaks each year which would have otherwise gone unreported and unmanaged. While Part A of the GSSS could technically continue operating using the existing dashboard should it not be decommissioned, this evaluation has identified several key areas for improvement moving forward. These recommendations include the revision of coding to improve signal sensitivity, adding new syndromes that signify more complex illness such as acute fever and rash, broadening of source data beyond public emergency departments to improve community representativeness and upgrading the dashboard to ensure longevity. Implementation of these recommendations would improve the GCPHU's ability to conduct widespread community disease surveillance and identify and respond to any emerging disease threats on the Gold Coast.

At the time of writing, the GSSS was the first, and only enhanced syndromic surveillance system operating in Queensland Health. With the 2032 Games fast approaching and a need to develop a centralised state-wide disease surveillance system, the learnings from this evaluation will help to inform future surveillance planning.

Acknowledgements

My contribution to this evaluation was part of a much larger team effort. I would firstly like to thank Kirsty Nichols for conducting the initial phase of the GSSS evaluation and paving the way for my project. Thank you to the current and past GCPHU employees who helped me to understand the history behind the GSSS. Thank you to Christobel Mak and Jacqueline Pittaway for your input while the evaluation and GSSS itself was constantly evolving. Finally, thank you to my supervisors Dr Fiona May and Dr Amalie Dyda for your advice and support on the execution of this project.

Abstract

Background

In preparation for the 2018 Commonwealth Games the Gold Coast Public Health Unit (GCPHU) enhanced their routine disease surveillance by introducing a Gastrointestinal Syndromic Surveillance System (GSSS). The GSSS aimed to identify and interrupt the spread of gastrointestinal illness using signal detection and enhanced follow up. Seven years later, the GSSS continues as a legacy system, routinely detecting community outbreaks of gastrointestinal illness on the Gold Coast. To help improve the system locally, and to inform the surveillance strategy for the 2032 Brisbane Olympic and Paralympic Games, Queensland Health requested an evaluation of the GSSS.

Methods

I evaluated the signal detection and case identification component of the GSSS using the United States Centers for Disease Control and Prevention's *Updated Guidelines for Evaluating Surveillance Systems* as a framework. I focused on assessing the simplicity, stability, flexibility, acceptability, positive predictive value (PPV), data quality, representativeness, and timeliness of the system.

Results

The timeliness of the signal detection and case identification component of the GSSS is satisfactory as it operates in real time, with emergency department presentation data feeding into an internal dashboard for analysis and public health action every 10-15 minutes. The system is well accepted by surveillance officers, largely because of the system's simplicity, including that analysis takes no more than 15 minutes to complete each day. While system errors can be more complex to resolve with end users reporting timeframes exceeding six months, the system engineers remain confident that the system is flexible and stable enough to achieve its purpose. The system demonstrated excellent data quality, with no missing data between 2021-2023 that would impact the identification of gastroenteritis trends. The overall PPV was high for a syndromic surveillance system, estimated at 80%. While the system was not entirely representative of the Gold Coast population, it was representative of the disease under surveillance. During this period the GSSS detected 13,379 instances of gastroenteritis while the GCPHU only recorded 5,230 laboratory-confirmed cases of notifiable gastroenteritis. The

median age of GSSS cases was 23-years, and almost 30% of cases were aged 0-4-years despite this age group only representing 5% of the total Gold Coast population.

Conclusion

The signal detection and case identification component of the GSSS is well accepted by its users due to its interface simplicity and the quality and timeliness of data availability. However, the GSSS would benefit from a system upgrade and the development of formal change request and system testing processes to enhance system stability and flexibility for both the system engineers and end users. While the GSSS has a relatively low false positive rate, it is recommended that the GCPHU reassess the coding used to identify instances of gastrointestinal illness to improve sensitivity, as well as explore additional data sources to improve the representativeness of system.

Background

Mass gatherings are large events that are often attended by tens-to-hundreds of thousands of people and can last days to weeks.(2) Mass gatherings can be planned, such as the Olympic and Paralympic Games, or can occur spontaneously such as during natural disasters that result in displaced persons.(3) Depending on the nature of the event, mass gatherings can pose various public health concerns, including environmental challenges like overcrowding, poor sanitation and dehydration, the introduction of foreign diseases, and the risks associated with large-scale food preparation.(4) These factors, combined with the potential for rapid disease transmission in a large population, ultimately increase the strain on local healthcare systems.(4-6) This has been well documented in the context of the Hajj, one of the largest annual mass gathering events in the world. Previous pilgrimages have resulted in several meningococcal outbreaks due to factors such as low vaccine coverage and prolonged close contact, with the 2000-2001 outbreak leading to the international transmission of the unusual meningococcal serogroup W135.(7-11)

To mitigate these risks, planned mass gatherings such as major sporting events, religious celebrations or cultural festivals typically are monitored using syndromic surveillance as an early warning system to identify disease introduction and transmission, and to reassure communities if there are no signals detected.(12-16) During the 2012 London Olympic and Paralympic Games the UK Health Protection Agency engaged syndromic surveillance as an early warning system for health-related incidents.(17) Although no outbreaks were detected, the surveillance data provided reassurance to stakeholders that no significant public health events were occurring.(18)

Syndromic surveillance uses syndrome or symptom data as a proxy for diagnosis data, enabling the real-time detection of public health threats, allowing for faster response and intervention. Syndromic surveillance is particularly useful in contexts where laboratory testing may be delayed or unavailable.

In preparation for the 2018 Gold Coast Commonwealth Games (the Games), the Gold Coast Public Health Unit (GCPHU) strengthened their standard disease surveillance efforts by implementing an enhanced Gastrointestinal Syndromic Surveillance System (GSSS). The aim of the GSSS was to identify and interrupt the spread of gastrointestinal illness using early signal detection.

Gastroenteritis is a highly infectious illness that can be caused by viruses such as norovirus or rotavirus, bacteria including *Salmonella* or *Campylobacter*, or parasites like *Cryptosporidium*.(19) The incubation period and duration of illness depend on the cause, however infection commonly results in diarrhoea and/or vomiting.(20) While infection in immunocompromised individuals can lead to severe disease,(21) the majority of individuals will experience a short-lived illness that does not require healthcare intervention. The GCPHU chose to focus on gastroenteritis as it is often a self-limiting illness that is not always captured in the Queensland Notifiable Conditions System (NoCS) due to disease notification requirements as well as health seeking and testing behaviours. For example, the estimated incidence of gastroenteritis in Australia is 17.2 million cases per year.(22) However, in 2023 only 61,305 cases of notifiable gastrointestinal disease as defined by the National Notifiable Diseases Surveillance System (cases of botulism, campylobacteriosis, cholera, cryptosporidiosis, haemolytic uraemic syndrome, hepatitis A, hepatitis E, listeriosis, paratyphoid, salmonellosis, Shiga toxin-producing *Escherichia coli*, shigellosis, and typhoid) were reported across Australia.(23) Additionally, it is estimated that in Australia only one stool sample is completed in every 140 persons with gastrointestinal symptoms resulting in very few confirmatory diagnoses.(24) This suggests that most cases of gastroenteritis in Australia are missed by traditional case-based surveillance.

Additionally, gastroenteritis can spread quickly from person to person through the faecal-oral route or via contaminated food or water.(20) The crowded environment of the Games would further amplify this risk, making proactive interventions crucial. By targeting gastrointestinal illness for surveillance, the GCPHU could take tangible steps to mitigate outbreaks by stopping onward transmission if the system identified an increase in cases. These actions could include promoting effective hand hygiene, improving food safety, recommending appropriate cleaning practices, and issuing public health alerts if needed.

The implementation of the GSSS at the Games was also driven by the large norovirus outbreak during the 2014 Glasgow Commonwealth Games, where 48 cases were reported among staff at the athlete's village.(25) This not only attracted substantial media attention (26,27) but also posed a considerable risk of infection to athletes, potentially impacting the competition. By monitoring gastroenteritis syndrome data and identifying and addressing common exposure sources, the GCPHU were able to fill surveillance gaps left by unreported or non-notifiable gastroenteritis, such as norovirus.

Operating the GSSS at the Games involved two main parts; Part A, gastroenteritis signal detection and case identification, and Part B, enhanced follow up to identify common exposures for public health follow up.

Part A: Signal detection and case identification

Gastroenteritis cases were identified by using pre-determined gastroenteritis International Classification of Diseases 10th revision (ICD-10) codes and Systematized Nomenclature of Medicine – Clinical Terms (SNOMED CT) codes from two public Gold Coast emergency departments (ED), three private Gold Coast hospitals, and Queensland's telehealth service, 13HEALTH. Data were captured in real-time using the Gold Coast Hospital and Health Service Health Management Information System (MIS) dashboard. Multiple Gold Coast General Practices provided diagnosis data as sentinel sites however this was not as timely as the syndromic surveillance sources.

To determine whether the number of gastroenteritis presentations was higher than expected, the MIS dashboard displayed the 2014-17 presentation average and a daily upper and lower control (95% confidence interval). For the period of the Games, if the daily presentation count was above the upper control for two consecutive days, an outbreak would be declared.

Part B: Enhanced follow up and public health action

Using data captured in Part A, any individuals identified with gastroenteritis were then sent an SMS with a link to complete an online EpiInfo survey. The survey sought to identify any common eating or swimming exposures. Returned survey data would be analysed by GCPHU staff to determine any common exposures for public health action.

During the Games no outbreaks of gastroenteritis were identified, however the daily presentations for gastroenteritis were almost two standard deviations higher than the four-year mean indicating there was increased disease spread throughout the Games. This trend was a useful insight for public health messaging and planning and supported the continuation of the system after the conclusion of the Games for general gastroenteritis surveillance across the Gold Coast.

Over the next few years, the GSSS legacy system continued to operate with small changes made to reflect shifts in operational or financial capacity. For example, after the Games ended, the data sources for Part A were scaled back by excluding the three private hospitals and focusing on the two public EDs, Gold Coast University Hospital (GCUH) and Robina Hospital. 13HEALTH also ceased data provision, and the data cleaning and matching component of Part

B became semi-automated using Stata17. In late 2020, childcare attendance was included on the exposure survey after an increase in gastrointestinal illness reports in childcare centres. In 2024, the exposure survey was modified to improve accessibility and an additional triage question was included to support assessing the positive predictive value (PPV) of the data used in Part A. These changes were enabled by shifting the survey from EpiInfo to REDCap. Despite all these changes, there was not a complete evaluation of the GSSS at any stage.

In 2022, the GCPHU commenced an evaluation of the GSSS to either guide the next iteration of the GSSS or decide to discontinue it, however due to operational capacity MAE scholar Kirsty Nichols only evaluated Part B of the GSSS as part of her course requirements.(28) Kirsty's evaluation assessed the GSSS against its intended aim of detecting common exposure sources and clusters of gastroenteritis on the Gold Coast and implementing appropriate public health action or prevent further disease. This involved assessing the ease of operation of the system and the timeliness between receiving a survey response to public health action, the willingness of staff to participate in the enhanced component of the GSSS, the representativeness of survey responses and the flexibility to improve the GCPHU processes associated with Part B. Kirsty's evaluation identified that the GSSS is a useful system and should continue. She identified eight key recommendations as part of her evaluation. Two of the recommendations included the need to evaluate Part A of the GSSS:

- Recommendation six: investigate the flexibility and stability of the MIS platform to reduce operational risk to the GSSS and its flow-on impact to Part B.
- Recommendation seven: evaluate the sensitivity, specificity, completeness and representativeness of the MIS data to ensure the GSSS is an accurate representation of the Gold Coast community incidence.

To complete the GSSS evaluation and fulfil my MAE competencies, I evaluated Part A of the GSSS using the United States Centers for Disease Control and Prevention's (US CDC) *Updated Guidelines for Evaluating Surveillance Systems* (1) as a framework. This evaluation was timely, with the *Queensland Public Health Review 2023* (29) identifying the need for Queensland Health Communicable Diseases Branch to consult with GCPHU on the potential extension of GCPHU's syndromic surveillance capacity statewide in preparation for the 2032 Brisbane Olympic and Paralympic Games (2032 Games).

Aims and objectives

The primary aim of this project was to complete the GSSS evaluation by assessing the current Part A of the system.

The objectives of this project include:

- Action recommendations six and seven of the Part B evaluation.
- Identify recommendations to improve the usefulness of the GSSS at the GCPHU.
- Combine both Part A and B evaluations into an internal report to inform the surveillance planning for the 2032 Games.

Methods

To conduct this evaluation, I used the US CDC's *Updated Guidelines for Evaluating Surveillance Systems* (1) as a framework. This process involved describing Part A of the GSSS, analysing the data utilised in the GSSS, and engaging relevant stakeholders to assess the performance and overall usefulness of the system. The findings were then used to develop recommendations for improving Part A of the GSSS and to inform future surveillance planning for the 2032 Games.

Scope

This evaluation does not assess archived components of Part A such as previous data sources captured during the Games. Only elements of Part A which are active at the time of writing have been assessed.

The description and evaluation of Part B of the GSSS was completed by previous MAE scholar Kirsty Nichols in 2022 and as such are not included in this report.

Ethics

This project was approved by the Australian National University Human Research Ethics Committee, protocol 2017/909. All data in this project has been managed in accordance with the *Queensland Public Health Act 2005* and the *Public Health Regulation 2018*.

System Description

When the GSSS was developed, there were no official documents which outlined the system. In 2023, the GCPHU developed a *Gold Coast Public Health Unit Syndromic Surveillance Guideline* which outlined the background, purpose, scope, and process flow for the iteration of the GSSS which was current at the time.(30) To help me to describe Part A of the GSSS, I primarily utilised the internal options paper (31) which informed the development of the GSSS for the Games, the *Gold Coast 2018 Commonwealth Games Summary Report* (32) and the newly developed *Gold Coast Public Health Unit Syndromic Surveillance Guidelines*.(30) In addition to these documents, details of the system were obtained through formal and informal discussions with GCHHS staff involved with Part A of the GSSS.

Stakeholder engagement

Stakeholders associated with Part A of the GSSS were identified by reviewing internal documentation on the GSSS (30-32) and engaging in informal conversations with GCPHU staff. Relevant stakeholders included the external consultant data scientists who develop MIS dashboards on behalf of the Gold Coast Hospital and Health Service (GCHHS), the GCHHS data engineers who maintain the MIS system, and the Data Officers and Epidemiologists at the GCPHU who analyse ED presentation trends in MIS and execute Part B of the GSSS.

To better understand the roles and responsibilities, attitudes and beliefs towards the system operation and performance of Part A, I conducted one-on-one semi-structured interviews via Microsoft Teams for the GCHHS data engineers and developed a short Microsoft Forms survey for the GCPHU end users. I was unable to interview the external data scientists as at the time of this evaluation as they were no longer directly supporting the GSSS process. The GCHHS data engineers and GCPHU staff were asked different sets of questions (Appendix B), tailored to their role in Part A of the GSSS (Table 4.1). I chose semi-structured interviews for the GCHHS data engineers because I had less familiarity with their roles in the GSSS and interviews can often result in more in-depth insights compared to surveys. To ensure I captured their insights correctly, I used reflective listening to allow the participant the opportunity to correct my understanding or add to their response. Surveys were distributed to the GCPHU end users as I was familiar with the role of this group in Part A of the system, however I wanted to quantify the simplicity and acceptability of the system.

Table 4.1. Key stakeholders involved with the Gold Coast Gastrointestinal Syndromic Surveillance System (GSSS) Part A and their involvement in the system evaluation.

Stakeholder group	Number of participants	Type of engagement	Role/s in GSSS Part A
GCPHU[1] end users – Data officers	2	Microsoft Forms survey	1. Analyse MIS[2] graphs to identify any presentation trends 2. Monitor MIS dashboard for any data errors 3. Export line-listed case data to conduct Part B
GCPHU end users – Epidemiologists	2	Microsoft Forms survey	1. Analyse MIS graphs to identify any presentation trends 2. Monitor MIS dashboard for any data errors 3. Export line-listed case data to conduct Part B 4. Troubleshoot issues and communicate with MIS experts as needed.
Consultant data scientists	0	No engagement	1. Develop dashboards for MIS using GCHHS[3] ieMR[4] data
GCHHS data engineers	2	Individual semi-structured video interviews	1. Maintain the MIS platform 2. Conduct quality control checks on MIS dashboards prior to moving them from the test environment to production

[1] Gold Coast Public Health Unit.
[2] Management Information System.
[3] Gold Coast Hospital and Health Service.
[4] Integrated Electronic Medical Record.

Evaluation of surveillance attributes

To evaluate the performance and overall usefulness of Part A of the GSSS, I focused on assessing the attributes of simplicity, stability, flexibility, acceptability, PPV, data quality, representativeness, and timeliness (Table 4.2). Data captured through stakeholder consultations, responses collected from the REDCap exposure survey sent to cases in Part B of the GSSS (Appendix C), and GSSS source data were analysed to assess these attributes. I did not assess the sensitivity of the ED source data for Part A of the GSSS because there was no capacity for a medical practitioner to verify the diagnoses codes for a sample of historical ED presentations, and very few presentations had diagnostic pathology performed. Without these means of assessment, I could not reliably confirm the true positives and assess the sensitivity of the system. Additionally, without access to ED data that was not coded as gastroenteritis, I could not identify any false negatives. Without these variables I could not confidently calculate the sensitivity of Part A.

Data sources

Part A of the GSSS uses a single secondary data source, ED gastroenteritis presentation data captured in the GCUH ED and Robina Hospital ED Emergency Department Information System (EDIS). The EDIS data is stored in the Hospital Based Corporate Information System (HBCIS). Once a patient is registered with HBCIS, a patient record in the GCHHS integrated electronic medical record (ieMR) will be created. A copy of all relevant ieMR data is automatically sent to the GSSS MIS dashboard every 10-15 minutes where it is displayed both visually and in a table. The table includes the following demographic fields; ED facility visited, arrival date, patient name, Unique Record Number (URN), age, gender, triage category at the ED, presenting complaint, diagnosis, time spent in ED, departure time, departure destination, mobile number, suburb, postcode, treating clinician, and consent to receive SMSs from the GCHHS. Data was extracted from the MIS dashboard (MIS data) as an Excel spreadsheet for analysis. The MIS data was used to assess the data quality, representativeness and PPV of Part A of the GSSS (Table 4.2).

Data captured through stakeholder consultation was tabled in Excel for analysis (Table 4.2). Core themes relating to the GSSS's simplicity, stability, timeliness, flexibility, and acceptability from each stakeholder group were manually extracted from the two semi-structured interviews with the GCHHS data engineers and free-text response fields from the GCPHU end-user survey. Attitudes towards these attributes were quantified using a Likert scale in the survey distributed to GCPHU end users.

Cases of notifiable gastroenteritis reported to the GCPHU (residence in GCHHS) between 1 January 2021 and 31 December 2023 were exported from NoCS to investigate the representativeness of the GSSS and to determine if the two systems were capturing the same individual people or the same population. For this evaluation, notifiable gastroenteritis was defined as a confirmed case of; campylobacteriosis, cholera, ciguatera, cryptosporidiosis, haemolytic uraemic syndrome, hepatitis A, hepatitis E, listeriosis, paratyphoid, salmonellosis, Shiga toxin-producing *Escherichia coli*, shigellosis (probable or confirmed), typhoid, or yersiniosis as per the Queensland Health grouping of notifiable conditions.(33)

Table 4.2. Attributes identified, data sources, and methods used to evaluate Part A of the Gold Coast Gastrointestinal Syndromic Surveillance System.

Attribute	Description	Data source/s	Evaluation method/s
Simplicity	The structure and ease of system operation	Stakeholder interviews & MIS data	Stakeholders described their role in the system and whether they were able to perform their role with ease. The flow, amount and type of data were reviewed using MIS data.
Stability	The reliability and availability of the system	Stakeholder interviews	Stakeholders were asked to consider any barriers to the ongoing reliability and availability of the system.
Timeliness	The speed between the steps involved in the system	Stakeholder interviews & process documents	Stakeholders were asked to quantify the time taken to complete their role with the GSSS. Process documents identified the actual time taken for the system to operate.
Flexibility	The ability for the system to adapt to changing needs or be integrated with other systems	Stakeholder interviews	Stakeholders were asked to identify how the system would respond to any level of change and if they have examples of how the system has responded to change in the past.
Acceptability	The willingness of users to participate in the system	Stakeholder interviews	Stakeholders were asked to express their willingness and ability to complete their roles and identify any barriers to participation.
Data Quality	The completeness and validity of the data recorded in the system	Stakeholder interviews & MIS data	Stakeholders were asked how data completeness affects their role and how this is managed. Data completeness was assessed using MIS data from 2018-2023.
Representativ-eness	The representation of the health event by time, person and place over time	MIS data NoCS	The description of cases by person, place and time was compared between the notifiable gastroenteritis reported to the GCPHU and MIS GSSS case data from 2021-2023. Case proportions were then compared with the general Gold Coast population using data from the 2021 Census.
Positive Predictive Value	The proportion of cases in the system that did have the health event identified	MIS data	PPV estimates were calculated using the GSSS Part B survey data from 1 February 2024 to 30 September 2024 as a proxy for diagnoses confirmation.

Results

Description of the GSSS, its purpose, stakeholders, and operation

Part A of the GSSS aims to use ED syndrome data to identify instances of gastroenteritis in real time that are missed by traditional surveillance, allowing the GCPHU to better quantify the community incidence of disease and provide targeted public health education as necessary.

The population captured within Part A of the GSSS are individuals who present to either the GCUH ED or Robina ED with gastrointestinal illness. Once seen by a healthcare professional about their presenting complaint, a preliminary diagnosis is entered into ieMR using either a designated ICD-10 or SNOMED CT code. This is standard practice across healthcare settings and is not done specifically for the GSSS, as such, ED clinicians have not been included as system stakeholders for the purpose of this evaluation. If the assigned diagnosis code matches a list of pre-determined codes relating to gastroenteritis (Appendix D) the encounter will be included in the MIS gastroenteritis dashboard when it next automatically refreshes, every 10-15 minutes. This dashboard includes the patient data as a line-list as well as a series of visualisations that illustrate whether patient presentation counts for gastroenteritis have increased or decreased or are above the expected upper limit during the current day per hour or over a date period of choice, which Gold Coast suburbs have seen the most gastroenteritis cases during this period and which diagnosis codes have been most frequent. The process in which data is transferred from ieMR to the MIS platform is automated and does not require human intervention.

Each weekday morning, a data officer or epidemiologist from the GCPHU will log in to the MIS platform to review the gastroenteritis presentation dashboard before exporting the case line-list to action Part B of the GSSS. Using the various visualisations, the user will identify any unusual patterns or trends that may indicate a potential outbreak or cluster of gastrointestinal illness. There is no documented threshold for what constitutes a potential outbreak for investigation, however, should the user identify a change in gastroenteritis trends e.g., the previous two days of presentation data had spiked above what is expected or if year-to-date gastroenteritis presentations are trending above the five-year mean, the user would flag the signal with the Advanced Epidemiologist for consideration and further action. Each day, regardless of whether a signal is detected or not, the line graph depicting the previous seven days of ED gastroenteritis presentation data is exported from MIS and sent to the Epi, CDC and EH teams for awareness.

This presents another opportunity for expert public health staff to review the presentation data trends.

The MIS gastroenteritis dashboard, as well as any other MIS dashboards used throughout the GCHHS, is maintained by a small team of data engineers at the GCHHS. Each morning they will open the MIS platform and check to see if any of the automated data processes have failed overnight or throughout the morning. If all is working as usual, they will not look at any MIS dashboard independently. If an issue is flagged with the data upload, or if an end user such as the GCPHU identify an issue with a specific dashboard, they will investigate as needed. They are not responsible for making operational changes to the MIS dashboards, this is the responsibility of a consultancy company contracted by the GCHHS. Should a system fix be identified, or a change be requested by an end user or data engineer, the consultant company are responsible for the execution of the fix or change. After a change is executed, the GCHHS data engineers will perform quality control processes prior to deploying the change to the MIS user interface.

Data quality

The data used in Part A of the GSSS is a direct copy of the data entered into the GCHHS ieMR at the hospital which automatically pipes through to the MIS dashboard. The GCPHU does not have any responsibility for the entry of data into MIS.

Data quality was primarily assessed by reviewing the proportion of fields within the MIS dataset which were blank or unknown between 2021 and 2023 (Table 4.3) and asking GCPHU end users how missing data would impact their role in Part A of the GSSS.

Table 4.3. Proportion of missing data in the Management Information System gastroenteritis dashboard by key variables used by the Gold Coast Public Health Unit in Part A of the Gastrointestinal Syndromic Surveillance System, 2021 to 2023.

Variable	Year						TOTAL n=13,379	
	2021 n=4,103		2022 n=4,656		2023 n=4,620			
	n	%	n	%	n	%	n	%
Name	0	0	0	0	0	0	0	0
Age	0	0	0	0	0	0	0	0
Gender	0	0	0	0	0	0	0	0
Diagnosis	0	0	0	0	0	0	0	0
Suburb	7	<1	30	<1	13	<1	50	<1
Postcode	32	<1	59	1.3	98	2.1	189	1.4
Mobile number	156	3.8	151	3.2	160	3.5	467	3.5
Consent for SMS*	170	4.1	174	3.7	196	4.2	540	4.0

*Consent for patient to receive SMS messaging was introduced on 15 August 2023. Data was retrospectively updated in MIS which is why missing data is available prior to this date.

Between 2021 and 2023, there were no unknown or missing data for the variables: name, age, gender, or diagnosis. This was expected as these variables are primary demographics collected upon hospital presentation. This allows us to accurately describe the surveillance population by age and gender. Mobile number was missing for between 3-4% of cases each year. On 15 August 2023, the GCHHS added a new field to the dashboard which indicated whether the patient had consented to receiving SMSs about their hospital care. Between 15 August and 31 December 2023, 3.5% (70/1,980) of gastroenteritis presentations had a missing consent status, of these, 90% (63/70) also did not have a mobile number recorded. Missing or unknown data for mobile number and consent does not affect the aim of Part A of the GSSS, the system is still able to identify gastroenteritis cases and presentation trends. However, without a mobile number or SMS consent, the GCPHU cannot send these cases the exposure survey for Part B of the GSSS.

Less than 1% of all records between 2021-2023 were missing suburb data and less than 2% had missing values for postcode. Of those records where postcode was missing or unknown, 100% (n=189) had either missing or unknown suburb data, or had suburbs outside of Australia. In 2024, the GCHHS developed an official process for registering a patient with an overseas residential address to prevent missing or unknown data. The new process is to enter '*OVERSEAS-OTHER*' in the 'Patient Registration' suburb field, which automatically populates the postcode as 9399, before completing a separate 'Overseas Details' form where specific country and postcode is requested and marked *'NOT-STATED'* and 0003 if unknown.(34) Overseas-resident gastroenteritis cases that presented between 2021 and 2023 will only have their suburb and postcode data updated to the new process if they re-present to a Gold Coast public hospital, no retrospective data cleaning will occur. While incomplete suburb and postcode data does not impact the ability of the Part A to identify gastroenteritis cases, these variables would be useful during an international event such as the 2032 Games to describe the demographics of cases and identify any potential cultural clusters.

When the four GCPHU end users were asked about the data completeness of the MIS dashboard and how incomplete data would affect their work, majority of users (75%) indicated that the data is largely complete for the purpose of Part A, and that missing data would not affect their roles in Part A, but that Part B would be impacted by missing mobile and SMS data. One respondent indicated that the data was largely incomplete but when asked how this impacts their work, they said *'It is complete as it needs to be for surveillance purposes, that said, we don't really know denominators or cases that have been missed'*. Overall staff confirmed the system data is complete for operational purposes.

Representativeness

Representativeness was assessed by describing the MIS data between 2021-2023 by person and place and comparing these results to the composition of the general Gold Coast population as outlined in the 2021 Census both as proportions and rates. Additionally, presentation data was compared to notifiable gastroenteritis data collected in NoCS to determine if Part A of the GSSS was capturing the same population or was acting as a supplementary source of surveillance intelligence.

Between 2021-2023, there were 13,379 presentations to the GCUH and Robina EDs that were coded as gastroenteritis. The median age at presentation was 23-years (range 0-101-years, IQR 3-45-years) and females represented 59.1% (n=7,902) of presentations. When excluding non-Gold Coast residents and those with unknown or missing suburbs (n=2,000, 14.9%), the most frequented suburb of residence for gastroenteritis presentations was Southport (6.9%) followed by Pimpama (6.4%) and Upper Coomera (5%). In total, the rate of gastroenteritis in Gold Coast residents was 1,820 cases per 100,000 population.

During the same period, there were 5,230 cases of laboratory-confirmed gastroenteritis notified on the Gold Coast. The median age for notifiable gastroenteritis was older than the GSSS at 37-years (range 0-101-years, IQR 18-60-years). Comparatively, females represented a smaller proportion of illness (49.0% (n=2,565)) compared to the GSSS. Only looking at cases with a Gold Coast address (n=5,218, 99.8%), the most frequent suburb of residence was Southport (4.8%) followed by Robina (4.0%) and Upper Coomera (3.9%). The NoCS had a smaller proportion of non-Gold Coast residents recorded, however this is expected given notifications made to the Gold Coast are those who are residents and residents of other regions will be allocated to that region. In total, the rate of gastroenteritis in Gold Coast residents was 835 cases per 100,000 population.

Both the GSSS and NoCS have a large proportion of gastroenteritis cases in the 0-4-years age group, 27.8% and 13.1% respectively. According to the 2021 Gold Coast Census (35) this age group represents 5.4% (n=33,491) of the total population, indicating this age group is disproportionately affected by gastrointestinal illness. The 0-4-years age bracket had the highest rate of disease per 100,000 population using GSSS data with 11,101 cases compared to 2,063 cases per 100,000 using NoCS data. Both systems captured similar proportions of cases aged 5-34 years; however, NoCS showed a more even distribution across age groups thereafter, suggesting that older adults are underrepresented in the GSSS. Additionally, females make up 51.5% of the Gold Coast population, slightly less than what is represented in the GSSS. Finally, Southport is the most populous suburb on the Gold Coast, housing 5.9% of the population, followed closely by Upper Coomera, Robina and Pimpama. This likely explains the high proportion of cases in both NoCS and the GSSS residing in these suburbs.(35)

Positive predictive value

The GSSS does not use confirmatory diagnoses to identify gastroenteritis trends, limiting its ability to accurately determine true or false positives. Furthermore, very few individuals with gastrointestinal illness visiting the ED are asked to complete confirmatory testing, making laboratory confirmation largely unavailable to verify disease status. To calculate the PPV, the triage question in the exposure survey in Part B was used as a proxy to identify true and false positives. In this section, patients are asked whether their diagnosis at the hospital was caused by gastroenteritis or another condition. If they indicate a different cause, they are prompted to specify what that was, however, this field is not mandatory. As this question was only implemented in February 2024, a sample of data between 1 February and 30 September 2024 was used for this analysis.

Between 1 February and 30 September 2024, MIS identified 2,092 gastrointestinal illness presentations. After accounting for individuals who completed more than one survey (n=55) for the same ED presentation, a total of 744 exposure surveys (35.6%) were completed and included in this analysis. Of these responses, 60.2% (n=448) said their symptoms were caused by gastroenteritis, 21.2% (n=158) were unsure, 14.9% (n=111) said their symptoms were caused by another condition, and 3.6% (n=27) left the question blank. When looking at the records where another condition was indicated, 62.2% (n=69) indicated that they knew what caused their illness, 18.0% (n=20) were unsure of the cause, 18.9% (n=21) did not know what caused their illness, and less than 1% (n=1) left the field blank. Of those who indicated they knew what caused their gastrointestinal illness (n=69), the most common responses, excluding those who chose not to answer (n=20, 29.0%), included an allergy or reaction (n=9, 18.4%), followed by bowel or colon conditions (n=6, 12.2%) and respiratory conditions (n=6, 12.2%), then pregnancy-related hyperemesis (n=4, 8.2%). Six (12.3%) respondents reported gastroenteritis-related conditions (e.g., food poisoning). Despite acknowledging they had gastroenteritis, because these individuals had selected 'other condition' they are not asked to complete the rest of the survey and as such, the GCPHU may miss actionable information. This result suggests the question's phrasing may need revising to prevent misinterpretation and skewed results.

Using these results, there were 448 true positives and 111 true negatives for a PPV of 80.1% indicating that for every 100 cases identified by the GSSS, 80 would be true infectious gastroenteritis cases. Individuals who were unsure what caused their gastroenteritis or left the field blank were excluded from the PPV calculation.

$$\frac{448}{448 + 111} = 0.801$$

Because the focus of Part A is on real-time case detection, the benefits of capturing all instances of gastroenteritis in a timely manner outweigh the risks associated with including a small proportion of false positives, as such, an estimate PPV of 80.1% is appropriate. While the estimated PPV is favourable in this scenario, it may suggest the case definition would benefit from refinement to further reduce the detection of false positives. The data used in Part A are the diagnosis codes classified by clinicians upon the patient's initial ED presentation. If the GSSS were to wait for refined diagnoses as more information becomes available for each patient, this would hinder the overall timeliness of the system. In attempt to improve the Part A PPV without disrupting clinician processes (36) or affecting the timeliness of the system, it is recommended the GCPHU investigate which codes trigger data flow to MIS and whether these codes are specific enough to meet the aim of Part A. By refining the coding logic, the GCPHU should be able to eliminate some of the cases from the system who may have other conditions and are false positives. This would help to reduce unnecessary public health follow up by staff in Part B of the GSSS.

Because this calculation is based on a small sample of cases identified in the GSSS who completed the exposure survey after the triage question was introduced, it cannot be implied that this result is representative of the GSSS population under surveillance. As more survey data becomes available, or if another method of case validation is identified, further validation with a larger sample would strengthen the accuracy of the PPV estimate.

User acceptability and system simplicity

The amount, type and flow of data used for Part A are representative of a simple surveillance system. To meet the aim of the GSSS, only a diagnosis code is required to establish that the case definition has been met. The additional demographic data made available is not required for gastroenteritis signal detection, however it supports the description of the surveillance population. All data used for Part A is secondary data requiring no additional public health resources and the integration between ieMR and MIS is completely automated. Should the GSSS move to another platform in the future, the source data (ieMR) would stay the same and continue to be fully integrated.

Once data is made available in MIS, the Epidemiology and Data team at the GCPHU execute Part A of the GSSS as part of their daily business. In the GCPHU end-user survey, no participants reported any barriers to engaging in Part A of the GSSS, and all participants indicated that all steps throughout the process are relatively easy. Overall, experienced staff reported the process was straightforward and it could be completed in about 15 minutes. In contrast, less experienced staff indicated that it might take them up to 30 minutes. This difference in timing likely reflects their varying levels of experience and confidence rather than any issues with the system itself. A review of internal documents indicated there are standard operating procedures (SOP) to support staff in the execution of Part A, further reducing participatory barriers.

The GCHHS data engineers indicated that maintaining the MIS dashboards is relatively easy and only occupies a small proportion (approximately 5%) of their daily responsibilities. Both staff members advised they have access to SOPs to support their work, and they have no technical or operational barriers which would prevent them from supporting Part A of the GSSS. Should a technical error arise, both respondents indicated it would be a simple fix, with the greatest barrier to resolution being the communication required between parties to understand the problem or change in a timely manner.

Stability and flexibility

The MIS dashboard has been used for Part A of the GSSS for almost seven years. GCPHU end users indicated that generally, the MIS dashboard has been readily available over this period. However, all staff indicated the dashboard is somewhat unreliable. One staff member reported *'MIS has broken a few times in the past. GCPHU staff have no ability to control or fix the system'*. On the rare occasion when the GCPHU does find an error or need to change something in the dashboard, a GCPHU epidemiologist will alert the GCHHS data engineers via email, who forward the information to the external developers for action. After this, there is back-and-forth email communication between all three parties to confirm elements of the request. Once actioned, the developers then run the fix by the GCHHS data engineers for quality control before the GCHHS team launch the change in the MIS the test environment. The GCPHU end users then are asked to review the change in the test environment and provide any feedback. Once all parties are happy with the change, the GCHHS data engineers will launch the change into the MIS production environment. All GCPHU staff said that requesting a change is somewhat difficult, and having the change actioned can be very difficult. Qualitative responses indicated the difficulty tends to arise from delayed and informal communication between parties and the lack of institutional knowledge from the external developers. It must be acknowledged that at the time of evaluation, there was an ongoing data error in the dashboard which had taken over six months be resolved due to operational priorities and the MIS dashboard being transferred to a new system. The timing of this event may have influenced the survey responses regarding system stability and flexibility.

The GCHHS data engineers had an alternate perspective on the stability and flexibility of the MIS dashboard. The dashboard is a QlikView business intelligence tool which has been modified for the GSSS. Staff indicated that the tool is very stable in its current format and is unlikely to become unavailable or impact operational requirements of the GCPHU. Both respondents indicated the greatest threat to daily system operation would be the delay in data provision by the automated feed, however because the entire GCHHS ieMR system relies on this feed, any issues are swiftly resolved. When it was first developed for the Games, load testing was performed with no issues. However, since there are fewer end users in 2024, no load testing is currently conducted, increasing the risk of system failures. One staff member noted that if Part A of the GSSS were expanded to cover a larger geographical region for the

2032 Games, the existing MIS dashboard would not cope with the increased data load. Another GCHHS data engineer advised that if the current MIS platform were successfully expanded state-wide for the 2032 Games, the existing GCHHS MIS team would have the technical and operational capacity to provide the required maintenance support.

In the current format, GCHHS staff will review the dashboards each morning to identify any issues with the data flow from ieMR, however they will not monitor the logic behind the dashboards, leaving the potential for hidden errors to occur. As previously discussed, changes to the dashboard are not made by the GCHHS engineers, but they are responsible for performing quality assurance checks after changes are made by the external developers. Interviews with GCHHS staff suggested MIS is generally quite flexible, and changes are technically very easy, however they are not within their scope. The GCHHS data engineers are also responsible for MIS administration. Both staff indicated that if the GCPHU required a new user to be added to the MIS dashboard, it could be completed on the day of the request.

Timeliness

Part A of the GSSS aims to identify instances of gastrointestinal illness in near-real time to give the GCPHU a timely picture of community incidence, rather than relying on the delays and limitations of traditional laboratory-driven surveillance.

The MIS dashboard automatically refreshes every 10-15 minutes, pulling in any new gastroenteritis coded ieMR data and updating the visualisations. This process ensures that the dashboard delivers information in real time, offering timely insights into community gastroenteritis incidence. The GCPHU team routinely review the dashboard once in the morning on business days. Should there be an outbreak, or if there is a mass gathering event of interest like the Games, the GCPHU could check the dashboard sporadically throughout the day.

Gold Coast Public Health Unit end users were asked to quantify the time taken between logging on to the MIS platform, reviewing the gastroenteritis trend visualisations, exporting the seven-day presentation graph, and logging out. Majority of survey respondents (75%) indicated the process takes less than 15 minutes to complete each day, with one respondent indicating it can take up to 30 minutes.

Usefulness

To highlight the overall usefulness of Part A of the GSSS, the evaluated attributes have been summarised.

Part A of the GSSS detects instances of community gastroenteritis in an extremely timely manner, successfully meeting its aims and objectives. The execution of Part A allows the GCPHU to observe trends in disease incidence and identify whether case numbers are above what is expected and are indicative of an outbreak, based on several years of historical system data. In the stakeholder survey, a GCPHU end user noted, '*A system that is live and pulling real-time data is helpful for being able to pick up changes [in gastroenteritis] in a timely manner and be able to act on the data*.' This statement reflects the staff's recognition of the importance of real-time data and their willingness to engage with the system.

The system's PPV of 80.1% is appropriate for the aims of the GSSS, with a proportion of false positives being accounted for in the Part B exposure survey. Overall, the system process is straightforward and mostly automated, requiring minimal resources, and end users are generally supportive of its use. Most importantly, the data collected in Part A of the GSSS informs the actions of Part B, where common exposures are identified and are followed up by public health officials to prevent further disease transmission.

For the past seven years, the GSSS has proven to be a valuable tool in supplementing traditional gastroenteritis surveillance methods. In 2023 alone, the GSSS Part B identified 15 new community gastroenteritis outbreaks and was able to link 26 additional cases to known or previously reported outbreaks.(37) Without Part A informing Part B, these cases would potentially go unreported and unmanaged by public health, allowing onward transmission and increased community burden.

Discussion

This project evaluated the case identification process (Part A) of the Gold Coast's enhanced syndromic surveillance system.

The timeliness and high PPV of the GSSS supports real-time analysis, however the Part B survey continues to identify a small portion of cases who believe they did not have gastroenteritis. This suggests individuals are either being reclassified after the data has already been submitted to Part A of the GSSS, the codes used to identify cases are not specific enough to do so consistently and accurately, or the questions in Part B are not clear enough. While the GSSS currently meets the aim of traditional syndromic surveillance in that it detects large public health events rather than individual cases of illness,(38) the enhanced component of the GSSS relies on the accurate detection of cases in Part A, and the honest responses recorded in Part B. As such, it is recommended the GCPHU formally evaluate the case identification codes and assess them against those used in the New South Wales (NSW) Health state-wide Public Health Rapid, Emergency, Disease and Syndromic Surveillance (PHREDSS) system, established and expanded in 2003 to support the Rugby World Cup in Sydney, as the most-established local comparison. Should it be identified that specific codes need to be added, or excluded, these changes should be thoroughly tested using retrospective data, with staff weighing up the potential for the new coding to impact historical trends and future reporting.(39) Revision of survey questions in Part B was last evaluated in 2022 and would benefit from further review to ensure clarity of questions.

Additionally, syndromic surveillance depends on trained surveillance officers to identify signals. The GCPHU does not have a defined threshold to identify if a signal has been detected. This reliance on human judgment can introduce variability in detecting true public health events, further complicating the assessment of the system's sensitivity.(40) This evaluation did not directly assess the sensitivity of outbreak detection as this predominantly occurs through Part B of the GSSS. However, recent events have suggested Part A is failing to detect large community outbreaks of gastroenteritis independently of Part B. In the summer of 2023 to 2024, the Gold Coast experienced a large *Cryptosporidium* (crypto) outbreak where more than 250 cases were notified in NoCS. Crypto causes gastrointestinal illness that is relatively mild, however symptoms can be severe for people who are immunocompromised. During the outbreak, the GCPHU expected to see a rise in gastroenteritis cases beyond the normal summer peak on the GSSS MIS dashboard as both NoCS and Part B had identified cases with crypto diagnoses. However, the dashboard did not indicate that cases were higher than expected. Without an enhanced follow-up component, outbreaks caused by non-notifiable conditions with mild illness, such as crypto, might go undetected by Part A of the GSSS.(41,42) A study by Colón-González et al. (41) evaluated the sensitivity of several syndromic surveillance systems in England for detecting community crypto outbreaks. This evaluation found that small, regional outbreaks would require over 900 people to be exposed per day for the ED surveillance system to detect them, and that detection would likely only occur after three weeks, limiting timely public health action. It is recommended that the GCPHU use historical baseline data to establish a threshold for signal detection that accurately represents local, seasonal trends, to enhance the early detection of community outbreaks.

The GSSS was not representative of the Gold Coast population. This is likely attributed to the limited occurrence of severe gastroenteritis outbreaks on the Gold Coast. Almost one third of cases identified by the GSSS were children aged less than four years. This is not unexpected, as young children are particularly vulnerable to developing gastrointestinal illness compared to older children and adults. Their weaker immune systems and frequent exposure to group settings such as childcare make them more prone to contracting gastroenteritis, often multiple times throughout their childhood.(43,44) This age group is also at higher risk of severe disease compared to older age groups due to dehydration and is more likely to seek urgent healthcare support rather than wait for an appointment with a primary care provider.(44-47) While Australian children aged less than 5-years have the highest rates of gastroenteritis-related general practitioner (GP) visits per capita, adults aged 15-64-years are estimated to account for largest proportion of gastroenteritis-related GP visits (66.4%).(44) This age group represents 47.6% of GSSS cases, suggesting adults are more likely to seek care for gastroenteritis from a GP rather than presenting to an ED.(48) However, adults also tend to experience milder gastrointestinal symptoms with most illnesses lasting a maximum of two days.(24) Research shows that Australians are statistically more likely to visit a GP or other care provider if their symptoms persist for three days or longer,(24) as such a proportion of adults with mild symptoms may not seek care at all and are likely missed by both traditional and syndromic surveillance systems. Overall, there were more females than males in both the GSSS and NoCS datasets. This is not unexpected as females are traditionally more likely to seek healthcare than males. Between the 2022 and 2023 financial year, 86.9% of Australian females saw a GP compared to 77.6% of males,(49) and females accounted for 51% of all ED presentations.(48) Despite the GSSS not being entirely representative of the Gold Coast community, it remains effective at capturing the impact of gastroenteritis on young children and monitoring ED trends.

By expanding Part A data sources beyond the ED, the GCPHU will be able to capture a broader range of cases, including milder instances, which will provide a more accurate picture of community incidence and increase the opportunity to detect outbreaks. The 2018 evaluation of the several syndromic surveillance systems run by the Real-time Syndromic Surveillance Team at Public Health England (41) revealed that while ED data successfully detected 100% of influenza outbreaks observed during the study period, it was insufficient for detecting gastrointestinal outbreaks, specifically outbreaks of crypto, with outbreak detection sitting between 15-47% across three ED facilities. However, the inclusion of additional data sources such as General Practitioner consultations increased the detection to up to 95% in some locations. On the Gold Coast, additional sites for surveillance could include the new Banyahrmabah Satellite Hospital in Tugun which serves as a walk-in healthcare site for non-life-threatening injuries and illnesses, potentially capturing instances of gastroenteritis which are less severe. This hospital is part of the GCHHS network and uses the same data systems as GCUH and Robina, reducing the risk of interoperability concerns. While the use of private general practice data is not feasible for the GSSS financially or logistically, the support of Commonwealth-funded Medicare Urgent Care Clinics is yet to be explored. These clinics may help to identify non-urgent instances of gastrointestinal illness, potentially filling the gap left by the current GSSS. The use of 13HEALTH data and sentinel pharmacies should be reconsidered, if not as routine data sources, but for the capacity to scale up surveillance during large events such as the 2032 Games. However, without access to a unique identifier, particularly if pharmacies or 13HEALTH are involved, using multiple data sources across different levels of healthcare carries the risk of signal inflation, as the same individual may present at multiple points of care.(39)

While syndromic surveillance systems are often intended for early outbreak detection, particularly during mass gathering events, their real value frequently lies in using routine data to track outbreak size and spread after detection and to provide reassurance that an outbreak has not occurred.(38,41,42) This is particularly relevant for gastroenteritis where illness is primarily mild.(42,50-52) A study from England (42) used retrospective national gastrointestinal syndromic surveillance data and eight localised outbreak reports to investigate whether the syndromic surveillance systems supported the detection of the outbreaks. The study indicated that syndromic surveillance systems failed to detect all eight gastrointestinal outbreaks, but generated weak signals that in the context of a confirmed outbreak would have contributed to outbreak management efforts. Furthermore, learnings from the London 2012 Olympic and Paralympic Games (13) identified that while no significant public health events were detected through routine or event-specific forms of syndromic surveillance, providing reassurance to organising bodies, the media, and the public, that no gastrointestinal illness, specifically norovirus, was spreading was vital to communicate for peace of mind. The concept of using a syndromic surveillance system to show not only the presence, but absence of disease outbreaks should be embedded as a core concept within the development of future surveillance systems. This will not only foster public confidence in reporting authorities but alleviate fears during mass gatherings or during an outbreak response.

A sustainable syndromic surveillance system relies on strong stakeholder relationships and a shared understanding between public health users, data providers, and data recipients.(36) Using two decades of syndromic surveillance evaluation data in England, Smith et al. (2019) reported that syndromic surveillance activity must be beneficial for the surveillance team, without being onerous on the data provider, similar to that of a pathology provider and a nationally notifiable disease system. Without the case data, the secondary purpose of syndromic surveillance is obsolete. Smith identified that surveillance teams must develop and maintain trust and transparency with the data custodians, as if there is a breach of trust or misunderstanding, it could jeopardise the execution of the syndromic surveillance system. Stakeholder interviews with the GCPHU team suggested the technological and operational aspects of Part A are simple, easy to perform and relatively stable. However, both groups identified that while changes to the system dashboard are theoretically easy to perform, there are no set guidelines relating to change requests, resulting in miscommunication between parties, delayed results, and decreased user acceptance. This disrupted relationship resulted in a long delay in system improvement, compromising the accuracy and usability of the GSSS during the study. To improve the flexibility and user acceptability of Part A, it is recommended that an official data error notification process and change request process is developed and both parties remain in contact regularly to maintain a positive stakeholder relationship.

When developing and implementing a surveillance system it is important to consider the human resources that will be required as the systems changes, and as staff turnover inevitably occurs.(53,54) The 2010 Practical Guide for Implementing Syndromic Surveillance in Pacific Island Countries and Territories (54) states that regular staff training and re-training is essential to ensure the syndromic surveillance outputs are consistent when faced with staff turnover. It is also recommended that system managers train and familiarise external partners in advance to increase capacity if local workforce is limited during a mass outbreak scenario. GCHHS data engineers indicated that should the GSSS be expanded beyond the geography of the Gold Coast, they would have the technical and operational capacity to maintain it. While this may be true at the time of interview, regardless of whether the GSSS remains local or is expanded, it is recommended the training of new staff, both IT and surveillance-focused, on the Gold Coast and across Queensland is prioritised to support the integrity and longevity of the system.(36,55)

It is important to note that the MIS dashboard currently used for Part A is scheduled for decommissioning in the coming months. The MIS system is being replaced by a new hospital management system, SystemView, that aims to improve GCHHS reporting capabilities by allowing staff to visualise ieMR data that is collected by the GCHHS. The GCPHU are currently working with the system developers to ensure recommendations from this evaluation are incorporated into the SystemView development. This includes the revision of gastroenteritis coding logic, the need to perform regular system testing and the development of an appropriate feedback loop to better communicate current and anticipated system failures. Aspects relating to the simplicity, stability, flexibility and timeliness of the case identification process will need to be reassessed after the implementation of the new dashboard as results may vary.

Finally, there are no standardised protocols for case and outbreak detection using syndromic surveillance on the Gold Coast, in Queensland or Australia. Similar to findings reported in local (56) and international evaluations,(57-61) the lack of agreed best practice and comparable literature complicates the ability to assess and validate the system against others. The 2008 evaluation of the use of PHREDSS in a local region by the Hunter New England Public Health Unit (56) identified that each region captured within the PHREDSS system may have differing ED management and data practices to other regions, and different alert thresholds to other surveillance systems, and as such their evaluation has limited generalisability. They also recognised that without specific local and state surveillance objectives and measures, larger community outbreaks are likely to be detected, but smaller, local outbreaks may go undetected unless part of a mass gathering or disaster response. Establishing state or national guidelines that incorporate local distinctions would enhance the integrity of syndromic surveillance systems. The GSSS, like many other syndromic surveillance systems, operates as a local system reliant on specific infrastructure, public health operations and of course, has been designed and influenced by the local epidemiology of the condition under surveillance. As such, the GSSS is context-specific cannot be accurately compared other syndromic surveillance systems including the well-established NSW Health PHREDSS system.(63) Therefore, the specific recommendations in this report should not be generalised, but instead serve as a guide to inform syndromic surveillance system planning and evaluation considerations.

Recommendations

Part A of the GSSS is an effective resource to identify trends of community gastroenteritis, and as such, it is recommended the system continues. Based on the evaluation of the Part A system attributes, there are several recommendations (Table 4.4) which would aim to improve the efficiency and overall usefulness of Part A and in-turn, Part B:

Table 4.4. Key issues identified with Part A of the GSSS and proposed recommendations for the GCPHU.

Item	Identified issue and associated recommendation/s
1	*The coding logic used to identify gastroenteritis cases at the hospital has not been formally evaluated since the inception of the GSSS.*
	Audit and amend the gastroenteritis coding logic to improve the sensitivity and specificity of the case definition, in turn, improving the PPV: 1. Audit historical GSSS ED data with the support of a public health physician to identify if the codes used are diagnostically appropriate. 2. Review the MIS source coding list according to the audit results. 3. Link the Part B exposure survey responses indicating they had another condition with their original ED diagnosis code. See if there is a common code causing false positives. 4. Identify any codes that are missing or should be excluded from the list. Keep in mind specificity in relation to the aims of the GSSS. 5. Compare the list with the NSW PHREDSS gastroenteritis codes list. Identify any differences. 6. Test the codes using retrospective GSSS data. Identify how the new list will impact trends and overall positive predictive value. 7. Implement new coding logic as necessary. 8. Reevaluate the Part B exposure survey triage question to assess whether the change in coding has improved the PPV.
2	*The population captured by the GSSS is heavily represented by young children aged 0-4. Improve the representativeness of the GSSS by considering additional data sources.*
	Develop an options paper regarding the expansion of GSSS source data beyond that of ieMR from two public hospitals. Consider the addition of sentinel sites, specifically when surveillance is required to scale up during mass gathering events. Consider: 1. Reinstating pharmacy sentinel sites. 2. Reinstating 13HEALTH call data. 3. Presentations at the Banyahrmabah (Tugun Satellite Hospital), also a GCHHS site. 4. Presentations to the Gold Coast Medicare Urgent Care Clinic. Potentially as a sentinel site during mass gathering events.

<table>
<tr><th>Item</th><th>Identified issue and associated recommendation/s</th></tr>
<tr><td rowspan="2">3</td><td>Stakeholders identified requesting changes or rectifying system errors can be difficult due to a lack of formal change request processes.</td></tr>
<tr><td>Consult with GCPHU end users, GCHHS data engineers, and the external system developers to develop a formal change request/error notification process.

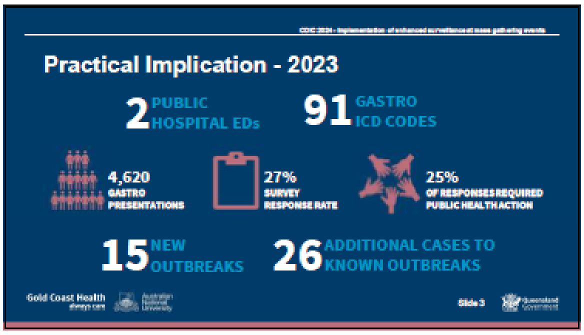
1. Develop a SOP indicating how GCPHU end users can request changes or notify errors and who should be contacted.
2. Develop a form that details the error/change needed, what it is impacting, how urgent the fix is, and contact details of the primary end user, to support the data engineers and consultants to better understand the context and action the request.</td></tr>
<tr><td rowspan="2">4</td><td>The current MIS gastrointestinal illness dashboard is not actively monitored by technical staff, nor is any routine system testing performed, increasing the risk of system failure.</td></tr>
<tr><td>When the GSSS is transferred to the new replacement dashboard, consult with GCPHU end users and the external system developers to implement routine system testing with an appropriate feedback loop to communicate the stability of the system and prevent system failure.</td></tr>
<tr><td rowspan="2">5</td><td>There are no pre-determined thresholds for GCPHU staff to know when a signal has been detected, reducing the overall sensitivity of the system.</td></tr>
<tr><td>GCPHU to review the historical gastroenteritis presentation data and identify seasonal thresholds which would support staff in the identification of an accurate signal for public health investigation.</td></tr>
<tr><td rowspan="2">6</td><td>The GSSS only monitors community instances of gastroenteritis. Additional syndromes should be explored to broaden the capacity of the GSSS and improve overall local disease surveillance. Not all syndromes will require an enhanced SMS survey component, but rather can be used to supplement traditional case-based surveillance.</td></tr>
<tr><td>GCPHU to work with the SystemView developers to include additional syndromes to the dashboard such as refining influenza-like illness coding, fever, rash or other. Review PHREDSS syndrome coding as an example.</td></tr>
</table>

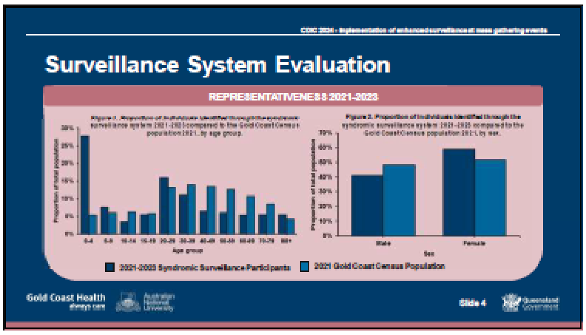
Based on the insights gained from this evaluation, several key considerations have been outlined to guide the planning of other syndromic surveillance systems, including the planning for the 2032 Games:

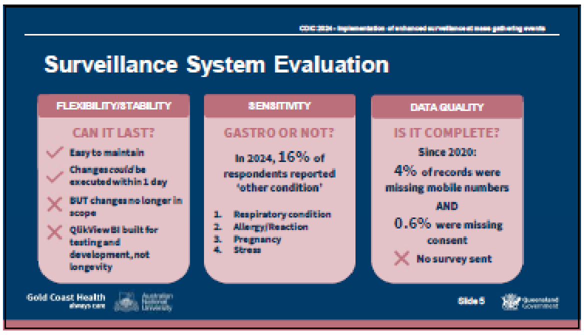
Table 4.5. Considerations for case identification and system management of future syndromic surveillance systems.

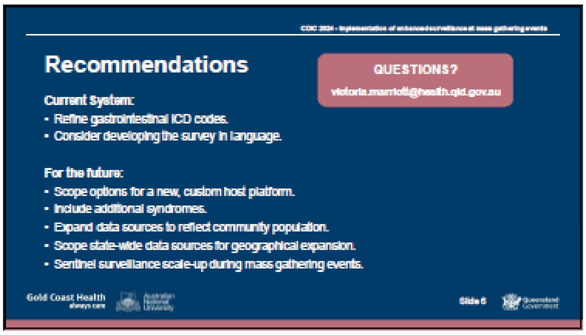
Item	Consideration
1	Formally define the aims, objectives, operation, and evaluation timeline of your system to prevent business continuity risks and to remain accountable.
2	If developing the system for a single event, consider the legacy of that system in a business-as-usual environment. Consider the resources needed to operate and maintain the system after the event, including training and upskilling staff.
3	Identify and define thresholds for: • Sensitivity • Specificity • Positive predictive value • Signal detection • Outbreak identification This should include thresholds during period of enhanced surveillance such as during a mass gathering event, and periods of routine surveillance. Include this information in a standard operating procedure to support staff participation.
4	Formally document the data flow, data management and data security aspects of the system to prevent business continuity risks and to remain accountable.
5	Establish and document an official system change request procedure to prevent miscommunication between stakeholders, reduce delays in execution and formally record when a change has been made for auditing purposes.
6	Reduce the reliance on external consultants for the ongoing maintenance of the system. Support in-house training to prevent delays in identifying or correcting system errors.
7	Schedule routine system testing to identify any problems and create a feedback loop so end users are made aware of issues in a timely manner.
8	Identify a range of data sources that will ensure the population under surveillance is representative of both the epidemiology of the condition and the geographical population. This will involve identifying sentinel sites which can support case identification during periods of enhanced surveillance such as the 2032 Games. Consider how these sources might impact your baseline sensitivity, specificity and positive predictive value.
9	Follow your evaluation timeline and action recommendations as necessary to ensure the system remains useful.

Appendix A – Project slides from CDIC 2024









Appendix B – Interview and survey questions to inform stakeholder consultations

B.1. Semi-structured interview prompts for GCHHS data engineers

These prompts were used to guide discussion with GCHHS data engineers. Questions were slightly adapted during the discussion as needed.

System description and stakeholders	
1	Can you please describe your role at the GCHHS?
2	How are you involved with the MIS dashboard?
Simplicity The structure and ease of system operation	
3	As MIS administrators, how easy is it to add a new user to the MIS dashboard?
4	How are data made available in MIS? How does it flow from the hospital to the dashboard? Are there any issues with this system integration? If yes, please describe them.
Stability The reliability and availability of the system	
5	Noting MIS has turned off several dashboards recently and various data coding errors have been identified in the gastro dashboard, how stable do you think the gastro dashboard is? Why?
6	Do you think the MIS gastro dashboard will be turned off? Why/why not?
7	Does your team perform any system load testing? If yes, how frequently and what are the results? If no, why not?
Timeliness The speed between the steps involved in the system	
8	How much time would you spend on the MIS gastro dashboard maintenance?
9	How often is the MIS dashboard updated?
Flexibility The ability for the system to adapt to changing needs or be integrated with other systems	
10	If a dashboard error is identified, or a change is requested by a GCPHU end user, how easy would it be to execute that request? Are there any barriers that would impact the ability to make changes?
11	If a dashboard error is identified, or a change is requested by a GCPHU end user, how much time would it take to execute that request? Are there any barriers that would impact the timing?
Acceptability The willingness of users to participate in the system	
12	What is your personal opinion/s of the MIS gastro dashboard. Do you like supporting the system?

B.2. Microsoft Forms survey for GCPHU end users

Gastrointestinal Syndromic Surveillance Evaluation - GCPHU End Users

You have been invited to complete this survey as you have been identified as a GCPHU employee who uses the MIS dashboard as part of the Gastrointestinal Syndromic Surveillance System (GSSS).

This survey forms part of a larger research project which aims to evaluate first half of the GSSS to determine the overall usefulness of the case identification process. Learnings from this project will help inform how to improve the GSSS. Any findings will be published in the researcher's thesis and shared internally with Queensland Health.

In this survey, you will be asked about how you use the MIS dashboard in your role and your thoughts and attitudes towards the MIS component of the GSSS. Your responses will hel[p] us to identify how the MIS dashboard could be improved for end users.

Your participation in this survey is completely voluntary. If you decide not to participate, it will not affect your work or relationship with the researcher in any way. You can withdraw from the survey at any point, even after your responses have been submitted.

The survey should take no more than 10 minutes to complete.

If you have any questions or concerns about this survey, please contact victoria.marriott@health.qld.gov.au.

1

I consent to participating in this short survey about the MIS dashboard component of the Gastrointestinal Syndromic Surveillance System and understand that:

- My responses will not be identifiable and will only be used for the purpose of this study.
- My participation is voluntary and I can withdraw at any time.
- I know who to contact should I have questions about this study.

○ Yes

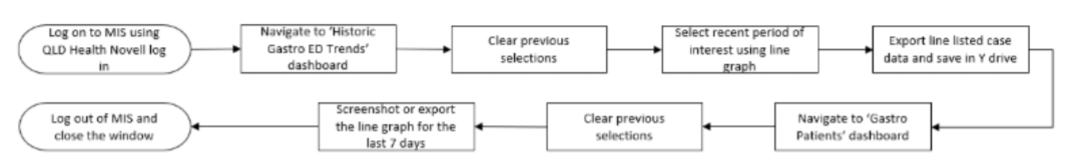
○ No

Submit

2

The first part of the GSSS process involves reviewing gastro trends on the MIS dashboard and extracting case data to complete the SMS component of the system (see flow chart below).

Please rate each stage of the MIS GSSS process from 'very difficult' to 'very easy' based on your personal experience. *



	Very difficult	Somewhat difficult	Not difficult or easy	Somewhat easy	Very easy
Logging on to MIS	○	○	○	○	○
Navigating to the Historic Gastro ED trends dashboard	○	○	○	○	○
Selecting the time period of interest on the line graph	○	○	○	○	○
Exporting and saving the MIS linelist data	○	○	○	○	○
Navigating to the Gastro Patients dashboard	○	○	○	○	○
Exporting the line graph for the last 7 days	○	○	○	○	○

3

On average, how much time does it take you to complete the MIS component of the GSSS?

Please do not include the time taken to do other components of the GSSS such as Stata, TIMS, or preparing the email.

◯ Up to 15 minutes

◯ Up to 30 minutes

◯ Up to 45 minutes

◯ Greater than 45 minutes

4

Sometimes the GCPHU need to add or change something in the MIS dashboard such as the inclusion of the SMS consent field. Changes have to be performed by GCHHS and external data scientists on request of GCPHU staff.

Based on your experience, please indicate how difficult or easy it has been to request or see a change made, using a scale from 'very difficult' to 'very easy.' *

	Very difficult	Somewhat difficult	Not difficult or easy	Somewhat easy	Very easy
Requesting a change to the MIS dashboard	◯	◯	◯	◯	◯
Having the change be actioned	◯	◯	◯	◯	◯

5

Please explain your answer on how the MIS component of the GSSS responds to change. Feel free to use an example.

Enter your answer

6

In a surveillance system, it is important to have a complete dataset to improve the accuracy and reliability of the system outputs. Based on your experience, how complete would you consider the data in the MIS dashboard?

Think about whether you have seen a field marked as 'missing' or blank. *

	Very incomplete	Largely incomplete	Largely complete	Very complete
How complete is the data in the MIS dashboard?	◯	◯	◯	◯

7

How does/would missing data affect your role in the GSSS process?

Enter your answer

8

The MIS dashboard has been used by the GCPHU for the GSSS for the last 7 years. Ignoring the fact that the GSSS will move to SystemView in the next few months, if the GSSS were to remain using MIS, how reliable do you think the MIS dashboard is? *

	Very unreliable	Somewhat unreliable	Neither reliable nor unreliable	Somewhat reliable	Very reliable
How reliable is the MIS dashboard?	○	○	○	○	○

10

Actioning the MIS component of the GSSS is a routine part of the Data and Epidemiology team's daily business.

Do you have any barriers to participating in the system? *

○ Yes

○ No

11

If yes, what barriers are preventing you from participating in the system?

The value must be a number

12

Do you have any finals comments about the MIS component of the GSSS?

Enter your answer

Submit

Appendix C – REDCap exposure survey sent to gastroenteritis cases identified in Part A of the GSSS

Gold Coast Gastro Illness Survey

AAA

Gold Coast Health investigates possible outbreaks of gastrointestinal illness to detect and prevent further spread in the community.

Gastrointestinal illness may also be known as 'gastro', 'food poisoning' or a 'tummy bug' and can cause symptoms such as nausea, vomiting and diarrhoea.

Gastro can be caused by a few things such as an infection with a virus, bacteria, parasite, or toxin. It can spread from person-to-person, through food or drinks, or from exposure to water.

The information collected in this survey is confidential and is being collected in accordance with the *Public Health Act 2005*. Only authorised officers from Queensland Health will see your information.

This survey should only take between five (5) and ten (10) minutes to complete. Please only complete one (1) survey per person, per Emergency Department presentation.

For more information, please contact the Gold Coast Public Health Unit by email at GCPHU@health.qld.gov.au

Who are you completing this survey on behalf of?

This is the person who was sick and presented to the Emergency Department.

If multiple people under your care presented to the Emergency Department, please complete one (1) survey per person.

- Myself
- My child
- A person under my care

Patient Details:

Please provide _____.

First Name:

Last Name:

Age:

Phone Number:

Please provide the phone number this survey was sent to.

Symptoms such as nausea, vomiting and diarrhoea can be caused by conditions other than gastro.

Do you think the symptoms were caused by an infection such as gastro, food poisoning or a tummy bug?

- Yes - The symptoms were caused by gastro, food poisoning or a tummy bug
- No - The symptoms were caused by another condition
- Unsure

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Gold Coast Gastro Illness Survey

AAA

Page 1 of 4

This illness may have been caused by something you ate or drank.

Please answer the following food and drink questions.

Please provide the details for where you ate or drank in the three (3) days prior to this illness. This could be a:

- *Bakery*
- *Food truck or market*
- *Takeaway shop, cafe or restaurant*
- *Home delivery service (meal prep delivery, takeaway delivery)*
- *Pub, hotel or club*
- *Private function (wedding, birthday party, work event etc.)*
- *Childcare or other care facility*
- *Public event (sporting event, music festival etc.)*
- *Petrol station*
- *Theme Park*

Please do not include any food or drink that was purchased from a supermarket and prepared at home.

	Food/Drink Details
E.g.	*Venue: X Takeaway Shop* *Suburb: Hollywell* *Food/Drink: Chicken burger, hot chips with aioli, chocolate milkshake*
1	**Venue:** **Suburb:** **Food/drink:**
2	**Venue:** **Suburb:** **Food/drink:**
3	**Venue:** **Suburb:** **Food/drink:**

4	Venue: Suburb: Food/drink:
5	Venue: Suburb: Food/drink:

Click to add additional food/drink venues:

Additional food/drink details

Did anyone else eat or drink with you and get sick? If yes, how many people?

Please do not count the person this survey is about.

Yes

No

Unsure

Please provide any further information relating to the food and/or drink consumed here:

Next Page >>

Gold Coast Gastro Illness Survey

AAA

Page 2 of 4

Gastro can be spread by person-to-person contact.

Please answer the following questions about specific settings.

In the past week (7 days) did you visit, attend or work at a childcare centre?

- Yes
- No
- Unsure

Please provide the name, suburb and reason/s for visiting the childcare centre/s.

	Childcare Centre Details
E.g.	Centre name: X Childcare Centre Suburb: Palm Beach Reason for visit: Worked at the childcare
1	Centre name: Suburb: Reason: Worked at the childcare Visited the childcare e.g., picking up/dropping off a child Enrolled at the childcare e.g., childcare attendee Other

Click to add more childcare centres:

Additional childcare centres

Did anyone else attend the same childcare centre and get sick? If yes, how many people?

Please do not count the person this survey is about.

- Yes
- No
- Unsure

Please provide any further information relating to the childcare centre/s here:

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Gold Coast Gastro Illness Survey

A A A

Page 3 of 4

Gastro can also be spread through contaminated water.

Please answer the following questions about water sources.

In the past week (7 days) did you swim or play in water? This may be in a:

- Pool e.g., swimming lessons
- Water play area
- Theme Park
- Natural waterway e.g., beach, ocean, river, creek.

Yes

No

Unsure

Please provide the name and suburb of where the water activity e.g., swimming and/or playing, took place

	Water Details
E.g	*Name: Main Beach* *Suburb: Surfers Paradise*
1	Name: Suburb:
2	Name: Suburb:
3	Name: Suburb:

Did anyone else attend the same water activity and get sick? If yes, how many people?

Please do not count the person this survey is about.

Yes

No

Unsure

Please provide any further information relating to the water activity here:

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Gold Coast Gastro Illness Survey

AAA

Page 4 of 4

Thank you for your help. Please let us know if you have any further comments on this illness.

8. **Additional information**

9. **Gold Coast Health may contact you for further information on the locations where you may have gotten sick. This can help us to potentially prevent others from getting sick. Please advise if you do not wish to be contacted.**

I DO NOT wish to be contacted

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Submit

Appendix D – ICD-10 and SNOMED CT codes used to identify cases of gastroenteritis in Part A of the GSSS

Source	ICD	ICDDescription	Flag_Gastro
FirstNet	R11	NAUSEA AND VOMITING	1
FirstNet	A04.4	OTHER E COLI INFECTION	1
FirstNet	A09.0	OTH GASTROENTERITIS & COLITIS INFECT	1
FirstNet	A09.9	GASTROENTERITIS & COLITIS UNSP ORIGIN	1
FirstNet	A05.9	BACTERIAL FOOD-BORNE INTOXICATION UNSP	1
FirstNet	A04.5	CAMPYLOBACTER ENTERITIS	1
FirstNet	A08.1	ACUTE GASTROENTEROPATHY DT NORWALK AGENT	1
FirstNet	A08.4	VIRAL INTESTINAL INFECTION UNSPECIFIED	1
FirstNet	A08.2	ADENOVIRAL ENTERITIS	1
FirstNet	A07.1	GIARDIASIS [LAMBLIASIS]	1
FirstNet	A02.0	SALMONELLA ENTERITIS	1
FirstNet	A04.7	ENTEROCOLITIS DT CLOSTRIDIUM DIFFICILE	1
FirstNet	A07.8	OTHER SPEC PROTOZOAL INTESTINAL DISEASES	1
FirstNet	T62.9	NOXIOUS SUBSTANCE EATEN AS FOOD UNSP	1
FirstNet	A08.3	OTHER VIRAL ENTERITIS	1
FirstNet	A04.9	BACTERIAL INTESTINAL INFECTION UNSP	1
EDIS	A04.7	PSEUDOMEMBRANOUS COLITIS	1
EDIS	A05.9	FOOD POISONING	1
EDIS	A07.9	DYSENTERY	1
EDIS	A07.9	PROTOZOAL INTESTINAL INFECTION	1
EDIS	A08.4	VIRAL GASTROENTERITIS	1
EDIS	A08.4	VIRAL INTESTINAL INFECTION	1
EDIS	A09	GASTROENTERITIS	1
EDIS	R11	NAUSEA / VOMITING - NO DIAGNOSIS	1
EDIS	R11	NAUSEA AND VOMITING	1
SNOMED	397503006	Salmonella enterica subspecies arizonae infection	1
SNOMED	42338000	Salmonella gastroenteritis	1
SNOMED	90974009	Salmonellosis (except human typhoid & paratyphoid)	1
SNOMED	186134009	Infection of gastrointestinal tract by Salmonella enterica subspecies arizonae	1
SNOMED	90271007	Intestinal infection caused by Arizona group	1
SNOMED	276288002	Recurrent salmonella septicemia	1
SNOMED	449083008	Sepsis caused by Salmonella	1
SNOMED	2523007	Salmonella pneumonia	1
SNOMED	6803002	Salmonella osteomyelitis	1
SNOMED	71299003	Salmonella arthritis	1
SNOMED	77645007	Salmonella meningitis	1
SNOMED	47375003	Localized Salmonella infection	1
SNOMED	402962004	Salmonella infection with skin involvement	1
SNOMED	302229004	Salmonella food poisoning	1
SNOMED	302231008	Salmonella infection	1

Source	ICD	ICDDescription	Flag_Gastro
SNOMED	66301008	Infection caused by Group A Shigella	1
SNOMED	34335000	Infection caused by Group B Shigella	1
SNOMED	186105003	Shigella boydii (group C)	1
SNOMED	55760004	Infection caused by Group C Shigella	1
SNOMED	69794009	Infection caused by Group D Shigella	1
SNOMED	274081004	Bacillary dysentery	1
SNOMED	36188001	Shigellosis	1
SNOMED	111817006	Infection caused by Shigella	1
SNOMED	312109000	Bacterial dysentery	1
SNOMED	92827005	Colitoxicosis	1
SNOMED	240353001	Enteropathogenic Escherichia coli gastrointestinal tract infection	1
SNOMED	240336008	Enterotoxigenic Escherichia coli food poisoning	1
SNOMED	240352006	Enterotoxigenic Escherichia coli gastrointestinal tract infection	1
SNOMED	240355008	Enteroinvasive Escherichia coli gastrointestinal tract infection	1
SNOMED	240354007	Verotoxigenic Escherichia coli gastrointestinal tract infection	1
SNOMED	446328009	Intestinal infection caused by Escherichia coli O157:H7	1
SNOMED	428874003	Intestinal infection caused by Escherichia coli serotype O158	1
SNOMED	240337004	Verotoxigenic Escherichia coli food poisoning	1
SNOMED	69810009	Acute hemorrhagic colitis caused by Escherichia coli	1
SNOMED	240335007	Escherichia coli food poisoning	1
SNOMED	11840006	Traveler's diarrhea	1
SNOMED	240356009	Enteroadherent Escherichia coli gastrointestinal tract infection	1
SNOMED	371323006	Neonatal colibacillosis	1
SNOMED	111839008	Intestinal infection caused by Escherichia coli	1
SNOMED	18081009	Enteric campylobacteriosis	1
SNOMED	111835002	Infection caused by Campylobacter fetus	1
SNOMED	446122002	Intestinal infection caused by Campylobacter coli	1
SNOMED	447354007	Intestinal infection caused by Campylobacter jejuni	1
SNOMED	86500004	Campylobacteriosis	1
SNOMED	240334006	Yersinia enterocolitica food poisoning	1
SNOMED	80960004	Infection caused by Yersinia enterocolitica	1
SNOMED	240357000	Clostridial enteric disease	1
SNOMED	186431008	Clostridium difficile infection	1
SNOMED	5.891E+12	Clostridium difficile diarrhea	1
SNOMED	423590009	Clostridium difficile colitis	1
SNOMED	82930004	Intestinal infection caused by Pseudomonas	1
SNOMED	186136006	Proteus gastrointestinal tract infection	1
SNOMED	266077001	Staphylococcal gastrointestinal tract infection	1
SNOMED	186137002	Proteus mirabilis gastrointestinal tract infection	1

Source	ICD	ICDDescription	Flag_Gastro
SNOMED	307759003	Helicobacter pylori gastrointestinal tract infection	1
SNOMED	421224000	Intestinal infection caused by Enterobacter aerogenes	1
SNOMED	36529003	Intestinal infection caused by Morganella morganii	1
SNOMED	78128001	Helicobacter-associated colitis	1
SNOMED	186138007	Morganella morganii gastrointestinal tract infection	1
SNOMED	32527003	Staphylococcal enterocolitis	1
SNOMED	266078006	Pseudomonas gastrointestinal tract infection	1
SNOMED	446988001	Intestinal infection caused by Aeromonas hydrophila	1
SNOMED	398570005	Diarrhea caused by staphylococcus toxin	1
SNOMED	30493003	Intestinal infection caused by Proteus mirabilis	1
SNOMED	111819009	Staphylococcal gastroenteritis	1
SNOMED	27858009	Clostridial gastroenteritis	1
SNOMED	421429008	Gastrointestinal infection caused by Enterobacter aerogenes	1
SNOMED	446081009	Small bowel bacterial overgrowth syndrome	1
SNOMED	66379009	Bacterial overgrowth syndrome	1
SNOMED	105628008	Human typhoid AND/OR paratyphoid fever	1
SNOMED	414530001	Intestinal infectious disease caused by Gram-negative bacteria	1
SNOMED	312108008	Bacterial intestinal infectious disease	1
SNOMED	274080003	Bacterial gastroenteritis	1
SNOMED	312121001	Bacterial gastrointestinal infectious disease	1
SNOMED	202699004	Enterobacterial spondylitis	1
SNOMED	75375008	Bacterial enteritis	1
SNOMED	414529006	Intestinal infectious disease caused by anaerobic bacteria	1
SNOMED	398384001	Staphylococcus aureus food poisoning	1
SNOMED	84622004	Food poisoning caused by staphylococcus	1
SNOMED	409562009	Inhalational botulism	1
SNOMED	38719000	Toxicoinfectious botulism	1
SNOMED	414820001	Neonatal botulism	1
SNOMED	414531002	Intoxication with Clostridium botulinum toxin	1
SNOMED	398565003	Infection caused by Clostridium botulinum	1
SNOMED	398523009	Foodborne botulism	1
SNOMED	409563004	Intestinal botulism	1
SNOMED	398530003	Wound botulism	1
SNOMED	409564005	Foodborne botulism, type A	1
SNOMED	409565006	Foodborne botulism, type B	1
SNOMED	409567003	Foodborne botulism, type F	1
SNOMED	414488002	Infantile botulism	1
SNOMED	409566007	Foodborne botulism, type E	1
SNOMED	39747007	Enteritis necroticans	1
SNOMED	82051003	Infection caused by Clostridium perfringens type D	1
SNOMED	370514003	Enterotoxemia	1
SNOMED	66218005	Infection caused by Clostridium perfringens type A	1

Source	ICD	ICDDescription	Flag_Gastro
SNOMED	89861008	Infection caused by Clostridium perfringens type B	1
SNOMED	46609008	Infection caused by Clostridium perfringens type C	1
SNOMED	70014009	Food poisoning caused by Clostridium perfringens	1
SNOMED	81159000	Food poisoning caused by Vibrio parahaemolyticus	1
SNOMED	406626001	Infection caused by Vibrio parahaemolyticus	1
SNOMED	19894004	Food poisoning caused by Bacillus cereus	1
SNOMED	414286000	Food poisoning caused by Vibrio vulnificus	1
SNOMED	111802007	Food poisoning caused by Clostridia	1
SNOMED	240333000	Bacillus licheniformis food poisoning	1
SNOMED	19547001	Food poisoning caused by streptococcus	1
SNOMED	446438003	Poisoning by ingestion of fish contaminated by bacteria	1
SNOMED	416482004	Food-borne gastroenteritis	1
SNOMED	66107000	Bacterial food poisoning	1
SNOMED	186116005	Acute amebic dysentery	1
SNOMED	39224005	Acute amebiasis	1
SNOMED	235747003	Amebic colitis	1
SNOMED	235748008	Fulminant amebic colitis	1
SNOMED	4915001	Infection caused by Entamoeba coli	1
SNOMED	111912001	Acute amebic dysentery without abscess	1
SNOMED	79934001	Infection caused by Endolimax	1
SNOMED	387754006	Amebic dysentery	1
SNOMED	186117001	Chronic intestinal amebiasis	1
SNOMED	111911008	Chronic intestinal amebiasis without abscess	1
SNOMED	55023005	Amebic nondysenteric colitis	1
SNOMED	20958005	Ameboma	1
SNOMED	95897009	Amebic hepatitis	1
SNOMED	75119003	Amebic liver abscess	1
SNOMED	65095005	Amebic lung abscess	1
SNOMED	27908001	Amebic brain abscess	1
SNOMED	278479003	Amebic granuloma of skin	1
SNOMED	238449000	Amebiasis of skin	1
SNOMED	400086005	Amebic ulcer of skin	1
SNOMED	406559005	Amebic infection of central nervous system	1
SNOMED	399924003	Perianal amebiasis	1
SNOMED	388759003	Infection caused by Entamoeba histolytica	1
SNOMED	240363009	Amebic toxic megacolon	1
SNOMED	8776008	Amebic cystitis	1
SNOMED	240663001	Penile amebiasis	1
SNOMED	240664007	Amebic abscess of skin	1
SNOMED	240364003	Amebic perianal ulceration	1
SNOMED	26826005	Amebic appendicitis	1
SNOMED	240661004	Non-intestinal amebic infection	1
SNOMED	50227004	Amebic balanitis	1
SNOMED	237105008	Vulval amebiasis	1

Source	ICD	ICDDescription	Flag_Gastro
SNOMED	240362004	Symptomatic non-invasive amebic infection	1
SNOMED	111910009	Amebic infection	1
SNOMED	50277001	Infection caused by Iodamoeba	1
SNOMED	105637008	Disease caused by Endamoebidae	1
SNOMED	240361006	Asymptomatic amebic infection	1
SNOMED	30211004	Infection caused by Hartmannella	1
SNOMED	266169003	Free-living ameba infection	1
SNOMED	48252005	Infection caused by Entamoeba	1
SNOMED	23874000	Chronic amebiasis	1
SNOMED	56722001	Infection caused by Balantidium coli	1
SNOMED	105638003	Disease caused by Balantidiidae	1
SNOMED	57725006	Balantidiasis	1
SNOMED	10679007	Infection caused by Giardia lamblia	1
SNOMED	58265007	Giardiasis	1
SNOMED	70683005	Infection caused by Cryptosporidium nasorum	1
SNOMED	240370009	Cryptosporidiosis	1
SNOMED	240371008	Chronic intestinal cryptosporidiasis	1
SNOMED	66160001	Cryptosporidial gastroenteritis	1
SNOMED	26081002	Infection caused by Cryptosporidium crotalis	1
SNOMED	75333007	Infection caused by Cryptosporidium muris	1
SNOMED	58777003	Infection caused by Cryptosporidium	1
SNOMED	7977009	Infection caused by Cryptosporidium meleagridis	1
SNOMED	15907009	Infection caused by Cryptosporidium parvum	1
SNOMED	105654000	Disease caused by Cryptosporidiidae	1
SNOMED	32168002	Infection caused by Frenkelia	1
SNOMED	14523006	Infection caused by Isospora belli	1
SNOMED	240374000	Chronic intestinal isosporiasis	1
SNOMED	58051000	Infection caused by Isospora hominis	1
SNOMED	360425009	Human coccidiosis	1
SNOMED	47433000	Infection caused by Hammondia	1
SNOMED	44502009	Infection caused by Besnoitia	1
SNOMED	370518000	Enteric coccidiosis	1
SNOMED	62005008	Coccidiosis	1
SNOMED	58994008	Hepatic coccidiosis	1
SNOMED	371423007	Isosporiasis	1
SNOMED	75712001	Renal coccidiosis	1
SNOMED	182182000	Embadomoniasis	1
SNOMED	240368000	Retortamonas intestinalis infection	1
SNOMED	27335004	Infection caused by Sarcocystis lindemanni	1
SNOMED	105647006	Disease caused by Vahlkampfiidae	1
SNOMED	187239003	Psorospermiasis	1
SNOMED	240366001	Chilomastix mesnili infection	1
SNOMED	28980009	Infection caused by Chilomastix	1
SNOMED	39458004	Infection caused by Cystoisospora	1
SNOMED	421204004	Blastocystis hominis infection	1

Source	ICD	ICDDescription	Flag_Gastro
SNOMED	71572001	Infection caused by Enteromonas	1
SNOMED	43758005	Infection caused by Hexamita	1
SNOMED	105649009	Disease caused by Plasmodiidae	1
SNOMED	105656003	Disease caused by Enteromonadidae	1
SNOMED	105643005	Disease caused by Retortamonadidae	1
SNOMED	52872005	Infection caused by Vahlkampfia	1
SNOMED	240372001	Cyclosporiasis	1
SNOMED	32298001	Intestinal infection caused by Trichomonas vaginalis	1
SNOMED	105642000	Disease caused by Sarcocystidae	1
SNOMED	105639006	Disease caused by Chilomastigidae	1
SNOMED	67915005	Intestinal trichomoniasis	1
SNOMED	29979000	Infection caused by Enteromonas hominis	1
SNOMED	88905005	Sarcosporidiosis	1
SNOMED	240375004	Intestinal microsporidiosis	1
SNOMED	105644004	Disease caused by Hexamitidae	1
SNOMED	240365002	Intestinal flagellate infection	1
SNOMED	89933001	Protozoal intestinal disease	1
SNOMED	240367005	Dientamoeba fragilis infection	1
SNOMED	240369008	Intestinal ciliate infection	1
SNOMED	240338009	Viral food poisoning	1
SNOMED	266079003	Enteritis caused by specified virus	1
SNOMED	415822001	Viral gastroenteritis caused by Rotavirus	1
SNOMED	186150001	Enteritis caused by rotavirus	1
SNOMED	415353009	Rotavirus food poisoning	1
SNOMED	359662008	Rotavirus infection of children	1
SNOMED	74621002	Epidemic vomiting syndrome	1
SNOMED	24789006	Viral gastroenteritis caused by Norwalk-like agent	1
SNOMED	445152004	Inflammation of intestine caused by Norovirus	1
SNOMED	240343002	Small round structured virus food poisoning	1
SNOMED	240339001	Adenovirus food poisoning	1
SNOMED	236063005	Adenoviral gastroenteritis	1
SNOMED	70880006	Adenoviral enteritis	1
SNOMED	283877002	Calicivirus gastroenteritis	1
SNOMED	446754004	Enteritis caused by Human coxsackievirus	1
SNOMED	308119005	Infantile viral gastroenteritis	1
SNOMED	32580004	Enterovirus enteritis	1
SNOMED	446756002	Enteritis caused by Human enterovirus 71	1
SNOMED	426137009	Cytomegaloviral enteritis	1
SNOMED	446755003	Enteritis caused by Human echovirus	1
SNOMED	283876006	Astrovirus gastroenteritis	1
SNOMED	312131008	Viral infection of the digestive tract	1
SNOMED	1.3641E+13	Viral colitis	1
SNOMED	78420004	Viral enteritis	1
SNOMED	285344007	Viral gastritis	1
SNOMED	111843007	Viral gastroenteritis	1

Source	ICD	ICDDescription	Flag_Gastro
SNOMED	312088007	Fungal gastroenteritis	1
SNOMED	447004005	Enteritis caused by fungus	1
SNOMED	266081001	Colitis, enteritis and gastroenteritis presumed infectious	1
SNOMED	425739008	Brainerd diarrhea	1
SNOMED	39963006	Toddler diarrhea	1
SNOMED	286870008	Viral and ill-defined gastrointestinal infections	1
SNOMED	86615009	Epidemic diarrhea	1
SNOMED	59253004	Catarrhal dysentery	1
SNOMED	19213003	Infectious diarrheal disease	1
SNOMED	20547008	Ill-defined intestinal infection	1
SNOMED	111938001	Septic enteritis	1
SNOMED	14255005	Hemorrhagic dysentery	1
SNOMED	32097002	Necrotic enteritis	1
SNOMED	359613008	Acute infectious nonbacterial gastroenteritis	1
SNOMED	36789003	Acute infective gastroenteritis	1
SNOMED	235224000	Hemorrhagic enteritis	1
SNOMED	79099006	Colitis presumed infectious	1
SNOMED	236066002	Prototheca diarrhea	1
SNOMED	707222009	Epidemic gastroenteritis	1
SNOMED	186156007	Infectious colitis, enteritis and gastroenteritis	1
SNOMED	55184003	Infectious enteritis	1
SNOMED	111939009	Dysentery	1
SNOMED	46799006	Dysenteric diarrhea	1
SNOMED	30140009	Enteritis presumed infectious	1
SNOMED	12463005	Infectious gastroenteritis	1
SNOMED	18229003	Suppurative colitis	1
SNOMED	57419008	Gastroenteritis presumed infectious	1
SNOMED	266071000	Intestinal infectious disease	1
SNOMED	43240000	Diarrhea of presumed infectious origin	1
SNOMED	81318004	Hemorrhagic colitis	1
SNOMED	64613007	Inflammation of small intestine	1
SNOMED	409587002	Severe diarrhea	1
SNOMED	267060006	Diarrhea symptom	1
SNOMED	95545007	Hemorrhagic diarrhea	1
SNOMED	707352004	Institution-acquired gastroenteritis	1
SNOMED	43752006	Inflammation of small intestine and colon	1
SNOMED	25374005	Gastroenteritis	1
SNOMED	409966000	Acute diarrhea	1
SNOMED	52457000	Ileitis	1
SNOMED	64226004	Colitis	1
SNOMED	240332005	Infantile gastroenteritis	1
SNOMED	275297005	Diarrhea and vomiting, symptom	1
SNOMED	47941007	Purulent enteritis	1
SNOMED	74744007	Typhlocolitis	1

Source	ICD	ICDDescription	Flag_Gastro
SNOMED	128333008	Diarrheal disorder	1
SNOMED	39341005	Infectious colitis	1
SNOMED	396336000	Acute and chronic colitis	1
SNOMED	69776003	Acute gastroenteritis	1
SNOMED	409506009	Hemorrhagic gastroenteritis	1
SNOMED	236077008	Protracted diarrhea	1
SNOMED	62315008	Diarrhea	1
SNOMED	721682003	Colitis caused by Salmonella	1
SNOMED	196746003	Persistent vomiting	1
SNOMED	78104003	Regurgitation of gastric content	1
SNOMED	300366003	Vomit contains feces	1
SNOMED	91173007	Radiation-induced nausea and vomiting	1
SNOMED	23971007	Acute vomiting	1
SNOMED	225586007	Vomiting food	1
SNOMED	300359004	Finding of vomiting	1
SNOMED	275746003	Pus in vomit O/E	1
SNOMED	302769004	Regurgitates after swallowing	1
SNOMED	64581007	Postoperative nausea	1
SNOMED	18773000	Cyclical vomiting syndrome	1
SNOMED	275745004	Feculent vomit on examination	1
SNOMED	43464002	Bile pigment regurgitation	1
SNOMED	2919008	Nausea, vomiting and diarrhea	1
SNOMED	398286002	Regurgitation - no aspiration detected	1
SNOMED	332982000	Uncontrollable vomiting	1
SNOMED	85023004	Nasal regurgitation	1
SNOMED	698861005	Intractable nausea and vomiting	1
SNOMED	167842006	Vomit odor feculent	1
SNOMED	84480002	Retching	1
SNOMED	63722008	Chronic vomiting	1
SNOMED	301790009	Vomited meal	1
SNOMED	102622004	Regurgitation of food	1
SNOMED	37224001	Psychogenic vomiting	1
SNOMED	167841004	Vomit odor offensive	1
SNOMED	73335002	Increased nausea and vomiting	1
SNOMED	249493007	Posseting	1
SNOMED	9814003	Violent retching	1
SNOMED	236084000	Chemotherapy sickness	1
SNOMED	272044004	Complaining of vomiting	1
SNOMED	16932000	Nausea and vomiting	1
SNOMED	33841007	Decreased nausea and vomiting	1
SNOMED	1488000	Postoperative nausea and vomiting	1
SNOMED	419219000	Drug-induced nausea and vomiting	1
SNOMED	49206006	Habit vomiting	1
SNOMED	72245005	Postoperative vomiting	1
SNOMED	38685005	Concealed vomiting	1

Source	ICD	ICDDescription	Flag_Gastro
SNOMED	275371002	Black vomit	1
SNOMED	275744000	Bilious vomit on examination	1
SNOMED	167847000	Vomit: excessive alkalinity	1
SNOMED	167835006	Vomit: undigested food present	1
SNOMED	236083006	Intermittent vomiting	1
SNOMED	424580008	Post-tussive vomiting	1
SNOMED	71419002	Bilious vomiting	1
SNOMED	236062000	Vomiting - infective	1
SNOMED	249500002	Effortless vomiting	1
SNOMED	444673007	Hyperemesis	1
SNOMED	249497008	Vomiting symptom	1
SNOMED	167833004	Vomit: mucous present	1
SNOMED	3094009	Vomiting in infants AND/OR children	1
SNOMED	34923007	Self-induced vomiting	1
SNOMED	422587007	Nausea	1
SNOMED	1.46291E+14	Vomiting without nausea	1
SNOMED	422400008	Vomiting	1
SNOMED	300365004	Vomit contains food	1
SNOMED	1.34021E+14	Vomiting fecal matter	1
SNOMED	8579004	Projectile vomiting	1
SNOMED	84642008	Chronic regurgitation	1
FirstNet	443266019	Vomited meal	1
FirstNet	444525010	Traveler's diarrhoea	1
FirstNet	1494813012	Gastroenteritis - presumed infectious origin	1
FirstNet	1495457013	Colitis - presumed infectious origin	1
FirstNet	1776288018	Acute and chronic colitis	1
FirstNet	2981624018	Refractory nausea and vomiting	1
FirstNet	87291015	Ileitis	1
FirstNet	60035014	Cryptococcal gastroenteritis	1
FirstNet	61368016	Acute infective gastroenteritis	1
FirstNet	3288270015	Infective diarrhoea	1
FirstNet	3289954016	Epiploic appendagitis	1
FirstNet	105916019	Chronic vomiting	1
FirstNet	106758018	Colitis	1
FirstNet	107324019	Postoperative nausea	1
FirstNet	107385015	Enteritis	1
FirstNet	109787018	Bacterial food poisoning	1
FirstNet	1216067013	Campylobacter diarrhoea	1
FirstNet	199494017	Nausea; vomiting and diarrhoea	1
FirstNet	201773015	Bloody diarrhoea	1
FirstNet	482917017	GE - Gastroenteritis	1
FirstNet	65964017	Infectious colitis	1
FirstNet	40246014	Acute vomiting	1
FirstNet	42550011	Gastroenteritis	1
FirstNet	372241019	Posseting	1

Source	ICD	ICDDescription	Flag_Gastro
FirstNet	3028980018	Norovirus infection	1
FirstNet	115902018	Acute gastroenteritis	1
FirstNet	118642013	Bilious vomiting	1
FirstNet	424321010	Viral gastritis	1
FirstNet	2871803016	Hyperemesis	1
FirstNet	353845013	Adenoviral gastroenteritis	1
FirstNet	353885019	Intermittent vomiting	1
FirstNet	3596017	Postoperative nausea and vomiting	1
FirstNet	6235011	Vomiting in infants AND/OR children	1
FirstNet	140077016	Retching	1
FirstNet	2649590014	Vomiting after coughing	1
FirstNet	302636011	Persistent vomiting	1
FirstNet	302637019	Emesis - persistent	1
FirstNet	1205543012	Diarrhoeal disorder	1
FirstNet	2548995017	Food-borne gastroenteritis	1
FirstNet	2553827013	Gastroenteritis due to food poisoning	1
FirstNet	2575853019	Vomiting symptom	1
FirstNet	3325752011	Salmonella colitis	1
FirstNet	365356015	Viral vomiting	1
FirstNet	365357012	Viral diarrhoea	1
FirstNet	96833015	Giardiasis	1
FirstNet	103578017	Diarrhoea	1
FirstNet	1221139016	PONV - Postoperative nausea and vomiting	1
FirstNet	1221437012	N&V - Nausea and vomiting	1
FirstNet	1221438019	N+V - Nausea and vomiting	1
FirstNet	2817356016	Infection of gastrointestinal tract by Salmonella enterica subspecies arizonae	1
FirstNet	286580015	Clostridium difficile infection	1
FirstNet	499248015	D - Diarrhoea	1
FirstNet	2577806018	Drug-induced nausea and vomiting	1
FirstNet	2617456017	Blastocystis hominis infection	1
FirstNet	2642366013	Chemotherapy-induced nausea and vomiting	1
FirstNet	120038014	Postoperative vomiting	1
FirstNet	121789013	Increased nausea and vomiting	1
FirstNet	124991010	Food poisoning	1
FirstNet	426349018	Viral and ill-defined gastrointestinal infections	1
FirstNet	1229515016	Infective colitis	1
FirstNet	1233857016	FP - Food poisoning	1
FirstNet	15155012	Projectile vomiting	1
FirstNet	179018017	Viral gastroenteritis	1
FirstNet	179084014	Dysentery	1
FirstNet	473899018	Acute infectious nonbacterial gastroenteritis	1
FirstNet	474374019	Diarrhoeal disease	1
FirstNet	479228018	Infectious diarrhoea	1
FirstNet	2469182015	Acute diarrhoea	1

Source	ICD	ICDDescription	Flag_Gastro
FirstNet	70642011	Salmonella gastroenteritis	1
FirstNet	455796017	Viral infection of the digestive tract	1
FirstNet	3318940014	Regurgitation of gastric content	1
FirstNet	28667013	Nausea and vomiting	1
FirstNet	31652013	Cyclical vomiting syndrome	1
FirstNet	31653015	Periodic vomiting	1
FirstNet	31654014	Cyclical vomiting	1
FirstNet	151072010	Radiation-induced nausea and vomiting	1
FirstNet	451427012	Infantile viral gastroenteritis	1
FirstNet	1785835015	Salmonella enteritis	1
FirstNet	407086011	C/O - vomiting	1
FirstNet	409835011	Bacterial gastroenteritis	1
FirstNet	411261012	Diarrhoea and vomiting; symptom	1
FirstNet	2643559016	Clostridium difficile colitis	1
FirstNet	2643930014	Nausea	1
FirstNet	2643931013	Vomiting	1
FirstNet	2646073012	Post-tussive vomiting	1
FirstNet	2647991011	Nauseated	1
FirstNet	2647992016	Emesis	1
FirstNet	91741012	Infectious enteritis	1
FirstNet	21441016	Infectious gastroenteritis	1
FirstNet	130136015	Viral enteritis	1
FirstNet	3023261012	Viral colitis	1

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Chapter V – Teaching

Teaching field epidemiology

Contents

Introduction

Teaching and peer-learning are aspects of the MAE program designed to build the next generation of public health leaders and field epidemiologists. During my MAE, I developed and facilitated a peer-to-peer teaching activity for my cohort in 2023 and a group lesson for the first-year scholars in 2024.

Lessons from the field: non-communicable disease clusters

Background

The Lessons from the Field (LFF) activity allows scholars to share with their peers a key learning from their field placement. I developed my LFF (Appendix A) based on a complex non-communicable disease (NCD) cluster I worked on during the first year of my placement. My role in the Gold Coast Public Health Unit (GCPHU) investigation was to identify whether the number of alleged cases were more than expected.

Non-communicable disease (NCD) investigations often arise when there are several cases of a NCD such as cancer or a birth defect in a specific population over a period of time. These investigations are infrequent, unique and rarely require substantial evaluation as they are often representative of what is expected in that population.(1) As such, there are few epidemiologists across the region with significant experience in the field. Contributing to this knowledge gap is the omission of teaching about investigations of NCD cluster investigations in the MAE curricula. I decided to conduct my LFF on NCD clusters to introduce the concept to my peers to support their professional development.

My role

I developed a case study based on a fictitious scenario:

> *A lecturer at a local university has contacted your Public Health Unit regarding an alleged cancer cluster. They report several colleagues have become unwell with melanoma, breast cancer and prostate cancer in the past few years. He is concerned that the radiation from the nearby phone tower is causing the cancers.*

I asked scholars to conduct an epidemiological assessment using their jurisdictional NCD cluster guidelines to determine if the:

- Cancer incidence for the region containing the university population was greater than expected.
- Alleged risk was biologically plausible as described in the International Agency for Research on Cancer (IARC) Monographs.
- Time between risk exposure to cancer diagnosis was reflective of relevant latency periods.

Scholars were then prompted to develop a lay summary and accompanying communication strategy to express any findings to the complainant and any other relevant parties.

I provided scholars with the mock population data, links to the IARC Monographs to research carcinogenic hazards, and a copy of the *Queensland Non-Communicable Disease Guidelines* for reference. Scholars were encouraged to complete the exercise individually, and discuss any challenges experienced at the follow-up videoconference.

During the videoconference, I provided scholars with sample answers (Appendix A) for the case study and facilitated discussion on the challenges associated with an alleged cancer cluster investigation. Using real-life examples from my field placement, I explored why it is important to allay the fears of the community, even if no causal relationship is established.

By the end of the exercise, scholars were expected to:

- Locate their relevant jurisdictional guidelines for non-communicable disease clusters.
- Conduct a basic non-communicable disease (cancer) cluster epidemiological analysis using the jurisdictional guidelines.
- Communicate findings in a lay summary with the intent to allay fear/concerns.
- Identify and explain some of the challenges associated with a non-communicable disease (cancer) cluster investigation.

Evaluation

Using Qualtrics, I developed three questions on a five-point scale (1=strongly disagree, 5=strongly agree) for scholars to provide feedback on the learning objectives, content, and facilitation of the LFF exercise (Table 5.1). All participants responded to the survey (n=6). Overall, scholars agreed that this exercise was a valuable learning experience, and the content and facilitation supported their learning. Scholars mostly agreed that the learning objectives were met, however it was noted that the second objective may have been too ambitious for the timeframe of the exercise. Upon reflection, it may have been more appropriate to expect students to identify the roles and responsibilities of an epidemiologist in a non-communicable disease cluster analysis instead of ‘conduct’ an epidemiological analysis.

Table 5.1. Evaluation of Lessons of the Field (n=6)

Question	Average	Range
The session met the learning objectives		
Locate the jurisdictional guidelines for non-communicable disease clusters.	4.5	4-5
Conduct a basic non-communicable disease (cancer) cluster epidemiological analysis using the jurisdictional guidelines.	4.67	3-5
Communicate findings in a lay summary with the intent to allay fear/concerns.	4.67	4-5
Identify and explain some of the challenges associated with a non-communicable disease (cancer) cluster investigation.	5	5-5
Session Feedback		
The subject matter was interesting	4.83	4-5
The content was useful (in practice and/or in theory)	4.83	4-5
The workload of the case study was appropriate	4.67	4-5
The use of real examples supported my learning	5	5-5
Overall, this session was a valuable learning experience	5	5-5
Facilitator Feedback		
The facilitator stimulated my interest in the subject matter	5	5-5
The facilitator communicated clearly and effectively	5	5-5
The facilitator provided case study feedback and/or addressed questions	5	5-5
Overall, the facilitators approach supported my learning	5	5-5

Reflection

Prior to this session I had never led a structured teaching exercise and did not understand how much effort went in to developing teaching materials.

When creating the case study, it was challenging to come up with a scenario that would be valuable for everyone in the group as I did not know the existing knowledge base. I tested my case study with colleagues at my placement who had experience with NCD clusters, and with colleagues who had no NCD investigation experience. Both groups said the case study was valuable, however the experienced staff mentioned the questions may be too simple. I tweaked the case study to be slightly more challenging based on this feedback, however in hindsight I think as an introductory session to NCD clusters, it would have been more appropriate to keep the questions simple. The concept-development stage of my LFF took much longer than anticipated and made me appreciate all the hard work and planning that goes into teaching sessions.

Overall, I thoroughly enjoyed the LFF process. This experience was not only a valuable learning exercise for my peers, but it was a great introduction to teaching and a positive reinforcement of what I have learnt at the GCPHU.

Teaching to first-years scholars: An introduction to One Health in Australia

Background

During my third course block, my cohort planned and delivered a teaching day for the first-year scholars. We were required to develop content that was absent from the MAE curriculum.

My group comprised of Elaine Ung (Commonwealth Department of Health and Aged Care), Michaela Gilbert (Commonwealth Department of Agriculture, Fisheries and Forestry), Marie Heloury (Australian Centre for Disease Preparedness and the Peter Doherty Institute) and Tiana Mahncke (New South Wales Ministry of Health) (Figure 5.1). We decided to provide scholars with an introduction to One Health, specifically focussing on the importance of transdisciplinary collaboration.

One Health involves collaborative, multi-sectoral efforts to achieve positive health outcomes by recognising and utilising the connections between animals, humans, and the environment. In field epidemiology, operating with a One Health lens is vital when considering the introduction, spread and control of zoonotic conditions. For example, when conducting mosquito-borne disease surveillance, it is imperative to consider environmental changes such as increased rainfall and high temperatures as these can promote mosquito breeding and influence case numbers.

We chose this topic as One Health was not thoroughly covered throughout the MAE curriculum despite being a contemporary aspect of field epidemiology.

The objectives of our session were to:

1. Outline the concepts of One Health.
2. Identify the stakeholders required for a One Health response to an acute incident.
3. Develop a multi-sectoral action plan for a One Health response to an acute incident.

My role

My role was to facilitate an interactive group task that covered the third objective; develop a collaborative action plan for a One Health incident response. Using a fictitious scenario based on the 2022 Japanese Encephalitis (JEV) incursion to Australia as a case study (Appendix B), I allocated scholars into four key stakeholder groups: Human Health, Agriculture, Industry and

Environment/Ecology and provided them with a brief prepared by Michaela (Appendix C) describing their sector, their responsibilities and knowledge. I then asked the groups to write down what their priorities would be during the scenario and what information and support they could provide to other industries. Next, I had the scholars move around the room and liaise with other sectors to achieve their priorities. To increase engagement, I gamified the activity using chocolate. Each time a stakeholder group successfully collaborated with another sector and achieved an outcome e.g., Human Health providing JEV vaccines to Industry workers, and Industry workers reporting signs of animal infection to Human Health etc. they exchanged a chocolate. After 20 minutes, I brought the group back together to discuss who they chose to collaborate with, why or why not, and any challenges experienced.

Evaluation

Using a Mentimeter poll at the conclusion of our session, scholars identified that the lesson met the learning objectives and was interactive, interesting, and supportive of their learning (Table 5.2). Verbal feedback from the MAE staff suggested our session was very engaging and educational.

Table 5.2. Evaluation of Teaching First Year Scholars (n=15)

Question	Average (1-5)
The session met the learning objectives	
Outline the concepts of One Health	4.9
Identify the stakeholders required for a One Health response to an acute incident	4.8
Develop a multi-sectoral action plan for a One Health response to an acute incident	4.9
Session Feedback	
The session was interactive	4.6
The content was useful and interesting	4.5
The facilitators approach supported my learning	4.3

Reflection

Acknowledging and addressing imposter syndrome is crucial in creating a safe and supportive space for discussion, particularly throughout the MAE program. During the session it was apparent that many of the first-year scholars did not have previous One Health experience. Whilst my group expected this, we did not factor in the need for greater facilitation to promote discussion. We found scholars were apprehensive to propose ideas, potentially due to the fear of being judged or criticised for their response. Sharing our own One Health learning journey, specifically that we had no concept of One Health at our first course block, could have alleviated some of the insecurity in the classroom.

Conducting a group teaching activity requires effective collaboration. Our group found it difficult to agree on what content was most important to cover, an issue that transcends into the One Health context. This experience highlighted the importance of learning objectives. We ended up agreeing to focus on content that covered the learning objectives, with the remaining time allocated evenly across the group for additional content of their choice.

The first-year teaching session was a memorable component of my MAE experience. I left the classroom feeling empowered knowing I had translated my field experiences into knowledge for others.

Figure 5.1. Teaching to first-year MAE scholars – One Health Response: An Introduction. (Left to right) Victoria Marriott, Michaela Gilbert, Marie Heloury, Elaine Ung.

Appendix A – Lessons from the field: Worksheet with sample answers

Investigating non-communicable disease clusters:

Learning Objectives

After this case study and videoconference session, you should be able to:

1. Locate and use protocols/guidelines for non-communicable disease clusters in your placement/jurisdiction.
2. Conduct a basic non-communicable disease (cancer) cluster epidemiological analysis using information provided by the informant/s and additional sources as required.
3. Communicate findings in a lay summary with the intent to allay fear/concerns.
4. Identify and explain some of the challenges associated with a non-communicable disease (cancer) cluster investigation.

Case Study:

Today your Public Health Unit (PHU) received this email from a concerned member of the public:

> Dear Public Health, 01/01/2023
>
> There is a cancer cluster at my work. I work as a lecturer at Clusterville University in the EPI region. Over the past 10 years there have been 5 breast cancer (all female), 6 prostate cancer (including me) and 2 melanoma diagnoses in university staff. One of the breast cancer cases has died.
>
> I am very worried about the university staff and students. I think everyone is getting sick because of the radiation from the phone tower that was built near campus a few years ago. Since it was built, fish and birds have been dying in the University Lake.
>
> The university staff won't go back to work until this has been investigated. I think the building needs to be relocated like the ABC Toowong Cancer Cluster or the phone tower be removed.
>
> I expect to hear from you as soon as possible.
>
> John +61 123 456 789

Your Public Health Physician (PHP) called the informant to address their concerns. The informant's concerns were not addressed and requested the PHP conduct a further assessment. Classified as a Type 1 (first stage) investigation, the PHP has asked you to conduct an epidemiological analysis to support this level of assessment. You were provided with the following additional information from the PHP and Environmental Health Team:

- Two cases of alleged breast cancer were reported as non-invasive (benign). One of these cases was the individual who passed away.
- All alleged cases were in their 60s-70s when diagnosed.
- The mobile tower was constructed in 2015. The University is approximately 300m from the tower and is surrounded by residential zoning.
- In 2018 there was community concern regarding radiation from the tower. In 2019, the Department of Radiation and Nuclear Science conducted testing which found no significant results.
- The entire University staff are aware of this complaint. It is unknown if students are aware.

Questions:

Locate and utilise the non-communicable disease cluster guidelines for your placement/jurisdiction to help formulate your answers. If your placement or jurisdiction does not have a set of guidelines, you can use the QLD Health non-communicable disease cluster assessment guidelines 2019.

Additional resources you may use to support your answers:

- International Agency for Research on Cancer (IARC): https://www.iarc.who.int/
- IARC Monographs - https://monographs.iarc.who.int/agents-classified-by-the-iarc/

1. Data collection: Your PHP has asked you to present the data for assessment in a table.

Considering biological plausibility and reported diagnoses/mortality, is there data you would record, but not use for your assessment? Why, why not?

All data provided by the informant would be recorded, however not all of it would be used to conduct an assessment. It would be appropriate to exclude the alleged melanoma cases from this assessment due to the lack of biological plausibility. It would also be appropriate to exclude the alleged non-invasive reports and any associated non-invasive deaths from your analysis. In QLD, non-invasive cancers are not investigated due to poor population data for these conditions.

Based on your decision above, present the data you would use for your assessment in a table. You can add or remove rows and columns as needed.

Table 1. Reported cancer cases and related deaths at Clusterville University, 2013-2023

Cancer type	Number of alleged cases	Number of alleged related deaths
Breast Cancer		
Prostate Cancer		
Total		

Would you request more information from the informant at this point in the investigation? Why, why not? Use the guidelines to inform your response.

At this point in a Stage 1 Investigation, no further questions would be asked of the informant. We do not need to confirm any of the alleged diagnoses nor calculate any specific rates.

Although this approach is against an Epi's instinct, you should use the information available to you in the first instance. Most investigations can be closed at a Stage 1. As an Epi, your role at this point is to calculate the expected case numbers per population for the geographical region. Should the alleged cases exceed what is expected in the region, there may be reason to progress to a Stage 2 investigation where more information would be requested.

2. Data analysis: Are the number of reported cases more than what would be expected for the area?

Using the provided data below, calculate the breast and prostate cancer incidence and SIR for the Clusterville SA2 and EPI region. The case and population data are a 10-year average.

Table 2. 10-year average breast and prostate cancer incidence for Clusterville SA2 and EPI state, 2013-2023.

Cancer	Clusterville (SA2) 10-year mean			EPI Region 10-year mean			SIR
	Cases	Population	Incidence per 100,000	Cases	Population	Incidence per 100,000	
Breast (female)	10.5	3,420	307	965.1	321,685	300	1.02
Prostate (male)	20.8	4,165	499	1065.2	363,986	293	1.70

Explain the results from the table in the context of the investigation.

The standardised incidence ratio (SIR) of breast cancer is 1.02 (0.91-1.14). As the confidence interval crosses 1, this result is not statistically significant. Overall, breast cancer incidence in Clusterville is not more than expected for the region. This information would support closing the Investigation at Stage 1. The SIR of prostate cancer is 1.7 (1.56-1.86) and is statistically significant. However, these results must be interpreted with caution. The age population structure in Clusterville is most likely different to the EPI Region. The inclusion of age standardised rates would improve the analysis and should be undertaken before closing the investigation at a Stage 1.

Where would you find your jurisdictional cancer incidence data and what level of data does it provide? E.g., In QLD we use the Oncology Analysis System (OASys), a database containing statistics on cancer in QLD.

The OASys database in QLD contains over 30 years of de-identified population cancer data from the Queensland Cancer Registry. It is presented in a dashboard format where you can point-and-click for incidence, mortality, prevalence, age-standardised rates, and survival rates. You can export data from the dashboard. Only QLD employees can request access to the database.

3. Biological plausibility:

What carcinogenic agent/s have sufficient evidence linked to breast and prostate cancer in humans? Are any of these explained by the Clusterville mobile tower?

Breast – Alcoholic beverages, Diethylstilbesterol (type of synthetic estrogen), Estrogen-progestogen oral contraceptives (combined), Estrogen-progestogen menopausal therapy (combined), X-and Gamma-radiation. There are several agents with limited evidence in humans. Prostate – No known carcinogen agents with sufficient evidence in humans. There are several agents with limited evidence in humans. None of the listed agents should be associated with the Clusterville tower. The tower would emit non-ionizing radiation. This would be enough to close a Type 1 investigation, however, should your team identify another potential causative agent, that finding should not be dismissed.

Considering the latency period for both breast and prostate cancer, is the University a likely exposure? Why, why not?

Latency should be considered in all investigations. Where latency periods are not well documented, a minimum of five years should be used, however a latency of 10-20years is more likely. Queensland Health uses a latency period of at least 18 years for breast cancer and 15 years for prostate cancer. The mobile tower was built 8 years ago. It is highly unlikely that the tower has any association with the alleged cancer cases as not enough time has passed for cancer to develop and be detected between tower development and alleged case identification.

4. Communication:

In less than 250 words, communicate your findings as a lay summary to the informant.

Good afternoon, John, thank you for email regarding Clusterville University. Queensland Health takes reports of potential cancer clusters very seriously and have conducted an assessment to investigate your concern. Based on our findings, the cancer diagnoses do not form a cluster and were not caused by the tower near the Clusterville campus. Both breast cancer and prostate cancer are common cancers than can take upwards of 15 years to develop and be detected. The mobile phone tower was constructed 8 years ago and has passed annual radiation testing. This means not enough time has passed for the tower to be the potential cause. Additionally, the number of breast cancers identified at the University is less than what we would expect for the Clusterville region. The number of prostate cancers is slightly higher than the general population of Clusterville, however this is most likely because the university population has more older males than the general population. Queensland Health are confident with the findings of the investigation and no further assessment is required. If you have any questions or concerns about this assessment, please call or email me at X. Unfortunately, I cannot comment on the cause of the dead animals by the lake. I have referred the matter on to the QLD Dept of Environment and Agriculture for investigation.

Would you communicate the findings with other stakeholders? If yes, who and how?

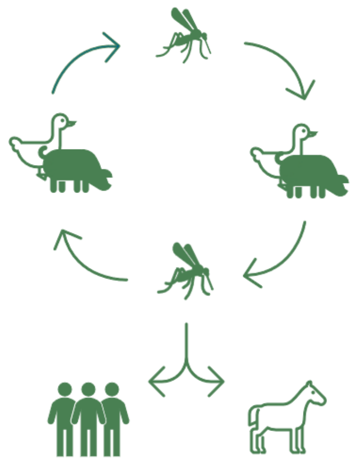
The findings should be provided in a written summary document and discussed verbally with relevant stakeholders. The main priority with the findings is to be clear, use lay language, provide education, and allay fears. Make sure to involve your communications department and any supporting organisations in the development of the document. This prevents miscommunication and misalignment of results. The findings should be shared with the University for their distribution to teachers, students, staff and if applicable, residents. The findings should also be communicated with the local government, environmental agencies e.g., for the dead fish/birds. Usually, the media will not get involved in a Type 1 investigation, however it is important to allay fears of the community should the media be involved. You want to be as transparent as possible. This would include distributing the summary to the relevant media authorities.

Appendix B – Teaching to first-year scholars: One Health Case study presentation

What is Japanese Encephalitis?

- Caused by the Japanese encephalitis virus (JEV)[1]
- It is spread through mosquito bites (*Culex sp.* mosquitoes in Australia) [1]
- Mosquitoes become infected through biting infected pigs and waterbirds (only these species develop sufficient virus levels).[1]
- JEV cannot be transmitted from human to human as humans (and horses) are considered "dead end hosts".[1]
- Infection in pigs can result in reproductive abnormalities including litter abnormalities (which can lead to substantial economic losses).
- [1]

1. Centre for Disease Control. Japanese Encephalitis [Internet]. 2015. Available from: https://www.cdc.gov/japaneseencephalitis/index.html



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Japanese encephalitis epidemiology in Australia

- JEV is endemic to parts of Asia and the Torres Strait region of Australia. [2]
- Human infection by JEV is commonly asymptomatic but can result in severe disease (encephalitis) and even death. Of symptomatic cases, 20–30% are fatal.[1]
- In 1995, JEV emerged for the first time in northern Australia causing an unprecedented outbreak in the Torres Strait. [2]
- The three outbreak cases from the Badu Island lived in close proximity to piggeries [2]

1. Centre for Disease Control. Japanese Encephalitis [Internet]. 2015. Available from: https://www.cdc.gov/japaneseencephalitis/index.html
2. Van den Hurk, A.F., et al., Japanese Encephalitis Virus in Australia: From Known Known to Known Unknown. Trop Med Infect Dis, 2019. 4(1).

CB3 – An introduction to One Health 13

Case study – Group exercise

- Southern states have notified cases in pigs and humans
- What is happening in QLD? Have we missed something?
- Break into four stakeholder groups:
  - Queensland Health
  - Queensland Department of Agriculture
  - Queensland Department of Environment and Ecology
  - Pork Farming Industry

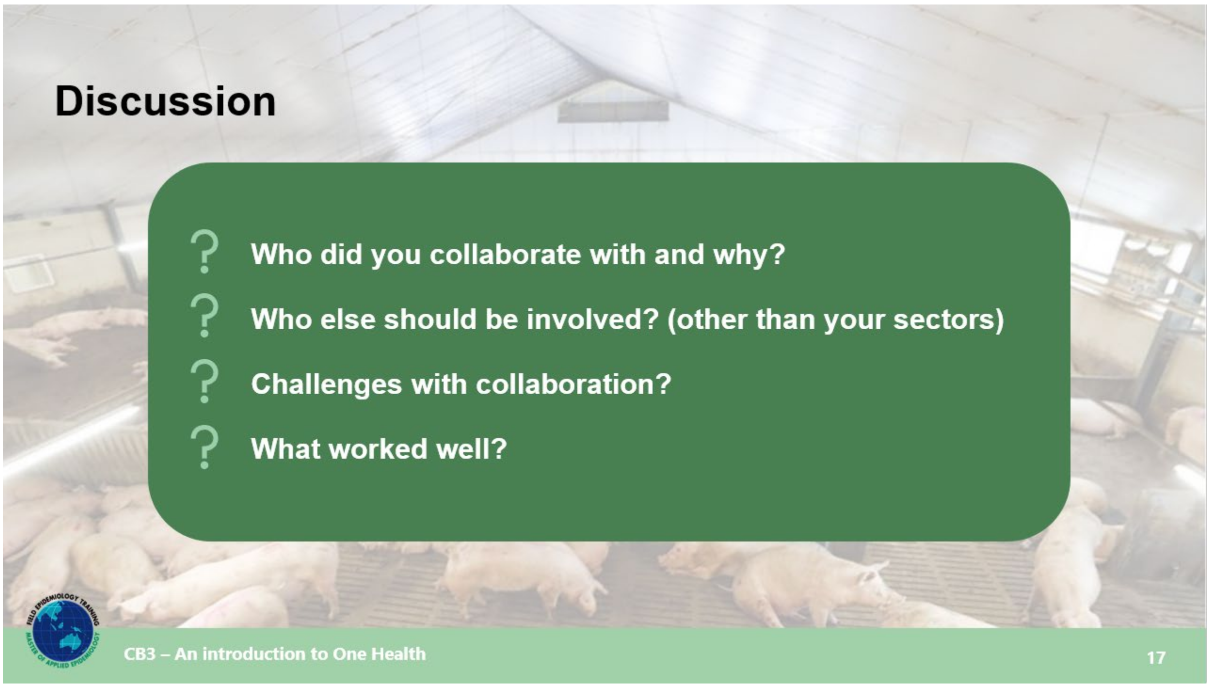
CB3 – An introduction to One Health 14

Case study – Group exercise

- Each sector must identify 3-5 actions relating to their sector
- Identify and liaise with the stakeholders who you will need to collaborate with
- Each collaborative action needs an exchange (chocolate)
- Document your decision making
- Things to consider:

SURVEILLANCE	TRADE	MORBIDITY & MORTALITY	COMMUNICATION
SENSITIVITIES E.G., POLITICAL	PREVENTION	RESOURCING	ECONOMICS

CB3 – An introduction to One Health 16


Discussion
Who did you collaborate with and why?
Who else should be involved? (other than your sectors)
Challenges with collaboration?
What worked well?
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Appendix C – Teaching to first-year scholars: Fictional stakeholder brief

Agriculture (Queensland Department of Agriculture and Fisheries)

Responsibility: Maintaining access to markets, protecting animal welfare, and managing the delivery of regional assistance to industry.

Affiliated with: The Commonwealth Department of Agriculture, Fisheries and Forestry

Scenario knowledge:

- Surveillance activities have identified positive detections of JEV in feral pigs in the Cape York Peninsula
- Other states (NSW and Vic) have reported detections of JEV in piggeries.
- Southern Queensland pork industries are concerned about the risk of JEV to their industry.
- Impacts on the pork industry could impact supply of pork products at supermarkets in Australia and products that are exported.

Public Health (Queensland Health)

Responsibility: Protect the community from public health threats, including through surveillance, research, and health promotion.

Affiliated with: The Commonwealth Department of Health and Aged Care

Scenario knowledge:

- Southern states of NSW have reported sporadic cases of Japanese Encephalitis in people.
- 2 individuals presented to Robina Hospital with symptoms of encephalitis, cause unknown (Viral and bacterial panels negative).
- Individuals are unrelated to each other and come from different LGAs in Southern Queensland. One individual works at BigPig Pork.
- JEV vaccination is not currently available in Queensland (other than travel vaccines).

Industry (BigPig Pork Farms)

Responsibility: Multibillion-dollar industry for the Australian economy. As a primary producer, BigPig is responsible for maintaining the health of pig herds and reporting any notifiable diseases to the state agriculture department.

Reports to: State agriculture department (as required)

Scenario knowledge:

- Litter abnormalities have been observed in BigPig Pork farms in Southern Queensland for 2 weeks, including an increase in the number of stillbirths and number of births of underdeveloped piglets.
- All standard testing has been negative to date.
- If litter abnormalities continue at the current rate there could be serious implications for BigPig to meet their market expectations.
- Staff at BigPig have voiced concerns about whether whatever is causing the litter abnormalities could affect their own health.

Ecology/Environment (Queensland Environment Department)

Responsibility: Protect and manage parks and forests for current and future generations, enhance Queensland's ecosystems, conserve, and protect Queensland's biodiversity and threatened species.(2)

Affiliated with: Commonwealth Department of Climate Change, Energy, Environment and Water

Scenario knowledge:

- It has been an uncharacteristically wet and warm summer and mosquito abundance has been described as “very high” in Southern Queensland
- Waterbirds (such as herons) have been sighted in unusual areas, including near large piggeries.
- Entomologists (including mosquito trappers) are concerned that they may be exposed to mosquito borne viruses.
- There is concern that Koalas (a threatened species) may be susceptible to severe illness from Japanese Encephalitis.

References

1. Queensland Health. 2019. Queensland Health non-communicable disease cluster assessment guidelines 2019 [Internet]. Brisbane, Australia [Available from: https://www.health.qld.gov.au/research-reports/population-health/cancer-clusters.
2. Queensland Government Department of Environment Science and Innovation. 2024. Department Overview [Internet]. [updated 05 Mar 2024; cited 2024 19 Oct]. Available from: https://www.desi.qld.gov.au/our-department/about/overview.

Chapter VI – Reflections

Additional field experience

Contents

Introduction

Throughout my placement with the Gold Coast Public Health Unit (GCPHU) I have been supported in completing my MAE competencies while also engaging in other public health activities which I have detailed in this chapter. In 2023, I had the opportunity to backfill a Senior Epidemiologist position at the GCPHU for three months while simultaneously completing my MAE program. This role allowed me to take on greater responsibilities such as chairing the GCPHU research portfolio and coordinating the development of an enhanced pertussis surveillance system. As an employee, I gained valuable insights into the role of a field epidemiologist. I believe this opportunity, paired with my learnings from the MAE program has better prepared me for my career after the completion of the MAE.

Coordinating the Gold Coast Public Health Unit Research and Innovation Portfolio

Background

For a portion of my MAE field placement, I worked part-time as a Senior Epidemiologist with the Gold Coast Public Health Unit (GCPHU). As part of this role, it was my responsibility to coordinate the research portfolio for the GCPHU.

My Contributions

As research coordinator, my main responsibility was to chair the bi-monthly GCPHU research and innovation meeting. This meeting is an opportunity for GCPHU employees who are interested in research to convene, talk about their current or future research endeavours, troubleshoot any concerns including ethics protocols or scientific writing, discuss any upcoming professional development opportunities or student placements, and receive updates from the Gold Coast Hospital and Health Service (GCHHS) Research and Development office. As the forum chair, I prepared the meeting agendas, facilitated the meetings, coordinated any actions arising and maintained the GCPHU relationship with the GCHHS Research and Development office.

In this role, I also provided ad hoc advice and support to employees at the GCPHU and the Gold Coast Sexual Health Service (GCSHS) for any research-related queries. This involved helping staff conduct literature reviews, draft ethics protocols, navigate the ethics pathway, prepare conference abstracts and posters, write journal manuscripts, and facilitate journal club sessions. As part of this process, I developed a series of internal documents to support staff navigate preparing for a scientific conference. These documents outlined how to apply for professional development leave and funding, a GCHHS style guide for poster development, where to get posters printed, how to write an abstract and the internal clearance process prior to conference submission.

Public Health Impact

Research is an area that is valued at the GCHHS as it is a key driver for best practice, ensuring our community receives the highest quality of care. However, conducting research in public health can sometimes come as a lower priority due to competing tasks, particularly when reactive public health action is required. By having a research coordinator, the GCPHU can keep research and the value it brings to public health practice front of mind. The pre-scheduled bi-monthly meetings allow staff to have designated time for research, maintain collaborative relationships between teams, and keep track of project progress for internal reporting. Outside of these meetings, having a research coordinator empowers staff to actively engage in research, offering the support they need to overcome concerns about difficulty or time constraints. With a dedicated person to guide and assist, research becomes more approachable and manageable.

The documentation I created to assist staff with the conference process has yet to be formally evaluated. However, initial feedback from those who used it to develop their posters suggests they would not have been aware of the style guide requirements or printing procedures without the new resources.

Lessons Learnt

To meet the MAE competencies, I had to complete a literature review, prepare a data analysis plan and ethics protocol, draft a journal manuscript, and present at a scientific conference. Working as the GCPHU research coordinator has highlighted why these elements are core to the MAE curriculum and essential for preparing MAE scholars to become field epidemiologists, as they reflect common practice in public health workplaces. My timely experiences as an MAE scholar have given me the confidence to share my knowledge and support my GCPHU and GCSHS colleagues throughout their own research journeys.

Additionally, this opportunity has helped me refine my chairing skills. Through chairing the research and innovation meetings, I have learned how to prepare and manage meeting documentation, keep meetings on time, and guide and prompt discussions.

Initiation and implementation of youth sexual health promotion on the Gold Coast

Background

In 2023, young people (aged 15-29 years) made up almost 70% of all sexually transmissible infection (STI) notifications on the Gold Coast.(1) Despite this figure, the Gold Coast Sexual Health Service (GCSHS) is not funded specifically to support sexual health promotion or disease prevention for this priority population group.

Neighbouring region, Northern New South Wales (NNSW), are leaders in the youth sexual health promotion space, particularly in opportunistic outreach STI testing at youth events including the renown three-day music festival, Splendour on the Grass. Eager to improve the Gold Coast Public Health Unit's (GCPHU) youth presence, I reached out to NNSW MAE Scholar Dr Megan Ellis to learn from their activities. Megan identified that the NNSW outreach model would be transferrable to the Gold Coast due to its similar socio-cultural profile and abundance of youth-targeted events.

My Contributions

I approached the GCPHU Health Promotion officer (HP) Katherine (Kat) Cacavas to discuss the idea of promoting youth health on the Gold Coast. I was particularly interested in exploring the possibility of outreach STI testing, similar to the model in NNSW. This idea was well received by the GCPHU and GCSHS, with the GCSHS keen to provide time and resources to support targeted outreach testing. Kat identified an opportunity with UniSport Australia to provide sexual health information and free STI screening for students and attendees at the National UniGames tournament. The UniGames tournament is held on the Gold Coast every two years and is an event where thousands of students from 43 Australian universities competing in 31 sports convene for one week of intense competition.

In preparation for the event, I supported the project proposal and ethics application which were led by the GCSHS. This involved ensuring the project met the consent requirements as stated in the *National Statement on Ethical Conduct in Human Research 2023* and had clear strategies to support young people should they test positive as part of this research pilot. I also collaborated with GCSHS staff to develop a short questionnaire to distribute at the event to learn about youth sexual behaviours, attitudes and knowledge around STIs and STI protection.

The results from this survey were intended to inform future youth sexual health messaging and strategies on the Gold Coast.

At the event, I walked around the venue having candid, relatable conversations about sexual health with young people while handing out condoms and dams. I was able to ask and answer simple questions about STIs using fact cards developed by Kat and the GCSHS team, however if someone had any clinical concerns or questions beyond my capacity, I was able to direct them to our onsite nurse practitioner or sexual health doctor for appropriate support. Each conversation or educational interaction was manually counted to help the GCPHU quantify our impact at the event. Back at the GCPHU stall we continued these conversations and offered merchandise and fact sheets on the topics of sexual health, vaping, sun safety, nutrition and hydration.

To normalise these conversations, we tapped into the competition element of the UniGames tournament and gamified our interactions. This included a cornhole game where participants were asked a question relating to sexual health and they had to find the right answer on the cornhole board and throw a beanbag into the corresponding hole. If they got the wrong answer, we would give them a fact connected to the right answer before taking a second throw and repeated this until they correctly answered the question. Participants competed against their UniGames teammates to see who could get the right answer the fastest. We had another game where participants were blindfolded and given a fruit or a vegetable and a sealed condom. When the timer started, participants raced against both their teammates and the clock to successfully put the condom on their fruit or vegetable. The person at the end of the event who put the condom on successfully the fastest won a $50 e-gift card.

Throughout the event I supported attendees to have a free and confidential, self-collect STI screening test. The self-collect test screened for various STIs depending on the participants sexual orientation as per the *Australian STI Management Guidelines* (Table 6.1).

Table 6.1. Sexually transmissible infection testing procedure for the National UniGames tournament, 2023.

Sexual and gender orientation	Site/specimen collected	STI test	
		Chlamydia	Gonorrhoea
Heterosexual male	Urine sample	✓	-
Heterosexual female	Vaginal swab	✓	✓
Gay and bisexual male	Throat OR rectal swab AND Urine sample	✓	✓

After the event, the GCSHS provided me with the final STI testing data as well as the survey results for analysis, interpretation, and reporting. Combining this information with the GCPHU educational interaction data, I developed a one-page event summary infographic (Appendix A) to share with UniSport Australia to demonstrate our impact at their event. This infographic was also shared internally via the GCHHS intranet page as a local success story.

Public Health Impact

The UniGames event was the first outreach STI testing service the GCSHS provided since before the SARS-CoV-2 pandemic. Over the course of five hours, onsite staff delivered 96 educational interactions, distributed 618 condoms, lubricant and dams, and conducted 28 STI tests. Of those tested, 62% of males and 36% of females had not previously had an STI screening test despite being sexually active. When compared to the day-to-day operations of the GCSHS, the UniGames outreach opportunity resulted in more screening tests for young people, indicating the benefits of outreach public health services.

The overall success of the UniGames pilot event resulted in the continuation of the youth sexual health outreach program. After this event, the GCPHU and GCSHS went on to provide outreach STI testing and educational interactions at the 2023 Safer Schoolies event, the 2024 UniSport Athletics National Championships, the 2024 Homeless Connect community event, and at Griffith University market day in September 2024.

While this work is evidently important, operating outreach services without additional funding or personnel can take away from routine responsibilities. To support the continuation of this work, I helped the GCPHU and GCSHS to prepare a grant application for the Queensland Sexual Health Research Fund (SHRF), a partnership between The Queensland Department of Health and the Australasian Society for HIV, Viral Hepatitis and Sexual Health Medicine. In August 2024, we were successful in receiving a $79,979 SHRF grant to help with outreach resourcing, allowing us to continue servicing the youth community of the Gold Coast. This was the maximum amount available for this grant, highlighting the fantastic work being conducted by the GCPHU and GCSHS.

Lessons Learnt

Throughout this experience I learnt how much time, effort and resourcing goes into health promotion and outreach events. From developing ethics protocols and applying for grants to creating educational resources, designing merchandise, building stakeholder partnerships, and setting up the event, running a successful event takes teamwork. After the UniGames event, I realised the positive impact on attendees far outweighs the effort. For example, an attendee expressed her gratitude for our service, sharing there was no sexual health service in her regional area. Interactions like these demonstrate how widespread outreach education and testing can be.

Overall, I thoroughly enjoyed being a part of the youth sexual health project. It is a topic that I am very passionate about and I am grateful that my initial idea was heard and supported by both the GCPHU and GCSHS. This collaborative effort was driven by Katherine Cacavas from the GCPHU, alongside Dr Caroline Thng, Dr Lisa Wang, Brian Clarke and the administrative team from GCSHS. I look forward to supporting the continuation of the project after the completion of my MAE program.

Development of communication material for Residential Aged Care Facilities after a listeria product recall

Background

In Australia, listeriosis is a relatively uncommon illness that is caused by consuming food contaminated with the bacteria *Listeria monocytogenes*. Listeria infection causes mild symptoms in healthy individuals but can be severe for those at high risk such as older people, pregnant women and those who are immunocompromised.

In September 2023, a cluster of cases of listeriosis were notified and genomically linked across Queensland (n=5), New South Wales (n=3) and Victoria (n=1). All five cases notified in Queensland were determined to have acquired their infection in hospital. After interviewing all five hospital-acquired cases, Metro South Public Health Unit Environmental Health Officers narrowed the potential source to several foods served at the implicated hospitals. Samples of these foods were sent to the Queensland Public and Environmental Health Reference Laboratories (previously known as Queensland Forensic and Scientific Services) for testing. Staff from the microbiology and genomics teams were able to isolate *Listeria monocytogenes* from a sample of shredded chicken that was later shown via whole genome sequencing to be genetically related to all cases associated with the cluster. After a four-week investigation and heavy media attention,(2, 3) Queensland Health identified that all cases had consumed the same implicated product, M&J shredded chicken, and issued a media release to advise the public.(4)

Soon after the media release, Food Standards Australia and New Zealand and Queensland Health announced a recall of certain commercial M&J Chicken products on the basis of *Listeria monocytogenes* contamination risk.(5) The recalled product was sold in commercial quantities and was not available for public sale.

In October 2023, the Gold Coast Public Health Unit (GCPHU) received an Excel spreadsheet containing M&J Chickens commercial customers located on the Gold Coast for follow up. The GCPHU Environmental Health team (EH) contacted each customer via phone to advise them of the recall and how to dispose of the product. No clinical discussions were had with the customer at this time.

My Contributions

The incubation period for listeriosis can be anywhere between 24 hours and two months. Because of this extended incubation period, my role was to go through the spreadsheet and identify any high-risk customers for ongoing monitoring such as residential aged care homes (RACH) and hospitals. I identified 18 RACHs that had a recent history of purchasing M&J shredded chicken products. No other high-risk customers were identified.

I provided the spreadsheet to the GCPHU Communicable Disease Control team (CDC) for reference as it would be important to know if any prospective outbreaks could potentially be linked back to the M&J recall.

In liaison with the EH, CDC and Epidemiology teams, I developed a letter (Appendix B) that summarised the recall, explained what listeriosis is, how it is transmitted, signs and symptoms, medical complications, and further actions required to prevent disease amongst RACH residents and staff. The letter was sent alongside the Queensland Health Listeria fact sheet (Appendix C) by the CDC team to all 18 RACHs for information and action.

Public Health Impact

Two RACHs responded to the letter in writing, both informing the GCPHU they had since disposed of any potentially contaminated product as per the provided advice. No cases of listeriosis were identified from any of the implicated RACHs.

Lessons Learnt

This experience taught me that it is important to provide health information both verbally and in writing, especially in scenarios with a lengthy follow up period. While the GCPHU EH Team advised each local consumer group of the recall verbally, it was only after the letter was distributed that all RACHs had disposed of their potentially implicated stock. By providing written advice, staff were able to refer to the document and distribute the information throughout the facility, potentially reaching staff absent at the time of the initial call made by GCPHU EH staff.

Development of an enhanced surveillance system for pertussis notifications

Background

Pertussis is a highly infectious, nationally notifiable respiratory disease caused by the bacterium *Bordetella pertussis*. Infection is common in Australia, with epidemic cycles historically occurring every three to four years. While pertussis can cause mild illness in adults, childhood infection can be life threatening, particularly in unimmunised infants. For this reason, the Gold Coast Public Health Unit (GCPHU) public health nurses actively follow up all notifications in children aged five years or younger.

After several years of low case numbers, in 2024 the Gold Coast saw a rapid increase in pertussis notifications, particularly in school-aged children and teenagers. While these cases do not meet the existing criteria for active follow up, the GCPHU saw the need for enhanced surveillance to identify any schools, high-risk settings or at-risk individuals that would require public health support.

My Contributions

I was tasked with developing a digital case screening questionnaire to streamline pertussis follow up in cases aged five years or older. My role in the process included:

- Collaborating with public health physicians, public health nurses and epidemiologists to identify key fields for collection and reporting including demographic and clinical details, as well as movement and contact history whilst infectious.
- Building and testing a user-friendly digital screening survey in EpiInfo to assist public health nurses triage case follow-up based on an internally developed risk assessment tool.
- Developing and implementing a process flow for distributing the EpiInfo survey via SMS, extracting returned survey data for analyses and displaying the information in a digestible format for public health nurse action.

Public Health Impact

The GCPHU are moving towards collecting enhanced surveillance data via SMS surveys for low-impact notifiable conditions. The use of digital case surveys allows public health staff to divert their already limited time to more resource-intensive follow up for notifiable conditions such as measles or meningococcal disease.

The pertussis survey was the second digital survey established by the GCPHU. This project followed the successful implementation of a cryptosporidiosis survey during the large east coast outbreak over the 2023-24 summer season. The cryptosporidiosis survey had an average response rate of 44.8% and resulted in several community exposure sources being identified and rectified.

While the pertussis survey has not yet been activated due to a change in strategic direction, it remains ready for implementation should the GCPHU require a streamlined follow-up approach in the future. Additionally, the development of the survey prompted discussion with public health units around Queensland to implement similar triage systems for pertussis notifications.

Lessons Learnt

During this experience I learnt about the clinical stages of pertussis and how they can impact onward transmission, as well as how difficult it can be to explain these stages in lay terms in a short survey. I have become familiar with the evolving epidemiology of pertussis on the Gold Coast and have recognised how devastating this disease can be for families of young children. From a technical perspective, I solidified my skills in EpiInfo and enhanced my knowledge on how to develop a user-friendly digital survey.

Redevelopment of the Gold Coast Public Health Unit website content

Background

The GCHHS website has dedicated subpages for each public service provided by the health service including public health, oral health, sexual health, immunisation, medical and surgical, mental health, alcohol and other drugs and more. These pages provide key information to the public including what each service does, how to access the service, community resources developed by that service. Prior to this project, the public health subpage, particularly the epidemiology section, contained outdated and complex language, unsuitable for the general community.

My Contributions

My role was to review and update the existing content for the epidemiology page and create content for a new page dedicated to public health research and training. For the epidemiology page, I revised the existing content and removed any information that was no longer relevant to the epidemiology team. For the public health research component, I summarised the GCPHU's research portfolio and identified opportunities for external collaboration. As for the training page, I liaised with GCPHU staff to list what formal and informal training opportunities were available within the unit and quantified our training outputs for the previous calendar year.

I assessed the readability of the new content against the Simple Measure of Gobbledygook (SMOG) Index.(6) The SMOG index is a readability formula that calculates how many years of education a person would need to understand a text. The Australian Government recommends public government information should be written to an Australian year 7 level.(7) After ensuring the text was at an appropriate literacy level, I sought feedback from non-public health trained individuals before sending the revised content to the Health Communications team for publication.

Public Health Impact

The GCPHU is not public facing, and our work is often misunderstood by the community. Having a digestible website supports community members to better understand and engage with the work of the GCPHU.

Lessons Learnt

Explaining complex concepts, such as disease epidemiology and surveillance, to a general audience is a difficult skill. The MAE program was pivotal in my understanding of lay summaries and their importance in public health communication. This project was an optimal opportunity to refine my understanding and improve my writing skills.

Presentation on proactive outbreak identification and management at the 2023 QLD face-to-face public health unit epidemiologists meeting

Background

On 25 October 2023, the QLD Public Health Unit (PHU) Epidemiologists gathered for a face-to-face event in Brisbane for the first time since 2019. The agenda covered strategic priorities for the future, how to enhance collaborative opportunities and shared learnings from past experiences.

My Contributions

I co-delivered a presentation with my placement supervisor Dr Fiona May; *Enhanced Surveillance – Proactive Outbreak Identification and Management*. The purpose of the presentation was to define the difference between traditional surveillance and enhanced surveillance, provide examples of enhanced surveillance systems, and discuss opportunities to translate these ideas into practice for QLD PHUs. My focus was to walk through the Gold Coast Gastrointestinal Enhanced Syndromic Surveillance System (GSSS), its benefits, limitations, and prospects.

Public Health Impact

At the time of presentation, the Gold Coast were the only QLD PHU with an active syndromic surveillance system. The presentation was well received with several epidemiologists engaging in discussion. There was strong interest in the upcoming evaluation of the GSSS as well as the opportunity to expand the system to other syndromes and regions of QLD for the purpose of early detection and disease prevention.

Lessons Learnt

This was my first presentation as an MAE scholar. Despite thorough preparation, I was very nervous as I was presenting to a room of established epidemiologists. I was worried about making mistakes, sounding uninformed or that my content might not be engaging given their extensive backgrounds. This was the first time I had experienced the phenomenon of imposter syndrome. However, after the presentation several audience members wanted to know more about the GSSS and iterated how valuable the presentation was. This experience reinforced the importance of sharing knowledge and engaging in peer-to-peer learning, particularly on contemporary topics like enhanced syndromic surveillance. Additionally, this presentation increased my confidence and prepared me for subsequent presentations throughout my MAE experience.

Appendix A – Youth health promotion at UniSport Nationals 2023, Infographic

Youth Health Promotion on the Gold Coast

UniSport Nationals 27 September 2023

Gold Coast Health always care | unisport

The UniSport Nationals tournament saw 6,000 students from 43 Australian universities and 31 sports travel to the Gold Coast (Kombumerri Country) for one week of elite competition.

On 27 September 2023, the Gold Coast Public Health Unit and the Gold Coast Sexual Health Service teamed up to provide a youth-specific public health activation at the 2023 UniSport Nationals tournament. This included education on sun safety, vaping, nutrition and hydration as well as onsite sexual health education and screening, the first outreach screening service since before the COVID-19 pandemic.

Over five hours, the Gold Coast Health team, comprising of a Health Promotion Officer, two Health Promotion students, an Epidemiology Scholar, a Sexual Health Nurse and an Administration Officer:

PROVIDED 618 CONDOMS, LUBRICANT & DAMS

CONDUCTED 28 STI TESTS
96% COMPLETION
7% POSITIVITY RATE

DELIVERED 96 EDUCATION INTERACTIONS

OF THOSE TESTED, 62% OF MALES & 36% OF FEMALES HAD NEVER HAD A SEXUAL HEALTH SCREEN

Gold Coast Sexual Health Service – STI screening and sexual health education

Gamified learning, drawing on the competitive nature of the UniSport Nationals

Gold Coast Health
Building a healthier community

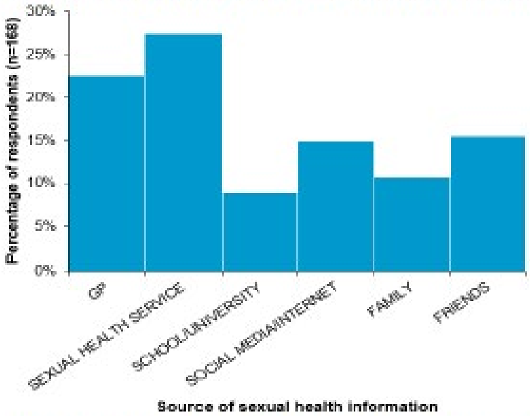
Queensland Government

Youth Health Promotion on the Gold Coast

UniSport Nationals 27 September 2023

Gold Coast Health always care | unisport

Where do you go for your sexual health information?



WHAT WE HEARD

"I DIDN'T LEARN ANYTHING AT SCHOOL ABOUT SEXUAL HEALTH"

"THIS [UNIGAMES] IS ACTUALLY A GREAT SPOT TO HAVE THIS [STI TESTING]"

"I DON'T NEED ONE [STI TEST]. I HAVE ONLY HAD THREE PARTNERS THIS YEAR"

"WHERE DO YOU GO FOR SEXUAL HEALTH ADVICE IF YOU ARE GAY?"

The activation at UniSport Nationals 2023 was a fantastic opportunity to provide impromptu health education, especially in the context of sexual health. The outreach screening proved successful, with a noticeably higher number of tests conducted for this demographic, when compared to the daily operations of the Gold Coast Sexual Health Service.

Both athletes and event organisers were supportive of the Gold Coast Health Team's services. UniSport Australia has since requested the ongoing presence of Gold Coast Health at future events.

This collaborative opportunity reinforces the importance of outreach public health services, specifically in the youth space.

Gold Coast Public Health Unit – covering youth-specific health education topics: vaping, nutrition, hydration and sexual health

Condoms, lubricant and dams with a sexual health survey QR code – provided after an educational interaction

Gold Coast Health
Building a healthier community

Queensland Government

Appendix B – Listeriosis alert letter sent to Gold Coast residential aged care homes impacted by the recall

Gold Coast Hospital and Health Service
Gold Coast Public Health Unit

Queensland Government

13th October, 2023

Dear Residential Care Facility Manager,

The Gold Coast Public Health Unit has recently contacted your facility alerting you about a food recall. A variety of oven roasted chicken products supplied by M & J Chickens are being recalled due to the risk of contamination with *Listeria monocytogenes*. The list of products recalled is below.

<u>Food recall</u>:
Brand: M & J CHICKENS
Batch: All products with a chilled use by date of up to and including 31 October 2023
Product: Chicken breast products, 2kg bag:

- Easy Serve Breast Fillet Shredded
- Oven Roasted Breast Fillet Shredded
- Oven Roasted Breast Fillet Shredded Lemon & Herb
- Oven Roasted Breast Fillet Shredded Peri Peri
- Oven Roasted Pizza Mix
- Oven Roasted Chicken Meat
- Oven Roasted Breast Fillet Sliced
- Oven Roasted Breast Fillet Sliced Tandoori
- Oven Roasted Breast Fillet Sliced Cajun
- Oven Roasted Breast Fillet Sliced Peri Peri

If consumed, food containing *Listeria monocytogenes* can cause serious disease in those with weakened immune systems such as elderly, frail residents of your facility. Early symptoms of listeriosis can include:

- Fever
- Headache
- Muscle aches
- Nausea
- Vomiting
- Diarrhoea

Listeriosis can later become invasive, causing:

- Meningitis (infection of the brain lining)
- Septicaemia (blood poisoning)

Symptoms can develop within 24 hours or up to two months after eating the contaminated chicken. For further information, please see the attached Queensland Health fact sheet.

As your facility may have had this product onsite, further action may be required to prevent disease.

We suggest that the following actions are undertaken by your facility:

1. Check if your facility has any of the recalled M & J chicken products onsite.
2. If these products are identified onsite, STOP using the recalled product immediately.
3. If you have been using the recalled products, advise the Gold Coast Public Health Unit via email – GCPHU-CDC@health.qld.gov.au.
4. If you have been impacted by this recall, contact your supplier for a refund and advice on how to dispose of the product.
5. Ensure that you clean and sanitise kitchen benches, cutting boards and utensils by using hot soapy water followed by a diluted bleach solution. Replace any excessively worn chopping boards.
6. Monitor residents for symptoms of listeriosis between now and the end of the year (2023). Please seek medical assistance and ask the GP to test for *Listeria*.

Postal	**Phone**	**Email**
PO Box 318, Nerang QLD 4221	(07) 5667 3200	GCPHU-CDC@health.qld.gov.au

Appendix C – Listeriosis fact sheet sent to Gold Coast residential aged care homes impacted by the recall

Queensland Health

Listeriosis

Listeriosis is a relatively uncommon disease caused by the bacteria Listeria monocytogenes. Listeria is widespread in nature and is commonly found in soil, water, mud, vegetation and sewage. It can also be found in raw meat, raw vegetables and unpasteurised dairy products. Some exposure to these bacteria is unavoidable. Every day, most healthy people eat foods that contain small amounts of Listeria with no apparent ill effects.

Listeriosis is of particular concern to pregnant women and people with a weakened immune system, such as diabetics, cancer and transplant patients, people who are HIV positive, and people with a history of alcohol abuse, as these people are at increased risk of contracting the disease.

Although the infection may cause minor or no symptoms in healthy people, including pregnant women, the risk of infection from a pregnant woman to her unborn child is high. Infection during pregnancy may lead to miscarriage, stillbirth, premature birth or a very ill newborn. The death rate in infected newborn babies is 20-30%.

Signs and Symptoms:

Healthy people may show few or no symptoms. If symptoms are present, they may vary from minor complaints such as fever, headache, aches and pains, vomiting and diarrhoea to more serious forms of the illness such as meningitis (infection of the lining of the brain) and septicaemia (blood poisoning).

Transmission

Listeriosis is mainly spread by eating contaminated food. The bacteria can also be transmitted from a pregnant mother via the placenta to an unborn baby or to the baby at the time of birth.

The average time from exposure to developing of the disease is about three weeks.

Treatment:

Listeriosis can be successfully treated with antibiotics if treatment is commenced early. However, newborn infants have a high mortality rate even with antibiotic treatment.

Prevention:

Pregnant women and other susceptible people are advised to avoid high risk foods.

What are high risk foods?
High risk foods are usually chilled ready-to-eat foods including:

- pate, uncooked smoked seafood, soft cheeses (eg. Brie, camembert, ricotta)
- cooked diced chicken (as used in chicken sandwiches)
- cold meat products (eg. cold roast meat, processed meats)
- pre-prepared and stored salads, raw seafood (eg. oysters)
- unpasteurised dairy products.

What foods are safe?
All freshly cooked foods, hard cheeses, fresh pasteurised milk and milk products, UHT milk, yoghurt, freshly washed vegetables and fruit, and canned foods are usually considered safe.

How can food be prepared safely?

- Refrigeration does NOT stop the growth of Listeria. High risk foods that have been prepared and then stored in a refrigerator for more than twelve hours should not be eaten by pregnant women or other susceptible people.
- Freshly cooked foods are safest. Conventional cooking destroys Listeria.
- Hot food should be thoroughly cooked and kept hot above 60 degrees C.
- Raw vegetables should be thoroughly washed before eating.
- Uncooked meats should be kept covered and separate from cooked foods and ready-to-eat food to avoid cross-contamination.
- Knives and cutting boards used to prepare uncooked foods should not be used to prepare cooked or ready-to-eat foods unless thoroughly washed first.

Other resources:

Queensland Health Food Safety (https://www.health.qld.gov.au/public-health/industry-environment/food-safety)

Related Content

URL: http://conditions.health.qld.gov.au/HealthCondition/condition/14/33/89/listeriosis
Version number: 8
Date published: 15/10/2018
Date generated: 1/03/2022

Queensland Government

Queensland Health fact sheets:

Shiga-toxin producing E coli (STEC) (http://conditions.health.qld.gov.au/HealthCondition/condition/14/33/568/Shiga-toxin-producing-E.-coli-STEC)
Suspected food-borne illness – advice
(http://conditions.health.qld.gov.au/HealthCondition/condition/9/93/590/Suspected-food-borne-illness--advice)
Suspected food-borne illness – information
(http://conditions.health.qld.gov.au/HealthCondition/condition/9/93/591/Suspected-food-borne-illness--information)

Help and assistance:

For further information, please contact your local doctor, community health centre or nearest public health unit
(https://www.health.qld.gov.au/system-governance/contact-us/contact/public-health-units).

Footnotes

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