

Applied epidemiology of infectious diseases for epidemic response in Australia and the Asia-Pacific region

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

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February 2019

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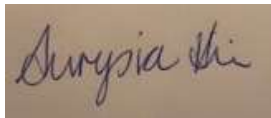
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Originality statement

'I hereby declare that this submission is my own work and that 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 or any other educational institution, except where due acknowledgement is made in the text. Any contribution to the research by others is explicitly acknowledge 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.'

Signed

A handwritten signature in dark ink on a light brown background. The signature appears to read 'Aurysia Hii' in a cursive script.

.....

Aurysia Hii

20 February 2019

Acknowledgement

There are many people who supported me throughout my Master of Applied Epidemiology (MAE) journey, without whom this degree would not have been possible.

I am grateful for the NHMRC Centre for Research Excellence, Integrated Systems for Epidemic Response (ISER) for selecting me to be an MAE Scholar and funding my scholarship. I would like to thank my field supervisors, Professor Raina MacIntyre and Dr Abrar Chughtai; and my academic supervisor Dr Tambri Housen for your support, guidance, patience, encouragement, expertise and advice over the past two years, I have learnt a lot. Tambri, thank you especially for your constant support and check-ins. I would also like to acknowledge and thank Dr David Muscatello for your time trying to find me a data analysis project, which unfortunately did not eventuate.

Thank you to the ISER team - Dillon, Mohana, Jessie, Chau, Moa, Elizabeth, Jing, Mallory and Valentina for being a wonderful team to work with over the last two years. Valentina, I have really valued your friendship.

I'd also like to say a big thank you to the staff and lecturers of the MAE program for some really interesting and inspiring course blocks, which were always a highlight to attend.

To the MAE 2017 cohort, I have really enjoyed sharing this journey with you. Thank you for being a wonderful support network and such an open and encouraging group. I am looking forward to seeing where we all end up. Thank you especially to the UNSW MAEs, Sophie and Jana for your friendship, support, advice and weekly ice-cream visits throughout these past years. Bobby and Ximena, our conversations always brought a sense of calm during overwhelming times.

To my family, in particular my Mum and Dad for putting a roof over my head, feeding me and your unwavering belief in me; Remy, Pashenka, Xavier, Fe the dog and my wonderful friends, I am so grateful for your constant support, encouragement, patience and love over the last two years through all of the many ups and downs that is MAE life - I would not have been able to do this without you!

Lastly, to my partner Patrick, it was an unexpected yet wonderful surprise to have met you towards the end of my MAE. Thank you for your love, encouragement, support

and almond croissants. I am so thankful that you were able to be a part of this journey with me!

Abstract

My field placement for the Master of Philosophy in Applied Epidemiology (MAE) during 2017 to 2019 was with the National Health and Medical Research Council funded Centre for Research Excellence, Integrated Systems for Epidemic Response. Due to my placement being an academic institute, I also worked at the South Western Sydney Public Health Unit (PHU) in the Communicable Diseases team from 5 to 15 February 2018 to fulfil the requirements of an outbreak investigation. The six chapters within this thesis demonstrate the work I have undertaken and lessons learned as part of meeting the requirements of the MAE.

For my major epidemiological project, I designed and implemented a stakeholder survey and workshop to understand the global outbreak surveillance needs of stakeholders involved in epidemic response in selected countries in the Asia-Pacific region. This study introduced me to a mixed methods approach using quantitative and qualitative methods. Findings from the research were presented at conferences, published in the *Western Pacific Surveillance and Response Journal* and used to inform the development of an epidemic observatory called Epi-watch.

I evaluated the Epi-watch epidemic observatory, a new surveillance system currently in development by ISER that provides critical analysis of global outbreaks and epidemics of public health significance. This was an internal evaluation focused on identifying areas for improvement and providing recommendations to inform further development of the system into a mature tool for use by stakeholders.

I worked at the PHU to gain outbreak investigation experience. My role there involved investigating a cluster of nine food poisoning cases following a catered private house party. Two possible sources for infection were identified, a catered sushi platter served at the party and a picnic held the previous day. A pathogen was not identified during the investigation. A retrospective cohort study was undertaken and along with other evidence, contaminated sushi was identified as the most likely cause of illness and *Salmonella* hypothesised as the causative agent.

My data analysis project aimed to investigate the impact of repeated influenza vaccinations on vaccine effectiveness and serological response. This was a retrospective secondary data analysis using data from a case control study conducted

from 2008 to 2010 by my field supervisor, Professor Raina MacIntyre. We hypothesised that there would be no difference between the number of influenza vaccinations and vaccine effectiveness and no difference between the number of influenza vaccinations and influenza A and B serological levels.

The teaching experience I gained included a lesson in the field on analysing qualitative data and being involved in a group teaching session with MAE peers for the 2018 first year cohort. Additional experiences gained included coordinating the establishment of a study to evaluate the effectiveness of a newly introduced high dose influenza vaccine compared to a standard dose during the 2018 influenza season in an aged care setting in Australia. Finally, I gained valuable experience undertaking a two-month placement as a Surveillance Officer in the World Health Organization Western Pacific Regional Office Field Epidemiology Training Program.

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List of Abbreviations

AR	Attack Rate
AMI	Acute myocardial infarction
ANU	Australian National University
CDC	United States Centers for Disease Control and Prevention
CI	Confidence Interval
CRE	Centre for Research Excellence
DDM	Data for Decision Making
EHO	Environmental Health Officer
ECDC	European Centre for Disease Prevention and Control
FETP	Field Epidemiology Training Program
GMT	Geometric mean
GP	General Practitioner
GPIN	Global Public Health Intelligence Network
HI	Hemagglutination inhibition
IHR (2005)	International Health Regulations
ILI	Influenza-like illness
ISER	Integrated Systems for Epidemic Response
LFF	Lesson From the Field
MAE	Master of Applied Epidemiology
MERS-CoV	Middle East respiratory syndrome coronavirus
NSW	New South Wales
NHMRC	National Health and Medical Research Council
NCIMS	Notifiable Conditions Information Management System

PCR	Polymerase chain reaction
PHSSN	Pacific Public Health Surveillance Network members
PICTs	Pacific Island Countries and Territories
ProMED-mail	Program for Monitoring Emerging Diseases
PHU	South Western Sydney Local Health District Public Health Unit
RR	Relative Risk
SARS	Severe acute respiratory syndrome
SAC	Scientific Advisory Committee
SOP	Standard Operating Procedure
SPC	Pacific Community
UNSW	University of New South Wales
VE	Vaccine effectiveness
WPRO	WHO Western Pacific Regional Office
WHO	World Health Organization

Chapter 1: Introduction

Summary of MAE experience

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1.1 Summary of MAE Experience

My field placement during the Master of Philosophy in Applied Epidemiology (MAE) program was with the National Health and Medical Research Council funded Centre for Research Excellence, Integrated Systems for Epidemic Response (ISER), based at the University of New South Wales (UNSW) in Sydney.

ISER is a new centre for research excellence, established in late 2015 with funding for five years. The purpose of ISER is to conduct applied health systems research, enhance collaboration and build capacity in health systems research for epidemic control. (1)

There are three core research programs of ISER: epidemic response, control and prevention; epidemic intelligence and risk analysis and the ISER academy, a cross-sectoral think-tank. During my placement, I was mostly involved in the epidemic intelligence and risk analysis program which aims to improve decision and policy making in public health by providing better frameworks for epidemic response. (1)

Below is a summary of some of the activities I was involved in during my placement.

Much of my work in this placement revolved around Epi-watch, a new epidemic observatory for outbreak scanning and rapid analysis. My major epidemiological study and evaluation of a surveillance system were focused on informing further development of Epi-watch into a final tool for stakeholders. Up until November 2017, I took on the role of presenting global outbreaks every week at the Epi-watch video-conference meeting for ISER participants and external stakeholders. This required me to collate and present relevant outbreaks identified by the Epi-watch team during the week. From mid-2018 I continued this role but on a rotational basis. Presenting outbreaks helped keep me informed of emerging and ongoing infectious disease outbreaks around the world. By reading into each event, I learnt about various diseases and the public health response to outbreak control and associated challenges across settings. At times I was also asked to provide more in-depth presentations on these outbreaks including: reasons contributing to the ongoing measles outbreak in Romania, common sources of listeria outbreaks, overview of Murray Valley encephalitis, possible reasons for the resurgence of mumps in the United States of America and an overview of meningitis in Nigeria. These tasks expanded my

knowledge of infectious diseases, developed skills in reviewing literature and gathering evidence, and provided an opportunity to improve my presentation skills. From mid-2018 I was also required to conduct daily outbreak scanning for Epi-watch. This involved reviewing selected data sources, such as ProMED-mail, identifying relevant outbreaks to report and entering outbreak details into a database to be automatically uploaded on the Epi-watch outbreak alert web page.

The 2017 Australia influenza season saw the highest level of influenza activity since the 2009 pandemic year. (2) Multiple severe outbreaks were reported in aged care facilities across the country (3, 4) and the elderly were most affected. The highest notification rates were seen in those aged over 80 years and more than 91% of deaths occurred in people aged over 65 years. (2) Additionally, the overall effectiveness of the 2017 seasonal influenza vaccine was measured to be very low (33%) for those presenting to a General Practitioner (2) and even lower in aged care facilities. (5) As a result, late in 2017, the federal Minister for Health announced the introduction of two new trivalent influenza vaccines for 2018, aimed to provide increased protection for people aged 65 years and over. (6)

My field supervisor, Professor Raina MacIntyre provided me with the opportunity to be involved in an observational study to measure the effectiveness of the new influenza vaccines offered under the Australian National Immunisation Program in 2018 to prevent influenza in residents of aged care facilities in NSW aged 65 years and over. My role in the study was to undertake a project to retrospectively calculate the burden of influenza and vaccine effectiveness in 2017 amongst residents and staff in an aged care facility in Sydney, NSW to provide as a comparator for the 2018 vaccine effectiveness study. This was going to form my data analysis project, however, due to not receiving ethics approval in time, it was not feasible to undertake this component of the project. Instead, my role involved coordinating the establishment of the 2018 vaccine effectiveness study with assistance from the study team. This included obtaining ethics approval from both the UNSW ethics committee and the specific aged care governance committee, developing the data collection tools and study documentation such as letters of invitation (Appendix 1.A), participant information and consent forms (Appendix 1.B) and a recruitment poster (Appendix 1.C) (these

documents contribute to the MAE requirement to develop a summary for a non-scientific audience and can be found in Appendix 1.A to 1.C. To maintain confidentiality, any reference to the aged care provider has been replaced with 'ACF study partner') and letters to GPs and NSW Health informing them of the study. Along with my field supervisors and study team, I met with eight aged care facility managers to discuss the project, sought their agreement to participate and determined the best way to implement the study, in particular, the consenting process.

Being involved in designing and implementing a large multi-site study was a great learning experience. My confidence in leading meetings with facility managers increased as I sought to obtain agreement to conduct the project and negotiate our involvement to reduce the burden on staff. I also learnt that recruiting participants can be challenging and takes time. The majority of residents were suffering from dementia, so consent was required from their next of kin, or other relevant persons. Additionally, recruiting staff who are busy and do shift work required a variety of strategies such as attending resident and staff meetings, distributing newsletters and posters and explaining the project in a simple way.

Whilst out at the South Western Sydney Public Health Unit conducting my outbreak investigation, I was asked to help facilitate a one-day workshop organised by the unit on managing influenza outbreaks for local aged care facilities. My role involved facilitating a small group discussion on identifying communication barriers and enabling factors during outbreaks in aged care facilities and developing an action plan to address identified barriers. I was fortunate to be involved in this workshop as it helped to consolidate my learnings on how a mixed methods approach can be used to identify and address stakeholder needs. I undertook a similar approach as part of a stakeholder survey and workshop I conducted for my epidemiological project, described in Chapter 2. This workshop also provided insight into some of the challenges in controlling outbreaks in aged care facilities, including issues around communication and education, resource limitations and the management of policies such as facility visiting restrictions. Ways in which the Public Health Unit can assist in addressing these issues were also discussed.

Finally, I was successful in being selected to undertake the World Health Organization (WHO) Western Pacific Regional Office (WPRO) Field Epidemiology Training Program from 23 September 2018 to 17 November 2018 in Manila, Philippines. My position was as a Surveillance Officer in the Health Emergency Information and Risk Assessment (HIM) Unit in the WHO Health Emergency Program (WHE). I was responsible for taking an all hazards approach to conducting daily event-based surveillance for the region, conducting daily event notification risk assessments, verifying official and unofficial information, presenting potential health threats to the WHE and WHO Regional Emergency Director and preparing weekly and bi-weekly surveillance reports on seasonal influenza and avian influenza. During my time at WPRO I was also responsible for managing two events, an outbreak of hand, foot and mouth disease (HFMD) in Vietnam and the response to cyclone Yutu in the Commonwealth of the Northern Mariana Islands. This involved conducting rapid and in-depth risk assessments and a public health situation analysis, communicating with WHO country offices, attending and documenting meeting outcomes and providing updates to the WHE senior leadership team on the events. I also developed a country profile on Samoa, collating relevant information on the country to be used by the HIM team as a quick reference resource to inform future rapid risk assessments and provided an exit presentation to the WHE on HFMD to inform future response to outbreaks in the region and highlight areas of the health system that require strengthening, such as development of national guidelines for prevention and control.

Working at WPRO enabled me to experience and contribute to implementing the International Health regulations (2005). In my field placement, I was involved in conducting event-based surveillance and developing resources for health professionals to utilise. What was missing in that role, however, was the operational, public health action aspect of what to do when a potential health threat has been identified.

Working at WPRO provided me the opportunity to fill this gap, and verify and respond to these public health threats. Additionally, my decision-making skills were strengthened by having to identify and justify why I selected potential health threats to report to WHE senior leaders at daily meetings. Conducting risk analyses, summarising and presenting information in a succinct and logical way and

understanding how to frame discussions with senior decision makers are important skills that I will be able to use throughout my public health career.

These activities are in addition to the work I conducted for the requirements of the MAE, outlined in Table 1 (below) and described in Chapters two through to six.

Table 1. Summary of MAE core competencies

Chapter	Chapter 1 MAE experience	Chapter 2 Epidemic intelligence stakeholder survey and workshop	Chapter 3 Epi-watch evaluation	Chapter 4 Investigation of a cluster of food poisoning	Chapter 5 Impact of repeated influenza vaccination	Chapter 6 Teaching experiences
Design and conduct and epidemiological study		✓				
Evaluate a surveillance system			✓			
Investigate an acute public health problem (outbreak investigation)				✓		
Analyse a public health dataset					✓	
Conduct a literature review		✓	✓	✓	✓	
Prepare an advanced draft manuscript for publication in a peer reviewed journal		✓				
An abstract and oral presentation at a conference		✓				
Develop a summary for a non-scientific audience	✓					
Prepare and deliver a lesson from the field						✓
Conduct a teaching session for first year MAE cohort						✓

1.2 References

1. NHMRC Centre for Research Excellence Integrated Systems for Epidemic Response [Internet]. Epi-watch; Sydney; 2017 [cited 2018 June 25]. Available from: <https://iser.med.unsw.edu.au/>.
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1.3 Appendices

Appendix 1.A: Influenza study letter of invitation for next of kin



Dear Sir/Madam,

Research Study Title: Impact of Influenza in Aged Care Facilities

I am writing to let you know about a research study that your relative/friend in your care has the option to take part in. The research is being conducted by UNSW Sydney in conjunction with ACF study partner. I am contacting you because we are inviting all residents and staff of selected ACF study partner facilities across Sydney to participate and we would like to seek your consent to include the person you care for in this study.

Influenza is a highly contagious respiratory disease and each year causes serious infections in people, particularly the elderly. The 2017 influenza season was very severe, and nursing homes were badly affected, with many residents and staff becoming ill and some residents dying. There was also concern that the 2017 influenza vaccine was not very effective, especially in protecting older people. As a result, the government is looking at making better vaccines available for people aged over 65 years.

In this study, we want to learn more about the impact of influenza in staff and residents in nursing homes and how effective the approved new influenza vaccine is in protecting people from infection in 2018. This study does not involve any treatments or interventions. Instead, we will monitor whether or not the person in your care received vaccination given as part of their care, and whether or not they develop influenza. This study will provide important information to inform and guide policies on influenza vaccination control programs for older people and nursing homes.

The following pages explain the research project and what involvement in the project entails. If you are interested in your friend/relative you care for to take part in this study, please provide your and their name below. A member of the

research team or ACF study partner will contact you to collect this form, discuss the study further and answer any questions you have, and obtain your written informed consent for your friend/relative you care for to take part. You can also provide your interest in taking part in the study by email to: r.macintyre@unsw.edu.au or by post to:

Attn: Abrar Chughtai
Room 208, Level 2 Samuels Building
UNSW Sydney
NSW 2052
Australia

Your Name	
Name of friend/relative you care for	
Aged care facility site name	

If you would like more information about this research study please contact either:

Name:	Professor Raina MacIntyre, Chief Investigator
Email:	r.macintyre@unsw.edu.au
Phone:	+61 2 9385 3811
Website:	https://research.unsw.edu.au/people/professor-raina-macintyre

Name:	Head of Research and Aged Care Clinical Services, ACF study partner
Email:	
Phone:	
Website:	https://sphcm.med.unsw.edu.au/people/associate-professor-christopher-poulos

Taking part in this research study is voluntary and you for your relative/friend under your care may choose not to take part. If you decide for him/her not to take part in this research, this decision will not affect their relationship with UNSW Sydney or ACF study partner.

This research has been reviewed and approved by The University of New South Wales Human Research Ethics Committee. If you have any complaints or concerns about the research study please email humanethics@unsw.edu.au or phone +61 2 9385 6222 quoting the following number HC17996.

Yours sincerely,



Professor Raina MacIntyre
Prof of Infectious Diseases Epidemiology; Head of School
School of Public Health and Community Medicine, UNSW

Appendix 1.B: Influenza study participant information and consent form for next of kin



School of Public Health and
Community Medicine

PARTICIPANT INFORMATION STATEMENT AND CONSENT FORM

Impact of Influenza in Aged Care Facilities (ACFs) Professor Raina MacIntyre

1. What is the research study about?

Your relative/friend under your care's aged care facility, in conjunction with ACF study partner is working with researchers from UNSW Sydney to find better ways of controlling influenza (the 'flu'). Each year flu causes serious infection which can lead to substantial illness and death. Flu in older adults is more severe than in other ages, more likely to result in death and is infectious to other people around you.

Every year the flu vaccine is offered free to people aged 65 years and over. In 2017 there was a very severe flu season, with many nursing home outbreaks and higher than usual deaths in older people. There was concern that the regular flu vaccine did not protect as well in 2017 as it usually does, especially in older Australians. As a result, in 2018, the Australian government will introduce more potent flu vaccines exclusively for people aged 65 years and over as part of the approved National Immunisation Program. People under 65 years will continue to get the regular flu vaccine. For those who receive the more potent vaccine, this helps mount a stronger immune response to flu and may provide better protection than the regular vaccine. In this study, we want to learn more about the impact of flu in staff and residents in nursing homes in 2018 and how effective the different influenza vaccines are in preventing flu in staff and residents of nursing homes.

The study is not giving any specific treatments or vaccines. It will involve monitoring the nursing home for flu outbreaks, looking at medical records of your relative/friend under your care, confirming their vaccination history with their GP and testing them for flu if they get sick.

GPs may prescribe and administer the flu vaccine as routine care. We encourage your relative/friend under your care to have yearly vaccination against the flu. Vaccination will only help protect from the types of flu covered

in the vaccine, so it is still possible to catch the flu despite vaccination. You cannot catch the flu from the vaccine, because it does not contain flu virus.

2. Who is conducting this research?

This study is being carried out by the following researchers		
Role	Name	Organisation
Chief Investigator	Professor Raina MacIntyre	UNSW Sydney
Co-Investigator/s	Dr Abrar Chughtai Professor William Rawlinson	ACF study partner UNSW Sydney SEALS Pathology
Student Investigator/s	Ms Aurysia Hii Ms Aye Moa Mr Suresh Mahendra Raj Mr Bravien Arrudshivah Mohana Kunasekaran	Australian National University/NHMRC CRE Integrated Systems for Epidemic Response UNSW Sydney UNSW Sydney UNSW Sydney UNSW Sydney
Research Funder	The study will be funded from Professor Raina MacIntyre's research funds.	

3. Inclusion/Exclusion Criteria

Before you decide for your relative/friend under your care to participate in this research study, we need to ensure that they are eligible to take part. Anyone who is a resident of ACF study partner facilities across Sydney can participate in this study. Residents must be aged 65 or over to be eligible to be included in our study. We will not include anyone receiving end of life palliative care.

4. Do I have to take part in this research study?

Participation in this research study is voluntary. If you do not want your relative/friend under your care to take part, you do not have to. If you decide to take part and later change your mind, you are free to withdraw him/her from the study at any stage.

5. What does participation in this research require, and are there any risks involved?

If you agree for your relative/friend under your care to participate in this study, the research team will monitor flu outbreaks in their nursing home and check whether they got vaccinated in 2018, and if they got the flu or not. To do this we need to collect information such as whether they were vaccinated for influenza, what type of vaccine they received, if they got sick in 2018 and any other illnesses they have. We will also collect information on any underlying health conditions such as diabetes, medications and whether they were

hospitalised. This will involve accessing medical records on site and asking questions of their doctor and the nursing home staff.

If your relative/friend under your care becomes ill in 2018 and experience symptoms of flu such as fever, sore throat, and aches, we will request your permission to test them for flu, you can choose to decline the test. Other infections can also cause these symptoms, so testing will confirm whether they have flu or not.

Testing for flu will involve a nose and throat swab by a trained member of the research team. To take a nose swab, a swab will be inserted 2-3cm into their nostril for several seconds to absorb secretions and then removed. A throat swab will involve inserting a swab into their mouth to collect cells from the back of the throat.

Testing for flu is a very minor procedure and you may experience some minor discomfort, gagging or coughing during the test. The test will be conducted by trained members of the research team and it should take less than a few minutes to do a nose and throat swab. The swab will be sent to South Eastern Area Laboratory Services for testing and results provided to the researchers and your nursing home for follow-up care.

There are no experimental treatments or vaccines in this study. We are only observing and measuring whether your relative/friend under your care got vaccinated as part of routine medical care, and whether they develop flu. The risks to participating in this study are minimal and may arise from discomfort, coughing or gagging when we take nose and throat swabs. There are minimal risks involved in participating in this interview. If you feel uncomfortable at any time during the interview you can let the research team know and withdraw from the interview and study at any time.

Every reasonable precaution will be taken to ensure their safety during the course of this study. If they suffer any serious injuries or complications as a result of this study, you should, as soon as possible, contact the research team who will arrange appropriate medical treatment free of charge in any Australian public hospital. Their participation in this study will not affect any right to compensation that they might have under statute or common law for any serious injuries or complications resulting from this study, caused by unsafe equipment or by negligence.

6. What are the possible benefits to participation?

The Australian government will introduce new influenza vaccines in 2018 for people aged 65 years and over, which can provide improved protection from flu in the elderly. This policy has arisen in rapid response to the very severe flu epidemic in 2017. Participation of your relative/friend under your care means we can formally measure if more potent vaccines work better at preventing flu in residents of aged care facilities. This will provide important information to inform and guide policies on influenza vaccination control programs for elderly people and nursing homes to better prevent influenza related illness and deaths. This will then have indirect benefits to your

relative/friend under your care and others into the future. A further benefit to participating is that if your relative/friend under your care gets ill, they will rapidly receive a test for flu. If flu is confirmed by this test within 48 hours, their GP may prescribe antiviral drugs which are proven to reduce the severity of flu if given within 48 hours.

7. What will happen to information about me?

By signing the consent form you consent to the research team collecting and using information about your relative/friend under your care for the research study.

To protect their privacy, we will only collect information that is relevant to our study and not any other information that could be used to identify them.

When the results of the study are published, only grouped data will be reported, we will not report or retain any individual level information. The information we collect will be stored securely at UNSW Sydney in locked filing cabinets and password protected computers. Only the named study investigators will have access to the data. Stored data will be destroyed after 7 years, the period required for research.

The information you provide on behalf of your relative/friend under your care is personal information for the purposes of the Privacy and Personal Information Protection Act 1998 (NSW). Your relative/friend under your care has the right of access to personal information held about him/her by the University, the right to request correction and amendment of it, and the right to make a complaint about a breach of the Information Protection Principles as contained in the PPIP Act. Further information on how the University protects personal information is available in the [UNSW Privacy Management Plan](#).

8. How and when will I find out what the results of the research study are?

The research team intend to publish and/ report the results of the research study in a variety of ways. All information published will be done in a way that will not identify participants. If you would like to receive a copy of the results you can let the research team know by providing your contact details (email/postal address) within this consent form. We will only use these details to send you the results of the research.

9. What if I want to withdraw from the research study?

Participation in this project is voluntary and if you decide for your relative/friend under your care not to take part or decide to withdraw at any time this will not affect their care at the nursing home or in any hospital.

If you do consent for your relative/friend under your care to participate, you may withdraw at any time. You can do so by completing the 'Withdrawal of Consent Form' which is provided at the end of this document. Alternatively,

you can ring the research team and tell them you no longer want him/her to participate.

If you decide for your relative/friend under your care to leave the research study, the researchers will not collect additional information. Any identifiable information will be withdrawn from the research project and the research team will destroy any information that was collected during his/her participation in the study.

10. What should I do if I have further questions about my involvement in the research study?

The person you may need to contact will depend on the nature of your query. If you require further information regarding this study or if you have any problems which may be related to your relative/friend's involvement in the study, you can contact the following member/s of the research team:

Research Team Contact Details

Name	Professor Raina MacIntyre
Position	Professor of Infectious Diseases Epidemiology, Head of School, SPHCM, UNSW
Telephone	+61 2 9385 3811
Email	r.macintyre@unsw.edu.au

Name	
Position	Head of Research & Aged Care Clinical Services, ACF study partner
Telephone	
Email	

What if I have a complaint or any concerns about the research study?

If you have a complaint regarding any aspect of the study or the way it is being conducted, please contact the UNSW Human Ethics Coordinator:

Complaints Contact

Position	UNSW Human Research Ethics Coordinator
Telephone	+ 61 2 9385 6222
Email	humanethics@unsw.edu.au
HC Reference Number	HC17996

Consent Form – Participant providing own consent

Declaration by the participant's guardian

- ☐ I understand I am being asked to provide consent for a relative/friend under my care to participate in this research study;

- ☐ I have read the Participant Information Sheet or someone has read it to me in a language that I understand;
- ☐ I understand the purposes, study tasks and risks of the research described in the study;
- ☐ I understand that researchers involved in this study will access his/her medical records to collect data for the purposes of this study, and I provide consent for this to happen;
- ☐ I understand that researchers involved in this study will ask nursing home staff and his/her doctor questions about illnesses arising after March 2018, and I provide consent for this to happen;
- ☐ I understand that researchers involved in this study will collect a nose swab and a throat swab and send this for laboratory testing, and I provide consent for this to happen;
- ☐ I provide my consent for the information collected about him/her to be used for the purpose of this research study only;
- ☐ I have had an opportunity to ask questions and I am satisfied with the answers I have received;
- ☐ I freely agree for my relative/friend under my care to participate in this research study as described and understand that she/he is free to withdraw at any time during the study and withdrawal will not affect his/her relationship with any of the named organisations and/or research team members;
- ☐ I understand that I will be given a signed copy of this document to keep;

- ☐ **I would like to receive a copy of the study results via email or post, I have provided my details below and ask that they be used for this purpose only:**

Name: _____

Address: _____

Email Address: _____

Participant Signature

Name of Participant (please print)	
Name of Guardian (if applicable) (please print)	
Signature (and date) of Participant or Guardian	Date:
Name of witness	
Signature and date of witness	Date:
Name of interpreter	
Signature and date of interpreter	Date:

Declaration by Researcher*

- ☐ I have given a verbal explanation of the research study, its study activities and risks and I believe that the participant has understood that explanation.

Researcher Signature*

Name of Researcher (please print)	
Signature of Researcher	
Date	

***An appropriately qualified member of the research team must provide the explanation of, and information concerning the research study.**

Note: All parties signing the consent section must date their own signature.

Form for Withdrawal of Participation

I wish to **WITHDRAW** my consent for my relative/friend under my care to participate in this research study described above and understand that such withdrawal **WILL NOT** affect his/her relationship with The University of New South Wales, his/her nursing home or ACF study partner. In withdrawing my consent I would like any information which she/he has provided for the purpose of this research study withdrawn.

Participant Signature

Name of Participant (please print)	
Name of Guardian (if applicable) (please print)	
Signature of Participant or Guardian	
Date	

The section for Withdrawal of Participation should be forwarded to:

CI Name:	Professor Raina MacIntyre
Email:	r.macintyre@unsw.edu.au
Phone:	+61 2 9385 3811
Postal Address:	Rm 208, Level 2, Samuels building School of Public Health and Community Medicine UNSW Medicine, University of New South Wales, Sydney Australia

Appendix 1.C: Influenza Study recruitment poster



Impact of Influenza in Aged Care Facilities



Invitation to Participate in Research

Last year was a severe flu season, especially for aged care facilities. Over 700 outbreaks occurred in aged care facilities in NSW alone in 2017. The vaccine was less effective in frail, older people last year. As a result, **new stronger flu vaccines are being provided for people 65 years and over by the Australian government in 2018.**

Researchers at UNSW Sydney (The University of New South Wales) and ACF study partner are seeking to learn about how the flu affects aged care facilities and how effective the new flu shots are in protecting people from the flu in 2018. The study has been approved by UNSW and ACF study partner.

Who can be in the study?

The study might be a good fit for you if:

- You work at a ACF study partner aged care facility in 2018.
- You or your loved one resides in a ACF study partner aged care facility in 2018.

What would happen in the research study?

This study does not involve any treatments or shots. Instead, we will monitor whether residents and staff receive a flu shot and whether they become ill with the flu.

If you decide to take part:

- Staff will complete a brief survey.
- For residents, we will review medical records to find out if you have received a flu shot this year or last year.
- We will follow up weekly to check if anyone has become ill.
- If there is an outbreak, we will take a nose or throat swab to test for flu with a rapid test that gives an answer straight away.

Who do I contact if I want more information or want to take part in the study?

Information packets can be found [*tailor for each site*]. Completed consent forms and surveys can be placed in the box in [*tailor for each site*].

If you would like more information or are interested in being part of the study, please discuss with the manager of this facility, or contact the research team directly. Contact details are available on the information sheet provided to your aged care facility. You can also call and speak to a member of the research team on 042276 3945.

Chapter 2: Major Epidemiological study Epidemic Intelligence Needs of Stakeholders in the Asia-Pacific Region, a stakeholder survey and workshop

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2.1 Prologue

My role

The project for my major epidemiological study was identified in October 2016, prior to beginning my field placement by the Integrated Systems for Epidemic Response (ISER) Scientific Advisory Committee (SAC) during their annual face-to-face meeting. The SAC provides strategic guidance to ISER on the direction of research activities and advice on translation of research into practice. At this meeting, SAC members agreed that a survey and workshop should be undertaken to seek stakeholder views and recommendations on how to further develop Epi-watch, a new epidemic observatory in development to better meet stakeholder needs.

Initially, the project was limited to stakeholders within Australia, however, during project development discussions with my field supervisor, Professor Raina MacIntyre, the scope of the project was expanded to include stakeholders from Indonesia, Malaysia, New Zealand and Pacific island countries and territories (PICTs). The main reason for this was to develop Epi-watch into a tool for stakeholders in the Asia-Pacific region. During project development, the scope of the workshop was further expanded to seek feedback from participants on their surveillance and epidemic intelligence needs to inform how ISER could meet those needs.

I was part of an international team consisting of my field and academic supervisors, study co-investigators from the Pacific Community (SPC), University of Otago and University of New South Wales and research assistants within the ISER team. I took on the role as primary project lead and carried out the following tasks:

- Contributed to the study design.
- Managed the project team.
- Managed the process to obtain ethics committee approvals from all countries involved in the study, including project modifications.
- Identified the study sample from each of the countries and territories involved in collaboration with the project team.

- Attended the Communicable Diseases Control Conference, 27-28 June 2017 to recruit participants to both the survey and workshop.
- A draft of the stakeholder survey had been developed by Mr Dillon Adams, research assistant, ISER. My role included finalising the questions, piloting and implementing the survey and cleaning and analysing the results. A copy of the survey can be found in Appendix 2.A.
- Workshop development and implementation including recruitment of participants; developing the agenda (Appendix 2.B); writing a participant workshop background paper (Appendix 2.C), participant biographies and facilitator questions to guide group discussion sessions; organising workshop presenters; delegating and providing oversight for other project administration tasks such as visa, travel and accommodation requirements, room booking and catering, printing and collation of workshop documents and name tags; arranging external transcription of the workshop, analysing the results and developing a summary of the workshop findings in collaboration with Ms Feroza Sulaiman (Appendix 2.D).
- Developed and delivered a presentation during the workshop titled 'Overview of available global epidemic sources.' A copy of this presentation is in Appendix 2.E.
- Provided an overview of the project and early findings at the ISER SAC face-to-face meeting on 12 October 2017. A copy of this presentation is in Appendix 2.F.
- Drafted and published the stakeholder survey manuscript in the Western Pacific Surveillance and Response Journal titled 'Epidemic intelligence needs of stakeholders in the Asia-Pacific region.' (1)
- Presented the findings of the stakeholder survey as a 'rapid fire poster presentation' at the Annual Scientific Meeting of the Australasian Epidemiological Association 2018 conference (2) (Appendix 2.G) and as a poster at the International Meeting on Emerging Diseases and Surveillance 2018 (3) (Appendix 2.H).

The body of this chapter is presented in two sections: the stakeholder survey and the stakeholder workshop. Separate abstracts are provided for each section.

Lessons learned

This was a large project consisting of two studies, the stakeholder survey and face-to-face workshop. It was also the first project that I began working on during my field placement and provided many new learning opportunities. This was the first time I had been involved in developing and obtaining ethics committee approval for a project both within Australia through the UNSW and ANU, and internationally through countries' own committees. Not only did I learn the process and requirements for seeking approvals across countries, such as submitting applications in a different language, but also the time it can take to obtain approval and factoring this into project timelines. Building good working relationships with contacts within Ministries of Health was very helpful for progressing these applications.

A key learning for being an epidemiologist is to continually ask the questions 'compared to what?' and 'what is the denominator?' The objective of this study was exploratory – to identify needs, and whilst it would have been interesting to undertake comparisons, the focus was not on comparing across contexts. To do this I would have needed a much larger sample and a different sampling strategy.

As this was an international project, being aware and respectful of different social and professional work cultures and resource issues was important to the success of the project. I was exposed to different working environments, with some being more formal and hierarchical than others. Resource limitation issues such as computer/internet access for survey completion were highlighted, as were staff schedule clashes for workshop attendance.

The intention to use a mixed methods approach combining both quantitative and qualitative data to provide greater insight into findings taught me about the richness of information these methods can provide. However, this was not fully realised given the change in scope of the workshop focus and instead a multimethod approach was taken. Multimethods research is a methodological approach where numerous methods are employed to explore a research topic. (4) Nevertheless, I have gained

skills in how to design and facilitate a workshop, from developing questions, to assisting facilitators guide group discussions and keep conversations on track. I learnt the importance of allocating sufficient time for group discussion and designing the format of discussions and interaction opportunities taking into account different cultural aspects. Throughout the process, I have had to become familiar with audio recording, transcribing, understanding methods for analysing qualitative data and using a qualitative software package, NVivo, for this process.

The process of designing and implementing a questionnaire has provided me with valuable skills that I will use throughout my public health career. This included designing effective questions, understanding the pros and cons of each, and maximising the number of completed surveys through survey design, for example, by managing the ease of response options and the order of questions. In particular, limitations of how questions were designed in the stakeholder survey later became apparent, which included leading questions that may have encouraged respondents to answer in a particular way or were interlinked, causing inaccurate results and a biased survey. The challenge of obtaining qualitative information and more personalised detailed feedback using a survey, for example, respondents' views on the usefulness of tools was another limitation when designing the questionnaire. This is where the strength of multi methods can be employed, to use data from a quantitative tool to inform further exploration in a qualitative way. Also, when developing survey questions, I learnt that it is important to ensure questions are specific and well defined so that interpretation of the question amongst all respondents is consistent and results are valid. Finally, it is always useful to refer back to the aim and objective/s of the study when designing questions to make sure they are relevant and will contribute to the study aims.

The importance of piloting a questionnaire on a comparable sample to that of the study is an important step that I learnt and should always be undertaken to avoid errors. I was also exposed to different recruitment methods, strategies to increase response rates, use of non-probability sampling methods and developing a purposive study sample.

Finally, I published a manuscript from this study, which provided me with hands on experience documenting this research project and the publication process, including how to respond to reviewer comments.

Public health implications

This project has provided insight into end-user needs to inform development of a future rapid epidemic intelligence service for Australia and the region, Epi-watch. By incorporating stakeholder feedback, it is hoped that Epi-watch will be developed into a system that is useful and meets end-user needs to help rapidly detect outbreaks for the region. Engagement with stakeholders during the workshop also provided information on the surveillance needs and challenges faced by public health professionals in the region that will be used to guide future research projects for ISER. Specifically, this study has already informed the development of a follow-up workshop held by ISER on 16-17 August 2018 on biosecurity in the Pacific, gaps and needs. This work has also facilitated development of links between ISER and the Pacific that can support future research initiatives.

Acknowledgements

There were many people involved in various aspects of this research project covering the design, ethics approvals, participant recruitment, workshop organisation, data analysis and manuscript preparation that I would like to acknowledge. My field and academic supervisors: Professor Raina MacIntyre, Dr Abrar Chughtai and Dr Tambri Housen, study co-investigators: Professor Michael Baker, Dr Jerico Pardosi, Dr Salanieta Saketa, Feroza Sulaiman; the ISER team: Dillon Adam, Chau Bui, Valentina Costantino, Elizabeth Kpozehouen, Mohana Kunasekaran and Semara Yanti; and Dr David Muscatello.

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2.2 Epidemic intelligence needs of stakeholders in the Asia-Pacific region, a stakeholder survey

This project was published as an original article in the *Western Pacific Surveillance and Response Journal* Volume 9, Number 4 2018.

Epidemic intelligence needs of stakeholders in the Asia–Pacific region

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Objective: To understand the global outbreak surveillance needs of stakeholders involved in epidemic response in selected countries and areas in the Asia–Pacific region in order to inform development of an epidemic observatory, Epi-watch.

Methods: We designed an online, semi-structured stakeholder questionnaire to collect information on global outbreak surveillance sources and limitations from participants who use epidemic intelligence and outbreak alert services in their work in government and nongovernment organizations in the Asia–Pacific region.

Results: All respondents agreed that it was important to remain up to date with global outbreaks. The main reason cited for following global outbreak news was as an early warning for serious epidemics. Mainstream media and specialist Internet sources such as the World Health Organization ($n = 54/91$; 59%), the Program for Monitoring Emerging Diseases (ProMED)-mail ($n = 45/91$; 49%) and the United States Centers for Disease Control and Prevention ($n = 31/91$; 34%) were the most common sources for global outbreak news; rapid intelligence services such as HealthMap were less common ($n = 9/91$; 10%). Only 51% ($n = 46/91$) of respondents thought that their sources of outbreak news were timely and sufficient for their needs.

Conclusion: For those who work in epidemic response, epidemic intelligence is important and widely used. Stakeholders are less aware of and less frequently use rapid sources such as HealthMap and rely more on validated but less timely traditional sources of disease surveillance. Users identified a need for more timely and reliable epidemic intelligence.

Emerging and re-emerging diseases are significant threats to global health security. The Asia–Pacific region has been the global epicentre for many emerging infectious diseases, including some with pandemic potential.¹ The emergence of new diseases such as severe acute respiratory syndrome and avian influenza, the threat of diseases external to the region such as Ebola, and recurring outbreaks of endemic diseases highlight the ongoing threat that infectious diseases pose to national, regional and international health security.^{1–4} The Asia–Pacific region encompasses two World Health Organization (WHO) regions: South-East Asia and the Western Pacific, home to 3.4 billion people, or over 53% of the world's population.⁵ The region is one of the most diverse areas in the world in terms of socioeconomic development, geography and geopolitical influence.⁵ It is also particularly vulnerable to emerging and re-emerging infectious diseases due to several factors including increased population growth and

movement, urbanization, globalization, limited access to health care, changes in food trade, land degradation and encroachment on natural habitats and antimicrobial resistance.^{1,6,7} This rapidly changing landscape, along with weak health systems, limited health infrastructure, resource constraints (financial, human, technical), geographical isolation and poor population health, challenge countries' abilities to adequately prevent, detect and respond to public health threats.^{8–11}

The ability to rapidly detect and respond to infectious diseases is critical to global health security. The International Health Regulations, or IHR (2005), provide the legal framework to protect the international community from these threats, requiring Member States to develop core capacities to detect, assess, notify and respond to public health threats and events of national and international concern.¹²

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Submitted: 22 May 2018; Published: 18 December 2018

doi: 10.5365/wpsar.2018.9.2.009

IHR (2005) emphasize the importance of incorporating event-based surveillance with traditional systems to detect public health risks.¹² Event-based surveillance is “the organized and rapid capture of information about events that are a potential risk to public health”.¹³ Information can be reported through official or unofficial channels such as media reports, health-care workers and nongovernment organizations.^{14,15} While traditional indicator-based surveillance systems are essential for collecting and analysing information on known diseases, event-based surveillance systems use broad definitions to detect rare or unusual events and are more timely and sensitive.^{13,16,17} They are an essential tool for the rapid detection and assessment of events that could pose serious risks to public health.

Increased availability and reliance on the Internet has driven the development and acceptance of event-based Internet surveillance as a key tool and source of epidemic intelligence.^{17,18} This method brings together disparate sources of data from the Internet to provide a comprehensive overview on the current state of global infectious disease events in near real-time for public health action.¹⁹ There are three types of event-based Internet surveillance methods for rapid epidemic detection: (1) existing Internet-based surveillance systems and news aggregators that use event-based reporting and syndromic surveillance; (2) search query surveillance using web-based search engines; (3) social media.²⁰

Understanding countries’ needs to detect and respond to infectious disease risks is relevant to common frameworks such as IHR (2005) and the Asia Pacific Strategy for Emerging Diseases that require cost-effective surveillance tools to coordinate health security activities. There are limited studies on the epidemic intelligence needs of end-users. A review of evaluations of 11 global electronic event-based biosurveillance systems found that evaluations focused on the quantitative analysis of system performance.¹⁶ The authors recommended that future evaluations assess the usefulness of systems for public health action for end-users. Stakeholder engagement in all stages of surveillance system development from planning to implementation is important to create a successful and useful system that meets end-users’ needs.^{16,21}

As part of the development of a new epidemic observatory, Epi-watch, we sought to understand the global

outbreak surveillance needs of stakeholders involved in epidemic response and surveillance in Australia, Pacific island countries and territories (PICTs), Indonesia and Malaysia. Epi-watch is an epidemic observatory currently in development by Australia’s National Health and Medical Research Council’s (NHMRC) Centre for Research Excellence, Integrated Systems for Epidemic Response (ISER) that monitors and provides critical analysis of global outbreaks and epidemics of public health significance for use by policy-makers, governments and other stakeholders.

The aim of this survey was to understand the global outbreak surveillance needs of stakeholders involved in epidemic response in Australia, PICTs, Indonesia and Malaysia to inform the further development of Epi-watch.

METHODS

A semi-structured stakeholder survey was developed and administered electronically using SurveyMonkey (San Mateo, California, USA) between 27 June 2017 and 9 October. The survey questions pertained to respondents’ employment characteristics (organization location and type, occupation and position level) and global outbreak surveillance sources (automated outbreak alerts, reasons for following outbreak news services, types of sources and services accessed, limitations of outbreak sources, timeliness and adequacy of outbreak news sources, types of journals accessed at least once a month and preferred format to receive information). Responses to questions consisted of pre-defined single and multiple choice options and a free text “other” option.

The survey was piloted in June 2017 on five individuals with infectious disease experience in government and academic institutions in Australia. Minor changes to the survey were made following feedback to improve the consistency and clarity of questions. Pilot participants were not included in the survey sample or results. The final survey was offered in English, French and Bahasa Indonesia. The survey questionnaire was forward-translated into French and Bahasa Indonesia.

We invited participants to complete the survey from the following countries and areas: Australia; PICTs (American Samoa, Cook Islands, Fiji, French Polynesia, Kiribati, Marshall Islands, New Caledonia, Niue, Commonwealth of the Northern Mariana Islands, Samoa,

Tokelau, Tonga, Vanuatu); Indonesia; and Malaysia. Our sample was targeted to selected countries so that results would be relevant to inform development of an epidemic intelligence system for use within the region. Malaysia and Indonesia were selected in particular because of ongoing, separate research on epidemic surveillance in the Malay and Indonesian languages.

We used several methods to recruit participants. Eligible participants were those who use epidemic intelligence and outbreak alert services in their work across government and nongovernmental organizations. Purposive and snowball sampling methods were used to select individual participants. Representatives of all PICTs were invited to participate through the Pacific Community (SPC).²² In Australia, participants were identified through the Communicable Diseases Network of Australia, federal and jurisdictional health department websites, an existing list of public health contacts held by the study team, colleagues and organization websites. Malaysian and Indonesian participants were identified through ministries of health. Participants were chosen based on their role and field of employment meeting the study inclusion criteria.

The survey was emailed to 108 participants from Australia, 13 participants from PICTs, four from Malaysia and three from Indonesia. Participants were asked to forward the survey link to relevant colleagues. Three email reminders to complete the survey were sent to countries with a low response rate to meet our overall target sample size of 88.

In addition to emailing eligible participants, a stakeholder workshop was organized by ISER in October 2017 to explore in more depth the outbreak surveillance needs of stakeholders. Workshop attendees were required to complete the survey as a prerequisite for attendance. Eligible attendees at the Communicable Diseases Control Conference in Melbourne, Australia from 27 to 28 June 2017 were also invited to complete the survey.

Responses were downloaded from SurveyMonkey and imported into and analysed using STATA-SE (Version 14.0, StataCorp, College Station, Texas, USA). To calculate proportions, two denominators were used as relevant, total number of responses or respondents. To ensure confidentiality of the respondents and strengthen the analysis, employment characteristic results from PICTs were combined; results from Malaysia and In-

donesia (Bahasa Indonesia and Bahasa Malaysia were considered part of a single language group, the Malay language) were also grouped together.

Ethics

Ethics approvals were obtained from the following committees: University of New South Wales (UNSW) Human Ethics Committee (HC17466), Australian National University Human Research Ethics Committees (2017/517), Malaysia Medical Research and Ethics Committee (NMRR-17-1784-37514), Indonesian Health Research Ethics Committee (LB.02.01/2/KE. 328/2017), Fiji National Health Research Ethics Review Committee (2017.145.MC), Tonga National Health Ethics and Research Committee (310817), and Samoa Health Research Committee (no reference number was allocated). The UNSW ethics approval for conduct of this research was accepted by ministries of health in American Samoa, Cook Islands, French Polynesia, Kiribati, Marshall Islands, New Caledonia, Niue, Commonwealth of the Northern Mariana Islands, Tokelau and Vanuatu.

RESULTS

There were 96 responses to the survey and a 96% (92/96) completion rate. Of the 128 surveys emailed to participants, we received a completed response rate of 72% (92/128). Five responses were excluded because respondents did not meet the study inclusion criteria, completed only the first section of the survey or selected a country from which ethics approval was not obtained, leaving 91 (95%) eligible responses.

Survey respondent characteristics

Of the 91 respondents, 55% (50/91) worked in organizations based in Australia, 30% (27/91) in organizations in PICTs and 15% (14/91) worked in Malaysia or Indonesia. **Table 1** shows the employment characteristics of survey respondents by region.

Importance of global outbreak news

All 91 respondents agreed that it was important to be up to date with global outbreaks. When asked about sources of automated global outbreak alerts (such as Google alerts or Program for Monitoring Emerging Diseases [ProMED]-mail updates), 60% (55/91) reported receiving

Table 1. Employment characteristics of survey respondents by country, 2017*

	Australia		PICTs		Malaysia/Indonesia	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Respondents	50	55	27	30	14	15
Organization type						
Federal/central government	15	30	13	48	9	64
State/territory government	30	60	4	15	2	14
Local government	3	6	6	22	3	21
International health	0	0	4	15	0	0
Peak body/organization†	2	4	0	0	0	0
Position level						
Senior decision-maker‡	17	34	10	37	5	36
Mid-career§	28	56	9	33	5	36
Junior	3	6	5	19	1	7
Other	2	4	3	11	3	21
Employment type**						
Surveillance, monitoring and control of communicable disease	29	58	22	81	12	86
Planning, prevention and preparedness	17	34	15	56	5	36
General public health	7	14	17	63	6	43
Policy	9	18	8	30	6	43
International emergency response	3	6	12	44	2	14
Domestic emergency response	8	16	2	7	0	0
Acute care	3	6	6	22	1	7
Environmental health	1	2	8	30	0	0
Defence/military	4	8	1	4	0	0
Other	3	6	4	15	1	7

* The total number of respondents by country/region was used as the denominator to calculate percentages separately by country/region.

† Peak body refers to an expert group that provides information, support, advocacy, coordination and strategic guidance to government or nongovernmental organizations.

‡ Senior decision-maker: manages a section/branch/division/head of an organization, has significant and/or final decision-making authority.

§ Mid-career: manages a small team, has some decision-making authority and/or influence.

|| Junior: no management role, has limited authority to make decisions.

** Categories were not mutually exclusive as respondents could select more than one option.

automated alerts, 18% (16/91) followed outbreak news as required, 15% (14/91) sometimes received automated alerts and 7% (6/91) never got alerts.

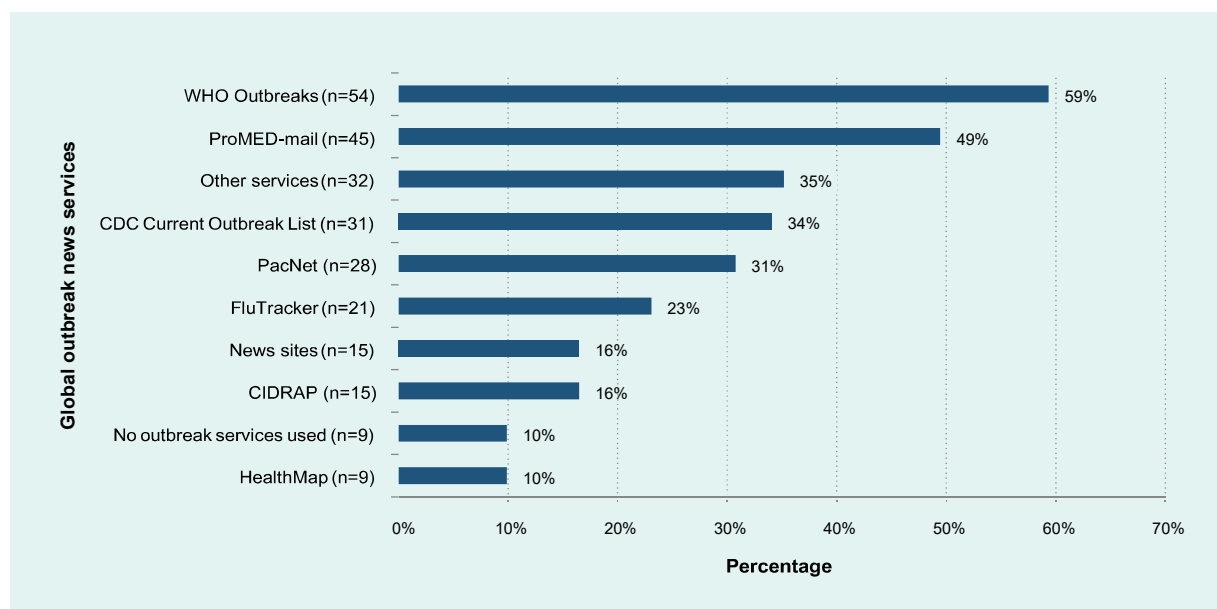
The most common reasons for following outbreak news were as an early warning for serious epidemics (91% [83/91]); to inform health system planning, preparedness and response (68% [62/91]); and to inform local surveillance needs (65% [59/91]) (Table 2).

Global outbreak news sources

Fig. 1 shows the proportion of global outbreak information services used by respondents at least once a month. WHO Outbreaks²³ was used by 59% (54/91) of respondents and ProMED-mail²⁴ by 49% (45/91).

Other relevant services listed included Outbreak News Today²⁵ (6), Global Public Health Intelligence Network (GPHIN)²⁶ (5), EPICore²⁷ (4), Epi-watch²⁸ (4), Global Incident Map²⁹ (3) and UN Dispatch³⁰ (2). In the free text option, the International Biosecurity Intelligence System (25% [2/8]) and the European Centre for Disease Prevention and Control (ECDC) weekly reports and threat assessments (13% [1/8]) were also mentioned.

When asked about other global outbreak news sources, 64% (58/91) of respondents used mainstream media and Internet sources that target health professionals, 49% (45/91) relied on colleagues and 44% (40/91) on health practitioners (Table 3). Official sources such as National IHR Focal Points (29% [5/17]), the WHO Event Information Site (24% [4/17]), ECDC (24% [4/17]), the

Fig. 1. Global outbreak news services used by respondents at least once a month, 2017[†]

* Categories were not mutually exclusive as respondents could select more than one option.

† Total number of survey respondents ($n = 91$) was used as the denominator to calculate percentages to identify the most common service used among all respondents.

CDC = Centers for Disease Control and Prevention; CIDRAP = Centre for Infectious Disease Research and Policy at the University of Michigan, USA; ProMED = Program for Monitoring Emerging Diseases; WHO = World Health Organization.

United States Centers for Disease Control and Prevention (USCDC) (18% [3/17]) and networks such as Pacific Public Health Surveillance Network (18% [3/17]) were reported as other sources used by respondents in the free text option.

Respondents were asked which journals they used at least once a month to access information on global outbreaks and infectious diseases. Multiple responses were allowed. Thirty-seven per cent (34/91) used the USCDC's Morbidity and Mortality Report, 35% (32/91) used the Bulletin of the World Health Organization, 24% (22/91) used the Western Pacific Surveillance and Response journal, 23% (21/91) used the Australian Department of Health's Communicable Diseases Intelligence journal and 20% (18/91) used ECDC's Eurosurveillance journal. Twenty-seven of 91 (30%) respondents did not use any of the journals from the options provided.

Limitations of global outbreak news

Just over half of respondents, 51% (46/91), thought their usual sources of global outbreak news were timely enough for their needs, 20% (18/91) did not find their sources timely and 29% (26/91) were unsure. Fifty-one

Table 2. Reasons for following global outbreak news, 2017[†]

Reasons for following global outbreak news	$n = 91$	%
As an early warning for serious epidemics	83	91
To inform health system planning, preparedness and response	62	68
To inform local surveillance needs	59	65
To inform local clinical and health system needs	40	44
For general interest	35	38
To fulfil IHR (2005) requirements	27	30
For the safety of staff deployed to affected areas	21	23
Outbreak alerts are not relevant for my needs	0	0
Other	4	4

* Categories were not mutually exclusive as respondents could select more than one option.

† Total number of respondents ($n = 91$) was used as the denominator to calculate percentages to identify the most common reasons for following global outbreak news among all respondents.

Table 3. Reported timeliness and sufficiency of global outbreak news sources, 2017*

Global outbreak news sources†	Are your sources of global outbreak news timely enough for your needs?						Are your sources of global outbreak news sufficient for your needs?					
	Yes		No		Unsure		Yes		No		Unsure	
	n	%	n	%	n	%	n	%	n	%	n	%
Mainstream media (n = 58)	29	50	13	22	16	28	28	48	15	26	15	26
Specialist Internet sources‡ (n = 58)	36	62	10	17	11	19	32	55	14	24	11	19
Colleagues‡ (n = 45)	23	51	10	22	11	24	20	44	11	24	13	29
Health practitioners (n = 40)	19	48	9	23	12	30	19	48	10	25	11	28
Communicable Diseases Network Australia (CDNA) (n = 36)	21	58	4	11	11	31	25	69	6	17	5	14
Social media (n = 27)	14	52	9	33	4	15	14	52	9	33	14	15
Other (n = 17)	11	65	2	12	4	24	10	59	2	12	5	29

* Total number of responses for each global outbreak news source was used as the denominator to calculate percentages for timeliness and sufficiency for each source separately, as not all respondents used all sources.

† Categories were not mutually exclusive as respondents could select more than one when selecting global outbreak news sources.

‡ One respondent who used these sources reported that timeliness and sufficiency were not relevant to their needs.

per cent (46/91) of respondents thought that their usual sources of global outbreak news were sufficient enough for their needs. Twenty-four per cent (22/91) found their sources were insufficient, and an equal proportion were unsure. One respondent (1/91) reported that timeliness and sufficiency were not personally relevant.

The timeliness and sufficiency of outbreak news sources were cross-tabulated by respondent's usual sources of global infectious disease outbreak news (Table 3). Sixty-two per cent (36/58) of respondents thought that specialist Internet sources such as event-based Internet surveillance systems were timely enough for their needs, and 55% (32/58) found these sources sufficient (Table 3).

When asked about the limitations of global outbreak news sources, 42% (38/91) of respondents reported that there was not enough critical appraisal, and 40% (36/91) did not have enough time to read/watch or listen to information. Thirty-two per cent (29/91) of respondents identified that there was not enough information, 30% (27/91) that the sources were not timely enough, and 26% (24/91) that there were too many different sources and did not know which one was best. Twelve per cent (11/91) reported other reasons, such as a delay in or no reporting of events at the country level and lack of local relevance. Nine per cent (8/91) reported no limitations in their sources. Multiple responses were allowed for this question.

Preferred format to receive global outbreak news

Respondents overwhelmingly preferred email as a mechanism to receive global outbreak news. Eighty-seven per cent (79/91) of respondents selected this option; 7% (6/91) of respondents preferred websites; 3% (3/91) chose a weekly video presentation; and one each opted for the use of short message service (SMS), social media and other formats. This question did not allow for multiple responses, and feedback from some respondents indicated that they may have had several preferred methods for receiving information, depending on the nature of the outbreak.

A final question asked respondents to provide any other feedback. Answers included needing information for different purposes such as preparation of emergency plans, border health control and advice to traveller consultations; a need to better inform health officials for preparedness, planning and response; and a need for systematized unified surveillance.

DISCUSSION

Our survey provides insight into the epidemic intelligence needs of a diverse range of stakeholders from across the Asia-Pacific region. There was consensus that timely and easily accessible global outbreak notifications are essential to plan for and respond to public health risks. Respondents' professional needs are consistent with the

key attributes of successful event-based surveillance systems: to be simple, flexible, timely and sensitive.¹⁵ With automated alerts being the predominant information-seeking strategy employed by respondents, Internet-based services that provide this function can support the rapid and timely identification of events to limit the spread and severity of disease outbreaks.³¹

A limitation of event-based surveillance systems is that new information is not necessarily disseminated efficiently.³² While HealthMap³³ is a rapid intelligence source, it was only used by 10% of participants, possibly reflecting low awareness of this resource. Consumers preferred global outbreak alert systems be flexible in the way information is accessed and disseminated. Email was identified by respondents as the preferred communication method to receive global outbreak news; however, these needs may change depending on the context of the outbreak and over time (reflecting generational change in the use of communication technology); systems should consider a range of media such as SMS and social media. Communication technologies such as social media can be harnessed for rapid access and dissemination of information to support emergency preparedness and response.³⁴

The use of mainstream media and specialist Internet sources for global outbreak news is not surprising given the increased accessibility and reliance on the Internet for information and acceptability of event-based Internet surveillance systems. Approximately 65% of initial reports to WHO about infectious disease events come from informal sources such as the Internet.³⁵ A 2017 systematic review of event-based Internet biosurveillance systems identified 50 systems, 37 of which were online and fully functioning at the time.³⁶ Many of these systems use mainstream media as a key source of information.^{17,36} The finding that the same proportion of respondents used both mainstream media and specialist Internet sources for global outbreak news suggests that Internet-based services are not meeting end-users' needs, and other media sources are required to supplement information leading to duplication of effort.

Timeliness of global outbreak news sources was a limitation identified by 51% of survey respondents. One study explored end-users' perceptions of the attributes of seven publicly available event-based Internet surveillance systems and found that timeliness scores ranged from 33% to 100%.¹⁵ Official sources such as WHO

Outbreaks²³ and the CDC's Current Outbreak List³⁷ were more commonly used by respondents over other services such as HealthMap³³ but are less timely. Previous studies have documented significant delays in official reporting of outbreaks compared to unofficial reports.^{38,39} Research has identified that the majority of event-based Internet surveillance systems are generated from North America and Europe; few local systems in the Asia-Pacific region and event-based surveillance systems in general are not well understood in developed and developing countries.^{32,36} Increased awareness of the availability and operability of systems providing timely, relevant and reliable information to professionals in the region could address some of these concerns.

Unofficial reports are key sources of information for Internet-based systems, but they can be subject to noise and false alerts, potentially causing unnecessary investigation or alert fatigue among responders.¹⁸ Our findings suggest that reliability and accuracy are important considerations in the choice of global outbreak surveillance sources; however, many respondents were unable to identify the best sources to use. WHO Outbreaks²³ and ProMED-mail²⁴ were the most commonly accessed sources by many respondents. ProMED-mail is qualitative, but it uses human moderators to review alerts for relevance and accuracy before dissemination, increasing the reliability of reports.⁴⁰ A service that can provide critical appraisal, including risk assessment within the broader context of the region, could address the need for more reliable information and help facilitate countries' abilities to assess risks and inform decision-making for the response required.

This study had several limitations. Due to the cross-sectional online survey design, we were unable to monitor trends in responses/behaviour over time, and findings may not be representative because of the snapshot nature of the timing of the survey and possible non-response bias. As we were interested in stakeholder views at a point in time, this design was appropriate. The online nature of the survey meant that questions could not be explored in-depth; however, a free text option was provided for most questions. Limited access to the Internet and computers in remote and resource-constrained areas could have affected the response rate. Compared to positing surveys, this was the most feasible option, and with some of the most remote PICTs participating, we do not believe access was a major barrier. The study employed purposive

sampling instead of probability sampling because of the small and highly specialized pool of eligible participants. While this approach ensured participation of professionals from a wide range of backgrounds and levels who use epidemic intelligence, it can create researcher bias because of the judgmental nature of sample selection. Epidemic response is a small and specialized field, so the sample frame from which we could draw was small, making purposive sampling the most appropriate. Limited inclusion of other large Asian countries, differences in participant selection across countries and low numbers of respondents meant that results could not be compared between countries and may not be generalizable to other countries or representative of the whole Asia-Pacific region. Finally, survey versions in languages other than English were not back-translated, which may have affected the quality of these responses. As 11% ($n = 10$) of respondents completed the survey in a language other than English, translation inaccuracies are unlikely to have any impact on the overall validity of the survey. Further research on language-specific needs for epidemic surveillance is warranted.

CONCLUSION

For those who work in epidemic response, epidemic intelligence is important and widely used. The choice of sources for global outbreak news varies, and there is less use and awareness of rapid sources such as HealthMap and more reliance on less timely, traditional sources such as WHO and public news media. We identified a need for more timely and reliable epidemic intelligence in the Asia-Pacific region. More effective and efficient sources and methods to deliver user-friendly intelligence to end-users should be explored. There are several global outbreak surveillance systems available; development of a new system should take into consideration how it can integrate into and add value to already established systems within the region.

Conflicts of interest

The authors declare no conflicts of interest.

Funding

This study was funded by the National Health and Medical Research Council Centre for Research Excellence, Integrated Systems for Epidemic Response APP1107393.

Acknowledgements

We would like to acknowledge the support of Dr Jerico Pardosi (University of New South Wales), Dr Elizabeth Kpozehouen (Kirby Institute) and Mr Dillon Adams (Kirby Institute) for their contribution to this study. We also thank and acknowledge ministries of health from all participating countries for their support and agreement to participate and all respondents for taking the time to complete this survey.

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2.3 Epidemic intelligence needs of public health stakeholders in the Asia-Pacific region, a stakeholder workshop

2.4 Abstract

Background

Strengthening public health surveillance systems relies on gathering information on the needs and challenges faced by the public health workforce. This knowledge can then be used to inform the development of strategies to address these needs. The limited capacity amongst many low and middle-income countries in the Asia-Pacific region to respond to public health threats and meet the requirements of the International Health Regulation (2005) core surveillance capacities highlights an area of opportunity and need. We investigated epidemic intelligence needs of stakeholders in the Asia-Pacific region to inform how these needs can be addressed. We also sought stakeholder feedback to inform development of Epi-watch, an epidemic observatory in development.

Methods

A stakeholder workshop was held on 9 October 2017 at the University of New South Wales, Sydney, Australia. Twenty-six purposively invited stakeholders who work in key areas of epidemic intelligence and outbreak alerts, across government and non-government organisations in the Asia-Pacific region attended. The workshop comprised of presentations and small group discussion. Inductive content analysis was conducted to analyse the resulting data.

Results

Five key themes emerged from the workshop discussions and included: surveillance challenges, the need for information sharing, the need for epidemic intelligence tools for rapid epidemic response, the importance of recognising contextual differences when developing surveillance tools and Epi-watch. Feedback on Epi-watch indicated that this tool would be of value for the region.

Conclusion

Many of the subthemes identified during this workshop have been documented previously, highlighting the ongoing challenge countries face in strengthening their surveillance systems to adequately respond to public health events of concern. Continued support and engagement with stakeholders directly involved in epidemic response is required to address their needs and build national and regional level capacity to prevent, detect, respond to and report events of public health significance.

2.5 Introduction

The Asia-Pacific region is the epicentre for many emerging and re-emerging infectious diseases, including some with pandemic potential. (1) With the region home to just over 50 per cent (3.4 billion) of the world's population and the ability to rapidly spread across countries, infectious disease outbreaks can have devastating consequences on human health and the economy. (2)

Early detection and rapid response is needed to control infectious disease outbreaks and mitigate their effects, but this is complex due to geographic, cultural, economic and socio-political diversity across the region. (2) In addition, the drivers of disease emergence and spread are myriad and contribute to the challenge countries face to adequately respond. These include rapid urbanisation, (3) increased travel and trade, (4) population growth and movement, (3) climate change, environmental degradation and encroachment into natural habitats, (3, 5) geographical remoteness, (6) growing global inequalities in economies and health, (7) weak health systems and limited resources and infrastructure. (6, 8)

Recognising the impact from and changing nature of the emergence and spread of infectious diseases, the International Health Regulations (IHR (2005)) were revised 13 years ago to provide a legal framework to strengthen global health security by requiring countries to improve their capacity to prevent, detect, respond to and report events of public health significance. (9, 10) However, challenges to meeting these requirements remain and outbreaks continue to pose a threat to national, regional and international health security. By 2012, seven years after the revised IHRs came into effect, 80% of 194 World Health Organization (WHO) member countries had not achieved the core capacities required to fully implement the IHR (2005). (11)

The 2014-15 West African Ebola outbreak renewed international focus on the need for countries to strengthen their core public health capacities to meet the IHR (2005) requirements. (7) An assessment of Ebola preparedness in the Asia-Pacific region by the WHO identified lack of capacity to respond to public health events of concern amongst many low and middle-income countries and highlighted areas for improvement. (1, 12) These included limited laboratory capacity, clinical management

and infection prevention and control, public health intervention measures and the need for multisectoral collaboration from all stakeholders. (12)

Given the difficulties in meeting IHR (2005) core surveillance capacities, understanding the needs of countries in the region is important to inform development of effective strategies to address these needs and improve capacity of the region to better detect, prevent and respond to emerging and re-emerging infectious diseases.

As part of the research goals of the National Health and Medical Research Council funded Centre for Research Excellence (CRE), Integrated Systems for Epidemic Response (ISER)¹ and in recognising the need to strengthen collaboration and improve epidemic control in the region, ISER conducted a stakeholder workshop on 9 October 2017. The aim of the workshop was to discuss and explore the epidemic intelligence needs of stakeholders in the Asia-Pacific region to inform how these needs can be addressed. The workshop also aimed to seek feedback from stakeholders to inform further development of Epi-watch, an epidemic observatory in development that monitors and provides critical analysis of global outbreaks. (13) Epi-watch consists of three components: 1. An outbreak alert service; 2. An 'Epi-digest' providing an interactive weekly summary of new and ongoing outbreaks via video-conference; and 3. Watching briefs providing critical analyses of outbreaks of concern. This paper reports on the qualitative analysis of the workshop discussion.

2.6 Materials and Methods

Purposive sampling was used to identify a subset of the small and specialised public health workforce who work in areas where epidemic intelligence and outbreak alerts are important, across government and non-government organisations in the Asia-Pacific region.

Invitations were sent to 108 stakeholders in Australia who were also asked to invite up to two colleagues working in the field to attend the workshop. Invitations requesting

¹ ISER was established in 2016 to address critical systems gaps in epidemic control through applied research to improve the control of epidemic diseases, to build national capacity in health systems and enhance collaboration across all stakeholders and sectors involved in epidemic response.

representatives to attend the workshop were issued to officials from Ministries of Health across the 22 Pacific Island Countries and Territories, Malaysia and Indonesia. Indonesia and Malaysia were selected because a related study was being conducted in epidemic intelligence in the Malay languages. Two representatives from a research institute in New Zealand were also invited. The workshop was conducted in English as it was determined that participants would have an appropriate level of working English.

An online stakeholder survey was undertaken in connection to this workshop from 27 June 2017 to 9 October 2017, to understand the global outbreak surveillance needs of stakeholders involved in epidemic response in Australia, the Pacific, Indonesia and Malaysia. (14) All workshop participants were required to complete the survey prior to attendance. An option to register interest in attending the workshop was offered at the completion of the survey.

The workshop was facilitated by the investigators from ISER. The workshop agenda comprised of presentations to help facilitate discussions covering: introduction of ISER and the purpose of the workshop, outcomes of a 2016 workshop on use of infectious disease modelling in policy decision making, (15) overviews of available global epidemic sources, the online survey results, current surveillance activities in the Pacific, Malaysia and Indonesia and demonstrations of selected epidemic intelligence tools developed by ISER as examples of enhancement to epidemic surveillance. Following the presentations, participants were asked to discuss in groups their needs in relation to epidemic intelligence, surveillance and tools that may address these needs. Four discussion groups were formed with representation from most regions in each group to facilitate dynamic discussion. UNSW and ISER attendees participated as either observers or workshop facilitators and presenters only, with contributions to the workshop discussions limited to responding to participant questions.

Written informed consent was sought from all participants. The workshop was audio recorded and question and discussion sessions were professionally transcribed verbatim and analysed by inductive content analysis (16) with assistance of NVivo software version 11. Transcripts were independently coded by two researchers (AH

and AAC) and code lists were cross-checked and agreed upon. Disagreements were adjudicated by a third researcher.

The post-presentation discussions and final workshop discussions were analysed concurrently and codes and sub-themes combined in order to obtain overarching major themes. The combined themes are presented in the results.

Ethics

Ethics approvals were obtained from the following committees: University of New South Wales (UNSW) Human Ethics Committee (HC17466), Australian National University Human Research Ethics Committees (2017/517), Malaysia Medical Research and Ethics Committee (NMRR-17-1784-37514), Indonesian Health Research Ethics Committee (LB.02.01/2/KE. 328/2017), University of Otago Human Ethics Committee (D17/302), Fiji National Health Research Ethics Review Committee (2017.145.MC), Tonga National Health Ethics and Research Committee (310817), Samoa Health Research Committee (no reference number was allocated). UNSW ethics approval for conduct of this research was accepted by Ministries of Health in American Samoa, Cook Islands, French Polynesia, Kiribati, Marshall Islands, New Caledonia, Niue, Northern Mariana Islands, Tokelau and Vanuatu.

2.7 Results

The workshop was attended by 26 specialist public health stakeholders from the following countries: American Samoa, Australia, Cook Islands, Fiji, French Polynesia, Kiribati, Malaysia, New Caledonia, New Zealand, Niue, Northern Mariana Islands, Samoa and Tonga (Table 1). One participant did not provide informed consent due to a conflict of interest. One participant elected to join the workshop by video conference.

Table 1. Epidemic Intelligence stakeholder needs workshop by affiliation and region, October 2017

Affiliation	Number of participants (Australia)	Number of participants (International)
National government (health, agriculture and defence)	5	11
State government (health and emergency response)	5	-
Local health jurisdictions	3	-
Peak bodies and academia	1	1
Study investigation team	4	1
UNSW and ISER faculty and students	10	-
Total	28	13

The main themes identified during the workshop discussions included: surveillance challenges, information sharing, the need for epidemic intelligence tools for rapid epidemic response and the importance of recognising contextual differences when developing surveillance tools. Specific issues related to the further development of Epi-Watch are reported under a separate theme.

Surveillance challenges

A number of challenges to conducting surveillance were discussed. The need for capacity building, lack of personnel with relevant expertise and skills, limited funding to retain staff and subsequent out-migration of the workforce to other countries were raised as health workforce issues affecting countries' ability to manage and maintain surveillance systems across the Pacific region.

- *“... the challenge that we have to continue these surveillance systems is capacity, capacity building, having people available [to operate the system].”*
- *“... it's hard for our local government to find the funding to pay [public health professionals] to [remain working in the country]. So what happens is [external] governments or agencies locate these*

personnel, offer them a higher pay and then we [are] left with the gap.”

- *“But that's one of the challenges we have, it's having the personnel there that can advise and move on these surveillance systems.”*

Gaps in current surveillance systems were highlighted, including limitations of laboratory capability and capacity to diagnose and report diseases, detecting importation of diseases from different ports of entry via air and sea and integration of animal disease surveillance with human surveillance systems.

- *“There are issues around lab capacity being very low in some areas with a decreased capacity to diagnose.”*
- *“...currently an international airport will open direct flights from all different countries, which will expose [our country] to other types of possible infectious diseases. That's something that can be a challenge, having that good defence in the ports.”*
- *“Some of the challenges we thought that existed in surveillance were around animal health exposure and needing to link other groups together, so needing to bring the animal groups in.”*

Barriers to reporting of communicable diseases were discussed, including difficulties associated with geographical remoteness and unwillingness to report because of the fear of a negative impact on tourism in Pacific Island countries where tourism is a major part of the economy.

“...for us we're a tourism driven economy, so we have a high degree of caution in ever putting anything out. So some of the [outbreak] alerts referred to, we wouldn't be able to indicate to the relevant authorities because they wouldn't be deemed to be a sufficient public health risk, worth the risk of adversely affecting [tourism].”

Information sharing

Information sharing emerged as a key theme amongst workshop participants. A need to be able to maintain knowledge, skill sets and document lessons learnt from each

outbreak to inform future response was raised. Gathering and documenting those experiences into a single resource was seen as a possible solution.

- *“Obviously, there was a lot that we learnt from each outbreak and part of that is how do we maintain that knowledge? How do we maintain those skill sets for future outbreaks?”*
- *“Then there are lessons learnt, and so being able to gather what works in practice, and gathering that experience into one resource would be extremely valuable.”*

The internet, social media and messaging apps were discussed as valuable tools in surveillance. Their value in supporting public health responses by facilitating communication and information sharing amongst responders was indicated by the following statement:

“One of our members uses a WhatsApp chat as a group and that's a very accessible, easy way of having a conversation around data that you've got.”

Barriers to information sharing were also discussed and included the impact of working in siloed or vertical structures that can impede integration with other systems and information sharing. Participants raised the importance of sharing information across local and international boundaries, different sectors and partner organisations to ensure a more comprehensive understanding and response.

“[one issue that] needs to be worked on is the silos and really needing those cross cultural, cross international boundaries, graph groups, partner groups for that sharing of information, because quite often each area is getting their view of the issue and not getting an overall picture and therefore not being comprehensive in their responses.”

Tools for decision making

There was an expressed need from participants for a variety of tools to inform decision making, risk assessment, planning, preparedness and response to outbreaks. Tools were needed to understand multiple factors associated with the increased risk of disease importation and the circumstances under which this can occur; to predict the

spread and trajectory of an outbreak from country to country across the Pacific for early warning; to model the effects of mass gatherings and the potential spread of disease both within the host location and when participants return to their home countries; to understand the effect of climate change and impact on disease; to predict the health effects from natural disasters and to assist with resource requirements and allocation, as indicated by the statements below:

- *“...our countries [decision makers] are advising us to provide them with a risk [level to decide] whether they should plan and put resources aside which is quite an ask to a pretty small country.”*
- *“...it would be nice to look at the risk factors of how the disease [will be brought] into a country [to] give responders [and] decision makers more time to think about an appropriate strategy to deal with the disease outbreak.”*
- *“If I'm here in [my country], I'm seeing [the outbreak] going up here, it's popping up in Niue, it's popping up in Tahiti, where is it going to go next? Are we going to be next?”*
- *“...my discussion was around early prediction of severity, [to] look at resourcing requirements and how that [will] affect the general public, but then also our own officers.”*

The risk of dissemination of disease from tourist cruise ships was raised as a concern across the Pacific region and the impact that this has on resource constrained local healthcare systems, as indicated by the following statements:

- *“...[there] was a tourist ship that was coming and we only found out that there was an influenza outbreak on it because they needed some Paracetamol. We stopped them from coming onto the island because we only had enough Paracetamol for us, we didn't have the resources if anything big happened.”*

- *“...a lot of cruise ships aren't self-sufficient, so they rely on the ports they visit for health care for their passengers, without consideration for what the local resources are.”*

Participants were shown examples of outbreak tools developed by ISER as examples of possible enhancements to epidemic response. This included a tool developed for Australia to forecast the severity of an influenza season, (17) and a tool developed around the West African Ebola epidemic (18) to assess risks for early detection and response. These were seen as useful by participants, who expressed a desire to have similar tools tailored and available for use in their own countries. Participants raised the need for tools that can be adaptable across different contexts.

- *“I wish we had this [risk assessment] tool. I think it's really good to have such tools more and more and even though in the [Pacific] region we still think that we may not be [at risk] in terms of our proximity to these countries where all these outbreaks are occurring.”*
- *“... having this tool here to use within the countries, it's a way for us to empower our own Pacific island personnel to do the risk assessment in our countries.”*
- *“... we talked about the risk assessment tool and being able to do that for all jurisdictions, but potentially also to be able to do it by disease because by disease it may vary in the risk.”*
- *“...it's a very useful tool to actually give us an indication of how the outbreak can affect us.”*

Contextual differences

Limitations in laboratory capacity, geographical characteristics and population differences were identified as significant contextual challenges that are important to recognise when developing epidemic surveillance tools for the Asia-Pacific region. Additional considerations for developing broad generic tools included: the variation in the epidemiology of specific diseases across countries, differences in prevention and control measures such as vaccination programs and variability in data quality. Absence

of tools calibrated for local Pacific needs and data to inform such tools, were highlighted as an important issue for the utilisation of current tools.

- *“We have two [influenza seasons] and they don't coincide with [the Australian influenza season]. Secondly, it's quite difficult to tell the dominant strain until a few months after [and] we don't have an influenza vaccine program.”*
- *“In the Pacific Islands, we would struggle in some of the basic input data that you would require for something like this [to predict the severity of the influenza season].”*

Participants underlined the importance of ensuring that tools were validated and that the margin for error in output was understood so that decisions regarding planning and response would be informed.

“...one of the things that we have to worry about when adapting this is [that if it] is going to influence policy or funding, we have to be careful [with] how [we] adapt [the tool].”

Epidemic observatory

Participants were interested in a number of features of the [Epi-watch outbreak observatory](#). (19) Factors to consider for future development included the ability to search the outbreak database and filter parameters such as date, disease and location, display disease trends and integrate different languages such as French and Malay.

The [Watching Briefs](#) (20) were seen as a useful, easily accessible resource that could provide a quick overview of pertinent outbreaks. One participant compared the Watching Briefs to the European Centre for Disease Prevention and Control (ECDC) risk assessment process and highlighted that these were very Europe specific and not necessarily relevant to this region, indicating that additional region-specific briefs would add value.

“As far as the watching briefs, I also found them useful. I compared them to the ECDC risk assessment process which I find very useful but they're very Europe specific and not necessarily from my part of the

world. I wondered whether you had compared what other people do and the relative merits [and] borrowing some of their [ideas]?”

There was an expressed interest to participate in the ‘Epi-digest’ online video conference calls to be aware of outbreaks to improve preparedness and response. There was a suggestion to use Epi-watch as a platform to develop an expert advisory group to provide contextual understanding and support to authorities who respond to outbreaks, particularly in countries with limited resources, as explained by the following statement:

“The value of those weekly meetings where you have discussion, where you have a whole lot of experts on board and you are able to discuss other people's understanding of it, we thought that having an expert group that was available in a [real] time way that would be incredibly valuable. If you're the only practitioner on an island a long way from anywhere else, and you get, we discussed H7N9 [you] need to understand what to do.”

2.8 Discussion

This study identified several important epidemic intelligence needs expressed by stakeholders across the Asia-Pacific region. Current challenges impeding countries’ ability to detect, prevent and respond to outbreaks included human resource issues, laboratory capacity, integration of animal and human surveillance and issues associated with reporting. The importance of sharing information within and across sectors and maintaining lessons learned were discussed as important considerations to improve and inform outbreak response. Participants expressed the need for generic epidemic intelligence tools to support decision making, planning, preparedness and response. We discuss opportunities to address these needs to improve surveillance and response capacity in the Asia-Pacific region below.

Workforce development

A knowledgeable, skilled, motivated and available workforce has been identified by WHO as one of the six core building blocks for an effective and efficient health system. (21) There is abundant literature to support many of the challenges raised during the

workshop to meeting this goal, in particular, to build capacity (22, 23) and retain the public health workforce. (24-27) Several approaches within the region have been trialled, (22, 23) including online open training courses, (28) in-service training, the Pacific Data for Decision Making (DDM) program, (29) specifically adapted for the Pacific region and Field Epidemiology Training Programs (FETP). (30) Evidence indicates that providing opportunities to undertake practical training in home countries, (24) financial and non-financial incentives, (24, 26) and improved working and living conditions (24) can contribute to retaining staff and to building country-specific capacity. To address workforce challenges raised during the workshop, training programs should be made available in-home countries and adapted to suit the local needs. (31) Additionally, opportunities to share resources and learn from others could be harnessed, for example, lessons learned from implementation of the FETP in Papua New Guinea (32) could be investigated to inform consideration in expanding the model to other countries.

Building a skilled and available workforce able to detect and respond to infectious disease threats requires investment and collaboration across multiple sectors, not just health. (31) Developing better human resource systems to collect data on workforce numbers and reasons for both leaving and staying in the workforce (31, 33) may be needed to inform sustainable, locally relevant, workforce planning and policies at the national and regional level and across sectors.

Building the capacity of the workforce to respond to public health surveillance needs will in turn provide the skills required for countries to strengthen their own surveillance systems and address new and ongoing challenges (34) – meaning countries will have a workforce with the right skills for the right job. However, this will only work if the workforce can be retained and positions are available.

In the meantime, there could be priority given for systems strengthening to detect diseases at ports of entry, including cruise ship surveillance and expansion of international flights.

One Health surveillance

Participants raised concerns about lack of integrated approaches to animal and human health surveillance. These concerns are reinforced by recent research identifying

several factors impeding integration of animal and human health ranging from siloed approaches across sectors, (35) limited laboratory capacity, (22) human resources (36) and research, (37) to lack of policies, (36) stakeholder commitment and leadership. (35, 38) For example, the IHRs (2005) do not incorporate a One Health approach and there is limited multisectoral engagement and coordination on zoonotic diseases or surveillance capacities. (39) Development of policies and frameworks supported by all sectors involved, increased collaboration and support from leading organisations (WHO, Food and Agriculture Organization, the World Organisation for Animal Health) (36) and better multisectoral engagement and coordination on zoonotic diseases and surveillance capacities is needed to support integration of a One Health approach. (22, 38) At a more practical level, developing interdisciplinary training programs integrating One Health could be one option to strengthen collaboration and understanding between animal and human health sectors and build workforce capacity for the region. (38) FETPs have been used as a method for fostering a workforce with an understanding of the importance of animal and human surveillance in Ghana (40) and Nigeria. (41) Building the animal health workforce should be done alongside human health workforce planning.

Information sharing

Effective cross-sector collaboration, coordination and communication have been demonstrated to be key factors in preventing and responding to outbreaks (42, 43) Availability of technology can be harnessed by public health professionals to facilitate rapid, real-time information sharing, particularly in resource limited settings and so professionals should be encouraged to utilise these tools, as relevant to their own context and needs. The workshop highlighted a number of examples of how technology could be used, such as through group chat applications like WhatsApp and web-based videoconferencing available through the epidemic observatory, Epi-watch. In addition, communication strategies and frameworks can facilitate information sharing during public health emergencies. Implemented as part of Singapore's response to the influenza A(H1N1) pandemic, this country's communication framework enabled a coordinated, whole of government response to the emergency. (43) Communication strategies should be developed for teams involved in epidemic response, which can be designed to break down siloed working structures and support

multisector engagement, for example, with the animal health sector. Strategies need to be embedded in routine day to day practice, which can be facilitated through national and international exercises, meetings and joint strategies. (44)

A workplace culture of learning and engagement in quality improvement approaches is important to continue to improve the public health response to future infectious disease outbreaks. (45) Reflections from workshop participants on the response to the severe acute respiratory syndrome (SARS) epidemic identified several key learnings for future outbreak response. (46) Further, reforms to the WHO to improve international response have been implemented following lessons from the 2014 West African Ebola outbreak. (47) Workplaces could encourage and provide training to identify, document, share and maintain knowledge and lessons learnt from each outbreak response. (45) Participants raised the need to document this information into one resource. A possible solution could be a centralised open access repository website for the region, which has been used by the Asia Pacific Malaria Elimination Network to promote the exchange of program challenges and strategies to inform future research, planning and capacity building. (48)

Reporting barriers

Public reporting of outbreaks can have devastating economic effects at the regional, country and community level. (49) For a region whose economy relies on tourism, the negative impacts of reporting suspected and confirmed outbreaks was raised as a barrier. However, the cost of not reporting can also be large, with the potential for diseases to rapidly spread to other countries, increased burden on the health system and implications on the livelihood and health of individuals. (49) Options to support early detection and response of suspected outbreaks should be considered to mitigate adverse economic effects. Offering incentives to encourage countries to report suspected outbreaks may be beneficial. For example, through economic compensation which has been used in response to H5N1 avian influenza (50, 51) or undertaking a cost-benefit analysis to provide evidence of the economic costs associated with early reporting to enable quick response compared to delayed or no reporting. Development of event-based surveillance systems for the region, such as Epi-watch could provide publicly available, early detection capabilities to facilitate increased

transparency and earlier response by both national and international responders. Alternatively, the current method used in the Pacific since 2000 to enable unverified information to be shared amongst Pacific Island Departments or Ministries of Health and key Pacific Public Health Surveillance Network members (PHSSN) (52) through PacNet-restricted for action. (53) An evaluation of the PHSSN identified positive response from the information generated and publicly shared by the system, however, it is unclear if PacNet-restricted is adequate as the evaluation did not cover this component. (6)

Epidemic intelligence tools

During the workshop, participants expressed the need for tools to support decision making, risk assessment, planning, preparedness and response to outbreaks. Work has been done in several areas to support outbreak preparedness and response, including risk assessments on the spread of the Zika virus (54, 55) and the West African Ebola epidemic (55-58) for the Asia-Pacific region. Furthermore, models to predict the likelihood of Ross River virus, (60) dengue (61) and influenza outbreaks (62) ahead of time, travel related spread of the 2014 West African Ebola epidemic (63) and SARS (64) and the risk of outbreaks during mass gatherings have been researched. (61) In addition, 18 freely available and commercial tools for modelling outbreaks are available. (15) A 2016 workshop on stakeholder needs for practical, real-time modelling tools (15) identified similar requirements for epidemic intelligence tools as this workshop, indicating that available resources are not fully addressing stakeholder requirements. Research from elsewhere (15, 65) supports the findings from our workshop, suggesting that several factors should be considered when designing resources for epidemic control to broaden their relevance and applicability. These factors include capacity of the workforce to use the tools, applicability to the local context and credibility to inform decision making. Given the wide interest from stakeholders and in particular, from PICTS, it will be useful to develop tools directly with those who will be using them to address contextual differences such as data availability, epidemiology of diseases, geographical remoteness and build workforce capacity to understand and be able to use the tools.

Event-based surveillance is recognised as an important component of surveillance for its rapid detection, dissemination and identification of rare and unusual event capabilities. (66) A systematic review of event-based internet biosurveillance systems identified 50 systems, of which 37 (26%) were fully functioning. (67) The review found few to no systems across Africa, Asia, Australia and South America available to monitor epidemic threats in these regions. There is an opportunity for Epi-watch to be developed to fill a gap in epidemic intelligence for the Asia-Pacific region, particularly as none of the current systems offer user responsiveness through the added components of videoconferencing and watching briefs on request.

Strengths and Limitations

An important strength of this study was that the workshop brought together professionals who may not have had the opportunity to interact otherwise and elicited needs from those directly involved in epidemic intelligence, making the findings relevant to people directly involved in outbreak management and response. There were some limitations with our study. Whilst we had good representation from Australia and the Pacific, the limited inclusion of other large Asian countries means that results may not be representative of the whole Asia-Pacific region. In addition, participants may not have been representative of all people who use epidemic intelligence. We were unable to get representatives to attend from all sectors, across all jurisdictions at local, state and national levels in Australia and only representatives from the health sector attended from countries outside of Australia, although the option to attend via video-conference was provided. Due to the format of the workshop, some participants may have contributed more than others during post presentation feedback sessions and group discussions, which may have influenced the discussion. We attempted to mitigate this by offering participants the option to give additional feedback to the investigation team via email, however, no further feedback was received.

2.9 Conclusion

Our study identified several important themes on the epidemic intelligence needs of stakeholders across the Asia-Pacific region. Workforce capacity and retention, integration of animal and human surveillance and issues associated with reporting

suspected outbreaks were identified as challenges for outbreak detection and response. Several factors were discussed to improve public health surveillance including cross-sector collaboration, information sharing and the importance of working with local partners when developing tools for epidemic response. Many of these challenges have been identified elsewhere, and are not new to the region, indicating the ongoing challenge and commitment required to address these needs. A holistic approach to strengthening public health surveillance is needed encompassing all levels and sectors involved to develop effective, efficient and sustainable strategies for each country and the wider region.

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Appendices

Appendix 2.A: Epi-watch stakeholder survey

Epi-watch Stakeholder Survey

Globalisation, travel and trade have led to rapid transnational spread of epidemics. Recent examples of global threats to human health include the 2014 Ebola epidemic and the 2009 H1N1 pandemic. Timely response to these threats can be enhanced by electronic event-based surveillance, predominantly from media reports, blogs and social media. The [NHMRC Centre for Research Excellence, Integrated Systems for Epidemic Response](#), is doing research on rapid epidemic intelligence to enhance timeliness of outbreak detection in the Pacific region.

We would like to understand your outbreak surveillance needs as a stakeholder. Your response will inform the development of an early alert surveillance system, Epi-Watch (see details further in the survey). There will also be an opportunity to participate in a stakeholder workshop and provide further feedback.

Section 1 - Pre-survey demographics

Q1: In which country is your organisation based? (select one that applies)

- | | | | |
|---|--|---|--|
| ☐ American Samoa | ☐ Guam | ☐ Niue | ☐ Solomon Islands |
| ☐ Australia | ☐ Kiribati | ☐ Northern Mariana Islands | ☐ Tokelau |
| ☐ Cook Islands | ☐ Marshal Islands | ☐ Palau | ☐ Tonga |
| ☐ Federated States of Micronesia | ☐ Nauru | ☐ Papua New Guinea | ☐ Tuvalu |
| ☐ Fiji | ☐ New Caledonia | ☐ Pitcairn Islands | ☐ Vanuatu |
| ☐ French Polynesia | ☐ New Zealand | ☐ Samoa | ☐ Wallis and Futuna |
| ☐ Indonesia | ☐ Malaysia | ☐ Other (please describe.....) | |

Q2: How would you best describe the primary organisation you work for? (select one that applies)

- ☐ Federal government / Central government
- ☐ State/Territory government
- ☐ Local government
- ☐ Non-government organisation
- ☐ International health (i.e. MSF, RedR, WHO)
- ☐ Peak body/organisation (i.e. RACGP, AMA, RNZCGP)
- ☐ Other (Please describe.....)

Q3: How would you best describe your current occupation? (select all that apply)

- ☐ Policy
- ☐ Planning, prevention and preparedness
- ☐ General public health
- ☐ Surveillance, monitoring and control of communicable diseases
- ☐ Environmental health
- ☐ Domestic emergency response (i.e. ambulance)
- ☐ International emergency response (i.e. humanitarian disaster, infectious disease response)
- ☐ Acute care
- ☐ Defence/military
- ☐ Other (Please describe.....)

Q4: What level is your position? (select one that applies)

A general guide is provided below. As position levels can vary between organisations, if this is not reflected below, please describe your level separately.

- ☐ Junior (i.e. no-one reports to you, you have limited authority to make decisions)
- ☐ Mid-career (i.e. you manage a small team, you have some decision-making authority and/or influence)
- ☐ Senior decision maker (i.e. you manage a section/branch/division/head of an organisation, you have significant and/or final decision-making authority)
- ☐ Other (Please describe.....)

Section 2 – Global outbreak alert services

This section asks questions about your sources and views on global outbreak alert services.

Q1: Do you feel it is important to be up to date with global outbreaks? (select one that applies)

- ☐ Yes
- ☐ No
- ☐ Unsure

Q2: Do you currently receive automated global outbreak alerts (e.g. google alerts, ProMED-mail updates)? (select one that applies)

- ☐ Yes

- ☐ No, I never get outbreak alerts
- ☐ No, I only follow outbreak news as required
- ☐ Sometimes
- ☐ Unsure

Q3: What are your reasons for following global outbreak news? (select all that apply)

- ☐ As an early warning for serious epidemics
- ☐ To fulfil International Health Requirements
- ☐ To inform local surveillance needs
- ☐ To inform local clinical and health system needs
- ☐ To inform health system planning, preparedness and response
- ☐ For the safety of staff deployed to affected areas
- ☐ For general interest
- ☐ Outbreak alerts are not relevant for my needs
- ☐ Other (Please describe.....)

Q4: What are your usual sources of global infectious disease outbreak news? (select all that apply)

- ☐ Mainstream Media e.g. TV News, Website, Radio
- ☐ Social Media e.g. Twitter
- ☐ Communicable Diseases Network Australia/NZ (CDNA)
- ☐ Health practitioners (doctors, nurses, public health officers)
- ☐ Colleagues
- ☐ Specialist internet sources such as Healthmap, ProMED-mail, PACNET or CIDRAP news
- ☐ None
- ☐ Other (Please describe.....)

Q5. Do you feel that your current sources of global outbreak news are timely enough for your needs? (select only one that applies)

- ☐ Yes
- ☐ No
- ☐ Unsure
- ☐ Not relevant to my needs

Q6: Do you feel that your sources of global outbreak news are sufficient for your needs? (select only one that applies)

- ☐ Yes
- ☐ No
- ☐ Unsure
- ☐ Global outbreak news services are not relevant for my needs

Q7. What are the limitations of your current sources of global outbreak news (even if you find them sufficient)? (select all that apply)

- ☐ Not timely enough
- ☐ There is too much information
- ☐ There is not enough information
- ☐ There are too many different sources, I don't know which one is best
- ☐ I don't have enough time to read/watch/listen
- ☐ There is not enough critical appraisal
- ☐ No limitations
- ☐ Other (Please describe.....)

Q8: What, if any, global outbreak news service/s do you currently use at least once a month? (select all that apply)

- ☐ ProMED-mail
- ☐ CIDRAP News
- ☐ Outbreak News Today
- ☐ CDC Outbreaks
- ☐ WHO Outbreaks
- ☐ Flu Tracker
- ☐ Global Incidents Map
- ☐ HealthMap
- ☐ GPHIN
- ☐ PACNET
- ☐ EpiCore
- ☐ News sites such as Google news alerts
- ☐ Epi-watch
- ☐ UN Dispatch
- ☐ Epi-break
- ☐ Other (Please describe here.....)

- ☐ I don't use any service specifically for outbreak news

Q9: Do you use any of the following journals at least once a month for information on global outbreaks and infectious diseases? (select all that apply)

- ☐ CDC Morbidity and Mortality Weekly Report (MMWR)
- ☐ Eurosurveillance
- ☐ Communicable Diseases Intelligence (CDI), published by the Australian Government Department of Health
- ☐ Bulletin of the World Health Organisation
- ☐ WPRO Bulletin
- ☐ Other (Please list here.....)
- ☐ None of the above

Q10: What would be your preferred format to receive global outbreak news? (select one that applies)

- ☐ Email
- ☐ Website
- ☐ RSS
- ☐ SMS
- ☐ Weekly video presentation
- ☐ Social Media e.g. twitter
- ☐ Other (Please describe here.....)

Q11: Do you have any other comments to add?

(Please describe here.....)

Section 3 – Epi-watch

The Australian National Health and Medical Research Council Centre for Research Excellence, Integrated Systems for Epidemic Response (ISER) is a multi-centre, international Centre that conducts applied systems research, enhances collaboration and builds capacity in health systems research for epidemic control.

One of the tools developed by ISER to support epidemic control is Epi-watch, an epidemic observatory which aims to provide rapid global epidemic intelligence and critical analysis of significant outbreaks for policy makers, government and other stakeholders.

Having been established in early 2016, Epi-watch is a work in progress and we would like your feedback on how we can make it more useful to your needs.

The three components of Epi-watch include:

1. Outbreak Alerts: A rapid intelligence service providing global outbreak alerts from publicly available sources on a daily basis. You can view the alert tool [here](#).
2. Watching Briefs: Peer reviewed critical analyses on outbreaks of concern. These can be prepared on request for stakeholders. You can view an example [here](#).
3. Epi Digest: A web-based weekly presentation, discussion and review of current global outbreaks to inform policy makers, government and other stakeholders.

Q1: Have you heard of the Integrated Systems for Epidemic Response (ISER) (select one that applies)?

- ☐ Yes
- ☐ No
- ☐ Unsure

Q2: Have you ever viewed Epi-watch previously (select one that applies)?

- ☐ Yes
- ☐ No

Can you please review the outbreaks listed over the last two days [here](#) and answer the following questions:

Q3: From your review, were there any outbreaks listed over the past two days that you were not aware of? (select one that applies)

- ☐ Yes, I identified additional outbreaks that I was not previously aware of
- ☐ No, I was aware of all outbreaks listed
- ☐ Unsure

Q4: Would any of the components of Epi-watch (described above at the beginning of section 3) be useful for you? (select all that apply)

- ☐ Outbreak alerts
- ☐ Watching briefs on request and tailored for your needs

- ☐ Joining a weekly review of global outbreaks by web link (which may include someone from your team joining)
- ☐ None of the above

Thank you for completing the survey.

To help us identify a more representative sample of participants for this study, can you please provide an email contact for colleagues who we can invite to participate in this survey to epiwatch-ISER@unsw.edu.au.

We will be hosting a stakeholder workshop in 2017 to improve our epidemic observatory, Epi-watch. Would you be interested in attending a stakeholder workshop at UNSW on 9 October 2017 to provide more feedback and help us develop an epidemic alert service that meets your needs? Costs will be covered for one participant per organisation from outside of Sydney and Australia.

- ☐ Yes
- ☐ No
- ☐ Maybe

Please provide your contact details if you are interested in attending the workshop. The survey you just completed is anonymous and your contact details will not be linked to your responses.

Name:

Email address:

Name of Organisation:

Appendix 2.B: Epi-watch stakeholder workshop agenda

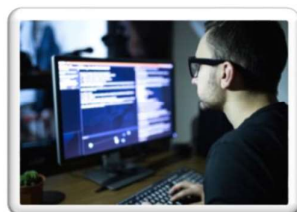


Epi-watch stakeholder workshop on global outbreak surveillance

9 October 2017 10am - 4pm

Ronald Lu/HK seminar rooms on the lower ground of Scientia building
(G19 on the map),

Entry via gate number 11, Botany Street
University of New South Wales



This stakeholder workshop on rapid global epidemic intelligence to enhance the usefulness of outbreak detection systems is being carried out by the Australian National Health and Medical Research Council Centre for Research Excellence, Integrated Systems for Epidemic Response (ISER). ISER is a multi-international centre that conducts research in epidemic control.

This workshop will discuss global overview of available epidemic alert services and global epidemic intelligence for infectious disease outbreak detection and response, to inform the development of a rapid epidemic intelligence service which may be of value for Australia and the Pacific region.

The workshop aim is to inform the development of EpiWatch to ensure is relevant to the practical needs of those who use rapid epidemic intelligence services. The workshop attendees are professionals who work in government and non-government organisations in areas where epidemic intelligence and outbreak alerts are important.

Enquiries:

Elizabeth Kpozehouen, Email: e.kpozehouen@unsw.edu.au , Tel: +61 2 93851192

Auryia Hii, Email: a.hii@unsw.edu.au mob: 0422 920 178



Program

Ronald Lu/HK seminar rooms on the lower ground of Scientia building (G19 on the map), Entry via gate number 11, Botany Street

Time	Topic
9:00 am	Registration desk opens: tea & coffee served
10:00 am	Acknowledgment of country, welcome and introduction: Professor Raina MacIntyre, Director, ISER & Head of School of Public Health & Community Medicine, UNSW, Sydney
10:15 am	Overview of NHMRC CRE - Integrated Systems for Epidemic Response (ISER): Professor Raina MacIntyre, Director, ISER & Head of School of Public Health & Community Medicine, UNSW, Sydney
10:30 am	Outcomes of a 2016 workshop on real-time infectious disease modelling into routine public health practice: Dr David Muscatello, Senior Lecturer in infectious diseases epidemiology, School of Public Health & Community Medicine, UNSW, Sydney
10:40 am	FluCast Demonstration - <i>Aims to forecast severity of influenza season prior to the epidemic peak</i> : Ms Aye Moa, PhD candidate, School of Public Health & Community Medicine, UNSW, Sydney
11:00 am	Morning tea
11:20 am	Overview of available global epidemic sources: Ms Aurysia Hii, Master of Philosophy in Applied Epidemiology Scholar, ISER & Australian National University
11:30 am	Surveillance in the Pacific: Dr Saketa Salanieta, Acting Director, Public Health Division, Research, Evidence and Information Programme, Pacific Community (SPC), Fiji
11:45 am	Overview of Epi-watch - An observatory for outbreak scanning and rapid analysis: Mr Dillon Adams, Research Officer & Master of Philosophy Student, School of Public Health & Community Medicine, UNSW, Sydney
12:15 pm	International surveillance activities in Malaysia and Indonesia: Dr Feroza Sulaiman, Postgraduate Student & Ms Semara Yanti, Postgraduate Student, School of Public Health and Community Medicine, UNSW, Sydney
12:30 pm	Discussion on current surveillance activities and gaps: Professor Raina MacIntyre, Director, ISER & Head of School of Public Health & Community Medicine, UNSW, Sydney
1:00 pm	Lunch
1:45 pm	EpiRisk demonstration - <i>A risk assessment tool for early detection and response to outbreaks</i> : Dr Abrar Chughtai, Lecturer, School of Public Health & Community Medicine, UNSW, Sydney
02:15 pm	Discussion - Stakeholder needs and feedback: Professor Raina MacIntyre, Director, ISER & Head of School of Public Health & Community Medicine, UNSW, Sydney
03:00 pm	Next steps and closing: Professor Raina MacIntyre, Director, ISER & Head of School of Public Health & Community Medicine, UNSW, Sydney

Appendix 2.C: Epi-watch stakeholder workshop background paper

Background paper

Epi-watch stakeholder survey and workshop

National Health and Medical Research Council (NHMRC), Centre for Research Excellence, Integrated Systems for Epidemic Response

The urgent nature of epidemic infectious diseases brings specific challenges in disease control. Epidemics can cause immediate health, social and economic impacts, and require complex cross-sectoral and global response as illustrated by the 2014-16 Ebola epidemic. Travel and globalisation mean that infections spread rapidly around the world, so that global solutions are required for epidemic control. This Centre addresses critical systems gaps in epidemic control.

The [NHMRC, Centre for Research Excellence \(CRE\), Integrated Systems for Epidemic Response \(ISER\)](#) conducts applied systems research, enhances collaboration and builds capacity in health systems research for epidemic control. It brings together experts in field epidemiology and epidemic response, military experts, international law and risk science experts, and government and non-government agencies involved in epidemic response. The [ARM Network](#) for epidemic response is central to the CRE, with the co-founders all being part of the CRE. This Centre is international, with partners in Australia, New Zealand, USA, China and Malaysia who work together to solve global problems in epidemic response. A pillar of the CRE is the ISER Academy, which is a think-tank and convenor of important dialogue, capacity building and generation of ideas, between all stakeholders and sectors involved in epidemic response.

ISER plays a major role in building national and international multisectoral capacity to respond effectively to infectious diseases and bioterrorism threats, and to generate new research which can be translated into improved epidemic response. The Centre's unique strength is its experience and track record in real field response to epidemics, combined with academic rigor and research.

ISER Programs

Epidemic response, control and prevention

ISER conducts research in applied field epidemiology, outbreak response, on performance of deployed international health responders, barriers to deployment, rapid diagnostics, personal protective equipment, vaccines, other interventions, and on engagement with response agencies. The ARM network and our links to key NGOs and other organisations involved in epidemic response facilitate this research. ISER contains the largest body of Australian expertise in field epidemiology and epidemic response.

ISER academy

This is a novel, cross-sectoral think-tank that provides a forum for collaboration between public health, health systems, emergency medicine, paramedics, defence, security, law enforcement, legal experts and ethicists, and it includes workshops, research on joint leadership of epidemics, identifying gaps in legislation surrounding bioterrorism, and research surrounding the international law and ethics of engineered pathogens. ISER also provides capacity building, skills development and mentoring for junior researchers, and encourage linkages between essential sectors in epidemic response

Epidemic intelligence and risk analysis

This research aims to improve decision and policy making in public health by providing better frameworks for epidemic response. The Centre conducts research on epidemic modelling techniques, risk analysis science, evaluating current bioterrorism response systems, digital disease surveillance, predictive research and ethics in epidemics. This research is collaborative and multisectoral. Epi-watch has been developed within this theme.

Epi-watch

Epi-watch is an observatory within ISER for outbreak scanning and rapid analysis using leading expertise in field epidemiology and epidemic response. The aim is to monitor global epidemics and to provide critical analysis of important epidemics for use by policy makers, government and other stakeholders. The Epi-watch team meets weekly to review current outbreaks, analyse epidemic patterns and provide a summary and critical analysis. The team comprises senior academics, epidemiologists and postgraduate students who work daily on Epi-watch under the supervision of CRE chief investigators.

The outputs of Epi-watch include:

Outbreak alerts – rumour surveillance and rapid intelligence

This rapid intelligence service provides outbreak news from publicly available sources, including websites (ProMED mail, FluTrack, HealthMap, WHO, CDC, CIDRAP), newspaper reports (Outbreak News, Google news), social media (Twitter, Facebook), infectious disease blogs and journal articles. Outbreaks of important infectious diseases are regularly posted on the [alert page](#).

Watching briefs – critical analysis

Watching briefs are prepared on outbreaks that are serious, persistent, have unusual aspects or high case fatality rates. In addition to descriptions of current outbreaks, the Watching Briefs include trends in case notifications, literature review, critical analysis, comparison with past outbreaks, a focus on unusual features and key questions. Watching Briefs are posted regularly on the [ISER website](#) and can be prepared on request for stakeholders.

Epi Digest

A web-based weekly presentation, discussion and review of current global outbreaks to inform policy makers, government and other stakeholders.

Epi-watch Stakeholder Workshop

ISER is arranging a stakeholder workshop to understand the outbreak surveillance needs of key Australian, Asian and Pacific Island Countries and Territories and how these needs can be met by our epidemic observatory, Epi-watch. Several stakeholders from Australia, Pacific countries, Indonesia and Malaysia, who use rapid epidemic intelligence services will be attending the workshop.

The workshop presentations will cover overviews of available global outbreak sources, surveillance activities in the region and demonstrations of epidemic intelligence tools developed by ISER (Epi-watch, FluCast, and EpiRisk). After initial presentations, we will discuss current surveillance activities, gaps, and the needs and requirements of stakeholders and how these can be met through further development of Epi-watch.

Approximately 40 participants are expected to attend this workshop. Those attending come from a broad range of sectors involved in epidemic response such as public health units, state/territory departments of health, ministries of health, emergency services, defence and biosecurity. This workshop provides an opportunity to bring together stakeholders to discuss surveillance needs in a collaborative and multisectoral way.

Suggested readings

- **Attachment A:** Muscatello DJ, Chughtai AA, Heywood A, Gardner LM, Heslop DJ, MacIntyre CR. Translation of real-time infectious disease modeling into routine public health practice. *Emerg Infect Dis.* 2017 May. <https://dx.doi.org/10.3201/eid2305.161720>
- **Attachment B:** Yan SJ, Chughtai AA, Macintyre CR. Utility and potential of rapid epidemic intelligence from internet-based sources. *International Journal of Infectious Diseases.* 2017 July. <http://www.sciencedirect.com/science/article/pii/S1201971217301996>

Appendix 2.D: Summary of stakeholder workshop findings

Preliminary summary of results: Epi-watch stakeholder workshop, 9 October 2017

Aim: The aim of the workshop was to understand the outbreak surveillance needs of key Australian, Asian and Pacific Island Countries and Territories (PICT) and to inform the development of Epi-watch, an epidemic observatory developed by **the NHMRC Centre for Research Excellence, Integrated Systems for Epidemic Response (ISER) for outbreak scanning and rapid analysis.**

Attendees: Invitations to attend the workshop were sent to government representatives of national, regional and local jurisdictions, peak bodies and non-government organisations from the following sectors: health, defence, biosecurity, emergency services, international health and general practice. There were 42 participants (28 external, 14 internal). Presentations were delivered by staff and students of the NHMRC Centre for Research Excellence Integrated Systems for Epidemic Response (ISER); and Pacific Community (SPC). The workshop was facilitated by Professor Raina MacIntyre, Director, ISER and Head of SPHCM, UNSW. Ethics approvals were obtained from the following committees: UNSW Human Ethics Committee (HC17466), ANU Human Research Ethics Committees (2017/517), Malaysia Medical Research and Ethics Committee (NMRR-17-1784-37514), Indonesian Health Research Ethics Committee (LB.02.01/2/KE. 328/2017), University of Otago Human Ethics Committee (D17/302), Fiji National Health Research Ethics Review Committee (2017.145.MC), Tonga National Health Ethics and Research Committee (310817), Samoa Health Research Committee. UNSW ethics approval for conduct of this research was accepted by Ministries of Health in American Samoa, Cook Islands, French Polynesia, Kiribati, Marshall Islands, New Caledonia, Niue, Northern Mariana Islands, Tokelau and Vanuatu.

Preliminary outcomes

Background: An overview of a stakeholder workshop held in April 2016 on real-time infectious disease modelling into routine public health practice was provided as background (available at: <https://dx.doi.org/10.3201/eid2305.161720>). This workshop found that there is a need to develop better modelling tools that are simple, easily understood, clearly indicate underlying assumptions and limitations, and able to guide policy and decision making.

Surveillance in the Pacific: The Pacific Public Health Surveillance Network (PPHSN) established under the Secretariat of Pacific Communities (SPC) and WHO caters to individual PICT and regional needs for epidemic intelligence and public health response. Regional indicator-based and event-based surveillance systems support member countries' surveillance systems that vary widely in their existing capacities. Priority is given to outbreak-prone communicable diseases.

Outcome: PPHSN's early warning system tools such as the interactive epidemic and emerging disease alert map and moderated e-mail forum (PacNet) is seen as highly valuable, particularly the sharing of information between countries. Some challenges include completeness and timeliness of information, current utilisation by individual countries and political context within which information can be disseminated.

Overview of Epi-watch: Epi-Watch is an observatory within ISER for outbreak scanning and rapid analysis of global outbreaks and epidemics using publicly available sources. Its outputs include 'Outbreak Alerts' for daily rumour surveillance and rapid intelligence, 'Watching Briefs' for on-demand critical outbreak analysis, and a weekly web-based 'Epi-digest' to inform stakeholders of current global outbreaks.

Outcome: There was a positive perception on the usefulness of Epi-watch, specifically for nations in the Asia Pacific region. Factors to consider for future development of the Outbreak Alert component of the tool should allow for information to be filtered on parameters such as date, disease, location and disease trends and integration of other languages such as French, Chinese. The Watching Briefs were seen as useful and should be further developed with a focus on the Asia Pacific region to increase their relevance for stakeholders. There was an expressed interest to participate in the 'Epi-digest' online conference calls, develop capacity and support access to experts through UNSW/ISER and participating countries, possibly through development of an advisory group. Future development of Epi-watch should focus on presenting information that is user focused to increase usefulness of the system.

International surveillance activities in Malaysia and Indonesia: Research done within ISER on outbreaks reported in the Malay and Indonesian-language compared ProMED-mail, HealthMap and Epi-Watch, and showed search results limited to English-language sources miss a large proportion of outbreaks in Indonesia and Malaysia. With 290 million native speakers of the Malay languages and the potential of epidemic spread between countries through travel and trade, the inclusion of keywords could provide a more comprehensive epidemic intelligence data for the region.

Outcome: Internet penetration and the availability of online news media in English and local languages may influence the usability of internet-based surveillance systems within different communities. The future inclusion of common local languages such as Malay, Indonesian and French could further improve epidemic intelligence sharing among the Asia Pacific countries. The use of machine translation such as Google Translate would still require some form of human intelligence to ensure context integrity of the original information is maintained.

Other tools: Two tools developed by ISER, Flucast and Epi-Risk were presented and discussed. The aim of Flucast is to predict the severity of an emerging influenza season before the epidemic peak.

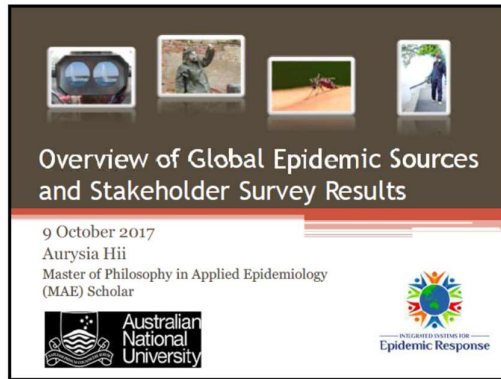
EpiRisk is a risk assessment tool for the early detection and response to outbreaks.

Stakeholder needs and feedback group discussions

- *Epidemic intelligence is imperative in guiding public health measures:* Epidemic intelligence allows for a robust, reliable and predictive outbreak detection system. The surveillance data must be actionable and able to be put into context. Information sharing across local and international boundaries, and different sectors, such as animal health surveillance, ensures a more comprehensive preparedness and response plan by the corresponding authorities.
- *Early prediction of outbreak severity can assist in resource prioritisation and surge capacity:* First responders attending to outbreak cases often face health risks and may fall sick themselves. Unplanned shortages in workforce capacity could be mitigated with proper planning and preparedness by health authorities. Consideration of other sources of data for early detection of outbreaks such as pharmaceutical usage is important.

- *Timeliness of outbreak information:* Timely information is needed for rapid risk assessments and the development of relevant protocols and response for emergency operation centres and other responding authorities. Gathering timely information from remote and isolated areas remain an ongoing challenge for many local health authorities.
- *Early prediction of potential risks for the exportation/importation of infectious diseases:* International arrivals via cruise ships, air travel and mass gatherings expose PICT to the high risk of importation of infectious diseases and antimicrobial resistance that can overwhelm local health systems capacities. Being able to predict the spread of outbreaks to other countries in the pacific region would be useful for preparedness and response planning.
- *Capacity building in the PICT:* Many surveillance systems capacities in the PICT are limited by their resources to retain experts in relevant fields and to set up adequate laboratory facilities. Training the local workforce and retaining the necessary skillsets are major challenges. Consolidating the lessons learnt from past outbreaks in one resource point would be beneficial.
- *Modern communication technologies used in surveillance activities:* Internet, social media and messaging apps are invaluable tools in current surveillance systems and public health responses. However, using these technologies requires a necessary trade-off between accuracy and timeliness of data.

Appendix 2.E: Epi-watch stakeholder workshop presentation

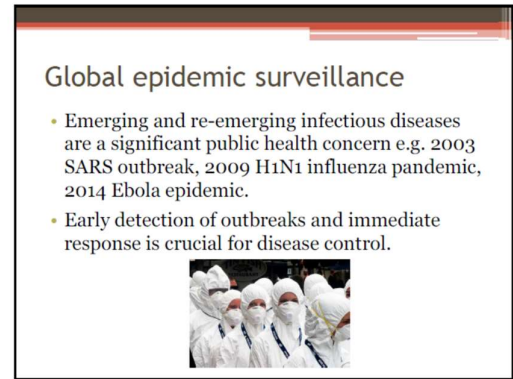


Overview of Global Epidemic Sources and Stakeholder Survey Results

9 October 2017
Aurysia Hii
Master of Philosophy in Applied Epidemiology
(MAE) Scholar

Australian National University
Epidemic Response

1

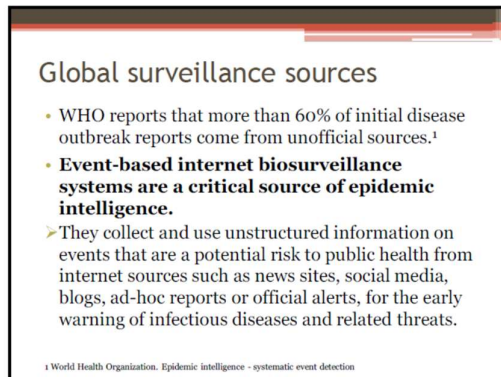


Global epidemic surveillance

- Emerging and re-emerging infectious diseases are a significant public health concern e.g. 2003 SARS outbreak, 2009 H1N1 influenza pandemic, 2014 Ebola epidemic.
- Early detection of outbreaks and immediate response is crucial for disease control.



2

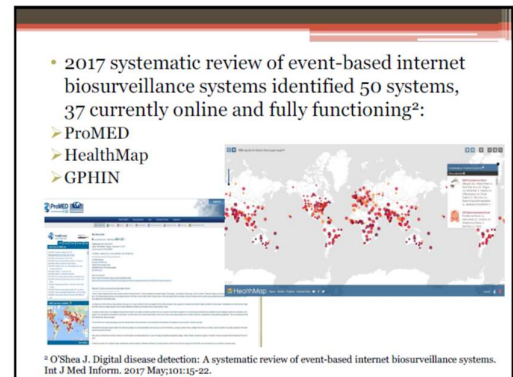


Global surveillance sources

- WHO reports that more than 60% of initial disease outbreak reports come from unofficial sources.¹
- Event-based internet biosurveillance systems are a critical source of epidemic intelligence.**
- They collect and use unstructured information on events that are a potential risk to public health from internet sources such as news sites, social media, blogs, ad-hoc reports or official alerts, for the early warning of infectious diseases and related threats.

¹ World Health Organization. Epidemic intelligence - systematic event detection

3



- 2017 systematic review of event-based internet biosurveillance systems identified 50 systems, 37 currently online and fully functioning²:
- ProMED
- HealthMap
- GPHIN



² O'Shea J. Digital disease detection: A systematic review of event-based internet biosurveillance systems. Int J Med Inform. 2017 May;101:15-22.

4



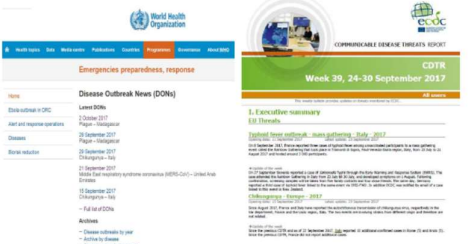
Networks and restricted sources

- Communicable Diseases Network Australia (CDNA)
- WHO International Health Regulations (IHR) Event Information Site (EIS)
- Pacific Public Health Surveillance Network
- National IHR Focal Points
- EpiCore
- Association of Southeast Asia Nations Emergency Operations Center (ASEAN-EOC) Network

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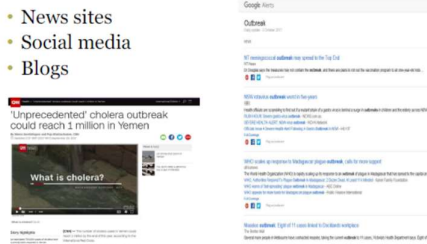
Official sources



6

Unofficial sources

- News sites
- Social media
- Blogs



The screenshot shows a Google search for 'Unofficial sources'. The top results include a news article about a 'Unprecedented' cholera outbreak in Yemen reaching 1 million cases, and a video titled 'What is cholera?'. The search results are displayed in a standard Google format with snippets and links.

7

Journals

- CDC Morbidity and Mortality Weekly Report
- Eurosurveillance
- Communicable Disease Intelligence
- Bulletin of the World Health Organisation



The image shows the covers of three journals: MMWR (Morbidity and Mortality Weekly Report), Eurosurveillance, and Communicable Disease Intelligence. The covers are displayed side-by-side, showing their respective logos and titles.

8

Stakeholder survey results

Online semi-quantitative survey about global outbreak surveillance sources and needs.

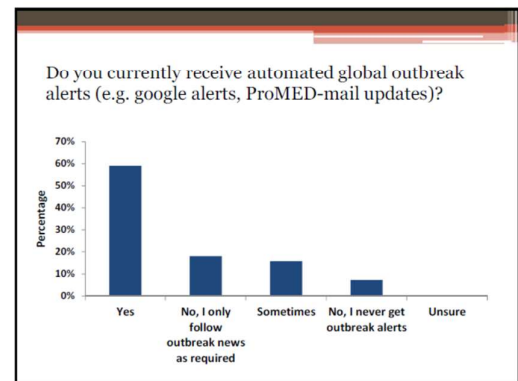
Participants

- employed by an Australian, New Zealand, Indonesian, Malaysian or Pacific Island government or non-government organisation; and
- work in areas where epidemic intelligence and outbreak alerts are important.

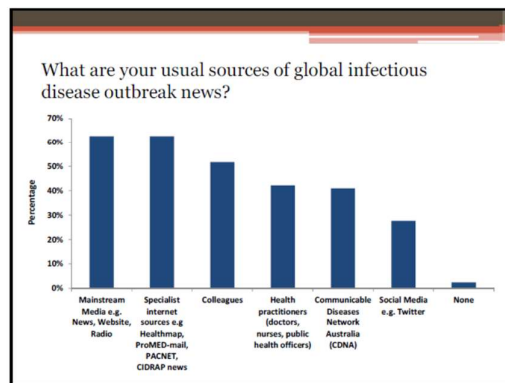
Recruitment

- A purposive sampling strategy to identify initial participants.
- Snowball sampling to identify additional participants.

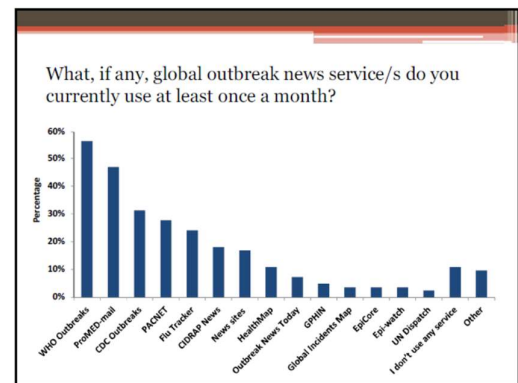
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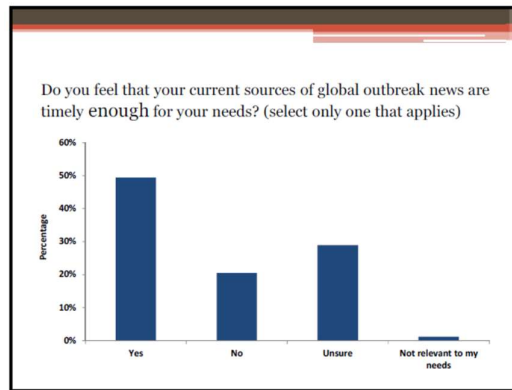
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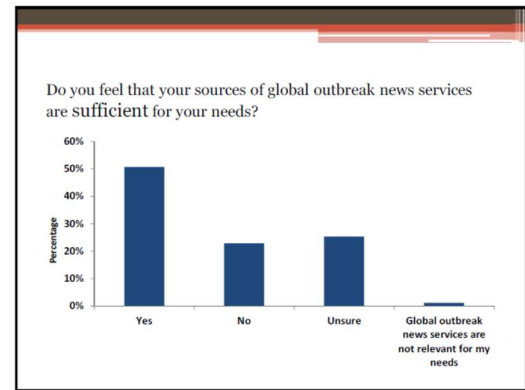
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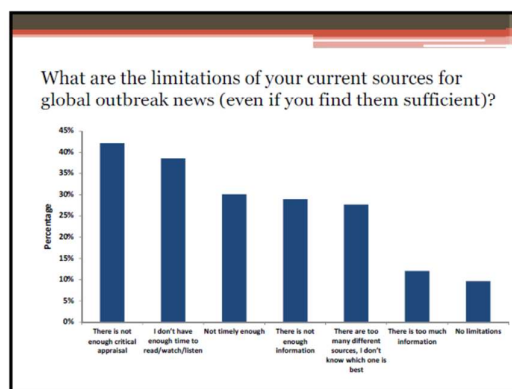
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13



14



15

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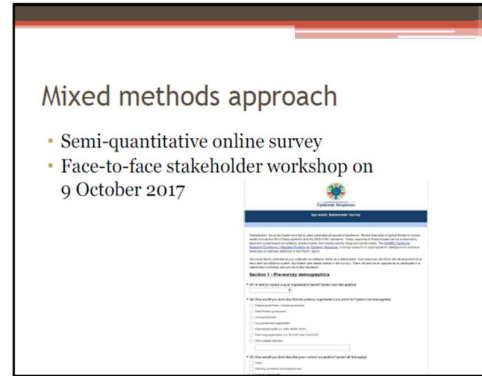
INTEGRATED INSTITUTE FOR
Epidemic Response

16

Appendix 2.F: Outcomes from Epi-watch stakeholder survey and workshop, presentation for the Scientific Advisory Committee



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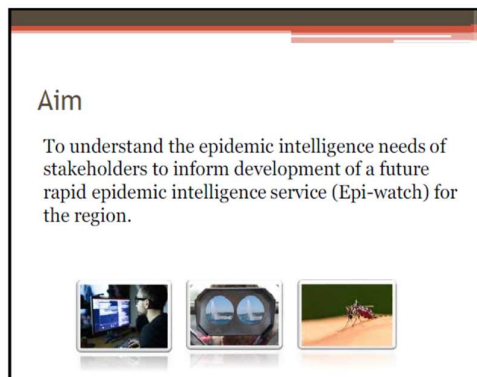
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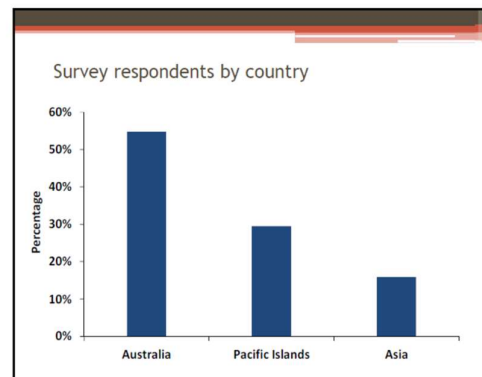
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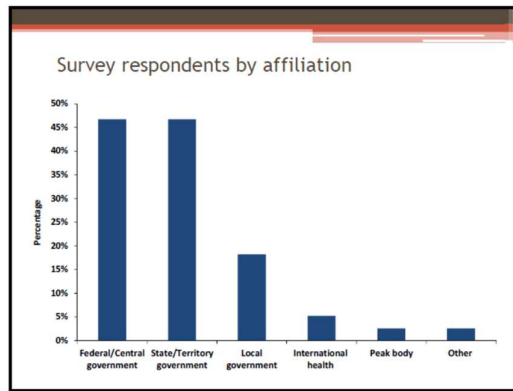
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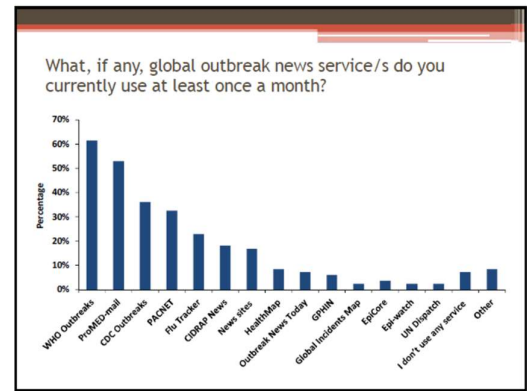
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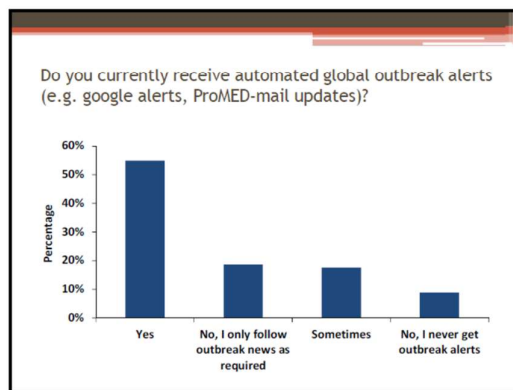
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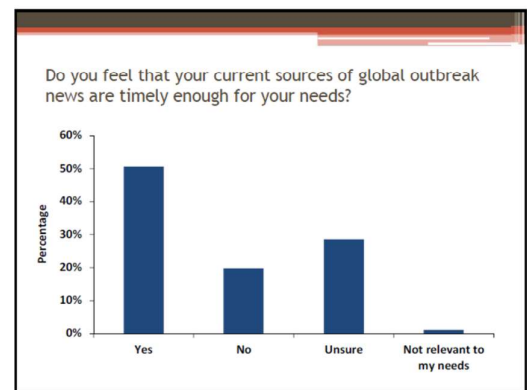
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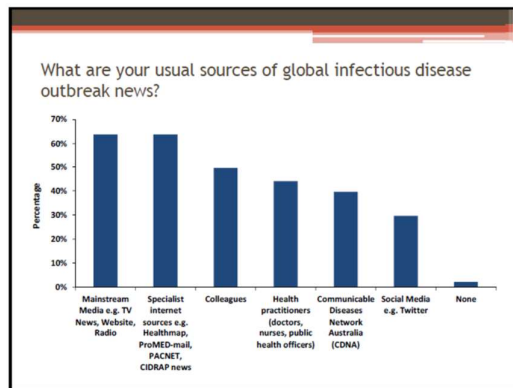
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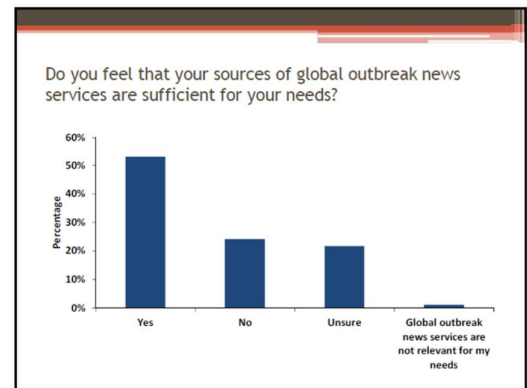
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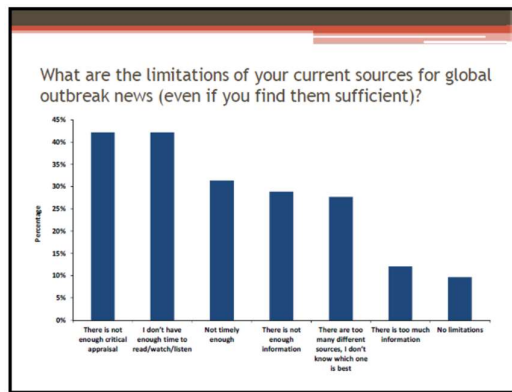
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13

Workshop overview

Presentations:

- Overview of ISER
- Outcomes of a 2016 workshop on real-time infectious disease modelling into routine public health practice
- Global epidemic sources and survey results
- Surveillance in the Pacific
- International surveillance activities in Malaysia and Indonesia

16

Stakeholder Workshop

Recruitment

- Online registration through survey
- Invitation

14

Tools:

- Epi-watch observatory
- FluCast demonstration - Aims to forecast severity of influenza season prior to the epidemic peak
- EpiRisk demonstration - A risk assessment tool for early detection and response to outbreaks

Discussion - Stakeholder needs and feedback

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Workshop Participants

Affiliation	No. participants (Australia)	No. participants (International)
National government Including defence	6	12
State Government Including ambulance service	5	-
Public Health Unit	3	-
Peak bodies	1	-
Total	15	12

ISER: 10
Study investigation team: 5

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Early outcomes

- Epi-watch outbreak alerts – improve functionality for users i.e. to filter by disease and region
- Watching briefs – interest in this resource
- Interest in joining Epi-watch weekly outbreak reviews
- Need to build capacity – tools such as risk assessment can be useful
- Maintain knowledge and lessons learnt

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Epi-watch Evaluation

Objectives

- describe the development of Epi-watch, including the reasons why and main objectives behind its development;
- evaluate the attributes of Epi-watch using the CDC *updated guidelines for evaluating public health surveillance systems*; and
- assess the usefulness of the system for stakeholders.

19

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22

Appendix 2.G: Rapid fire poster presentation, Australasian Epidemiological Association conference, 2018

For this rapid fire presentation, I was allowed up to three slides to accompany my one minute presentation, which are presented below.



There are several global event-based surveillance systems in existence around the world. In order to improve outbreak detection and reduce duplication, new systems should integrate with, and add value to, what has already been established. Timely and reliable epidemic intelligence is important for early detection and response to outbreaks, however, current systems do not appear to be meeting these needs. Additionally, having a variety of sources is important for professionals working in outbreak response. Through the implementation of an online stakeholder survey, we identified a number of important needs from professionals working in epidemic response across the Asia-pacific region. Understanding these needs can help us to develop systems that are better targeted to stakeholders. If you would like to know more, my poster is on the Epidemic intelligence needs of stakeholders in the Asia-pacific region.

Appendix 2. H: Epidemic intelligence needs of stakeholders in the Asia-Pacific region, poster



Epidemic intelligence needs of stakeholders in the Asia-Pacific region

Aurysia Hii¹, Abrar Ahmad Chughtai², Tambri Housen¹, Salanieta Saketa³, Mohana Priya Kunasekaran⁴, Feroza Sulaiman¹, NK Semara Yanti², Chandini Raina Macintyre^{2,4}

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Introduction

- Global surveillance systems are crucial for early detection, assessment and response to public health threats.
- The ability for countries to develop core capacities to detect, assess, notify and response to these threats both nationally and internationally is a requirement set out in the International Health Regulations (2005)¹.
- Understanding countries' needs is important to inform development and improvement to these capacities and systems.

Aims

- To understand the global outbreak surveillance needs of stakeholders involved in epidemic response in Australia, Pacific Island Countries and Territories (PICTs), Indonesia and Malaysia to inform further development of Epi-watch.
- Epi-watch is an epidemic observatory currently in development by Australia's National Health and Medical Research Council's (NHMRC) Centre for Research Excellence, Integrated Systems for Epidemic Response that monitors and provides critical analysis of global outbreaks and epidemics of public health significance for use by policy makers, governments, and other stakeholders.

Methods

- Design**
- Cross-sectional online semi-structured stakeholder questionnaire.
- Sample**
- Purposive and snowball sampling methods were used to identify the sample.
 - Participants included those who used epidemic intelligence and outbreak alert services in their work in government and non-government organisations in the following countries: Australia, PICTs: (American Samoa, Cook Islands, Fiji, Kiribati, Marshall Islands, Niue, Northern Mariana Islands, Samoa, Tokelau, Tonga, Vanuatu, New Caledonia, French Polynesia), Malaysia and Indonesia.
 - 128 participants were identified.
- Analysis**
- Descriptive statistical analysis including frequencies and cross-tabulations were undertaken.

References

1. World Health Organization. International Health Regulations (2005). Manila, 2006. Available from: <https://www.who.int/ihr/ihregulations/2005/index.html> [accessed 16 January 2018].

Acknowledgements

We would like to acknowledge the support of Dr. James Pebody, Dr. Elizabeth Kitchener and Dr. Oliver Adams for their contribution to this study. We also thank all participating members of health from all participating countries for their support and agreement to participate and all respondents for taking the time to complete this survey.

Funding

Funding was received from the National Health and Medical Research Council Centre for Research Excellence, Integrated Systems for Epidemic Response (RFF110230).



Results

Importance of global outbreak news

- All respondents (N=91) agreed that it was important to remain up to date with global outbreaks.
- The main reason respondents follow outbreak news was for early warning of serious epidemics (83/91; 91%).

Table 1. Employment characteristics of survey respondents by country, 2017

	Australia n (%)	PICTs n (%)	Indonesia/ Malaysia n (%)	Total Respondents n (%)
Respondents	50 (55)	27 (30)	14 (15)	91 (100)
Organisation type				
State/territory government	30 (60)	4 (15)	2 (14)	36 (40)
Federal/central government	15 (30)	13 (48)	9 (64)	37 (41)
Local government	3 (6)	6 (22)	3 (21)	12 (13)
International health	0 (0)	4 (15)	0 (0)	4 (4)
Peak body/organisation	2 (4)	0 (0)	0 (0)	2 (2)
Position level				
Mid-career ^a	28 (56)	9 (33)	5 (36)	42 (46)
Senior decision maker ^b	17 (34)	10 (37)	5 (36)	32 (35)
Junior ^c	3 (6)	5 (19)	1 (7)	9 (10)
Other	2 (4)	3 (11)	3 (21)	8 (9)
Employment type (multiple responses allowed)				
Surveillance, monitoring and control of communicable diseases	29 (58)	22 (81)	12 (86)	63 (69)
Planning, prevention and preparedness	17 (34)	15 (56)	5 (36)	37 (41)
Policy	9 (18)	8 (30)	6 (43)	23 (25)
Domestic emergency response	8 (16)	2 (7)	0 (0)	10 (11)
General public health	7 (14)	17 (63)	6 (43)	30 (33)
Defence/military	4 (8)	1 (4)	0 (0)	5 (5)
Acute care	3 (6)	6 (22)	1 (7)	10 (11)
International emergency response	3 (6)	12 (44)	2 (14)	17 (18)
Other	3 (6)	4 (15)	1 (7)	8 (9)
Environmental health	1 (2)	6 (22)	0 (0)	7 (8)

^aMid-career: manages a small team, has some decision-making authority and/or influence.

^bSenior decision maker: manages a section/branch/division/head of an organisation, with a significant and/or final decision-making authority.

^cJunior: no management role, has limited authority to make decisions.

Limitations of global outbreak news sources

- Only 5.1% (46/91) of respondents thought their sources of outbreak news were timely and sufficient for their needs.

Table 2. Limitations of global outbreak news sources, 2017*

Limitations	n	%
There is not enough critical appraisal	38	42%
I don't have enough time to read/watch/listen	36	40%
There is not enough information	29	32%
Not timely enough	27	30%
There are too many different sources, I don't know which one is best	24	26%
There is too much information	11	12%
Other	11	12%
No limitations	8	9%

*Multiple responses were allowed for this question.

Conclusions

For those who work in epidemic response, epidemic intelligence is important and widely utilised by stakeholders involved in epidemic response. The choice of sources for global outbreak news varies and there is less use and awareness of rapid sources such as HealthMap, and more reliance on less timely, traditional sources such as the WHO as well as public news media.

We identified a need for more timely and reliable epidemic intelligence in the Asia-Pacific region. More effective and efficient sources and methods to deliver user-friendly intelligence to end-users should be explored.

There are a number of global outbreak surveillance systems available, development of a new system should take into consideration how it can integrate into and add value to already established systems within the region.

Sources of global outbreak notifications

- Mainstream media and specialist internet sources were the most commonly used sources for global outbreak notifications.

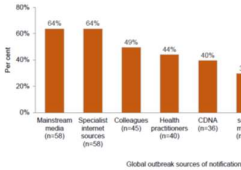


Figure 1. Global outbreak news sources used by respondents, 2017*

*Multiple responses were allowed for this question.

Global outbreak news services used at least once a month

- World Health Organization (WHO), ProMED-mail and Centers for Disease Control and Prevention (CDC) were the most common services accessed for global outbreak news.

- Use of rapid intelligence services such as HealthMap were less common.

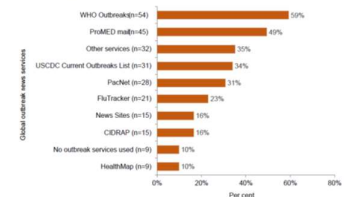


Figure 2. Global outbreak news services used by respondents at least once a month, 2017*

*Multiple responses were allowed for this question.

Chapter 3: Evaluation of a surveillance system

Evaluation of Epi-watch, a new epidemic observatory in development

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3.1 Prologue

My role

One of the main roles during my field placement in the Centre for Research Excellence, Integrated Systems for Epidemic Response (ISER) was being involved in the operation and development of Epi-watch. Epi-watch is an epidemic observatory currently being developed by ISER. Given my involvement with Epi-watch, discussions with my supervisors occurred during the beginning of my placement for the opportunity to conduct an early evaluation of this surveillance system and inform its ongoing development. My role as the sole evaluator for this project included:

- Conducting a desktop and literature review for documents relevant to the development and operation of Epi-watch and event-based surveillance systems generally.
- Developing an evaluation plan.
- Designing and conducting semi-structured interviews with system operators.
- Designing and implementing a stakeholder survey and workshop (Chapter 2).
- Analysing Epi-watch data.
- Assessing Epi-watch system attributes against the United States Centers for Disease Control and Prevention (CDC) *Updated guidelines for evaluating public health surveillance systems*. (1)
- Preparing the evaluation report.

Lessons learned

I found the initial task overwhelming due to having to synthesise evidence from multiple sources and experiencing scope creep on multiple occasions. Defining the objectives of the evaluation and developing an evaluation plan guided me through how to assess each of the attributes, including what information I needed to collect, and it kept me focused on the relevant aspects of the system to evaluate. This was also the first time that I have had to design, collect and analyse information from a semi-structured qualitative interview tool. I learnt that limiting the number of questions was important to maintain engagement and interest from participants and manage the

time taken to self-transcribe interviews. Limiting questions was challenging as I viewed information from all questions as valuable, but this was not necessarily relevant for the task at hand. How I phrased the questions was also important to ensure that they were not 'leading' and did not contribute to biased answers. Knowing when and how to prompt interviewees for further explanation was also useful and learning how to do this in practice was helped by watching YouTube tutorials on conducting interviews. I sought feedback on the interview tool from my academic supervisor and two independent parties from the University of New South Wales and the Australian National University. In retrospect, piloting the tool on system operators may have led to more relevant improvements, such as the length of the tool. Finally, I learnt about some of the issues associated with an internally conducted evaluation as opposed to an independent external evaluation.

Public health implications

The findings from this evaluation were used to provide recommendations to further improve internal processes and to inform development of a more sustainable, efficient and effective surveillance system. It provides documentation of the reason behind the development of Epi-watch and the initial, current and potential future operation of the system. The evaluation highlighted areas for improvement that can readily be addressed, such as developing and documenting processes for the operation of the system, and some aspects that may require further discussion and time to address, such as engagement with ISER investigators and end-users to promote and increase use of the system. It is hoped that Epi-watch can continue to be refined into a useful system for stakeholders and those who work on it.

Acknowledgements

I would like to acknowledge my supervisors, Professor Raina MacIntyre, Dr Abrar Chughtai and Dr Tambri Housen and the Epi-watch team for their assistance and guidance in conducting this evaluation. In particular, I would like to thank especially Dillon Adam, who provided extensive insight into the system.

3.2 Abstract

Background

Epi-watch is an epidemic observatory, developed in 2016 by the National Health and Medical Council funded Centre for Research Excellence Integrated Systems for Epidemic Response. The aim of Epi-watch is to monitor and provide critical analysis of global outbreaks and epidemics of public health significance for use by policy makers, government and other stakeholders. As Epi-watch is a new system still in development, a formative evaluation was undertaken to identify areas for improvement and provide recommendations to inform future development of the system into a final tool for use by stakeholders.

Methods

The United States Centers for Disease Control and Prevention (CDC) *Updated guidelines for evaluating public health surveillance systems* was used to evaluate relevant attributes of Epi-watch. Information to assess these attributes was gathered through literature and desktop review, a stakeholder survey and workshop, interviews with system operators and analysis of the Epi-watch database and publicly documented outbreaks.

Results

The attributes of the Epi-watch surveillance system found to be working well were simplicity, flexibility and sensitivity. Simplicity, however, was influenced by operator experience. Operators who were new to using the system found it more challenging to operate compared to those who had been working on Epi-watch for a longer period.

Issues related to timeliness, stability and data quality were identified. Fifty per cent of selected outbreaks during 2017 were reported in Epi-watch prior to official reporting, there were 38% (151/395) of days over a 12-month period where outbreaks were not reported. No data dictionary or validation processes were in place to maintain data quality.

Internally, Epi-watch is useful as a learning opportunity for operators, to be aware of global outbreaks and to stimulate research within ISER. Although there was limited

awareness and use by external stakeholders, feedback indicated that the outbreak alert, watching briefs and weekly video conference would be useful for their needs.

Conclusion

The evaluation found that overall, Epi-watch is meeting its purpose to monitor and provide critical analysis of global outbreaks and epidemics of public health significance for use by policy makers, government and other stakeholders through outbreak alerts, watching briefs and weekly video conferences. Several recommendations are made to improve Epi-watch that are focused on strengthening operational processes and system documentation, automating various components of the system, improving resource management and reviewing the development and direction of the system.

3.3 Introduction

3.3.1 Public Health importance of event-based surveillance

Infectious diseases continue to pose a threat to people around the world. Over the past few decades we have seen an increase in emerging and re-emerging diseases that have caused significant morbidity, mortality and economic loss, such as severe acute respiratory syndrome (SARS), Middle East respiratory syndrome coronavirus (MERS-CoV), avian influenza, pandemic influenza (H1N1) 2009, Ebola and Zika virus. (2-4) We can expect that infectious diseases will continue to pose a threat given the driving causes are diverse and difficult to avoid. For example, increased population growth and mobility, (5) interaction between humans and animals due to encroachment on habitats, (5, 6) urbanisation (5) and globalisation. (7) Coupled with weak health systems, (8, 9) resource constraints (financial, human, technical) (8, 9) and insufficient investment in surveillance, (8, 9) adequately preventing, detecting and responding to outbreaks is challenging.

Early detection and response to an outbreak is important on several levels. If left unchecked, outbreaks can rapidly spread, resulting in serious disruption to the social and economic stability of countries and impact upon the health of individuals and communities around the world. (10) Strengthening global public health surveillance for early warning has been recognised as a critical component to mitigating these impacts, (3) which is recognised in the revised International Health Regulations (IHR (2005)).

The IHRs (2005) are a legally binding instrument involving 196 member countries whose mandate is to prevent, control and respond to the international spread of disease with minimum impact on international trade and travel. (11) They require member countries to “develop the capacities of their surveillance systems to detect, assess, notify and respond to all acute health events or health risks that may constitute a threat to human health.” (11) Official and unofficial sources are also recognised as important components to meet the early warning and alert requirements, with countries asked to “strengthen and develop both routine, or indicator-based, surveillance and event-based surveillance.” (12)

Traditional, indicator-based surveillance involves the routine collection and reporting of structured data on disease notifications based on standard case definitions to central health agencies through a formal reporting process. (13, 14) While data collected by these systems are generally very accurate, they can lack timeliness and sensitivity, be expensive to run and resource intensive. (13, 15) These disadvantages mean that on their own, indicator-based surveillance systems are not appropriate for early detection of outbreaks and for many countries, not feasible to implement. Thus, event-based surveillance is needed to fill in these gaps.

Event-based surveillance, also known as rumour surveillance is “the organised and rapid capture of information about events that are a potential risk to public health.” (13) Unstructured and ad-hoc information is used from official or unofficial sources such as news, web browser queries, social media, healthcare workers or non-government organisations. (13) This means that event-based surveillance is not limited by the constraints of indicator-based surveillance and can provide earlier warning to detect rare, emerging or unknown diseases or events that may signify an outbreak. (13) This early warning and near real time dissemination of information can be attributed to use of open source data, automation and limited reliance on official approval processes for reporting. (13, 16) The separation from government control of reporting means that there is increased transparency for public reporting of information. (17, 18) Another important role for event-based surveillance is filling a gap in resource poor settings where traditional surveillance systems are weak or non-existent as event-based surveillance can be designed and operated in an inexpensive, accessible and simple way. (15, 19-22)

Use of unofficial or unverified data sources, however, means that event-based surveillance is less reliable, subject to noise and high false-positive alerts. (15, 18, 19) Therefore, verification of reports by public health officials is important, but can also be resource intensive. (19) Systems can also be prone to bias through over reliance on a limited number of data sources, geographical reporting bias from sources focused predominantly on outbreaks in the United States of America, use of single language sources (mainly English reporting) and incorporation of human moderators to review

and post relevant outbreaks, which can lead to false negatives where the end-user requirements differ from the moderators. (23, 24)

With increased use and reliance on the internet as an important data source, a number of electronic web-based surveillance systems have been established. These systems encompass the event-based surveillance model but use the internet for data sources, processes, analysis and dissemination of information. (14) A systematic review conducted in 2017 identified 41 web-based surveillance systems, 28 (68%) of which were currently online and fully functioning. (14) Four of these systems monitor global coverage of public health risks: the Program for Monitoring Emerging Diseases (ProMED-mail), HealthMap, Global Public Health Intelligence Network (GPHIN) and Medical Information System (MEDISYS). (25, 26) The most commonly used systems include ProMED-mail with over 83,000 subscribers in more than 200 countries and HealthMap, receiving approximately 20,000 unique users per month. (27, 28)

ProMED-mail was established in 1994, and is focused on reporting outbreaks of emerging and re-emerging infectious diseases, acute toxic events and new evidence on drug or pesticide resistance in relation to human, animal and major crop plants. (29) It relies on a network of users to report outbreak information to the system via email. (30) HealthMap has been operating since 2006 and aims to supplement existing public health systems by conducting disease outbreak monitoring and real-time surveillance of emerging public health threats for both lay and public health users. (31) HealthMap integrates data from a wide range of sources by automated text processing algorithms. (31) Both HealthMap and ProMED-mail require human judgement at some stage in the form of curators and analysts to address misclassification and correct occasional mistakes. Both systems are freely available to the public via the internet.

There have been several documented examples where event-based surveillance systems have alerted authorities to an unusual event earlier than official reporting. Early reports of unusual acute respiratory illness activity in Guangdong Province, China were captured by GPHIN and discussed online through ProMED-mail well before official government reports of the 2002-2003 SARS outbreak. (28) More recently, ProMED-mail provided an early report of the 2014 Ebola epidemic approximately five months prior to the official declaration of an international health emergency. (32)

3.3.2 Context and scope of the evaluation

Epi-watch is an epidemic observatory developed by the National Health and Medical Research Council funded Centre for Research Excellence Integrated Systems for Epidemic Response (ISER) in 2016. The aim of Epi-watch is to monitor and provide critical analysis of global outbreaks and epidemics of public health significance for use by policy makers, government and other stakeholders. There are three components to Epi-watch: an outbreak alert, a weekly video conference and watching briefs.

The reason behind development of Epi-watch was prompted by a need to improve informal and rapid surveillance and reporting specifically focused on global epidemic and emerging infectious disease outbreaks. It was felt that there was a gap in the market that current systems such as ProMED-mail and HealthMap were not meeting. ProMED-mail is qualitative and HealthMap is not specifically designed for epidemics and they were seen as more generic tools. There was also a desire to develop a system that was responsive to stakeholder needs, which other services do not provide.

Development of Epi-watch began in December 2015. The focus was to design an automated, sustainable system that is not duplicative of other systems and provides added value for stakeholders that include policy makers, government and others within the funding span of ISER, to 2021.

As Epi-watch is a new system and remains in development, it was decided an early evaluation would be important to assess whether the system is meeting stakeholder needs and what improvements could be made. Therefore, the overall aim of the evaluation was to identify areas for improvement and provide recommendations to inform further development of Epi-watch into a final tool for use by stakeholders. The specific objectives were to:

- Describe the development of Epi-watch, including the reasons for and main objectives behind its development.
- Evaluate the attributes of Epi-watch and the system's overall usefulness using the United States Centers for Disease Control and Prevention (CDC) *Updated guidelines for evaluating public health surveillance systems*. (1)

Ethics approval for this evaluation was obtained from the Australian National University Human Research Ethics Committee (ANU HREC), protocol number 2017/909. Ethics approval for the stakeholder survey and workshop were obtained separately from University of New South Wales Human Ethics Committee protocol number HC17466, the ANU HREC protocol number 2017/517 and from country specific ethics committees and Ministries of Health.

3.4 Methods

This evaluation was conducted from June 2017 to April 2018 using a mixed methods design (Table 1). The evaluation was conducted using the CDC *Updated guidelines for evaluating public health surveillance systems* as the primary guide for evaluating the attributes of Epi-watch. (1) It should be noted that no specific international guidelines exist for evaluating attributes relevant to event-based surveillance systems.

Supplemental information from evaluations of other systems and the CDC *Framework for Evaluating Public Health Systems for Early Detection of Outbreaks* (33) were used to support the approach to evaluating Epi-watch. The evaluation focused specifically on assessing the following attributes: simplicity, flexibility, data quality, acceptability, sensitivity, timeliness, stability and usefulness. System specific quality indicators were developed for each attribute as described in Table 2. Representativeness was not included as data was not available to determine whether outbreaks in Epi-watch were representative of all actual outbreaks reported. Predictive value positive was not assessed as data was not available on outbreaks or cases investigated that were actual events.

The evaluation focused on the outbreak alert service as this is the component of Epi-watch designed to fulfil the core event-based surveillance function of early warning and detection of unusual patterns of disease. Where relevant, the remaining two components, the weekly video conference and the watching briefs, were also considered. A description of these components can be found at section 3.5.

Table 1. Summary of methods used to evaluate Epi-watch

Evaluation components	Literature review	Desktop review	Stakeholder survey	Stakeholder workshop	Informant interviews	Epi-watch database	Website views
Public health importance	X						
Describing the surveillance system							
Describe Epi-watch		X			X		
System attributes							
Simplicity		X			X		
Flexibility					X		
Data quality						X	
Acceptability					X		X
Sensitivity						X	
Timeliness		X			X	X	
Stability					X	X	
Usefulness			X	X	X		

Table 2. Indicators used to assess the attributes of Epi-watch

Attribute	Indicator
Simplicity	Establishing, collecting and reporting events is perceived as straightforward by system operators. The case definition is easy to apply, as perceived by system operators. Coordinating and running the system is straightforward and simple, as perceived by the system administrator. Staff training requirements are adequate to operate the system.
Flexibility	The system can adapt to changing needs including search terms and data sources with minimal impact on time, resources and cost.
Data quality	Data entered into the fields in the Epi-watch database are complete, accurate and consistent.
Acceptability	Stakeholders use the system based on: • reported use by stakeholders, • number of hits on the outbreak alert and watching brief page, • number of requests for watching briefs, and • number of stakeholders participating in weekly conferences. System operators perceive there is value in the system.
Sensitivity	The proportion of MERS-CoV cases detected by the system compared to cases reported by the WHO. The proportion of outbreaks detected by the system compared to the selected list of officially reported outbreaks in 2017.
Timeliness	Outbreaks are reported on Epi-watch at the same time or prior to official or unofficial sources as measured by the time interval between: • the date outbreaks were reported by Epi-watch in 2017 and the date of official reporting, and • the date events are reported on Epi-watch and the news item report date. The number of times data sources are scanned each day. The time taken from entering outbreaks into the database to reporting on the outbreak alert website.
Stability	The ability of Epi-watch to provide daily outbreak alerts.
Usefulness	ISER Director's perception of Epi-watch's ability to contribute to the prevention and control of outbreaks, improved understanding of outbreaks and stimulation of research. Feedback from stakeholders during the Epi-watch workshop is positive. Epi-watch strengths and weaknesses.

Data sources

I conducted a desktop review of all documents relevant to Epi-watch including the Standard operating procedure (SOP), presentations introducing and explaining the system and the Epi-watch website (34). The system description was informed by a combination of desktop review and interviews with system operators for information that was not formally documented.

I undertook 10 face-to-face structured interviews with people involved in developing, establishing and operating Epi-watch. The questionnaire guide used for these interviews is in Appendix 3.A and was provided to interviewees two days prior to interview. Interviews were voice recorded, transcribed and analysed for key themes.

To inform future development of Epi-watch, a stakeholder survey was conducted from 27 June to 9 October 2017 and a workshop was held on 9 October 2017 (refer to Chapter 2 for more information). The aim of the stakeholder survey was to understand the global outbreak surveillance needs of stakeholders involved in epidemic response in the Asia-Pacific region. The aim of the workshop was to engage with stakeholders to identify what their epidemic intelligence needs were, in order to inform development of Epi-watch. Participants included people who use epidemic intelligence and outbreak alert services in their work across government and non-government organisations in Australia, Indonesia, Malaysia, New Zealand and Pacific Island Countries and Territories.

To evaluate web-based surveillance systems, signals identified by the system should be compared to official notifications, considered the 'gold standard' during the same time period, however, these can be difficult to obtain. (35) Sensitivity of Epi-watch was assessed in two ways: 1. using MERS-CoV as a disease specific case study; and 2. through selected outbreaks that occurred during 2017.

Cases of MERS-CoV reported on the WHO MERS-CoV disease outbreak news page (36) for the period 1 April 2017 to 30 September 2017 were collated into an excel database and considered the gold standard reference to calculate sensitivity. This method has been employed in a previous evaluation that used official reports of highly pathogenic avian influenza A/H5N1 as the gold standard. (37) MERS-CoV was selected as official

case notifications were available from the WHO to use as the gold standard reference. Furthermore, cases could be identified and extracted from the Epi-watch database and under-ascertainment of reporting was less likely from both data sources as MERS-CoV had been identified as a disease to report on Epi-watch as there is global public health concern regarding the disease and WHO member countries are urged to report and verify cases. (38)

Selected outbreaks that occurred in 2017 were also identified as an additional method to assess the sensitivity and timeliness of the system. Outbreaks were identified from a report on *the 10 Biggest Infectious Disease Outbreaks of 2017* (39) published by Contagion, a news resource that aims to provide practitioners and specialists information on infectious disease and the WHO *Disease Outbreak News* in 2017. (40) Outbreaks were selected that met the Epi-watch reporting case definition: ‘outbreaks that are serious, persistent, have unusual aspects or high case fatality rates’ (see section 5 outbreak alert below). Outbreaks were excluded if they began in 2016, an official notification date could not be found, or it was not possible to identify and match the report in Epi-watch with the official report.

The time period was also dependent on time zone differences between Australia and countries in the Western hemisphere. An additional day was added to the original news article report date originating from these countries to account for this difference when calculating timeliness.

Other data sources included data extracted from the Epi-watch database and the number of unique views on the Epi-watch outbreak alert and watching brief web pages.

Data were analysed using Microsoft Office Excel 2016 (Microsoft Corp., Redmond, WA, USA) and Stata version 14 (Stata Corp., College Station, TX, USA).

3.5 Epi-watch system description

Purpose and objectives

Epi-watch aims to monitor and provide critical analysis of global outbreaks and epidemics of public health significance through openly available sources for use by

policy makers, government and other stakeholders through outbreak alerts, watching briefs and weekly video conferences. The objectives of these are outlined below¹:

1. The outbreak alert is a rapid intelligence service that aims to provide daily outbreak alerts from publicly available sources for stakeholders who may be too busy to conduct their own search.
2. The weekly video conference aims to provide a summary of new outbreaks of concern; review ongoing outbreaks of significance; discuss outbreaks of unknown aetiology; propose and discuss future watching briefs and evaluate Epi-watch strategies and update as agreed upon.
3. Watching briefs aim to provide critical analyses on outbreaks that are serious, persistent, have unusual characteristics or high case fatality rates. They are intended for busy public health professionals who cannot dedicate resources for this task.

System description

The three components of Epi-watch are described below. Figures 1a and 1b outline the flow of information through each of these elements.

Outbreak alert

The Epi-watch outbreak alert is a web-based surveillance system. Currently, the system collects information from 20 publicly available web-based data sources which are listed in the SOP in Appendix 3.B. Scanning of 9 of these sources are mandatory in the SOP whilst the remaining 11 are optional. These data sources include a combination of official and unofficial sources such as the World Health Organization, the CDC, other event-based surveillance systems such as ProMED-mail and HealthMap, websites, blogs and social media (Facebook and Twitter).

The outbreak alert is currently semi-automated, meaning that a combination of manual and computer automated processes are involved in scanning and reporting events. The initial data collection is done in a semi-automated fashion using prescribed search terms through Google alerts. Search terms include general terms, such as

¹ The purpose and objectives have been compiled from multiple sources including the SOP, presentations and interview with the Director of ISER.

'outbreak,' 'infectious' and 'unknown virus' and specific disease name terms such as 'measles,' 'salmonella,' 'anthrax' and 'Ebola.' Manual scanning of results from the Google alerts and other data sources is undertaken by system operators to identify events that meet the case definition for reporting, which is: 'outbreaks that are serious, persistent, have unusual aspects or high case fatality rates.' Social media searching involves following key organisations, researchers, academics and bloggers using key search terms.

Between February 2016 (the start of reporting) and March 2018, outbreak scanning was conducted five days a week from Monday to Friday, with weekend reports reviewed on the Monday. From March 2018 a rotating roster for scanning was introduced to ensure scanning covered the whole week, Monday to Sunday.

When an outbreak is identified, details are manually entered into the Epi-watch database, which consists of a Google spreadsheet. Outbreaks are then automatically uploaded and displayed on the Epi-watch website separately in a list format for each report by day and month and linked to the full news article. The automation of uploading reports onto the website from the spreadsheet was implemented in early August 2016. Prior to this, reports were manually uploaded onto the website.

An automatic and manual process for removing duplicate reports is conducted. The database automatically checks for duplicate reports, however, only reports originating from the same source are identified. Manual review of outbreaks is also conducted by each operator to identify duplicates prior to reporting.

The first outbreak alerts were reported on the website on 2 February 2016. Since reporting began on 2 February 2016 and up to 31 December 2017, 4,985 outbreak alerts have been reported on the Epi-watch webpage, averaging seven alerts per day.

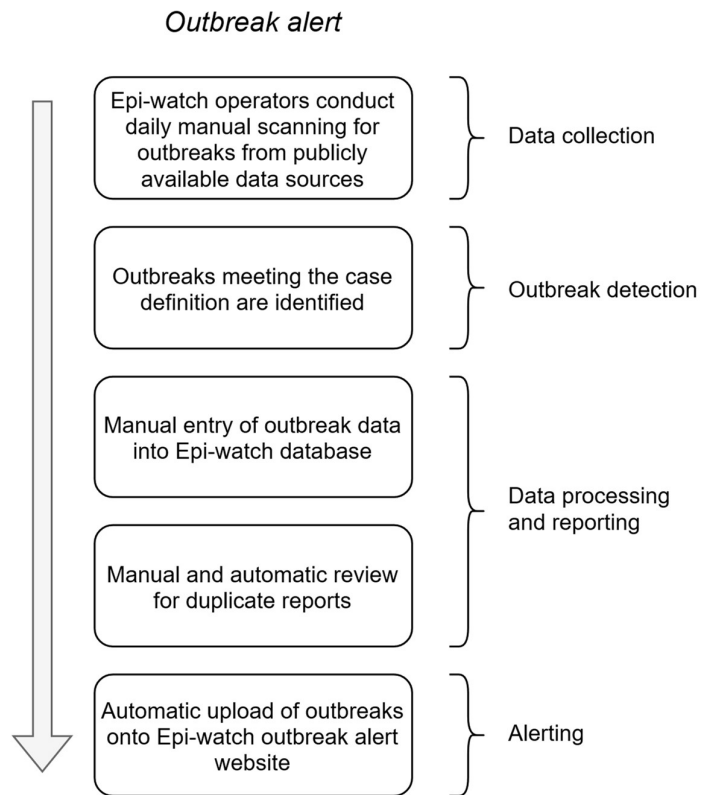


Figure 1a. Epi-watch outbreak alert flow of information, 2018

Weekly video conference

The weekly video conference is an interactive 30-minute web-based video conference to provide an overview and discussion of outbreaks reported on the Epi-watch outbreak alert over the previous week. Development of watching briefs are also identified during these meetings. This is a closed forum available to relevant stakeholders. To attend the meeting, stakeholders need to request access through the Epi-watch system administrator. The process for preparing the presentation involves selecting outbreaks from the Epi-watch database, gathering relevant information to describe each outbreak from various sources and collating these into a PowerPoint presentation that is then delivered to the ISER team and invited stakeholders. The presentation is converted to a PDF and emailed to those on the invitation list.

Development and delivery of the presentation is undertaken by the Epi-watch team on a rotational basis.

Watching briefs

Outbreaks that warrant development of a watching brief are identified during the weekly video conference and assigned to an ISER team member to develop using a standard template called a 'Watching Brief' (Appendix 3.C). Once drafted, the briefs are peer reviewed by two ISER Chief Investigators and once finalised, published on the Epi-watch webpage and posted on the ISER Facebook and Twitter social media sites.

Stakeholders from relevant health agencies can request development of a watching brief, tailored to their needs. The timeframe for provision of a brief is one week.

Since the inception of Epi-watch, 22 watching briefs have been developed, 14 during 2016 and eight (including 1 updated brief) during 2017. A list of these briefs can be found in Appendix 3.D.

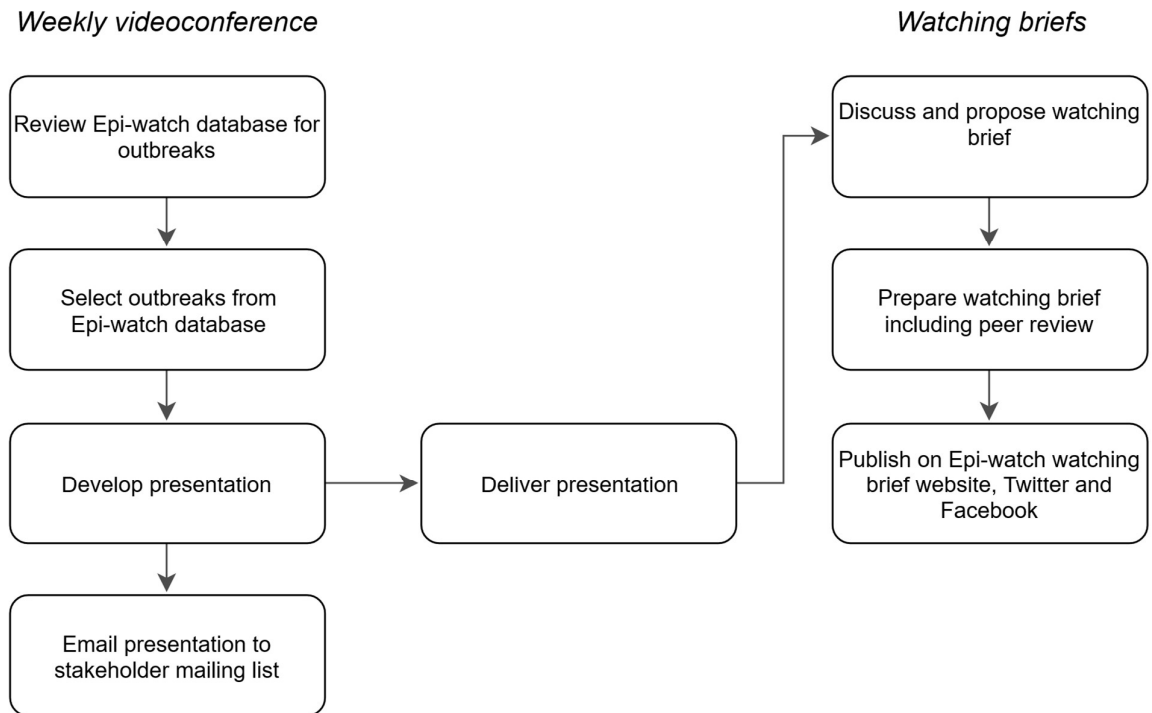


Figure 1b. Epi-watch weekly videoconference and watching briefs flow of information, 2018

Operation and management

Epi-watch was conceived by the Director of ISER, whose role is to provide overall strategic direction and lead the development of the system. Funding was provided under the NHMRC ISER grant APP1107393. Management and implementation is overseen by the Team Leader who supervises the Epi-watch team and System Administer who is responsible for day-to-day management and implementation. A team of long-term post-doctoral researchers, PhD students, research assistants and short-term student interns are responsible for operation of the three components of Epi-watch. The operation and management structure of Epi-watch is depicted in Figure 2.

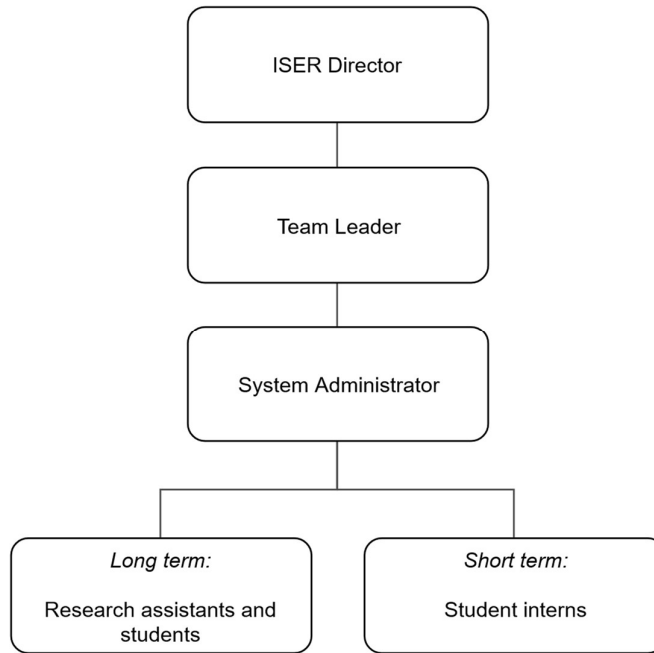


Figure 2. Epi-watch management structure

At the time of the evaluation there were six people funded through ISER and three interns working on Epi-watch. In addition, the role of Team Leader had been transferred to another ISER staff member who had not yet begun working on Epi-watch. Preparation of watching briefs are not confined to the core Epi-watch team, but can also be prepared by other ISER members. The nature of relying on a student base means that there is variation in the number of people available to operate the system and there is ongoing staff turn-over when students complete their internships and degrees.

In terms of the time spent on operating Epi-watch, approximately:

- 10 hours per week is spent on management.
- 31 hours per week is spent on scanning and reporting outbreaks.
- Seven hours on average per week is spent on preparing the weekly video conference presentation.
- Four and a half days on average to complete a first draft of a watching brief.

3.6 Evaluation of system attributes

3.6.1 Simplicity

Recommendations - Simplicity

1. There is a need to develop and document a number of processes and procedures for the operation of Epi-watch:
 - 1.1 Develop a flow chart outlining how to apply the case definition.
 - 1.2 Discuss application of case definition and flow chart during the weekly video conference as a way to continue to build capacity within the team and improve specificity.
 - 1.3 Develop guidelines to assist operators to determine what information should be reported for each outbreak at the weekly video conference and review whether this meets stakeholder needs.
 - 1.4 Develop and implement a process to increase production of watching briefs during the weekly video conference.
 - 1.5 Document the process for the weekly video conference and watching briefs and specify roles and responsibilities.
2. Review the process for reporting news headlines on the outbreak alert and provide more guidance on what to include. Update the SOP to reflect correct case definitions for the outbreak alert and watching briefs.
 - 2.1 Provide system operators with training to apply the amended case definition for outbreak alert reporting.

Respondents discussed both the structure and ease of use of all three components of the system; outbreak alert, weekly video conference and watching briefs.

The structure of Epi-watch is simple and straightforward due to:

- Decisions on the direction of Epi-watch only needing approval from the Director of ISER.
- Operators not being constrained by hierarchical approval processes in the day to day running of the system.
- Use of publicly available data sources rather than reliance on external parties for the provision of data.
- Minimal steps to collect, manage and prepare data for reporting purposes.
- The current manual design and use of software that is simple to learn, such as Google sheets and Microsoft PowerPoint.

Respondent's level of experience appeared to influence the perceived ease of use of all three components of Epi-watch, with those new to the system finding it more challenging to operate. With increased experience, operators found the system easier to use. Strengthening processes and procedures for the use of the system will assist to address the challenges raised.

Some of the difficulties experienced by system operators included:

- The decision-making process required to identify which outbreaks to report both for the outbreak alert and weekly video conference. While a case definition exists for the outbreak alert, there was mixed response from operators in terms of how easy this was to apply. Inconsistent criteria to select outbreaks to report during the video conference were also being used by operators. Methods included selecting new outbreaks and rare diseases, outbreaks that had significant impact and required more discussion, outbreaks that were ongoing or based on operator interest. Reasons for these inconsistencies included lack of documented processes, too many outbreaks to report in the allocated time period and outbreaks reported on the outbreak alert that were not relevant i.e. did not meet the case definition.
- Deciding what additional information to provide for each outbreak and how to best present ongoing outbreaks during the weekly video conference was

reported as a challenge and added to the time taken preparing the presentation.

- Difficulty with and limited engagement of ISER investigators in the peer review phase of the watching briefs. It may be relevant to re-visit the peer review process for the watching briefs to consider whether a more systematic process involving more reviewers is required and how to engage ISER investigators in the review process. For example, identifying interested investigators and aligning briefs to their area of interest, limiting the number of times an investigator is asked to review briefs, highlighting the value of briefs and incentivising involvement, such as through publication in a journal.
- Not producing watching briefs as regularly as envisaged and needing a better system was raised for peer reviewing and finalising briefs during the weekly video conference. All operators found the template easy to use, providing structured guidance to developing the brief.
- Keeping within the 30-character word limit and not knowing what information end-users required when operators described the news report headlines when uploading outbreaks on the alert page.

One of the main aims for the future development is to automate the outbreak data collection process, which will address some of the decision-making challenges involved in selecting outbreaks, as a large part of this should be addressed through automatic identification of reports. While difficulties deciding what reports to select from this list may still exist, developing guidance for decision making will assist with this process. One of the main strengths of Epi-watch is the use of human operators involved in the selection of relevant outbreaks. However, reliance on subjective assessment by different operators can also be a limitation of this method.

Case definition

The case definition for reporting outbreaks on the outbreak alert and developing watching briefs as outlines in the SOP is: 'outbreaks will be included and reported if they are serious, persistent, have unusual aspects or high case fatalities.' However, following the initial draft of this report, the ISER Director has since clarified that this case definition was intended for the watching briefs. The case definition for overall

reporting for the outbreak alert are the prescribed search terms outlined in the SOP in Appendix 3.B. Given this clarification, case definitions should be amended in the SOP. Operators understanding as indicated through interviews was that the former case definition was used for outbreak alert reporting and there was mixed response when asked how difficult this was to apply. Therefore, training should also be provided to system operators on how to apply the case definition using search terms for consistent reporting and feedback on the ease of this process sought.

It was suggested that a flow chart could be developed to guide new operators on how to apply the case definition. This could outline what questions to consider and how to decide what outbreaks to report in different contexts. For example, during the influenza season when there are numerous reports or if there is limited information on an outbreak. This would have added benefits of maintaining the quality and consistency of reporting and ease the burden on long term staff. Discussing how this process was applied in practice or how selected outbreaks were reported based on the case definition during the weekly video conference could be a way to continuously build capacity within the team and improve the specificity of the system to the case definition for reporting relevant outbreaks.

Coordination and running the system

Overall, no major difficulties with coordinating and operating the system were reported, however, two challenges were raised. Relying on a revolving flow of students to operate the system required continual coordination to ensure that roles were understood, processes adhered to and rosters updated. Ensuring that outbreak reporting occurred over the weekend and during university holidays was another challenge due to reliance on manual processes of human operators.

Training

A background in public health and infectious disease epidemiology is useful but not critical to be able to operate Epi-watch as working on Epi-watch, receiving feedback at the weekly video conference and writing watching briefs provides training and education to operators. For each component of Epi-watch, training is provided on a one-on-one basis by experienced operators and is predominantly learning on the job. The majority of operators found the training provided to be adequate.

3.6.2 Flexibility

Epi-watch can easily adapt to changing needs with little impact on time and personnel and no implications to funding. This is largely due to it being an event-based surveillance system, which are flexible in nature, being developed in-house and the underlying operating technology is simple. Any changes to the system require approval by the Director of ISER, which is a straight forward process.

Since operation, the following changes to the system have been undertaken:

- Search terms have been added, which requires updating the automated search algorithm. The impact on time and personnel is minimal and one-off, requiring each operator to update their own automated algorithms.
- Data sources have been added, which is a simple process involving system operators incorporating new sources into their daily scanning routine. There is a small impact on the time an individual spends on scanning for outbreaks when adding data sources, however, this was not able to be quantified.

3.6.3 Data quality

Recommendations – Data quality

3. Develop a data dictionary for the Epi-watch database to define the content, structure and format of the variables for which data is collected.
4. Automate fields within the database and create rules for data entry to reduce the number of errors associated with manual entry.
5. Identify a standardised way to categorise and report disease names and outbreak locations.

There are 11 data fields in the Epi-watch database, outlined in Table 3.

Table 3. Description of data fields in the Epi-watch database, 2018

Field name	Description	Category
ID	Unique ID number	Free text
Data entered	Name of data entry officer	Free text
Date reported	Date data was entered	Free text
Disease	Disease name	Free text
News item report date	Date that the outbreak was reported by the source	Free text
Place	Location of the outbreak by country and city if possible	Free text
News item headline	Description of the outbreak within a 30-character limit	Free text
Link	The URL link to the source	Free text
Any relevant comments to this outbreak	Additional comments that may be relevant to the outbreak	Free text
News Item Headline modified	Automatically creates an alert heading combining 'disease,' 'place,' and 'news item heading' variables	Automated formula
News item headline hyperlinked	Automatically assigns the URL link to news item headline	Automated formula

Completeness

Percentage of complete and missing fields for all variables in the database for the period 9 August 2016 to 30 April 2018 was calculated (Table 4). Data completeness for 10/11 variables was excellent, above 95% complete across all time periods.

Completeness for the 'any relevant comments to this outbreak' declined over time.

Reasons for missing data included:

- Operators forgetting to complete fields.
- Operators forgetting to drag cells down to automate fields with formulas.
- Errors in formulas.
- Addition of new data fields and not back-filling data. The 'disease' and 'news item report date' fields were added in 2016 and no back-filling was done.
- Not reporting the 'place' due to the nature of the report. For example, a report was on development of the Ebola vaccine and place was not stated.

- The data in the 'any relevant comments to this outbreak' field not being used and/or seen to add value.

Table 4. Data completeness of Epi-watch variables, 9 August 2016 to 30 April 2018 by date reported

Field name	2016 N=961		2017 N=3177		2018 N=682	
	n	%	n	%	n	%
ID	961	100	3177	100	682	100
Missing	0	0	0	0	0	0
Data entered	961	100	3177	100	682	100
Missing	0	0	0	0	0	0
Date reported	961	100	3177	100	682	100
Missing	0	0	0	0	0	0
Disease	930	97	3177	100	682	100
Missing	31	3	0	0	0	0
News item report date	930	97	3174	99.9	682	100
Missing	31	3	3	0.1	0	0
Place	960	99.9	3177	100	682	100
Missing	1	0.1	0	0	0	0
News item headline	961	100	3176	99.97	682	100
Missing	0	0	1	0.03	0	0
Link	961	100	3176	99.97	682	100
Missing	0	0	1	0.03	0	0
Any relevant comments to this outbreak	840	87	16	0.5	0	0
Missing	121	13	3161	99.5	682	100
News Item Headline modified	961	100	3176	99.97	682	100
Missing	0	0	1	0.03	0	0
News item headline hyperlinked	957	99.6	3164	99.6	682	100
Missing	4	0.4	13	0.4	0	0

Accuracy

Range and consistency checks to detect errors in the date fields ('date reported' and 'news item report date') were undertaken for the period 9 August 2016 to 30 April 2018.

Out of 4,820 records, 31 (0.6%) errors were identified in the 'date reported' field; seven in 2016, 12 in 2017 and 12 in 2018. Errors included incorrect year (e.g. 29/09/0201, 19/03/2028), month (e.g. 17/20/2019) and date format (e.g. 6//10/2016, 12/10.2016). Two errors were identified in the 'news item report date' field in 2017 due to incorrect date format (e.g. 27 Ju 2017). Errors in this field can result in alerts either not being reported on the outbreak alert page or reported on the wrong date.

Grammatical checks were undertaken for the 'disease,' 'place' and 'news item headline' fields for the period 1 to 31 December 2017. Of the 154 outbreaks reported during this period, 37 (24%) grammatical errors were identified; six in the 'disease' field, 3 in the 'place' and 29 in the 'news item headline' field. Errors included incorrect spelling, capitalisation, abbreviations, and not using plurals. These errors are reported on the Epi-watch webpage. The likely reason for the high frequency of errors in the 'news item headline' field could be due to the free text nature of the variable and 30-character limit. Consideration should be given as to whether this is a significant issue and whether it needs to be addressed given that these details are reported on the website. A possible solution could be through system automation, as relevant details can be pulled directly from the source, removing the need for manual entry and subsequent error. For the remaining fields, operators tended to use the autocomplete option in excel for frequently used words thus reducing the frequency of errors.

Consistency of disease and place fields

Consistency checks for disease and country names was undertaken for the period 9 August 2016 to 30 April 2018. There is inconsistency in reporting disease names as outlined in Table 5, with multiple names used for the same disease. Fewer inconsistencies in reporting country names were identified, the United States of America was reported four ways: US; U.S.; United States and USA. There is no standardised way to categorise diseases and country names, which are most likely determined based on how they are reported in the news source.

For the 'place' field, for the period 1 October to 31 December 2018, country level names were reported for 419/426 (98%) outbreaks and state/city/town/province level details reported for 210/426 (49%) outbreaks. Six instances of non-geographical locations were reported within the field (Table 6). Factors affecting low level of reporting state/city/town/province level details may include time constraints for data entry, absence of these details within the news item and unclear reporting requirements.

During the Epi-watch stakeholder workshop, participants raised the need to be able to search and filter alerts by different parameters such as disease type and location. Additionally, a future goal for Epi-watch is to be able to display disease trends over time and by location. To support this function, an agreed upon format and categorisation of disease name, type and location will need to be developed and implemented.

Table 5. Different classification of disease names in Epi-watch database for selected diseases, 9 August 2016 to 30 April 2018

Avian influenza	Unknown	Influenza	Escherichia coli	Legionnaires' disease	Diarrhoea
Avian Influenza (HPAI)	Mysterious disease	Flu	E Coli	Legionnaires	Acute Watery Diarrhoea
Avian Flu	Mysterious illness	Flu death	E coli	Legionnaires	Acute watery diarrhoea disease
Avian infleunza	Mystery Disease	Flu deaths	E coli 0157	Legionnaires disease	Diarrhea
Avian Influenza	Mystery illness	Flu-like	E Colli	Legionella	Diarrhoea
Avian influenza (birds)	Mystery illness causing fatalities (in dogs)	Infleunza A	E. coli	Legionella	Diarrhoea bug
Avian influenza (H5)	Mystery illness with fever causing fatalities	Influenza	E. Coli (MCR-1)	Legionellosis	Diarrhoea outbreak
Avian Influenza (H5N6)	Not yet classified	Influenza	E. coli 0157	Legionellosis	Diarrhoeal illness
Avian influenza (H7)	Unclassified virus (dengue-like)	Influenza (swine)	E. Coli EHEC	Legionnaire	Fatal, diarrhoea
Avian Influenza H5	Undiagnosed Acute Respiratory Illness	Influenza A	E. Coli O157	Legionnaire's	
Avian Influenza -HPAI H5N8	Undiagnosed bleeding disorder	Influenza A - H3 strain	E.coli	Legionnaires' disease	
Avian Influenza-Pathogenic H5N8	Undiagnosed Death	Influenza B	E.coli (EHEC)	Legionnaire's disease	
Bird flu	Undiagnosed deaths (animals)	Influenza D	E.coli (O157)	Legionnaires outbreak	
Bird flu (zoo birds)	Undiagnosed disease	Influenza epidemic	E.coli 0121	Legionnaires'	
H5	Undiagnosed illness	Influenza H3	E.coli 0157		
H5 (birds)	Undiagnosed illness (after consumption of pig)	Influenza H3N2	E.COLI EHEC		

H5N1	Undiagnosed illness (fatal)	Influenza hospitalisations	E.coli EHEC O157
H5N1 (in pigs)	Undiagnosed illness (horses)	Influenza vaccination	E.coli O103
H5N1 avian influenza	Undiagnosed illness in household cluster	Influenza-like illness	E.coli O157:H7 (STEC O157:H7)
H5N2	Undiagnosed illness -updates	Influenza-like illness (500 students)	E.coli outbreak
H5N2 (birds)	Undiagnosed mass mortalities	Infuenza	Ecoli
H5N3 (LPAI)	Undiagnosed mass mortalities (animals)	H1N1	E-coli
H5N5	Undiagnosed mortality cluster	H1N1	ECOLI O157
H5N6	Undiagnosed rash	H1N1 death	
H5N6 (birds)	Undiagnosed Urticaria Reaction	H1N1 influenza	
H5N6 (human)	Undiagnosed viral disease	H1N1pdm09	
H5N6+H5N8	Unexplained Cluster of Death	H1N1pdn09	
H5N8	Unidentified fatal illness	H2N3	
H5N8 (birds)	Unidentified illness	H3N2	
H5N8 (in birds)	Unidentified illness	H3N2 (pigs)	
H5N8 (wild birds)	Unknow disease	H3N2 zoonotic	
H793 LPAI influenza	Unknown	H3N2v	
H7N2	Unknown (Chikungunya-like)		
H7N2 (cats)	Unknown (dialysis patients)		
H7N4	Unknown bacteria		
H7N9	Unknown disease		

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H9N2	Unknown fatalities
H9N2 (fatal case)	Unknown illness
HPAI	Unknown infection
HPAI H1N5	Unknown mass mortalities (birds)
HPAI H5N1	Unknown mass mortalities (dolphins)
HPAI H5N6	Unknown viral infection
HPAI H5N8	
HPAI H7	
HPAI H9N2	

Table 6. Non-geographical locations reported in 'place' field, Epi-watch database, 1 October to 31 December 2017

Non-geographical locations
Fowler High School in Onondaga County, US
Lantian creative kindergarden & day nursery, Sceneway, Hong Kong
Leicester Royal Infirmary, England
Cannan Kindergarden & Nursery, Huijing City, Hong Kong
Dachang high school of Nanjing, Nanjing city, Jiangsu province, China
North Carolina college, US
A children's hospital, Urumqi city, Xinjiang province, China

3.6.4 Acceptability

Recommendations – Acceptability

6. Identification, clarification and documentation of Epi-watch stakeholders is needed for system operators to inform future development and uptake of the system.
7. Develop a marketing and communication strategy to promote external use of Epi-watch.
8. Develop and implement a process to monitor external use of Epi-watch.

System Operators

Overall, there was a high level of acceptance of Epi-watch amongst system operators, the majority agreed that there was added value in the system.

Some interviewees reported that the value of the system was unclear to them, and they did not know who the target stakeholders were. However, it was noted that once fully developed it would be a resource for the region and that it was useful as a way of being aware of global outbreaks.

External stakeholders

Epi-watch has been promoted over time at a number of forums such as meetings and conferences, however, it has not been extensively publicised in a targeted way to stakeholders. Current acceptability and uptake of Epi-watch amongst external stakeholders appears to be mixed as indicated by use of all three components of the system.

Results from the Epi-watch stakeholder survey conducted from June to October 2017 indicated limited use of the system amongst these target stakeholders, with only five of the 68 (7%) respondents reporting that they had previously viewed Epi-watch. This result is not unexpected given the system is still in development and has not been promoted externally.

The number of views to the Epi-watch outbreak alert and watching brief webpages are shown in Figure 2. Results indicate that stakeholders are accessing the outbreak alert page, and to a lesser degree the watching briefs. It should be noted that a proportion of these views are attributed to the system operators who also access the pages.

The large increase in views to both the outbreak alert and watching brief pages in August to October 2017 is likely attributed to the timing of the stakeholder survey. Since then, visits to the watching brief webpage have increased compared to before implementation of the survey, while there appears to be slightly fewer visits to the outbreak alert page.

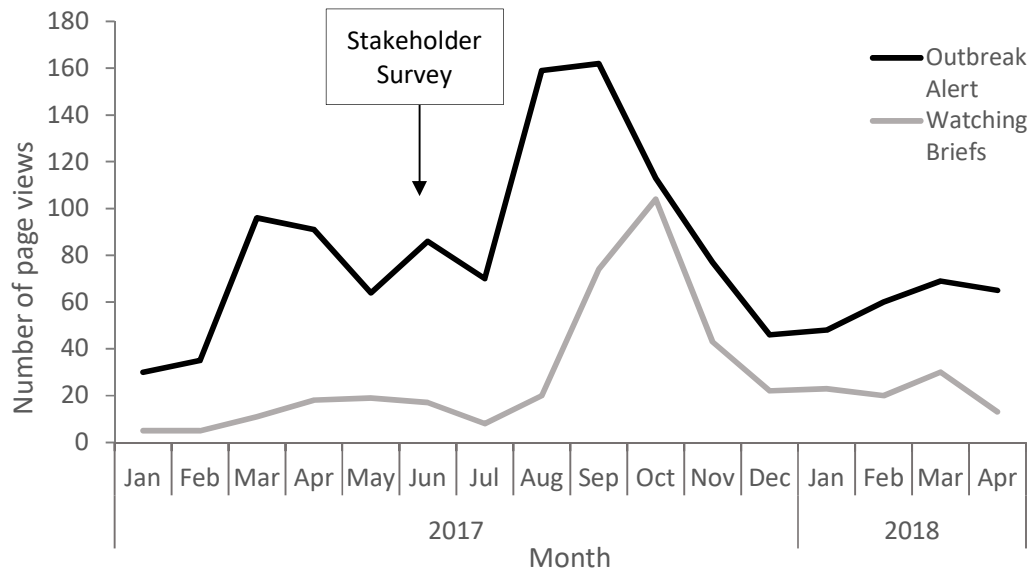


Figure 2. Number of page views on the Epi-watch Outbreak Alert and Watching Brief webpages, 1 January 2017 to 30 April 2018

Feedback from the Epi-watch stakeholder workshop conducted on 9 October 2017, indicated that participants were interested in all three components of Epi-watch. The watching briefs were seen as a useful resource to access. There was particular interest in participating in the weekly video conferences as a way of being aware of outbreaks and to have access to a panel of experts (see section 1.6.8) to discuss and provide support to stakeholders to inform outbreak response. However, since the workshop no requests from attendees to join the video conference or to develop a watching brief have been received.

Approximately 26 people are currently included on the weekly videoconference invitation list which includes ISER specific investigators, research assistants, students, interns and external stakeholders. All ISER research assistants and students attend on a regular basis, while attendance from external stakeholders and ISER investigators can range from no attendance up to four at a time.

There is no process to monitor use of Epi-watch and receive feedback from stakeholders. Once the system is promoted for external use, implementation of a simple monitoring and evaluation process will be important to inform future improvements, system changes and usefulness. One way of doing this could be to monitor visits to the outbreak alert and watching brief webpages on a regular basis.

Factors influencing acceptability

A number of factors influenced the level of acceptability, including:

- The perceived focus on reporting serious, persistent and unusual outbreaks that are unique to Epi-watch, separating it from other global event-based surveillance systems.
- Operator's belief that stakeholders would find value in the services provided by Epi-watch.
- The perceived potential value in the system as a global outbreak and early warning surveillance system for the region.
- As a learning opportunity for operators.
- Limited external publicisation of Epi-watch contributing to lack of awareness and use of the system amongst external stakeholders.

3.6.5 Sensitivity

There is high level of sensitivity in the Epi-watch outbreak alert. Sensitivity of Epi-watch was calculated using two approaches, detection of MERs-CoV for the period 1 May 2017 to 31 October 2017 and detection of 20 outbreaks reported by official sources during 2017.

For the period 1 May 2017 to 31 October 2017 there were:

- 167 human cases of MERs-CoV reported to the WHO by date of notification.
- 38 reports (of multiple cases) of MERs-CoV reported in Epi-watch.

Of the 38 reports in Epi-watch:

- Seven reports were duplicates and excluded from the analysis.
- Five reports did not have working links and were excluded from the analysis.
- Two reports did not have sufficient information to match cases to the WHO database and were excluded from the analysis.

This left 24 reports of 222 cases of MERs-CoV reported in Epi-watch. Of the 222 cases, 77 were duplicate cases, leaving 145 unique cases.

Of the 167 cases reported by WHO, 35 (21%) were not reported in Epi-watch. Of the 145 cases in Epi-watch, 14 (9.7%) were not reported by WHO. Of these, one was a suspected imported case into Hong Kong, one was a report of five suspected imported cases into Thailand returning from the Hajj pilgrimage and the remaining cases were reported from Saudi Arabia.

The sensitivity of Epi-watch in reporting MERs-CoV cases reported by the WHO was 80.6%.

A list of the outbreaks selected during 2017 to assess the sensitivity of Epi-watch detecting outbreaks is in Appendix 3.E. Epi-watch detected all 20 of these outbreaks, resulting in a sensitivity of 100%.

Unfortunately, it is problematic to compare sensitivity to other systems, as different methods are used between them and not all methods are publicly available. This highlights a potential research opportunity to develop an evaluation framework for such systems.

3.6.6 Timeliness

Recommendations - Timeliness

9. Automate the outbreak scanning process.
10. Develop timeliness indicators to monitor and assess system performance.

Outbreak Alert

Frequency of outbreak scanning can impact on timeliness. This can be measured based on the number of times data sources are scanned per day and the time from entering an outbreak into the database and subsequent reporting by the system (Table 2).

The system is meeting its timeliness target for frequency of reporting. All system operators reported that they conducted outbreak scanning once a day in the mornings, with some scanning more than once a day on some occasions. While not

documented in the SOP, operators are required to conduct scanning once per day. Once entered into the spreadsheet, outbreaks are automatically uploaded onto the website every five minutes. It may be necessary to review these indicators following automation of the system, as this will change its operational capacity i.e. automated scanning can occur as frequently as required by scheduling the data collection software, rather than relying on manual collection.

Of the 20 outbreaks reported during 2017 selected for analysis (Appendix 3.E), 50% (10/20) were first reported in Epi watch compared to the first official report either by country level governments or the WHO on their webpage (Table 7). Outbreaks were reported in Epi-watch on average 27 days earlier compared to official reports, which reported outbreaks on average four days earlier than Epi-watch .

Table 7. Comparison of timeliness of reporting outbreaks between Epi-watch and official reporting, 2017

2017 outbreaks	Number of Outbreaks (N=20)		Average (days)	Median (days)	Range (days)
	n	%			
Reported by Epi-watch first	10	50	26.8	11.5	1 to 114
Reported by official sources first	10	50	3.5	2.5	1 to 15

The difference in days from the date the outbreak was reported on Epi-watch and the actual news item publication date for the period 1 April 2017 to 31 December 2017 is shown in Table 8. The median difference was one day, with a range of zero to 58 days. Thirty-five percent of outbreaks were reported on Epi-watch on the same day as the news item was published, while 46% of outbreaks were reported in Epi-watch between one and two days after they were reported in the media.

Table 8. Delay in days between the date reported on Epi-watch and the original news item date, 1 April 2017 to 31 December 2017

Delay in reporting for Epi-Watch compared to news item report date	Number of reports	
	n	%
No difference	788	35
One day	725	32
Two days	316	14
Three days	221	10
Four days	117	5
Five days	41	2
Six days and over	55	2
Total	2263	100

Specific timeliness indicators to measure system performance against have not been developed for the outbreak alert. However, it's stated objective is to be a 'rapid intelligence service'. Instead, timeliness indicators have been developed based on stated goals of event-based surveillance, which is the timely and rapid detection and dissemination of public health events. (13) This can be assessed based on system detection of events prior to official reporting and dissemination of information at the time it is reported. These indicators have been used to assess timeliness for other similar systems. (15, 37, 41) Using these measures, the outbreak alert does not appear to be meeting its objective of a rapid intelligence service as indicated by 50% of outbreaks being reported after official sources (Table 7) and 65% of outbreaks reported on Epi-watch one day or later after media publication (Table 8).

Factors impacting on timeliness of the outbreak alert included:

- The manual process of scanning sources only once a day in the mornings could lead to delays in reporting outbreaks published in the afternoon, as they will not be identified by Epi-watch until the following day.
- Instances where scanning does not occur, such as on the weekend and when operators are unwell. This is closely related to the stability of Epi-watch and is discussed in section 3.6.7 below.

Automation of outbreak searching will lead to improved timeliness by enabling scanning and uploading of reports to the website to occur as often as is required. Timeliness may be impacted if a human moderator is required to approve reports prior to uploading onto the website.

3.6.7 Stability

Recommendations – Stability

11. The following system processes and procedures should be developed and documented in the SOP:
 - 11.1 Develop a process to maintain daily outbreak reporting when operators are not available.
 - 11.2 Establish Epi-watch specific social media accounts for whole of system operator use.
 - 11.3 Develop a process to monitor whether daily outbreak scanning and reporting is being done.
12. Automate the outbreak scanning process.

Indicators for stability can be assessed against the stated objective of the outbreak alert, which is ‘to provide daily outbreak alerts’ and measured by an adequate workforce, daily outbreak reporting and consistent review of data sources.

There are adequate human resources available to operate and maintain the system due to the availability of funding through ISER to hire staff and access to students and interns through UNSW. However, inefficiencies in how the system is run, was raised by some operators during interviews, particularly in relation to the manual scanning process. In addition, funding availability attached to ISER is due to end in 2020, which could impact on the future sustainability of Epi-watch. Identifying ways to reduce the need for human resources such as automation and integration or collaboration with other institutions will assist to reduce reliance on funding sources required to operate the system.

Outbreak alert

From 1 April 2017, a process was introduced requiring system operators to scan and report outbreaks from Monday to Sunday. Prior to this, scanning was occurring from Monday to Friday, weekend outbreaks were caught up on the Monday. The outbreak alert does not appear to be meeting its objective to provide daily outbreak alerts, as discussed below. Dedicating an operator to undertake weekly or fortnightly checks for gaps in reporting and emailing a report to the team of the proportion of days missed, may assist with embedding the scanning process into daily routines, especially given the transient nature of the team.

For the 12-month period from 1 April 2017 to 30 April 2018, there were 151 (38%) days on which scanning and uploading outbreaks on Epi-watch was not undertaken, or there were no relevant outbreaks to report (Table 9). There are instances where there are no outbreaks to report, which was reported to occur approximately once a week, indicating that scanning days were missed. Factors impacting on outbreak scanning are discussed below.

Table 9. Number and proportion of days that news items were and were not reported on Epi-watch, 1 April 2017 to 30 April 2018

News items reported on Epi-watch	Number of days	
	n	%
Yes	244	62
No	151	38
Total	395	100

While the SOP outlines that scanning occurs seven days a week, from Monday to Sunday, in practice this does not always happen as indicated in Table 10, where the majority of outbreaks, 47% (71/151) were not reported over the weekend.

Table 10. Number and proportion of days by day that news items were and were not reported on Epi-watch, 1 April 2017 to 30 April 2018

Day	Not reported		Reported	
	n	%	n	%
Monday	10	7	47	19
Tuesday	17	11	39	16
Wednesday	21	14	35	14
Thursday	21	14	35	14
Friday	11	7	45	18
Saturday	36	24	21	9
Sunday	35	23	22	9
Total	151	100	244	100

The SOP outlines nine data sources that are required to be scanned. At the time of interview, five of these sources were being used by operators. These were ProMED-mail, Outbreak News Today, Center for Infectious Disease Research and Policy (CIDRAP), CDC Outbreaks and WHO Outbreaks. The sources that were not used were Global Incident Map, FluTrackers, H5N1 Blog by Crawford Kilian and Facebook and Twitter, which could result in missed reporting of relevant outbreaks. This indicates that there are inconsistencies with using required data sources amongst operators, potentially impacting on the stability and sensitivity of Epi-watch. Some operators reported using other sources that they found valuable, including WeChat, the Hungarian National Association of Radio Distress-Signalling and Infocommunications (RSOE) Emergency and Disaster Information Service (EDIS) and local news feeds as they felt that these were useful.

Factors impacting on the stability of Epi-watch included:

- Not updating the scanning roster following changes in staff, resulting in missed days and sources not being reviewed.
- No process to cover operators when they are unable to scan on allocated days, for example due to competing demands, being on leave (either planned or unplanned) or needing to attend university classes. When this occurs, operators will usually catch up on missed days when they return to the office.

- The reliance on short-term students and interns resulting in workforce fluctuations has some impact on the stability of the system as a result of needing to ensure that new operators understand and can conduct their role, which is dependent on the availability of experienced operators to assist with this and clearly documented roles and processes in a SOP.
- Limited human resources during university holiday periods and difficulties getting operators to dedicate their time to scan during these periods and on weekends.
- Operators forgetting to scan on allocated days.
- Operators not having personal social media accounts to access sources through Facebook and Twitter.
- Operators using selected data sources as they found that the majority of outbreaks were reported from fewer sources.

Challenges were raised with coordinating and running the system due to reliance on a revolving workforce (Section 1.6.1), which were also highlighted as affecting system stability (above). It may be useful to develop a timeline to assist with resource planning documenting when students arrive and leave to forecast resource allocation and inform when the roster needs to be updated.

3.6.8 Usefulness

Recommendations - Usefulness

13. Develop indicators to measure system usefulness.
14. Incorporate use of non-English search terms and data sources for outbreak scanning.
15. Reassess the objectives and focus of Epi-watch in terms of who the stakeholders are and whether the system needs to be more targeted towards the Asia-Pacific region with more regionally focused reporting.

Specific system indicators have not been developed to measure the usefulness of Epi-watch. Instead, those outlined in the CDC *Updated guidelines for evaluating public health surveillance systems* (1) were used to assess this attribute, as described in Table 2.

It is difficult to identify situations where Epi-watch has been used to identify, prevent or control an outbreak as the system is not yet being widely used and there is no method to collect this information. However, the Director of ISER believes that while feedback has not been received, circulation of watching briefs to senior officials in public health departments has been useful and provided more in-depth analysis of outbreaks to inform action. Through the weekly video conferences, Epi-watch has also been used to stimulate research within ISER, (for example investigation into influenza A(H1N1) deaths in India) and to develop watching briefs.

From the perspective of system operators, the majority found Epi-watch useful to keep up to date with outbreaks, as a way to learn about different diseases and outbreak response, for future research and career development.

Feedback on the potential usefulness of Epi-watch was received from participants during the stakeholder workshop and was positive. The elements of Epi-watch found useful included access to watching briefs to increase awareness of outbreaks in the region and as a readily accessible resource for those working on the frontline, such as general practitioners.

Some participants also highlighted the usefulness of access to experts through the weekly video conferences as a way to discuss and share information about outbreaks. The video conference was seen by both the Director of ISER and stakeholders as a way to keep up to date on current global outbreaks, in particular, for those who are time poor.

As part of the stakeholder survey, respondents were asked to indicate the components of Epi-watch they would find useful, with multiple responses allowed. Sixty-four of 91 (70%) survey participants responded to this question. Of the 64 responses, 91% reported that they would find the outbreak alert useful, 63% the watching briefs and 42% the weekly video conference (Table 11).

Table 11. Stakeholder feedback on usefulness of Epi-watch components by country, 2017

Response	Australia		PICTs		Indonesia/ Malaysia		Total	
	n	%	n	%	n	%	n	%
Outbreak alert	29	50	19	33	10	17	58	91
Watching brief	18	45	13	33	9	23	40	63
Weekly video conference	8	30	14	52	5	19	27	42
None	5	83	1	17	0	0	6	9

The strengths of Epi-watch as highlighted by system operators during interviews:

- The interactive nature and ability to be responsive to stakeholder needs through the weekly video conferences and watching briefs.
- Academic liberty to report and comment on outbreaks without constraint.
- Ability to undertake continuous research on global event-based surveillance systems.
- The potential benefit of incorporating different languages to identify outbreaks. Three research projects have been undertaken by ISER interns to identify early signals of infectious disease outbreaks using key search terms in French and the Malay and Indonesian language. These projects identified that selected global event-based surveillance systems (ProMED-mail, HealthMap and Epi-watch) were not detecting outbreaks in these languages, highlighting limitations of using English only search terms and data sources.
- Availability of comprehensive reviews and analyses of outbreaks through watching briefs.
- The narrow focus on outbreaks that are serious, persistent and unusual, and a focus on epidemic and emerging infectious diseases. More focused compared to other systems that are much broader.
- Involvement of human moderators to determine what should be reported, which makes the information more relevant.

The weaknesses identified by operators included:

- Intensive human resource requirements to operate a predominantly manual system and the need to find a sustainable model.
- The direction for development, purpose of, and the extent to which, the system is being used is unclear, and both the user-base and plans for future uptake are not well defined.
- The subjective and selective nature of reporting outbreaks, partially related to the manual operating processes of the system, but also due to lack of guidelines and systematic processes, means that there is some inconsistency across operators in how outbreaks are selected for reporting.
- Not having in house technical skills to develop the system further.

3.7 Discussion

I evaluated Epi-watch against the CDC *Updated guidelines for evaluating public health surveillance systems*. (1) Of the 10 attributes by which to evaluate surveillance systems, I was able to use eight. This was done using a combination of a desktop review, literature review, stakeholder survey and workshop, interviews with system operators and an analysis of the Epi-watch database.

The evaluation demonstrated that the Epi-watch system is made up of simple processes, a clear flow of data and flat hierarchical reporting structure. The system was found to be very flexible, with search terms and data sources easily added and amended. Epi-watch was also shown to be highly sensitive, reporting on a large proportion of outbreaks and high-profile disease events such as MERS-CoV that were later confirmed through official sources such as the WHO.

Whilst the operational processes were simple, the evaluation found that they were lacking in detail and formal documentation, requiring extensive operator experience.

This included, for example, determining what signals to report on Epi-watch.

Furthermore, some issues with timeliness were identified indicating that the outbreak alert is not meeting its stated objective as 'a rapid intelligence service to provide daily

outbreak alerts'. Compared to official reporting sources, Epi-watch reported 50% of selected outbreaks during 2017 earlier, whereas the other 50% were reported after official sources. Compared to other automated event-based systems, such as HealthMap that scan continuously throughout the day, (19, 42) Epi-watch only scans at one point in time each day. These issues with timeliness are very much related to the stability of the system, particularly in regard to the unreliability of scanning for outbreaks on a daily basis. When operators are away through sickness, weekends, holidays and so forth, scanning is delayed or even missed for certain sources. In addition, even when operators are available, not all data sources are scanned at a consistent frequency. Finally, the accuracy and consistency of the database needs to be improved. The data lacks validation and verification and there is no data dictionary. A combination of user error and uncertainty in data entry requirements has led to these data quality issues.

As Epi-watch is still in development and has had limited external exposure, it is too early to evaluate it in terms of its acceptability and usefulness out in the field, however, from the available data there appears to be value in the system for system operators and potential value for external stakeholders.

Overall, Epi-watch is meeting its purpose to monitor and provide critical analysis of global outbreaks and epidemics of public health significance for use by policy makers, government and other stakeholders through outbreak alerts, watching briefs and weekly video conferences. However, improvements can be made as outlined in detail in each of the attributes that were assessed. In summary, these specific recommendations can be grouped into four high level areas of further development for the Epi-watch system:

1. Strengthen system processes and documentation

As Epi-watch relies on a revolving base of human resources, strong documentation and clear processes will ensure consistent operation of the system, improving on all attributes, but especially noticeable will be the improvements to the stability, simplicity and data quality of Epi-watch.

2. Automation

By automating elements of the surveillance process, Epi-watch can be made more cost efficient and stable by removing some of the repetitive error-prone human functions. In terms of making use of technological innovations, this also puts it on par with some of the more well-established systems. This will make Epi-watch more sustainable in the long term, with reduced reliance on funding for human operators. Automation of the data collection processes will also address and improve issues associated with the timeliness and data quality of the system.

3. Improved resource management

A process for allocating workloads to operators and re-allocating tasks in the event of operator absence will ensure improved system stability, which will in turn improve timeliness. Such a process can be automated once defined. Implementing continuous quality improvement practices can also assist to improve system processes and outcomes. Additionally, incorporating staff turnover and associated training needs into these processes is important to maintain stability of Epi-watch over time, due to its reliance on a revolving student base.

4. System development and direction

Given feedback received from stakeholders through the workshop and survey, the future development and direction of the system should be revisited to ensure it is well defined, documented, sustainable and perhaps updated to ensure it is in line with stakeholder needs and regional focus. The operator interviews indicated that this direction needs to be articulated to those working on the system so that there is a mutual understanding amongst the full team, so operators have a good understanding of what they are working towards, for example, knowing who the stakeholders are and why their work is important and meaningful. Development of clear and measurable system indicators would also be beneficial to assess system performance and success against. These would enable future monitoring and evaluation activities for continued system improvement.

3.8 References

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3.9 Appendices

Appendix 3.A: Epi-watch evaluation interview guide

Questionnaire for Epi-watch evaluation administrator interviews

This interview guide is part of the evaluation of Epi-watch. The following questions focus on understanding the purpose and objectives of Epi-watch as well as key system attributes such as how simple, flexible, timely, stable and useful the system is. The information you provide will be used to inform the evaluation and how Epi-watch can be improved.

This interview will take approximately 30 minutes to an hour to complete. Some questions may not be relevant to you, if this is the case, you can just say pass or not relevant.

Date of interview: _____

Name: _____

Role, purpose and objectives

What is your job title?

What is your role in Epi-watch?

Approximately, how much of your time (hrs) is spent on Epi-watch each week?

What is your understanding of the reason behind the development of Epi-watch?

What is your understanding of the purpose of Epi-watch and each of its components?

- a. Outbreak alert
- b. Watching briefs
- c. Weekly epi-digest video conference

What is your understanding of the objectives of Epi-watch and each of its components? Do you feel Epi-watch is meeting these objectives?

- a. Outbreak alert
- b. Watching briefs
- c. Weekly epi-digest video conference

What is your understanding of what Epi-watch will look like when fully developed?

Is there a timeframe for completion and what is this?

What is your understanding of the intention for Epi-watch post ISER funding?

Simplicity

What data sources do you use for outbreak scanning

- ☐ Google News search terms
- ☐ ProMED-mail
- ☐ HealthMap
- ☐ Outbreak news today
- ☐ CIDRAP
- ☐ CDC outbreaks
- ☐ WHO outbreaks
- ☐ Global Incident Map
- ☐ Flu trackers
- ☐ H5N1 (blog by Crawford Kilian)
- ☐ Facebook
- ☐ Twitter
- ☐ Other: specify _____

How do you find the process for scanning and reporting outbreaks in terms of difficulty and complexity?

The inclusion criteria for reporting outbreaks are: *Outbreaks will be included and reported in Epi-watch if they are serious, persistent, have unusual aspects or high case fatality rates.*

Do you experience any difficulties in applying these criteria when reporting outbreaks?

How do you find the process for developing Watching Briefs in terms of difficulty and complexity?

How do you find the process for developing the weekly Epi-watch videoconference in terms of difficulty and complexity?

What training did you receive to undertake your role in Epi-watch and did you feel this was adequate?

Flexibility

Has the Epi-watch outbreak alert had to respond to changes in:

- search terms
- data sources
- other?

If yes, how did the system respond in terms of impact on time, personnel and/or funding?

Data Completeness

Do you have any difficulties with using the Epi-watch database? If yes, what are these

Do you think that the Epi-watch database should include other variables e.g. data source, location breakdown, outbreak type? Why/why not?

Acceptability

In your opinion, do you think there is added value in Epi-watch? Why/why not?

Timeliness

How many times do you scan for outbreaks each day?

- ☐ once a day
☐ twice a day
☐ three times per day
☐ Other (specify_____)

At what time during the day do you scan and report outbreaks?

Resources

On average, how much time do you spend scanning and reporting outbreaks each day?

On average, how long does it take you to develop a Watching Brief?

On average, how long does it take you to develop the weekly epi-digest videoconference?

Do you believe that there are adequate human resources to operate and maintain Epi-watch?

Stability

Have there been times where you have not been able to scan and report outbreaks?

If yes, why and what happened?

Are you aware of instances when the Epi-watch website was unavailable? What happened?

Are there any issues with coordinating and running Epi-watch?

Usefulness

Are you aware of any instances where Epi-watch has been used for public health action? If yes, in what way?

Is Epi-watch useful for you? If yes, in what way?

In your opinion, what are the main strengths of Epi-watch?

In your opinion, what are some of the weaknesses?

From the perspective of the end user, can you think of any improvements that could be made to the user interface in terms of accessibility and usefulness?

Would you like to provide any other feedback in relation to Epi-watch?

Appendix 3.B: Epi-watch Standard Operating Procedure



NHMRC Centre for Research Excellence, Integrated Systems for Epidemic Response (ISER):

The NHMRC Centre for Research Excellence, Integrated Systems for Epidemic Response (ISER) conducts applied systems research, enhance collaboration and build capacity in health systems research for epidemic control. It brings together experts in field epidemiology and epidemic response, military experts, international law and risk science experts, and government and non-government agencies involved in epidemic response.

EpiWATCH:

Vision: An observatory within ISER which monitors global epidemics and provides critical analysis of outbreaks of public health significance through openly available sources for use by policy makers, government and other stakeholders. EpiWATCH consists of three key pillars:

1. **Outbreak Alerts:** Rapid intelligence service providing outbreak alerts from publicly available sources
2. **Watching Briefs:** Critical analyses prepared on outbreaks that are serious, persistent, have unusual characteristics or high case fatality rates.
3. **Digest:** A regular presentation/newsletter available to inform policy makers, government and other stakeholders.

EpiWATCH Procedure:

The foundation supporting these three pillars is our team of post-doctoral researchers, students, interns who form the EpiWATCH Team and Administrators. The following search strategy will be used by the EpiWATCH team and administrators to identify outbreaks:

The EpiWATCH team will:

1. Monitor disease outbreak sources for outbreak alerts and updates
2. Upload details to the shared database
3. Attend weekly EpiWATCH meetings in School of Public health and Community Medicine
4. Present updates on selected infectious diseases outbreaks during EpiWATCH meetings
5. Prepare Watching Briefs on outbreaks of significance
6. Assist with writing journal papers and other publications

Outbreak inclusion criteria: Outbreaks will be included and reported in EpiWATCH if they are serious, persistent, have unusual aspects or high case fatality rates.

The EpiWATCH teams is divided into two teams of three members, alternating between teams every day following the current fortnightly schedule:

MON	TUES	WED	THURS	FRI	SAT	SUN
Team 1	Team 2	Team 1	Team 2	Team 1	Team 2	Team 1
MON	TUES	WED	THURS	FRI	SAT	SUN
Team 2	Team 1	Team 2	Team 1	Team 2	Team 1	Team 2

EpiWATCH administrator will:

1. Liaise with the EpiWATCH team and receive outbreak alerts from staff
2. Review outbreaks weekly (usually every Monday) in the [database](#) and EpiWatch [website](#)
3. Monitor trends in notifications and keep track of updates to analyse epidemic patterns and provide critical analysis
4. Review EpiWATCH Watching Briefs and post them on [website](#)
5. Prepare agendas for EpiWATCH meetings
6. Coordinate with other stakeholders & partners

Search strategy

Strategy 1: Google News

- Search daily on google news or set up daily alerts including the following search terms:

General Search Term	Specific Search Term
Outbreak	Zika
Infection	MERS
Fever	Salmonella
Virus	Legionnaire
Epidemic	Measles
Infectious	Category A Agents:
Illness	<i>Anthrax</i>
Bacteria	<i>Botulism</i>
Emerging	<i>Plague</i>
Unknown virus	<i>Smallpox and other related pox viruses</i>
Myster(ious)y disease	<i>Tularemia</i>
	<i>Junin Fever</i>
	<i>Machupo Fever</i>
	<i>Guanarito Fever</i>
	<i>Chapare Fever</i>
	<i>Lassa Fever</i>
	<i>Lujo Fever</i>
	<i>Hantavirus</i>
	<i>Rift Valley Fever</i>
	<i>Crimean Congo Hemorrhagic Fever</i>
	<i>Dengue</i>
	<i>Ebola</i>
	<i>Marburg</i>

Strategy 2: Websites

Websites for outbreak alerts (Must see)

- Promed – <http://www.promedmail.org/>
- Outbreak news today – <http://outbreaknewstoday.com/>
- Center for Infectious Disease Research and Policy (CIDRAP) – <http://www.cidrap.umn.edu/>
- CDC outbreaks (Local and international) – <http://www.cdc.gov/outbreaks/>
- WHO – Outbreaks – <http://www.who.int/csr/disease/en/>
- Global incident map – <http://outbreaks.globalincidentmap.com/>
- Flu tracker – <https://flutrackers.com/forum/>
- H5N1 (Blog by Crawford Kilian) <http://crofsblogs.typepad.com/h5n1/>

Websites for additional information (Optional)

- Emerging Viruses, Virus Discovery and Virus Characterization (Blog by Ian M Mackay) <http://www.scoop.int/t/virus-discovery-and-characterisation>
- Training Programs in Epidemiology and Public Health Interventions Network (TEPHINET) – <http://www.tephinet.org/>
- Health map – <http://www.healthmap.org/en/>
- Health map daily diseases – <http://www.healthmap.org/diseasedaily/category/outbreak>
- Disease Outbreak News (DONs) – <http://www.who.int/csr/don/en/>
- MedScape Infectious Diseases – <http://www.medscape.com/infectiousdiseases>
- WHO – The Weekly Epidemiological Record (WER) – <http://www.who.int/wer/en/>
- Nosocomial outbreak database – <http://www.outbreak-database.com/Home.aspx>
- WHO Dengue net – <http://apps.who.int/globalatlas/default.asp>
- Australia notifiable disease data – <http://www9.health.gov.au/cda/source/cda-index.cfm>
- NSW Infectious disease alerts - <http://www.health.nsw.gov.au/infectious/alerts/Pages/default.aspx>

Strategy 3: Social media

- Create a personal account on Facebook and Twitter
- Follow key organisations, researchers, academics and bloggers
- Use key word search to find new outbreaks or update on existing outbreaks

For any query, please contact;

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EpiWATCH website: <https://sphcm.med.unsw.edu.au/centres-units/centre-research-excellence-epidemic-response/EpiWATCH>

Appendix 3.C: Watching Brief template**Disease – Month – Year**

Watching brief	
Date of report	
Disease	
Origin	
Suspected Source	
Date of outbreak beginning	
Date outbreak declared over	
Affected countries & regions	
Number of cases	
Clinical features	
Mode of transmission	
Demographics of cases	
Case fatality rate	
Complications	
Available prevention	
Available treatment	
Comparison with past outbreaks	
Unusual features	
Critical analysis	
Key questions	
References	

Appendix 3.D: List of watching briefs completed, 2016 – 2017

Outbreak	Date
Plague in Madagascar	December 2017
Marburg virus disease	December 2017
Monkeypox in Nigeria	November 2017
Influenza Seasonal 2017 (updated)	November 2017
Hepatitis A 2017	October 2017
MERS	October 2017
Influenza H7N9	September 2017
Influenza season 2017	September 2017
Unknown Haemorrhagic Fever	June 2016
Meningococcal disease	June 2016
Enterovirus D68	May 2016
Lassa Fever	May 2016
Ebola Virus	April 2016
Elizabethkingia Anophelis	April 2016
Influenza H5N6	April 2016
Salmonella Saintpaul	April 2016
Salmonella Montevideoe	April 2016
Yellow Fever	April 2016
Zika Virus	March 2016
Influenza H7N9	March 2016
Salmonella Virchow	March 2016
Salmonella Anatum	March 2016

Appendix 3.E: List of selected outbreaks in 2017 for assessing sensitivity and timeliness of Epi-watch

Official Source	Outbreak	Link
WHO	Plague, Madagascar	https://www.who.int/csr/don/29-september-2017-plague-madagascar/en/
CDC	Multistate Outbreak of <i>Salmonella</i> Infections Linked to Imported Maradol Papayas	https://www.cdc.gov/salmonella/kiambu-07-17/index.html
WHO	Marburg virus disease – Uganda	http://www.who.int/csr/don/25-october-2017-marburg-uganda/en/
WHO	Cholera, Yemen	http://www.emro.who.int/pandemic-epidemic-diseases/cholera/cholera-cases-in-yemen.html
CDC	Multistate Outbreak of Shiga toxin-producing <i>Escherichia coli</i> O157:H7 Infections Linked to I.M. Healthy Brand SoyNut Butter	https://www.cdc.gov/ecoli/2017/o157h7-03-17/index.html
WHO	Diphtheria – Cox’s Bazar in Bangladesh	https://www.who.int/csr/don/13-december-2017-diphtheria-bangladesh/en/
CDC	Multistate Outbreak of Multidrug-Resistant <i>Campylobacter</i> Infections Linked to Contact with Pet Store Puppies	https://www.cdc.gov/campylobacter/outbreaks/puppies-9-17/index.html
WHO	Monkeypox – Nigeria	http://www.who.int/csr/don/21-december-2017-monkeypox-nigeria/en/
WHO	Circulating vaccine-derived poliovirus type 2 – Syrian Arab Republic	http://www.who.int/csr/don/13-June-2017-polio-syrian-arab-republic/en/
WHO	Circulating vaccine-derived poliovirus type 2 – Democratic Republic of the Congo	http://www.who.int/csr/don/13-June-2017-polio-drc/en/
WHO	Unexplained cluster of deaths – Liberia	http://www.who.int/csr/don/05-may-2017-unexplained-cluster-of-deaths-liberia/en/
WHO	Ebola virus disease – Democratic Republic of the Congo	http://www.who.int/csr/don/13-may-2017-ebola-drc/en/
WHO	Outbreak of <i>Salmonella</i> Agona infections linked to internationally distributed infant formula – France	http://www.who.int/csr/don/22-december-2017-salmonella-agona-infections-france/en/

Chapter 4: Outbreak Investigation

Investigation into the source of a foodborne illness cluster at a private house party

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4.1 Prologue

My role

On 30 January 2018, the South Western Sydney Public Health Unit (PHU) was notified of a cluster of food poisoning cases from a private house party by the New South Wales (NSW) Food Authority. Between 5 and 15 February 2018, I worked at the PHU within the Communicable Diseases Team to investigate the cluster. On my first day, the PHU received the contact details of the attendees which facilitated the commencement of an outbreak investigation. The purpose of the investigation was to establish the existence of an outbreak and if it existed, subsequently identify the source of the outbreak and recommend relevant public health action.

My role was to conduct hypothesis generating interviews, analyse the results and complete the NSW Food Authority investigation form to advise whether an environmental investigation was warranted. I interviewed seven of the 10 attendees, the other three interviews were conducted by Ms Heidi Lord, Clinical Nurse Specialist.

Lessons learned

This outbreak investigation gave me the opportunity to apply the skills learnt during course block by performing the steps of an outbreak investigation. One of the difficulties I faced was investigating a cluster of cases without an identified pathogen, which I was not exposed to during course block. In this instance I formulated a case definition based on clinical symptoms, possible place of exposure and time. This also required me to hypothesise a likely causative agent and source using epidemiological and environmental evidence gathered during the investigation, as well as published literature on similar outbreaks. I experienced some uncertainty during this process as I needed to make assumptions based on available evidence. Having laboratory confirmation of a pathogen may have increased my confidence, but this investigation taught me that this is not always available and how to use other sources to inform decisions.

This was also the first time I had interviewed members of the public. During this process I gained an appreciation for the time and persistence that is involved in contacting individuals and the additional information that should be obtained during foodborne investigations such as food handling and storage practices of food items. During course block the importance of not just relying on statistical significance, but also using common sense, judgement and other evidence was raised and I was able to apply this learning to this situation by also considering the proportion of illness by food items, other outbreaks associated with consumption of sushi and biological plausibility to identify a likely source. I also learnt how other surveillance data sources can be used to identify additional cases that could be epidemiologically linked through common risk factors that may indicate a larger outbreak, but also help to identify a source.

Public health implications

The public health implications from this investigation are somewhat limited due to a pathogen not being identified. However, it highlights the challenges faced during outbreak investigations and the assumptions that need to be made based on available evidence to presume a possible causative agent and source and consider appropriate control strategies in the absence of an identified pathogen. The evidence collected through this investigation led me to hypothesise that the most likely source of infection was contaminated salmon sushi.

This investigation highlights two gaps in management. Firstly, the importance of collecting faecal specimens when presenting to health care services, in particular, emergency departments with gastrointestinal symptoms when there is suspicion of an outbreak in order to facilitate identification of a pathogen. Knowing the cause of illness would assist in identifying the source of infection during foodborne outbreak investigations and inform recommendations and control measures to prevent further cases.

Secondly, the identification of sushi as a potential source of infection raises the importance of following appropriate food safety procedures for both food retailers and the general public when dealing with foods considered to be hazardous.

Acknowledgements

I would like to thank South Western Sydney Public Health Unit for welcoming me to the unit and providing me with the opportunity to gain experience in outbreak investigation. In particular, I would like to thank Dr Kate Alexander, Dr Katherine Todd, Ms Heidi Lord, Ms Paula Garcia and Mr Leng Boonwaat from the Public Health unit for their advice and assistance during this investigation.

I also thank my supervisors, Professor Raina MacIntyre and Dr Tambri Housen and Dr Ben Polkinghorne for their support and valuable feedback on outbreak investigations and preparing this chapter.

4.2 Abstract

Background

On 30 January 2018, New South Wales (NSW) Food Authority notified the Public Health Unit (PHU) of a cluster of suspected food poisoning cases following a private house party on 27 January 2018. Two possible sources for infection were identified – a catered sushi platter served at the party and a picnic held on 26 January 2018 where supermarket purchased roast chicken and coleslaw were consumed. An investigation was initiated to identify the source of illness and prevent further cases.

Methods

A descriptive analysis was conducted for 10 of the 11 party attendees who could be contacted, to identify the likely source of infection. As no ill attendees submitted a stool specimen for testing, a case was defined as anyone identified as attending the private house party on the evening of 27 January 2018 and who experienced any of the following symptoms of acute gastroenteritis: diarrhoea, fever, weakness, nausea, abdominal cramps or muscle pain within 48 hours of the event. Data was collected using a standardised foodborne illness investigation questionnaire over the telephone. An environmental investigation by local council Environmental Health Officers was undertaken at the premises which prepared the sushi platter. The NSW notifiable disease data were monitored to identify any similar gastroenteritis reports in the area with common risk factors linked to the cases.

Results

Of the 10 individuals interviewed, nine reported illness (attack rate 90%), and were classified as cases. Watery diarrhoea, fever and weakness were the most commonly reported symptoms experienced by eight cases and the duration of illness lasted for between 21.5 to 113 hours. The median incubation period based on exposure at the house party was 29 hours and ranged from 17 to 44 hours. Seven interviewed attendees also attended a private picnic on 26 January 2018, of these six were cases. Univariate analysis did not identify any statistically significant risk factors associated with consuming different sushi items or attending the picnic. Although the risk of

illness was twice as likely for those who consumed salmon sushi/nigiri compared to those who did not consume salmon sushi/nigiri, this was not statistically significant (RR 2.0, 95% CI 0.05-8.0, $P=0.2$).

An environmental inspection of the sushi premises did not identify any food safety issues. Food items served at the house party and picnic were not available for testing. A review of the NSW notifiable disease data did not reveal any similar cases with common risk factors that could be linked to this cluster.

Conclusion

Whilst a pathogen was not identified and epidemiological or environmental evidence could not conclusively link a food item to the cause of the outbreak, the raw salmon sushi served at the house party was the most likely food vehicle for infection. The causative agent was suspected to be *Salmonella* based on the incubation period from exposure at the house party, duration of illness and symptoms. Key issues highlighted during this investigation were the importance of testing faecal specimens when presenting to medical services with gastrointestinal symptoms to identify a causative agent and challenges in identifying the source in the absence of an identified pathogen. It also highlighted the importance of following food safety guidelines for hazardous foods, in this case sushi, to prevent contamination.

4.3 Introduction

On 30 January 2018, the South Western Sydney Local Health District Public Health Unit (PHU) was notified by the NSW Food Authority of a possible outbreak of gastroenteritis among a group of 11 individuals who attended a private house party on 27 January 2018. The NSW Food Authority was notified of this event by a complaint received by an attendee of the party. In NSW, public health and food safety are located across different agencies, with public health responsibility located within the Ministry of Health and food safety within the NSW Food Authority under the Department of Primary Industries. This relationship has led to establishment of formal and informal communication channels and cross collaboration to cooperate effectively during investigations. In addition, local Council Environmental Health Officers (EHOs) conduct inspections of retail food businesses in their local area through a partnership with the NSW Food Authority. (1) These inspections involve confirming that appropriate food safety practices are in place such as temperature control, cleanliness, hand washing and labelling to ensure compliance with the Food Standards Code. (1)

The PHU initiated an investigation on 1 February 2018, contacting the complainant and requesting the contact details of the party attendees. Contact details were provided to the PHU on 3 February 2018 and hypothesis generating interviews were conducted between 5 and 8 February 2018 by a member of the communicable diseases team and myself. Interviews were delayed due to contact details not being provided until the weekend and difficulties contacting individuals.

The group were all part of the same social circle which included two married couples and three individuals who shared the same house. Individuals experienced symptoms consistent with gastroenteritis including diarrhoea, fever, weakness, nausea, abdominal cramps, muscle pain and vomiting following consumption of sushi and nigiri platters that were purchased from a Fish Food Market in Sydney and provided at the party.

During interviews it was revealed that a number of individuals also attended a picnic the day prior to the party on 26 January 2018 where supermarket purchased roast chicken, coleslaw, pre-packaged ham, salami and cheese were consumed.

The purpose of the investigation was to identify the source of illness and prevent further cases. This report summarises the epidemiological, microbiological and environmental investigations into the cause of illness.

4.4 Methods

A descriptive analysis was conducted and relative risks (RR) calculated treating the small closed group of party attendees as a cohort. Interviews were conducted by telephone using an initial standardised PHU foodborne illness investigation questionnaire (Appendix 4.A). Information sought from interviews included basic demographic details, number of people attending the party, date and time of illness onset and resolution, symptoms experienced, food and drink items consumed during the event, whether individuals ate either with the same people or at any social functions or restaurants in the seven days prior to and post the house party, what they ate and when, contact with someone with a similar illness, overseas travel history and health seeking behaviour.

To identify additional cases who may not have attended the house party, passive case finding was undertaken, *Salmonella* notifications were reviewed from the Notifiable Conditions Information Management System (NCIMS) for the period two weeks prior to and post the house party for the local government area within which the sushi premises was located. Notifications were excluded if they were unconfirmed cases and infection was acquired either overseas or outside of NSW. In addition, laboratory confirmed *Salmonella* notifications were extracted from NCIMS for the same area for the period 13 January to 10 February, 2013 to 2018 by onset date in order to review seasonal patterns.

A publicly available register of penalty notices, available through the NSW Food Authority website was reviewed to identify any previously reported food safety complaints associated with the sushi premises.

Data were collected, entered and analysed in Microsoft Excel 2016 (Microsoft, USA) and STATA-SE (version 14.0, StataCorp, College Station, Texas). Univariate analysis of exposures was conducted, RR, 95% confidence intervals (CI) and *p*-values (significant at the 0.05 level) were calculated. Relative risks were calculated in preference for odds ratios as incidence data in exposed and unexposed were available, as was data on the whole cohort. Fisher's exact test was used to test for statistical significance as counts were less than five.

Ethics approval was provided by the ANU HREC under protocol 2017/909.

A case was defined as anyone identified as attending the private house party on the evening of 27 January 2017 and who experienced any of the following symptoms of acute gastroenteritis: diarrhoea, fever, weakness, nausea, abdominal cramps or muscle pain within 48 hours of the event. Selection of symptoms to include in the case definition were based on the majority of individuals reporting those symptoms.

4.5 Results

4.5.1 Epidemiological results

We interviewed 10 of the 11 individuals who attended the party nine to 12 days after the event. Six were female. The median age was 28 years (range 21 to 41 years). Age details were not collected for two individuals during interviews. The one well person was female, age details were not collected. Multiple attempts to contact the 11th individual were made, however, the case was lost to follow-up. The NSW Food Authority obtained the following details on the individual, who was female and unwell. Symptoms began on 29 January 2018 at 8.30am and included diarrhoea, nausea, fever and vomiting.

Of the 10 individuals interviewed, nine reported illness (attack rate 90%), and were classified as cases; demographic characteristics, reported symptoms and health

seeking behaviour are shown in Table 1. Eight experienced watery diarrhoea (bloody diarrhoea was experienced by one person), fever and weakness. Diarrhoea (3/9) and nausea (3/9) were reported as the first symptoms experienced. The median duration of illness was 72 hours (range 21.5 to 113 hours).

Six of nine cases sought medical attention. The treatment provided at the emergency department included provision of intravenous fluids, pain relief, blood pressure and temperature checks.

Table 1: Demographic characteristics and symptoms of gastroenteritis cases attending a house party in Sydney, Australia on 27 January 2018, (n=9)

Characteristic	n	%
Gender		
Male	4	44
Female	5	56
Symptoms		
Diarrhoea	8	89
Watery diarrhoea	8	89
Fever	8	89
Weakness	8	89
Nausea	7	78
Abdominal cramps	7	78
Headache	7	78
Muscle pain	7	78
Chills	6	67
Joint pain	6	67
Vomiting	5	56
Health seeking behaviour		
Emergency department	4	44
Primary health care	2	22
Hospitalised	0	0

Food items at the house party were consumed between 6pm and 8pm, six out of 10 individuals reported consuming food at 7pm. The median incubation period from time of exposure at the house party was 29 hours with a range of 27 hours (17-44 hours) and the epidemic curve was indicative of a point source outbreak (Figure 1).

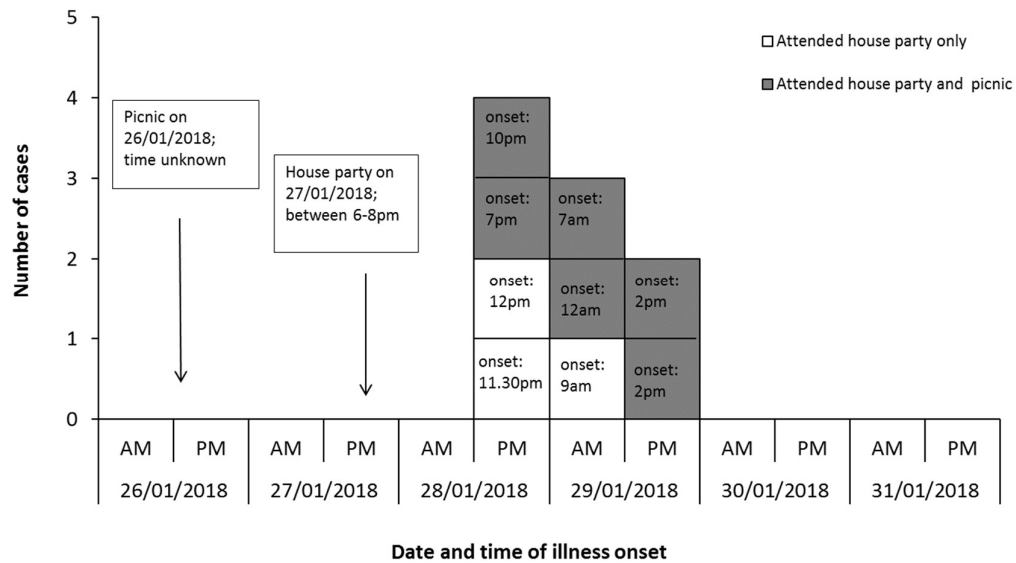


Figure 1. Epidemiological curve of foodborne cluster at private house party, Sydney, Australia, with a symptom onset date between 28 and 29 January 2018

The sushi platter consisted of raw salmon sushi and nigiri, tinned tuna and avocado, cooked chicken, cooked prawn and imitation crab stick/seafood stick sushi rolls. Other ingredients used in the sushi such as sauces i.e. mayonnaise were not gathered during the investigation.

Foods other than the sushi and nigiri platters that individuals recalled consuming included homemade garlic bread (5/9), potato chips (3/8), supermarket guacamole (1/2), crackers (1/2), instant noodles (1/4), lamingtons (2/4), chocolate (2/4), ginger biscuits (1/4) and alcoholic and non-alcoholic beverages.

Seven out of 10 party attendees also attended a private picnic on 26 January 2018, of these, six were cases (Figure 1). Only three individuals (all cases) recalled attending the picnic and were asked to recall the foods they ate. The food items consumed included supermarket purchased roast chicken, coleslaw, packet ham and pepperoni, cheese, crackers, coffee, orange juice, apple juice, lemonade and bottled water. Based on information from interviews, no leftovers from the picnic were served at the house party dinner the following evening.

Table 3 shows the univariate analysis of risk factors of eating different varieties of sushi as well as attending the picnic on 26 January 2018. Sushi was consumed by all house party attendees. While the risk of illness was twice as likely for those who consumed salmon sushi/nigiri compared to those who did not consume salmon sushi/nigiri, this was not statistically significant (RR 2.0, 95% 0.05-8.0, $P=0.2$) (Table 3). Univariate analysis did not show any statistically significant risk factors associated with consuming different sushi items or attending the picnic, and the relative risks for all other exposures (other than salmon sushi/nigiri) were below one. The one interviewed attendee who did not develop symptoms reported eating all food items except the salmon sushi/nigiri, and the one interviewed attendee who developed symptoms but did not report eating the salmon sushi/nigiri, reported eating all other sushi dishes.

Table 3. Univariate analysis of selected risk factors among attendees at private house party, Sydney, Australia, 27 January 2018

Exposure	Exposed			Unexposed			Crude RR	95% CI	<i>p</i> -value*
	Ill	Not ill	AR%	Ill	Not ill	AR%			
Raw salmon sushi/nigiri	8	0	100%	1	1	50%	2.0	0.5-8.0	0.2
Tin tuna sushi	7	1	88%	2	0	100%	0.9	0.7-1.1	1.0
Chicken Sushi	7	1	88%	2	0	100%	0.9	0.7-1.1	1.0
Prawn Sushi	5	1	83%	4	0	100%	0.8	0.6-1.2	1.0
Crab stick Sushi	6	1	86%	3	0	100%	0.9	0.6-1.2	1.0
Attended picnic	6	1	86%	3	0	100%	0.9	0.6-1.2	1.0

AR = Attack rate; RR = Relative risk; CI = Confidence interval, * 2-sided Fisher's exact

In the same region, there were five laboratory confirmed *Salmonella* notifications for the period 13 January to 10 February 2018 identified, which was similar to the previous five-year average for the same period of 6.2 notifications. A review of these five notifications did not reveal any cases with common risk factors that could be linked to this cluster.

4.5.2 Laboratory investigation

Blood and urine were tested for one individual and a blood test only for another. No pathogen was identified in blood or urine samples.

Stool samples were not collected for testing from cases who sought medical care.

No sushi food samples from the party were available for testing. Leftover food items from the picnic were not served at the house party or available for testing.

4.5.3 Environmental health investigation

A site inspection of the sushi premises was undertaken by EHOs between the 2nd and the 6th of February 2018, the exact date of the inspection was not obtained. No food safety issues were identified during this inspection and samples were not tested.

A review of the NSW Food Authority penalty notice register revealed no previously reported food safety complaints associated with the sushi premises.

4.6 Discussion

Findings from the epidemiological and environmental investigations and absence of a confirmed pathogen limited the ability to identify the source of this foodborne outbreak. However, based on the available evidence collected, I discuss a possible pathogen and source below.

Testing of blood and urine samples from cases who attended the Emergency Department did not reveal a pathogen. For people presenting to health services when a foodborne outbreak is suspected, stool culture and microscopy are more appropriate for identification of a causative pathogen compared to blood and urine analysis, which are more indicative of a systemic infection. (3)

The incubation period based on exposure to food items at the house party, duration of illness and symptoms suggest that the likely pathogen was nontyphoidal *Salmonella*. The median incubation period was 29 hours (range 17 to 44 hours) with symptoms lasting an average of 72 hours (range 21.5 to 113 hours), which coincides with the incubation period (6 to 72 hours, usually 12 to 36 hours) and symptom duration (three

to five days) for salmonellosis. (2) The clinical symptoms reported by cases included watery diarrhoea and bloody diarrhoea, fever, weakness, nausea, abdominal cramps, muscle pain and vomiting, were consistent with *Salmonella* infection. (2) Other pathogens notified in Australia were considered as a possible cause of illness based on similar incubation periods and included: *Shigella*, *Campylobacter*, norovirus and *Escherichia coli*, however, the symptoms and/or illness duration were not consistent with those identified during this investigation and so were considered less likely to be possible causes of illness. (2) Pathogens implicated in previous outbreaks associated with sushi such as *Bacillus cereus*, *Vibrio parahaemolyticus* and *Staphylococcus aureus* were also investigated, but again were considered less likely as possible causes due to inconsistencies with incubation period, illness duration, symptoms and/or risk factors. (2, 4)

While the univariate analysis did not produce statistically significant results for any of the risk factors assessed, based on attack rate, incubation period and published literature, (2) it is hypothesised that the most likely source of exposure was the salmon sushi. Sushi is considered a potentially hazardous food as it can contain uncooked ingredients and requires a large amount of manual handling during preparation. (5)

Outbreaks due to consumption of sushi are not uncommon, however, specific individual investigations are not widely published and no foodborne outbreaks due to raw salmon were identified during an empirical literature search. In Australia, for the period 2004 to 2015, 20 outbreaks associated with the consumption of sushi have been reported by the OzFoodNet Working Group. (6-18) Inadequate refrigeration and storage, poor food handling and hygiene practices including inadequate handwashing, cleaning and sanitising practices, cross-contamination, use of contaminated raw products and use of raw egg mayonnaise have been identified as some of the likely causes of these outbreaks. (6, 7, 10, 13-15, 17, 18) Cross-contamination and poor food hygiene and handling practices of the ingredients used within sushi are the main contributors to introduction of pathogens identified during sushi related outbreak investigations. (19-21)

Outbreaks associated with the consumption of sushi have been attributed to pathogenic bacteria including *Salmonella*, *Escherichia coli*, *Campylobacter jejuni*, *Vibrio parahaemolyticus*, *Bacillus cereus* and *Staphylococcus aureus*. (5, 15, 18-24) While presence of *Salmonella* is commonly associated with chicken and eggs, microbiological surveys conducted on the quality and safety of sushi and to detect pathogens in seafood have identified the presence of *Salmonella* on a small number of salmon and shrimp samples. (22, 25, 26) For *Salmonella* to be present in seafood it needs to be introduced, which can occur via cross-contamination during the processing and preparation stages of the product. (27)

Sushi is prepared using rice that has been acidified by adding vinegar. The NSW Food Authority recommends a pH of less than or equal to 4.6 and to avoid storing sushi at temperatures above 5 degrees Celsius for longer than four hours to inhibit the growth of some pathogenic bacteria. (28) However, *Salmonella* can survive and grow in pH levels ranging from 3.8 to 9.5, at temperatures between 5.2 to 46.2 degrees Celsius and in moist foods. (29) Therefore, it is biologically plausible that *Salmonella* can survive and grow in sushi and on salmon.

For this investigation, given that 90% of individuals who attended the house party fell ill and all consumed sushi, compared with 60% falling ill after attending the picnic; this supports the hypothesis that the sushi served at the house party was the likely vehicle for infection. Given that the one party attendee who did not develop symptoms reported eating all sushi items apart from the salmon sushi/nigiri, and the high relative risk associated with eating salmon sushi/nigiri (whilst not statistically significant), this is suggestive that the salmon sushi/nigiri was likely responsible for this outbreak. It is possible that the other party attendee who did develop symptoms but did not consume the salmon sushi/nigiri did not recall eating this item or cross contamination was involved. If the source of exposure was the picnic, it is difficult to explain how the other three individuals became ill, unless leftover food from the picnic was also served at the dinner the next day, however, interviewees did not reveal that this occurred.

Salmonella outbreaks are commonly linked to foods containing chicken meat and eggs. (30) It is possible that cross-contamination could have occurred if the sushi was

exposed to the chicken and coleslaw that were consumed at the picnic and those food items were contaminated, although it is more likely that cross-contamination occurred at the sushi premises during preparation due to increased risk and opportunity such as use of ingredients that were prepared in advance, manual handling and the common preparation area. (31) Mayonnaise is often used in chicken and tuna sushi and *Salmonella* outbreaks linked to raw egg mayonnaise in sushi have been reported previously. (6, 17) It is also possible that raw egg mayonnaise was used as an ingredient in the salmon sushi, however, this information was not collected during the investigation and environmental inspections did not identify any concerns.

The NSW Food Authority provides guidelines for retail and food service businesses for the safe preparation and display of sushi in line with the *Australia New Zealand Food Standards Code*. (28) These guidelines outline practices to reduce the risk of cross-contamination and provide advice on the appropriate temperature to transport, store and display sushi to inhibit the growth of pathogenic bacteria. Although environmental investigations did not reveal any issues with the food handling and hygiene practices at the place of purchase, it is also possible that the pathogen was already present in the ingredients used in the sushi and that it was transported and/or stored at temperatures that would promote the growth of bacteria, once it left the place of purchase.

To identify additional cases who had not attended the house party, passive case finding was undertaken by reviewing *Salmonella* notifications for the two weeks prior to and post the house party. No cases with common risk factors that could be linked to this cluster were identified. This suggests that the outbreak was limited to this cohort and that food storage and handling practices after the sushi left the place of purchase may have been a contributing factor, rather than a common source from either the place of purchase of sushi or the chicken/coleslaw. However, data from time of purchase to time of consumption was not collected.

4.7 Limitations

One of the main limitations of this investigation was that a pathogen was not identified, which limited the ability to identify the source for this cluster of cases. In addition, the small number of exposed people and high attack rate limited the ability to identify foods significantly associated with illness.

Confirmation bias was prominent. During interviews, individuals revealed that they had all discussed the event as a group and concluded that the source of infection was the salmon sushi, as the one well individual did not consume any salmon. This may have influenced individual's ability to recall other items consumed.

The length of time taken to interview individuals following illness contributed to poor recall bias, which affected individual's ability to recall the events and foods consumed in the week prior to, during and post the house party. A questionnaire specific to this outbreak with all food items available at the party and picnic was not developed, instead, individuals were asked to recall the food items they consumed. This resulted in limited data on exposures other than the sushi. As a complete list of the sushi available at the party was known to the interviewers, during interviews individuals were prompted to recall what sushi they ate, which resulted in more complete data.

Lack of information regarding when the sushi and chicken and coleslaw from the picnic was purchased, the food handling and storage practices employed, and the time of the picnic, limited the evidence available to inform possible sources and whether cross-contamination was a factor for this cluster.

4.8 Conclusion

Neither a pathogen nor source of this outbreak could be confirmed, however, based on available epidemiological evidence, it is possible that the pathogen was *Salmonella*, most likely caused by contaminated salmon sushi served at a private house party.

This investigation highlights the importance of implementing and maintaining adequate food safety procedures, including good hygienic practices for hazardous foods both in a business setting and privately with the consumer. As part of public

health follow up an environmental health inspection at the sushi premises was undertaken but did not identify any food safety issues.

The investigation also highlighted the importance of collecting faecal specimens in cases where foodborne illness is suspected upon presentation to a health practitioner, the importance of the availability of food samples for testing to aid the identification of a causative pathogen and the difficulties posed when a pathogen is unable to be identified.

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4.10 Appendices

Appendix 4.A: PHU foodborne illness investigation form

NSW Food Authority Number				
Date complaint received				
Food venue being investigated				
Surname of person interviewed				
First Name				
Date of birth				
Gender				
Address				
Postcode				
Occupation				
Telephone No - home				
Telephone No - mobile				
Illness Onset Date				
Illness Onset Time				
Date of illness resolution				
Time of illness resolution				
Symptom experienced first				
Nausea				
Vomiting				
Diarrhoea (loose stools)				
Watery diarrhoea				
Blood in Diarrhoea				
Abdominal Cramps				
Sore Throat				
Fever				
Chills				
Headache				
Muscle pain				
Joint pains				
Weakness				
Runny Nose				

Cough				
Rash				
Other				
Specify				
Still ill?				
Still have diarrhoea?				
How long ill in hours				
Doctor seen about illness?				
if yes can we contact doctor?				
Dr's Name				
Drs Telephone No.				
GP Address				
Were you admitted to hospital for your illness?				
If yes, name of hospital?				
Specimens taken?				
If yes, stool specimen date				
If yes vomit specimen date				
If yes, blood specimen date				
If no, are you willing to provide a specimen?				
Have you had contact with anyone with a similar illness in the week prior to the function?				
If yes when was the contact made?				
Date				
Name				
Telephone No.				
Date				
Name				
Telephone No.				
Date				
Name				
Telephone No.				
Were you ill prior to attending or during the function?				

if yes what were your symptoms				
Vomiting				
Diarrhoea				
Other - please specify				
How longer were you ill? - Total hours				
Have you recently travelled overseas?				
If yes please provide details.				
No. of people ill				
Number of people attending function/party				
Place of consumption				
Date of consumption				
Time food was eaten				
What did you eat and drink? Please enter food on consumption table				
Did you take any leftover food from this function home?				
If yes what did you take home?				
If yes, can we collect food for testing				
Have you eaten with the same person/people that attended this function in the week prior to this function				
If yes please give details of where and what you ate.				
Have you eaten with the same person/people that attended this function in the week after this function				
If yes please give details of where and what you ate.				
Have you eaten at any other social functions or restaurants in the week prior to the function?				
If yes please give details of where and what you ate.				
Have you eaten at any other social functions or restaurants in the week after the function?				
If yes please give details of where and what you ate.				

SECTION 3 FOOD HISTORY				
FOODS EATEN				
FOODS NOT EATEN				
ILL OR NOT ILL?				

Chapter 5: Data analysis

Influence of repeated influenza vaccination on serological response and vaccine effectiveness, 2007 to 2010

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5.1 Prologue

My role

My data analysis project involved assessing the impact of repeated influenza vaccination on immune response using a dataset from a previously conducted case-control study by my field supervisor, Professor Raina MacIntyre. The idea and research question for this project was proposed by Professor MacIntyre.

I was responsible for conducting a literature review, developing a data analysis plan, obtaining ethics approval from ANU, cleaning the dataset and conducting the analysis. I worked in close collaboration with my field supervisor during the data cleaning process.

Lessons learned

I learnt about the limitations associated with conducting a secondary data analysis during this study. These limitations were evident as some important factors for assessing the impact of repeated influenza vaccination were not available such as influenza subtype and pre-vaccination titres. It is important to understand the limitations of using datasets that were developed for different purposes. This is especially important in public health policy, where access to data can be limited and we need to make the most of the datasets that are available, for example administrative datasets like the Medicare Benefits Schedule. Another major learning was the requirement of a large sample size to calculate VE estimates. Without adequate numbers of infected and uninfected, and vaccinated and unvaccinated participants, the precision of VE estimates can be affected, confidence intervals become excessively wide and the power of the study to detect an effect is reduced. I also learnt the importance of exploring your dataset prior to conducting the analysis to get a sense of the limitations, missing data and how variables are coded. While this can be a time-consuming process at the beginning, it makes for a smoother process during the analysis stage. I also learnt that the influenza virus is complicated and there are many factors that affect influenza immunity when looking at vaccine effectiveness. Finally, my skills and confidence using a statistical package, STATA and my

understanding of univariate and multivariate logistic regression methods have improved as a result of this study.

Public health implications

Annual influenza vaccination is important in preventing infection, morbidity and mortality. However, there have been inconsistent findings on what impact repeated vaccination has on the immune response. This study will contribute to a larger study on the serological response to repeat vaccination being conducted by my field supervisor.

Acknowledgements

I thank my field and academic supervisors Professor Raina MacIntyre, Dr Abrar Chughtai and Dr Tambri Housen for their support and guidance during this study as well as the NHMRC CRE Integrated Systems for Epidemic Response for funding my scholarship. I also thank Louise Geddes, Research Assistant, Kirby Institute for her assistance with STATA coding.

5.2 Abstract

Background

Annual influenza vaccination is recommended as the primary method to prevent infection and reduce morbidity and mortality. Inconsistent findings have been reported on the impact of repeated vaccination on the immune response. Reduced protection associated with repeated vaccination has been observed. We aimed to investigate the impact of repeated influenza vaccinations in adults aged 40 years and older on serological response and influenza vaccine effectiveness (VE).

Methods

A retrospective secondary data analysis was conducted using data from a prospective case control study conducted by MacIntyre et al. Participants in this study were recruited from a tertiary hospital in Sydney, Australia during 2008 to 2010. Nasal and pharyngeal viral swabs and blood samples were collected from participants at baseline on recruitment and further blood samples collected 4-6 weeks post recruitment. Paired sera tested in parallel using a complement fixation assay was used to determine influenza A and B specific antibody titres and nucleic acid testing with inhouse PCR assays to test for influenza.

The geometric mean (GMT) and median were calculated on log transformed data separately for influenza A and B titres by vaccination status classified as zero, one or two vaccinations. The Kruskal-Wallis test was used to test for significant differences between medians. Influenza vaccination status was determined for the current year only and current and prior year for the period 2007 to 2010. VE was defined as $(1 - \text{odds ratio}) \times 100$ and calculated for participants aged 40 years and over using logistic regression.

Results

GMT titres were lower for those who were unvaccinated and highest in those with two vaccinations for both influenza A and B. Both influenza A ($\chi^2(2) = 47.154$, $p < 0.001$) and B ($\chi^2(2) = 40.041$, $p < 0.001$) median titres were statistically significantly different across vaccination groups. Compared to being unvaccinated, median titres were

significantly higher for participants with one and two vaccinations for both influenza A and B.

Compared with being unvaccinated, vaccination in both the study year and prior year was significantly protective (adjusted VE, 97%; 95% CI: 77 to 100). VE could not be estimated for vaccination in the study year only due to small sample size.

Conclusion

Vaccine induced influenza immunity is complex and affected by many factors. On their own, the findings from this study are limited in terms of how they contribute to understanding the effects of vaccination on immune response and contribute to influenza vaccine policy. However, even if repeated vaccination contributes to lower immunity, if some protection is still provided annual vaccination is worthwhile, particularly for high risk groups. Ongoing research is needed to better understand the impact of these factors on influenza immunity.

5.3 Introduction

Seasonal influenza is a respiratory virus that is often clinically mild, however, can also cause serious illness, particularly in young children and the elderly. Worldwide, influenza causes substantial morbidity and mortality, with an estimated 10-20% of the world's population infected annually (1) and between 290,000 to 650,000 deaths each year. (2)

Annual vaccination is the primary method to prevent infection, however, due to continual evolution of the influenza virus, vaccines must be reformulated every year to keep up with these changes. (3) In Australia, annual vaccination is recommended for all persons over six months of age. (4) The Australian National Immunisation Program (NIP) also funds vaccination for those most at risk of severe disease or influenza related complications, including all persons aged six months or older with certain medical risk factors; Aboriginal and Torres Strait Islander peoples aged six months and over; pregnant women and all adults aged 65 years and over. (5) Over the last four decades, however, the impact of repeated annual vaccination on protective effects against influenza has been questioned. This was first described in 1979 during a study on the long-term effects of inactivated influenza vaccination at an English boarding school, which found greater protection against influenza amongst those vaccinated for the first time compared to those with prior vaccination. (6) The decrease in protection after repeated vaccination became known as the Hoskins' paradox. (6) Reanalysis of the data in 1998 has since led to a dispute of these findings as the original results could not be proven. (7)

Since this time, multiple studies have assessed the effect of prior year vaccination on current year vaccine effectiveness (VE) estimates for protecting against laboratory confirmed influenza. Reduced VE estimates have been associated with repeated vaccination when compared to being vaccinated in the current year only. (8-10) However, other studies have reported similar levels of protection against influenza regardless of prior year vaccination status. (11, 12) A recent meta-analysis of five randomised control trials and 28 observational studies found no reductions in VE associated with vaccination in two consecutive influenza seasons compared with those

vaccinated in the current season, however, unexplained heterogeneity and imprecision of the studies did not rule out the possibility of reduced effectiveness. (13)

Immune response to influenza can be measured by antibody response to hemagglutinin, before and after vaccination or natural infection. (14) Studies measuring post-vaccination protection antibody levels have resulted in inconclusive findings. A reduced immune response was found in those with repeated vaccination compared to single vaccination, (15, 16) while a decrease in serologic antibody response was not found in subjects vaccinated annually. (17) Further, in an analysis of three cohort studies, the effects of repeated vaccination on immune response post-vaccination varied, with higher, similar or lower titres reported in the previously vaccinated group when compared to subjects not previously vaccinated. (18) Other factors found to influence post-vaccination titres include higher pre-existing serum hemagglutination-inhibition (HI) antibody levels, (18, 19) the type of vaccine (trivalent inactivated influenza vaccine or live attenuated influenza vaccine), (19) influenza subtype, (18), vaccine formulation (20, 21) and age. (22)

The impact of repeat vaccination on protection against influenza continues to be poorly understood as indicated by inconsistent findings from numerous studies in this area. Given the high disease burden associated with influenza and the importance of annual vaccination as the primary prevention method, continued research is needed to better understand what effect prior vaccination has on immune response to inform future influenza program and policy recommendations.

We aimed to investigate the impact of repeated influenza vaccinations in adults aged over 40 years on serological response and vaccine effectiveness. Although there are differences in immune competence by age, this study did not aim to assess age group differences, nor was the sample size large enough to analyse by age group.

We hypothesised that there would be:

1. no difference between number of influenza vaccinations and influenza A or influenza B titre results; and

2. no difference between number of influenza vaccinations and vaccine effectiveness.

Ethics approval for this analysis was obtained from the Australian National University Human Research Ethics Committee, protocol number 2018/502.

5.4 Materials and Methods

We undertook a retrospective secondary data analysis using data from a prospective case control study conducted by MacIntyre *et al.* (23)

Participants in the original study were recruited from a tertiary referral hospital in Sydney over the southern hemisphere winter seasons between 2008 to 2010 (from late June to October in 2008 and 2010 and late May to October in 2009). Study participants were patients aged 40 years and over admitted to the cardiology unit with an acute myocardial infarction (AMI), evolving or recent myocardial infarction (cases) and persons aged 40 years and over attending the orthopaedic or ophthalmic outpatient clinic during the same time period (controls). Controls were excluded if they reported a history of AMI, transient ischaemic attack or stroke in the previous 12 months and were matched for the same age cut-off and recruitment period. Cases were included if samples could be provided within 72 hours of the AMI and they resided in Sydney, were available for follow-up and provided consent.

Nasal and pharyngeal viral swabs and blood samples were collected from participants at baseline on recruitment and further blood samples collected 4-6 weeks post recruitment. Vaccination status was determined prior to sample collection. Paired sera tested in parallel using a complement fixation assay was used to determine influenza A and B specific antibody titres and nucleic acid testing with inhouse Polymerase chain reaction (PCR) assays to test for influenza as previously described. (23) A baseline structured questionnaire collected information such as medical and vaccination history, socio-demographic data and current comorbidities. Influenza vaccination history was collected for the year of recruitment into the study and the prior year. General practitioner (GP) and hospital records were used to validate self-reported influenza vaccination history. (23) If there were inconsistencies between GP and self-

reported vaccination status, the GP report was considered correct, while self-reported vaccination status was used if the GP could not be contacted. For this analysis, participants were considered to be unvaccinated if they reported unsure in either year, vaccinated in the current year or not vaccinated in the prior year and GP validation could not be confirmed.

For a full description of sample selection, data collection and validation please see MacIntyre et al. 2013. (27)

Data analysis

Data extracted from the database for this analysis included; recruitment year; demographic variables including age, sex, ethnicity, marital status and language; variables related to medical history and comorbidities including mobility issues, smoking and alcohol status, AMI, current medications, diabetes, asthma, influenza-like illness (ILI); number of influenza vaccinations ever received by the participant and GP verification status; influenza outcome and influenza A and B titre results.

Serological response

Participant's socio-demographic and health condition characteristics were summarised by number of vaccinations. The Pearson chi-squared (χ^2) was used to test for significant differences between groups, with $p \leq 0.05$ considered statistically significant.

The primary outcome measure was influenza A and influenza B titre results. The geometric mean (GMT) and median were calculated on log transformed data (14) separately for influenza A and influenza B, by number of vaccinations. Presented results were back transformed for ease of interpretation. The Kruskal-Wallis test was used to test for significant differences in median titre levels between groups. (16) A post hoc analysis using pairwise comparisons were performed using Dunn's (1964) procedure and a Bonferroni correction for multiple comparisons was used. (16) The ≤ 0.05 level was considered statistically significant. The proportion of influenza A and influenza B titres by number of vaccinations was calculated.

Participants with PCR or serological evidence of influenza infection were excluded from the baseline analysis to remove the effect of infection on serological response, however, they were included when calculating VE. Titre results < 4 were classified as 0,

≤ 8 were classified as 8 and ≤ 16 classified as 16. Titres reported as 'non-specific' were excluded from the analysis. A HI antibody titre ≥ 40 was used as a correlate of protective immune response against influenza. (24)

Vaccine effectiveness

Participant's socio-demographic and health condition characteristics were summarised by influenza outcome. The Pearson chi-squared (χ^2) was used to test for significant differences between groups, with $p \leq 0.05$ considered statistically significant.

VE was estimated for the period 2007 to 2010. VE was defined as $(1 - \text{odds ratio}) \times 100$ where the odds ratio is the odds of being vaccinated in the study year and testing positive for influenza divided by the odds of being vaccinated and testing negative. (9)

Crude and adjusted VE estimates and 95% confidence intervals (CI) were calculated using logistic regression where the outcome measure was influenza infection and the exposure variables were 1. vaccination in the current year only (the year of recruitment into the study), 2. vaccination in the current and prior year, and 3. not vaccinated in either the current or prior year (reference group).

Univariate analysis of all study variables was undertaken to identify potential confounders. Variables identified as statistically significant at the $p < 0.25$ level were included in the final multivariate model.

Confirmed influenza was defined as a positive PCR, or a four-fold rise in titre for influenza A or B between baseline and follow-up, or a single baseline titre of > 64 at baseline in an unvaccinated individual. (23)

Two different datasets were developed for analysing titre results and VE separately.

Data were analysed in STATA-IC (version 15.1, StataCorp, College Station, Texas) and figures produced using Microsoft Excel 2016 (Microsoft, USA).

5.5 Results

5.5.1 Serological analysis

Demographic characteristics

There were 559 participants included in the original database. To conduct the serological analysis, 53 influenza positive participants and 3 participants with 'non-specific' titre results were excluded, leaving a total of 503 participants. Demographic and health characteristics of participants included in the serological analysis are in Table 1.

Of the 503 participants, 38% (191/503) were unvaccinated, 15% (77/503) received one vaccination and 47% (235/503) two vaccinations. There were significant differences in probability distributions for age group ($p<0.001$), sex ($p<0.001$), marital status ($p<0.001$), AMI ($p<0.001$), smoking status ($p<0.001$), and self-reported asthma ($p=0.01$).

Table 1. Descriptive characteristics of participants by vaccination status, tertiary hospital in Sydney, Australia, 2007-2010*

Characteristic	Not vaccinated (N=191)		One vaccination (N=77)		Two vaccinations (N=235)		Total (N=503)		p Value *
	n	%	n	%	n	%	n	%	
Recruitment year									
2008	75	39.3	28	36.4	85	36.2	188	37.4	0.44
2009	74	38.7	24	31.2	92	39.1	190	37.8	
2010	42	22	25	32.5	58	24.7	125	24.9	
Age group									
40-64	136	71.2	36	46.8	33	14	205	40.8	<0.001
>65	55	28.8	42	54.5	202	86	299	59.4	
Sex									
Male	141	73.8	52	67.5	115	48.9	308	61.2	<0.001
Female	50	26.2	25	32.5	120	51.1	195	38.8	
Ethnicity									
Caucasian	142	74.3	61	79.2	196	83.4	399	79.3	0.17
Asian	35	18.3	8	10.4	22	9.4	65	12.9	
Aboriginal or Torres Strait Islander	2	1	1	1.3	3	1.3	6	1.2	
Other	12	6.3	7	9.1	14	6	33	6.6	
Marital status**									

Married/ de facto	128	71	44	62	132	58.9	304	64	0.002
Widowed/separated /divorced	33	18.3	23	32.4	82	36.6	138	29.1	
never married	17	9.4	4	5.6	10	4.5	31	6.5	
Other	2	1.1	0	0	0	0	2	0.4	
Language spoken at home									
English	152	79.6	65	84.4	204	86.8	421	83.7	0.13
Other	39	20.4	12	15.6	31	13.2	82	16.3	
AMI									
Yes	130	68.1	38	49.4	166	70.6	238	47.3	<0.001
No	61	31.9	38	49.4	166	70.6	265	52.7	
Smoker[§]									
Current	54	28.4	16	21.3	18	7.8	88	17.7	<0.001
Former	60	31.6	28	37.3	99	42.9	187	37.7	
Non	76	40	31	41.3	114	49.3	221	44.6	
Alcohol consumption[†]									
Sometimes/daily	114	60.1	47	61.8	115	50	276	55.6	0.06
Never	76	40	29	38.2	115	50	220	44.4	
Mobility[‡]									
Is mobile	135	71.1	52	68.4	144	61.5	331	66.2	0.11
Not mobile [#]	55	29	24	31.5	90	38.5	169	33.8	
Altered immune function medication^{††}									
Any	69	36.1	29	37.7	106	45.1	204	40.6	0.15
None	122	63.9	48	62.3	129	54.9	299	59.4	
Self-reported									
Diabetes	47	24.6	19	24.7	60	25.5	126	25	0.97
Asthma	13	6.8	5	6.5	35	14.9	53	10.5	0.01
ILI [¶]	28	25.9	11	22.9	34	24.1	73	24.6	0.91

*Pearson chi squared test

** Excludes 28 participants with missing data

§ Excludes 7 participants with missing data

† Excludes 7 participants with missing data

‡ Excludes 3 participants with missing data

not mobile includes some problems walking and confined to bed

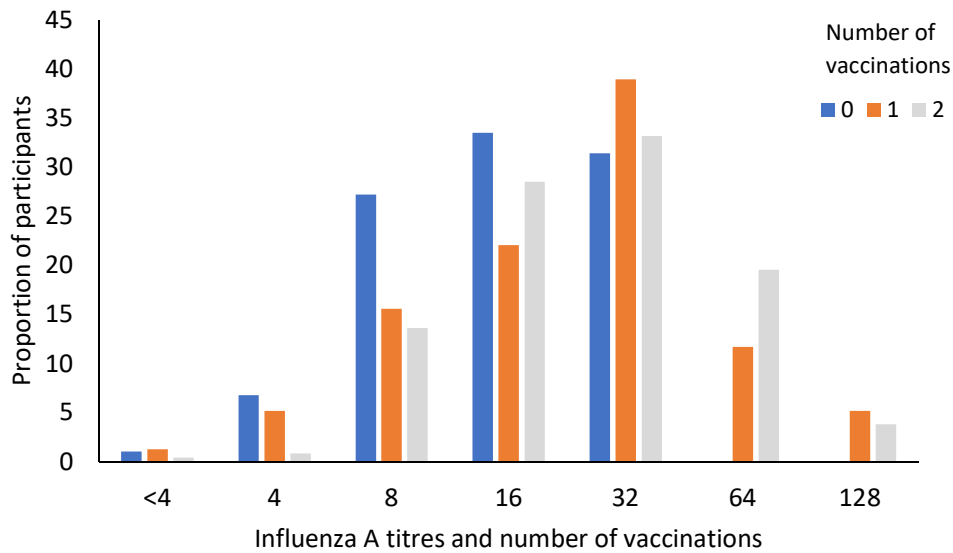
†† Is taking cortico or inhaled steroid medication

¶ excludes 206 participants with missing data

Influenza A and B titre analysis

Figures 1 and 2 show HI antibody titre proportions by number of vaccinations in subjects who did not develop influenza. Protection levels against influenza A and B (a HI titre ≥ 40) were achieved by participants who had one and two vaccinations. There were no unvaccinated subjects with titres >64 .

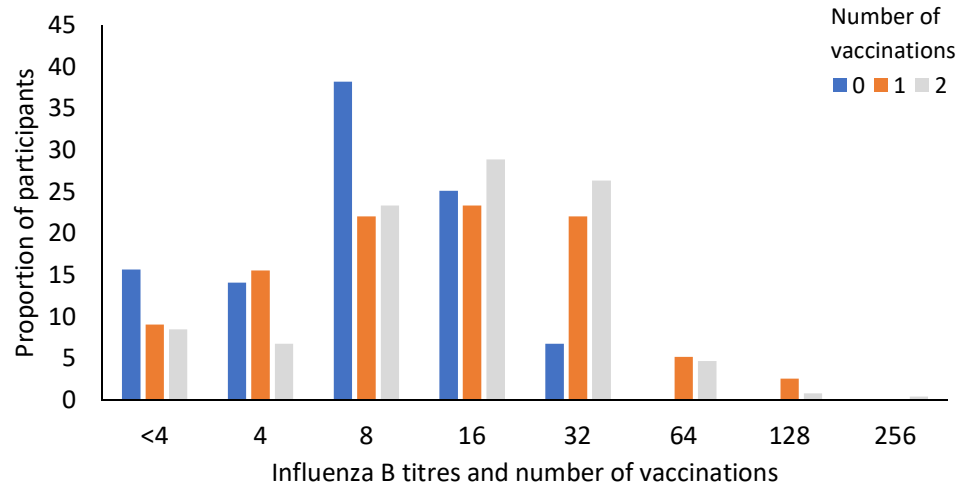
The proportion of influenza A HI titre 64 for participants with one vaccination was lower (9/77, 12%) compared to two vaccinations (46/235, 20%) (Figure 1). Similar proportions were observed for one vaccination (4/77, 5%) and two vaccinations (9/235, 4%) with antibody titres of 128.



*Includes titre results <4

Figure 1. Influenza A titre results by number of vaccinations, tertiary hospital in Sydney, Australia, 2007-2010*

The proportion of influenza B HI titre of 64 was similar with one (4/77, 5%) and two (11/235, 5%) vaccinations (Figure 2). A slightly higher proportion of participants with one vaccination (2/77, 3%) achieved titre levels of 128 compared to those with two vaccinations (2/235, 1%) (Figure 2).



*Includes titre results <4

Figure 2. Influenza B titre results by number of vaccinations, tertiary hospital in Sydney, Australia, 2007-2010*

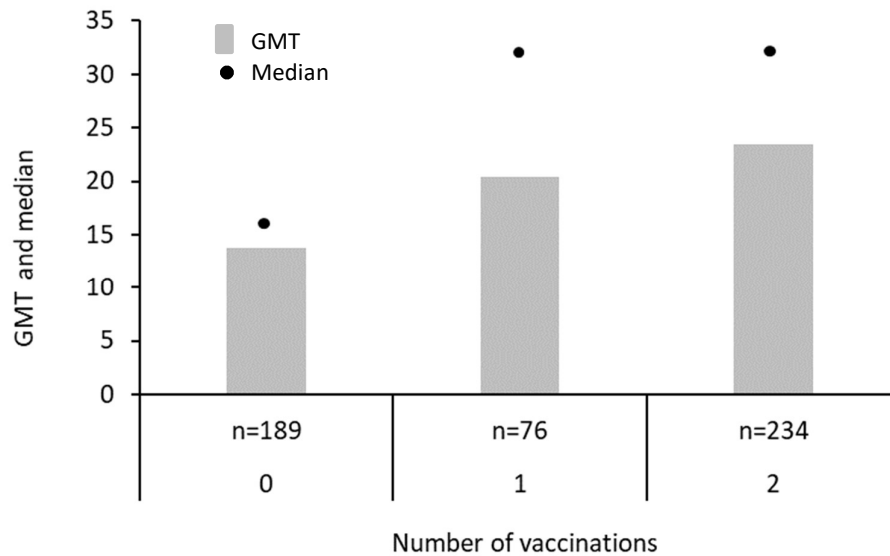
Measures of location

The geometric mean (GMT) and median antibody titres by number of vaccinations are presented as measures of location separately for influenza A and influenza B in Figures 3 and 4 respectively.

Influenza A GMT titres were lowest in unvaccinated participants and highest in those with two vaccinations (Figure 3). The same pattern was observed for influenza B GMT antibody titres (Figure 4). Influenza A GMT and median titres were higher compared to the corresponding measures for influenza B.

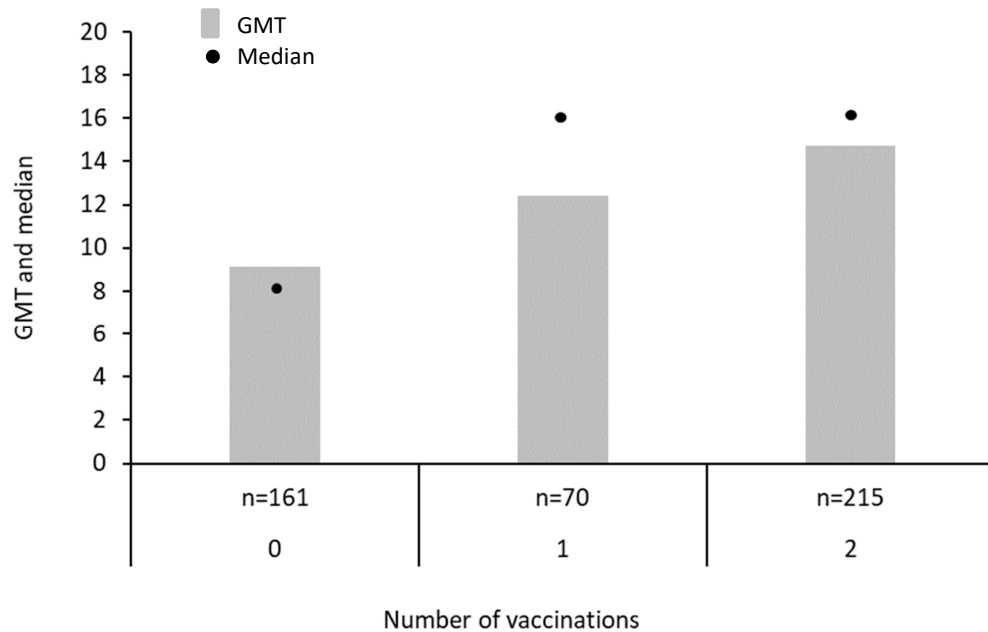
A Kruskal-Wallis H test was conducted to assess whether there were differences in antibody titre medians between groups that differed in number of vaccinations for influenza A, unvaccinated (n=188), one vaccination (n=76) and two vaccinations (n=234); and influenza B unvaccinated (n=161), one vaccination (n=70) and two vaccinations (n=16), separately. Distributions of influenza A and B titres were similar for all vaccination groups respectively, as assessed by visual inspection of a boxplot so met the assumption for similarity of distributions. Both influenza A and B median titres were statistically significantly different between different vaccination groups, A ($\chi^2(2) = 47.154$, $p < 0.001$) and B ($\chi^2(2) = 40.041$, $p < 0.001$), respectively. Post hoc pairwise comparisons with a Bonferroni adjustment showed statistically significant differences

of influenza A titres between the unvaccinated (median of 16) and one vaccination (median of 32) group ($p < 0.001$); and the unvaccinated and two vaccination (median of 32) group ($p < 0.001$). Statistically significant differences were also seen for influenza B titres between the unvaccinated (median of 8) and one vaccination (median of 16) group ($p = 0.002$); and the unvaccinated and two vaccination (median of 16) group ($p < 0.001$). There were no significant differences in median titres between 1 and 2 vaccinations for influenza A ($p = 0.98$) and B ($p = 0.5$), respectively.



*Excludes 4 participants with titres < 4 and 3 with 'non-specific' titres

Figure 3. Influenza A geometric mean and median titre results by number of vaccinations, tertiary hospital in Sydney, Australia 2007-2010*



*Excludes 57 participants with titres <4 and 3 with 'non-specific' titres

Figure 4. Influenza B geometric mean and median titre results by number of vaccinations, tertiary hospital in Sydney, Australia 2007-2010*

5.5.2 Vaccine effectiveness analysis

There were 559 participants included in the dataset used to calculate VE estimates. Demographic and health characteristics of these participants by vaccination status are shown in Appendix 5.A. Of the 559 participants, 10% (53/559) were influenza positive and 90% (506/559) influenza negative. Of the positive cases, 81% (43/53) had influenza A and 25% (13/53) influenza B. When participant characteristics were analysed by vaccination status, significant differences were found for age group ($p<0.001$), prior season vaccination ($p<0.001$), AMI ($p=0.02$) smoking status ($p=0.002$) and mobility ($p=0.008$) (Appendix 5.A). VE estimate calculations excluded participants vaccinated in the prior year only. Of these, 9 were positive for influenza and 43 were negative resulting in a total of 44 influenza positive participants and 463 influenza negative.

Unadjusted and adjusted VE estimates for influenza by number of vaccinations are shown in Table 2. In the univariate analysis, year of recruitment, age group, ethnicity, AMI, smoking and alcohol status, and mobility were statistically significant at the <0.25 level and were included in the multivariate model.

Compared with being unvaccinated, vaccination in both the study year and prior was significantly protective (adjusted VE, 97%; 95% CI: 77 to 100). VE could not be estimated for vaccination in the study year only due to no vaccinated influenza positive participants in the dataset (Table 2).

Table 2. Adjusted and unadjusted vaccine effectiveness estimates by number of influenza vaccinations, tertiary hospital in Sydney, Australia, 2007-2010*

Vaccination status	Influenza positive N=44		Influenza negative N=463		VE (95% CI)			
	n	%	n	%	Unadjusted	p Value	Adjusted	p Value
Not vaccinated	42	18	193	82	Ref		Ref	
Current year only	0	0	35	100	NE		NE	
Current and prior year	2	1	235	99	96 (81 to 99)	<0.001	97 (77 to 100)	0.001

Abbreviations: VE= vaccine effectiveness, CI=confidence interval, NE=not estimated

* Excludes 43 influenza negative and 9 influenza positive participants vaccinated in the prior year of recruitment into the study only

5.6 Discussion

This study found no evidence for reduced immunity when vaccinated in both the current and prior year. Higher immunogenicity against influenza A and B was observed in participants with two vaccinations, followed by one and none, as measured by GMT titres. Compared to being unvaccinated, significant differences in median titres were found for those with one and two vaccinations. These findings are supported by several studies that have found an increase in seroresponse with repeated vaccination for influenza A and B in both young adults and the elderly. (11, 17, 25) Pooled analysis from a meta-analysis of 12 serologic studies conducted during different time periods between 1971 to 1993 did not find a decrease in protection in multiple vaccination groups compared to single vaccination. (26) However, the authors noted that there was significant heterogeneity between trials.

Compared with being unvaccinated, vaccination in both the current and prior year was significantly protective (adjusted VE, 97%; 95% CI: 77 to 100). However, we were not able to calculate VE estimates for vaccination only in the study year (one dose) as there were no vaccinated influenza positive participants. Therefore, the study hypothesis that there is no difference between number of influenza vaccinations and vaccine effectiveness could neither be rejected nor accepted. Although the VE on the background of no past vaccination was technically 100%, the VE on the background of past vaccination was 97%.

This research does not support a negative effect of serial annual doses of vaccination. Several studies have been published that report higher VE estimates when vaccinated in both the current and previous season compared to one vaccination only in the current season. (13, 27-29) In a large cohort study of individuals aged 65 years and older, Örtqvist *et al.* (29) observed higher VE point estimates when vaccinated in both the current and prior year (VE range: 9% to 63%) than the current year only (VE range: 7% to 52%) in five of the six influenza seasons assessed. The trend in serological responses which we observed is in the same direction. However, other studies had opposite findings, demonstrating lower trends in serological response, (10, 15, 30-32) and reduced or minimal VE estimates (8, 9, 33) with repeated annual vaccination

compared to single or no vaccination. These trends were more pronounced amongst studies only considering the impact of two years of vaccination history (both current and prior vaccination). Only two studies demonstrated reduced effects amongst participants when vaccinated repeatedly over several years. (8, 30) Further variations have been found across influenza seasons, (34) by vaccine type (trivalent inactivated or live attenuated), (19) and by influenza subtype. (28, 35)

The immunology of influenza is complex and to date, there have been no conclusive explanations as to why multiple prior vaccinations may reduce serological response or vaccine effectiveness. This is a phenomenon that was first identified amongst British boarding school students in the 1970, subsequently named the Hoskin's paradox. (6) Several theories, however, have been postulated attempting to explain this finding.

One of the main theories for this variation is the antigenic distance hypothesis, which was proposed by Smith *et al.* (36) in 1999 using a computer model to simulate B-cell clones with different antigen specificities and vaccination status. This hypothesis works on the theory that differences in antigenic distance among vaccine strains and circulating epidemic strains impacts on vaccine efficacy. (36) A negative interference (high attack rate) is predicted when the current season influenza vaccine (v1) and prior season vaccine (v2) are antigenically similar and a positive interference (lower attack rate) results when the antigenic difference between v1 and the epidemic strain is small. (36) The antigenic distance hypothesis was tested in an observational study over three consecutive influenza A(H3N2) epidemics in Canada from 2010-11 to 2014-15. (33) Consistent with the conditions of the theory, vaccine strains for each season were similar and there was a mismatch between the vaccine and circulating strains. No positive interference was observed and a significant negative effect of prior vaccination (VE -33%; 95% CI: -78% to 1%) compared to single vaccination (VE 65%; 95% CI: 25% to 83%) in 2014-15 occurred. (33)

The antigenic distance hypothesis is subject to several limitations. The model only considers two years of vaccination history, which means that it cannot comprehensively explain the impact of additional prior vaccinations and natural exposure to influenza on the immune response. (36) These factors are discussed below.

It has been suggested that the first influenza strain an individual is exposed to leaves a defining immunological memory that then influences the future magnitude and quality of the antibody response. (37) This concept is known as the 'original antigenic sin' in which the body's immune system remembers the first influenza virus infection and, when infected by future strains the immune system is not able to mount an effective response as it is limited by the preferential response to the first infection. (37) This may explain, in part, why individuals respond better to vaccine strains that are antigenically similar to the very first influenza virus they were exposed to. This has been described in studies assessing levels of influenza protection based on the influence of immune memory and antibody response to subsequent exposure of variants of the A(H1N1) 2009 pandemic strain. (38, 39) It may also explain why fewer people aged 65 years and over were affected during the 2009 pandemic compared to younger age groups. (40-42) Our study was restricted to participants aged 40 years and older, meaning that study participants would have been exposed to influenza strains circulating 50-60 years ago that have been found to confer protection against the A(H1N1) 2009 pandemic virus. (43) Given that participants were recruited into the original study during 2009 and 2010 (the two years where the dominant circulating strain was A(H1N1)pdm09), the effect of the original antigenic sin would be relevant to assess in this study, however, we did not assess influenza seasons separately and this would be restricted by the sample size.

In addition to the first exposure to influenza, evidence suggests previous influenza infection can also influence the antibody response to subsequent strains, however, findings are inconsistent. (44, 45) A recent study in Japan observed reduced VE estimates among people with no recent history of influenza infection and repeated vaccination. (44) In contrast, higher VE estimates have been associated with recent natural infection. (45) The ability to assess the impact of first infection of influenza and prior natural exposure is important to inform the extent to which this influences immune response, however, access to this information is difficult as it is not routinely collected. Future studies should consider the role of naturally acquired influenza on serological response and VE.

A final consideration when investigating the immunology of influenza vaccination is the impact of intra-seasonal waning of the vaccine, which has been reported (46-48). It has been described that within four months post-vaccination, vaccine induced antibodies decline to below seroprotective levels (49) with young children and elderly adults most affected. (50, 51) This is another factor adding to the complexity of the immunology of influenza vaccination. Modelling of intra-seasonal waning was not conducted for this study. To assess immune response, antibodies are measured pre and approximately one-month post-vaccination in serologic studies (15, 31, 52) and by the test-negative design for VE estimates, (8, 33) which does not capture information required to assess waning. In addition, to provide evidence for waning immunity, large observational studies are also needed to demonstrate more precise VE estimates from time since vaccination. (53)

In summary, this study found no evidence of a detrimental effect of serial annual influenza vaccinations, nor a case for changing current recommendations. Influenza is a serious infection, and the vaccine is recommended annually for high risk groups. (5) Even if immunity is lower with serial vaccination, if it provides some protection from influenza infection, then this is still worthwhile, particularly for high risk groups.

5.7 Strengths and Limitations

The study was strengthened by GP validated vaccination data, which reduced the chance of recall bias and misclassification which would occur through self-report. We did, however, reclassify vaccination status for a subset of participants to unvaccinated when GP validation could not be confirmed (refer to methods section) which may have impacted on the findings due to misclassification. The use of PCR and paired sera allowed for two methods for influenza detection. This provides confidence that all influenza positive cases were detected and reduces the chance of misclassifying influenza outcome.

One of the main limitations of this study was the small sample size. This meant that VE could not be calculated for vaccination in the study year only nor by influenza subtype.

VE estimates are dependent on sample size. (54) Large sample sizes are required to ensure an adequate number of both infected and uninfected participants as well as vaccinated and unvaccinated groups, to calculate a more precise VE estimate and increase the power of the hypothesis tests to an effect. Small sample size limitations associated with VE estimates have been reported. (55) As the sample size in our study was small, the power of the hypothesis tests used in this study were low, which made it more challenging to be able to detect significant differences between groups, and could be why no significant difference was detected between the groups with one and two vaccinations within the serological analysis.

We did not have data on vaccination status beyond two years, which may limit the applicability of findings on serological immune response as studies have reported that the response may differ based on number of prior vaccinations. (8, 16) Additionally, swabs and blood tests were collected after vaccination only. This meant that we could not assess the extent to which post-vaccination titres changed in response to current season vaccination as pre and post-vaccination immune response was not measured. Some studies have reported that pre-vaccination titres affect post-vaccination titres, high pre-vaccination titres are associated with reduced seroconversion but increased seroprotection rates. (26, 32, 56)

Potential confounders have been associated with impaired immune response to the influenza vaccine (22, 57) and include age, sex, chronic conditions, heart failure and autoimmune conditions. These covariates were not adjusted for in the serological analysis and may have impacted on the findings, however, this was an initial exploratory analysis and the effect of confounders should be considered in future analyses.

5.8 Conclusion

Annual vaccination is the primary measure used to protect against influenza infection, however, the effects on immune response remain poorly understood. On its own, the findings from this study are limited in their ability to contribute to the evidence regarding the effect of multiple vaccinations on protection against influenza. Further studies are needed to explore the relationship of underlying factors such as intra-

seasonal waning, prior natural exposure and longer history of vaccination on the influenza vaccine induced immune response to help guide vaccination policies.

5.9 References

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5.10 Appendices

5.A. Descriptive characteristics of participants by influenza outcome, 2007-2010

	Influenza Positive (N=53)		Influenza negative (N=506)		Total (N=559)		p Value *
Characteristic	n	%	n	%	n	%	
Recruitment year							
2008	13	24.5	188	37.2	201	36.0	0.09
2009	20	37.7	190	37.6	210	37.6	
2010	20	37.7	128	25.3	148	26.5	
Age group							
40-64	36	67.9	207	40.9	243	43.5	<0.001
>65	17	32.1	299	59.1	316	56.5	
Sex							
Male	35	66.0	311	61.5	346	61.9	0.51
Female	18	34.0	195	38.5	213	38.1	
Ethnicity**							
Caucasian	35	68.6	402	79.5	437	78.5	0.32
Asian	9	17.6	65	12.9	74	13.3	
Aboriginal or Torres Strait Islander	1	2.0	6	1.2	7	1.3	
Other	6	11.8	33	6.5	39	7.0	
Marital status***							
Married/ de facto	36	75.0	305	63.8	341	64.8	0.38
Widowed/separated /divorced	11	22.9	139	29.1	150	28.5	
never married	1	2.1	32	6.7	33	6.3	
Other	0	0.0	2	0.4	2	0.4	
Language spoken at home^							
English	45	88.2	424	83.7	469	84.2	0.41
Other	6	11.8	82	16.2	88	15.8	
Prior season vaccination							
Not vaccinated	42	79.2	193	38.1	235	42.0	<0.001
current year only	0	0.0	35	6.7	35	6.3	
current and prior year	2	3.8	235	46.4	237	42.4	
prior year only	9	17.0	43	8.5	52	9.3	
AMI							
Yes	34	64.2	241	47.6	275	49.2	0.02
No	19	35.8	265	52.4	284	50.8	
Smoker [§]							
Current	19	38.0	88	17.6	107	19.5	0.002
Former	17	34.0	188	37.7	205	37.3	
Non	14	28.0	223	44.7	237	43.2	

Alcohol consumption[†]							
Sometimes/daily	34	66.7	278	55.7	312	56.7	0.13
Never	17	33.3	221	44.3	238	43.3	
Mobility[‡]							
Is mobile	43	15.7	333	66.2	376	67.9	0.008
Not mobile [#]	8	84.3	170	33.8	178	32.3	
Altered immune function medication^{††}							
Any	22	41.5	205	40.5	227	40.6	0.89
None	31	58.5	301	59.5	332	59.4	
Self-reported							
Diabetes	11	20.8	127	25.1	138	24.7	0.49
Asthma	7	13.2	53	10.5	60	10.7	0.54
ILI [¶]	10	25.6	74	24.7	84	24.8	0.9

*Pearson chi squared test

** excludes 2 participants with missing data

*** excludes 33 participants with missing data

[^] excludes 2 participants with missing data

[§] Excludes 10 participants with missing data

[†] Excludes 9 participants with missing data

[‡] Excludes 5 participants with missing data

[#] not mobile includes some problems walking and confined to bed

^{††} Is taking cortico or inhaled steroid medication

[¶] excludes 220 participants with missing data

Chapter 6: MAE teaching experience

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6.1 My role and lessons learned

The MAE requires scholars to conduct two exercises to demonstrate their teaching capabilities. These are a lesson from the field (LFF) and a teaching session for the first year MAE cohort during course block.

6.1.2 Lesson from the field

Due to the large size of the 2017 MAE cohort, we divided into smaller groups for the LFF sessions. My group consisted of Patiyan Andersson, Kelley Meder, Sophie Phelan, Natalie Strobel and Kaitlyn Vette. I participated in all five LFFs from February to August 2018 and conducted my LFF on 1 August 2018.

My LFF was titled “Using content analysis to analyse qualitative data” (Appendix 6.A) and was drawn from my experience analysing qualitative data as part of my epidemiological study. As our lectures during course block focused on the quantitative aspects of research, I saw an opportunity to show my fellow MAE colleagues the qualitative side. My LFF involved using content analysis to analyse part of a transcript from the stakeholder workshop I conducted (Chapter 2) with the assistance of NVivo version 11, a qualitative data analysis software package. My role included lesson planning, piloting the LFF and conducting and facilitating the lesson.

This was the first time I had conducted a formal teaching session. Reflecting on the task, I found that developing a lesson and preparing the corresponding teaching material takes a lot more time than I had initially envisaged. I also found that having to teach this topic in-turn led me to have a greater understanding of the concepts of qualitative research. It was also interesting to see the variation in how participants coded and categorised the data and discussed the influence of past experience on this. For future teaching, I would try to test exercises prior to implementation to get a sense of how it would work in practice and rectify issues. I had planned to get consensus from participants on the codes and categorisations from a subset of the transcript during the lesson, but in reality, this turned out to be quite difficult and time consuming, partly due to the set-up of the session being a videoconference. Nevertheless, I was still able to get the concept across to the group.

I developed a short evaluation survey on SurveyMonkey (Appendix 6.B) and received responses from four of the five participants. Overall, my LFF met its purpose and objectives, tasks were clear, it was an enjoyable experience for participants and was conducted in a reasonable time. Participant understanding of analysing qualitative data using content analysis was improved through my LFF. Appendix 6.B contains results from the evaluation survey.

6.1.3 Teaching session for first year MAE cohort

Our cohort was allocated three hours to conduct the teaching session for first year MAEs. We broke into four small groups based on common themes/skills we were interested in teaching. Twenty minutes were allocated for each group to conduct a formal classroom-based session. Following a short break, we provided a presentation containing an “MAE hot tip” from each second year MAE. The final 1.5 hours were allocated to four interactive epidemiology based teaching activities. Table 1 below provides an outline of all teaching sessions.

Table 1. MAE teaching session 2018

Session item	Time
Teaching session 1	
Communicating as a Field Epidemiologist in Public Health Emergencies	20 minutes
Writing tips	20 minutes
Logic models	20 minutes
Ethical considerations in surveys	20 minutes
Second year MAE hot tip	10 minutes
Teaching session 2	
Personal Protective Equipment	20 minutes
Epidemiology playdough activity	20 minutes
Epidemiology Pictionary activity	20 minutes
Epidemiology charades activity	20 minutes

For the first, formal teaching session, I formed a group with Patiyan Andersson, Sophie Phelan and Ximena Tolosa. Our teaching session was based on our prior and current

project experiences working with stakeholders in the Pacific region. We had identified that one of the most important skills for the success of our projects within these settings was effective communication. Thus, we decided to fill a gap we identified in our MAE course block lectures, to provide a teaching session on communicating with different stakeholders in a variety of field epidemiology roles. Our session was titled “Communicating as a Field Epidemiologist in Public Health Emergencies.” Appendix 6.C provides the presentation for this session. Our teaching session began with a case study of a hypothetical outbreak following a natural disaster in a Pacific island country. First year MAEs were divided into three groups and took on three different epidemiologist roles that required them to identify and communicate essential information to three different stakeholders. My role involved facilitating the group discussion on data collection and reporting issues at a local health clinic and feeding back answers.



The second teaching activity that my group conducted required first year MAE scholars to correctly don and doff Personal Protective Equipment (PPE) following the World Health Organization PPE donning and doffing guidelines. Once in PPE, scholars were sprayed with glitter, representing infectious bodily fluids and aerosols (see photo left: Sophie Phelan spraying participant in PPE). After removing the PPE, if scholars

were covered in glitter, it would indicate that guidelines were breached. The idea and PPE supplies for this activity came from participating in a study my field supervisor Dr Abrar Chughtai had conducted.

Each member of the group contributed to lesson planning, development of materials and the introduction or facilitation of the activity. I found that it was important to develop a limited number of simple objectives for this teaching session to keep within time. Our group also had many ideas we wanted to incorporate into the session, but

with the time limit this was not feasible. Referring back to the objectives as a reminder helped to keep us on track and reach a consensus. I also found that the group discussion we incorporated was the most important aspect to engage participants and in future I will incorporate different learning methods and activities into teaching sessions and allow adequate time.

Overall and surprisingly, I found both teaching exercises quite enjoyable and it was fulfilling to share knowledge and learnings with others.

We also conducted an evaluation of the first-year teaching session using SurveyMonkey, seeking feedback from both cohorts. Overall, the majority of respondents (n=27) found the format, presenter style and session content on communicating during public health emergencies either useful or highly useful. Results are presented in Appendix 6.D.

6.2 Acknowledgements

I would like to acknowledge the support of my academic supervisor, Dr Tambri Housen for assisting with my LFF and Jana Sisnowski for trialling the LFF. Also, the 2018 MAE Cohort, in particular:

- My LFF group: Patiyan Anderson, Kelley Meder, Sophie Phelan, Natalie Strobel, and Kaitlyn Vette.
- My MAE teaching session group: Patiyan Anderson, Sophie Phelan and Ximena Tolosa.

6.3 Appendices

Appendix 6.A: Lesson from the field

Using content analysis to analyse qualitative data

Zoom teleconference details:

Date: 1 August 2018

Time: 11am AEST / 9am AWST

Connection details: <https://uwa.zoom.us/j/345698584>

Instructions: For this lesson, you will need to download a free version of NVivo, a software tool for qualitative data analysis at: <https://www.qsrinternational.com/nvivo/trial>. Select the 'free trial' link and then the appropriate version for your computer and complete sign-up details. Select the 'trial NVivo 12 for 14 days' option and the 'NvivoPro' version (sorry for all the info you need to provide). Note that this free trial is only available for 14 days.

Learning objectives: By the end of this lesson, you should be able to:

- Understand the difference between inductive and deductive approaches to qualitative analysis
- Understand steps of content analysis to analyse qualitative data
- Analyse a qualitative transcript using content analysis methodology
- Create nodes in NVivo to help analyse your data
- Develop codes, categories and themes as part of your qualitative analysis

Resources: Please read the following paper outlining a hands-on guide to undertaking content analysis, which provided useful guidance for developing this lesson:

Erlingsson C, Brysiewicz P. A hands-on guide to doing content analysis. *African Journal of Emergency Medicine*. 2017;7(3):93-9. <https://doi.org/10.1016/j.afjem.2017.08.001>

Additional resources:

- NVivo training manual:
<http://download.qsrinternational.com/Document/NVivo11/11.3.0/en-US/NVivo11-Getting-Started-Guide-Pro-edition.pdf>
- Video on how to code in NVivo (note that there may be slight differences due to software versions): <https://www.youtube.com/watch?v=IDYZe0obn-4>
- Additional information on content analysis: Graneheim UH, Lundman B. Qualitative content analysis in nursing research: concepts, procedures and measures to achieve trustworthiness. *Nurse Education Today*. 2004;24(2):105-12.
- For some information on the difference between content and thematic analysis: Vaismoradi M, Turunen H, Bondas T. Content analysis and thematic analysis: Implications for conducting a qualitative descriptive study. *Nursing & health sciences*. 2013;15(3):398-405.

Background:

Emerging and re-emerging diseases are a significant threat to global health security. The Asia-Pacific region has been the global epicentre for many emerging infectious diseases, including some with pandemic potential, for example severe acute respiratory syndrome. Understanding countries' needs to be able to detect and respond to infectious disease risks is critical to global health security.

Given this context, upon starting your placement as a trainee field epidemiologist, you were tasked with organising a stakeholder workshop with representatives across government and non-government organisations from the Asia-Pacific region who use epidemic intelligence. The aim of the workshop was to identify the epidemic intelligence needs and challenges of stakeholders in the Asia-Pacific region to inform how these needs can be addressed by the work being undertaken by your field placement organisation.

The workshop has been completed and you have arranged for the discussions to be transcribed. Your role now is to qualitatively analyse the workshop discussions. A sample transcript from the workshop has been provided for you to analyse. **Note that this is confidential and not for distribution outside of this LFF.**

Question 1: There are two broad methods for approaching qualitative analysis, inductive and deductive analysis. State what method you would select for this analysis and briefly explain why.

Task 1: Open NVivo

Open NVivo and follow these steps to set up a new project:

1. select **blank project**
2. Write the name of your project in the **Title** box
3. Enter project description: *[This is useful, particularly if you are working on different projects or across a team, however, you can leave this blank]*
4. Tick the “write user actions to project event log”
5. Click **Browse** → select directory where you want to locate your project → Click **Save** → **OK**
6. The workspace (see below image) for you project will appear

The NVivo work space

See the contents of a folder in **List View**.
When you open items in a folder, they display in **Detail View**

Access Help

The ribbon helps you to locate all NVivo commands

Navigation View lets you organize your material into folders

Check the **Status bar** to see what is happening in your project

Work with your sources, nodes or other project items in **Detail View**.
Undock to work with your content in a separate window

The screenshot shows the NVivo workspace with the following components:

- Ribbon:** Contains tabs for HOME, CREATE, DATA, ANALYZE, QUERY, EXPLORE, LAYOUT, and VIEW. The ANALYZE tab is currently active, showing options for Nodes, Queries, and Reports.
- Navigation View:** A tree view on the left side of the workspace, showing the project hierarchy. It includes folders for Sources, Nodes, Classifications, Queries, Reports, and Maps. The 'Sources' folder is expanded, showing a list of interview transcripts.
- List View:** A table in the center of the workspace displaying the contents of the selected folder (Interviews). The table has columns for Name, Nodes, and References. It lists interviews such as 'Barbara', 'Betty and Paul', 'Charles', 'Dorothy', 'Helen', 'Ken', 'Margaret', 'Mary and James', 'Richard and Patricia', 'Robert', 'Soren', 'Thomas', and 'William'.
- Detail View:** A large area on the right side of the workspace, showing the content of the selected item (Interview: Betty and Paul). It includes a video player, a timeline, and a text area with the transcript of the interview.
- Status Bar:** Located at the bottom of the workspace, it displays information about the current project, including the number of sources, nodes, and references, and the current view mode (List View).

Task 2: Import your data

You can import a wide range of materials (called sources) into NVivo such as articles, interviews, survey results, audio/video recordings, pictures and web pages.

To import your transcript:

1. Select the **Import** tab
2. Select **Files**
3. Select the data file (transcript) to import and **ok**
4. Select **ok** in the **Document Properties** box

You should see your transcript in the **List View** screen. Double click on the transcript to view/open it in the **Detail view** screen. From here you can start to manipulate your data.

Task 3: Content analysis

Once you've decided on the general approach to use, you need to decide which methodology you are going to take to analyse your data. This is important to ensure that you take a systematic approach so that your findings are credible and useful and others can replicate the methodological approach. There are a number of methods that you can use, however, you decide that a content analysis approach is the best way to go. The aim is to systematically convert your text (data) into an organised summary of key results. There are six steps as outlined below, with a number of tasks within that you will need to complete:

Step 1

The first step of content analysis is to read and re-read your data until you become familiar with the content. Make sure as you are reading you keep the research question and aim in mind to give purpose and focus to what you are reading.

Task 4: Read the transcript excerpt from the workshop a few times. You can use a highlighter or jot down notes on things that start to stand out in relation to your research question. The research question is to identify the epidemic intelligence needs and challenges of stakeholders in the Asia-Pacific region.

Step 2

The second step is to organise your data, for example, by question if you have multiple interviews. As we are using a single transcript in response to one question, there is no need to organise this data any further.

Step 3

The third step is to code your data and develop categories and themes. We will be using NVivo to help with this.

Coding is a system to organise your data, that reduces it down into small chunks of meaning. A code can be thought of as a label; a name that best describes what a particular piece of text is about. Codes are usually one or two words long. You need to make sure that you code each segment of data/text that is relevant or captures something interesting about your research question. Some questions to ask yourself as you read through your transcript to help with coding include:

- What is this saying? What does it represent?
- What is this an example of?
- What do I see is going on here?
- What is happening?
- What is trying to be conveyed?

Task 5:

To create codes in NVivo:

1. In the **Detail view**, highlight a section of text from the transcript that you want to code → right click
2. Select **Code → Node → New node**
3. Type in the code name you want to allocate to this particular piece of text → **ok**
4. Right click on the node you've created → **node properties** → Check the box 'aggregate coding from children' which will allow you to create a hierarchy of nodes. You will need to do this for each new node created.
5. In the description you can type in a brief explanation of what the code is about. This can help with developing a code book
6. As you continue coding, you will see how many times a piece of text has been coded with the same name under 'references' in the list view.

Note: To code to the same node, highlight the piece of text, select **code to recent nodes** and select the relevant code name from the list. To uncode a piece of text double click on the node → select **uncode (or uncode from recent nodes)** and select the relevant node it was coded to. You can re-name nodes from the properties box

To save a list of all the coded text to file in a word document:

1. Right click on the code/node
2. Select **export → export node**
3. Select **reference view**
4. Select the location to save the file
5. **ok**

List the codes you came up with and the number of references you found in the transcript alongside each node. Please also provide a word document of the top two codes with the most references.

Code	Number of references

Step 4

The next step in content analysis is to develop categories from your codes. A category is made up of a number of codes that are related to each other, cover the same issue, have similar meaning. Categories answer the questions of who, what, when or where? Category names are usually short and factual. It is important that codes are not represented in two or more categories at the same time (they need to be mutually exclusive). If you find that your codes apply to more than one category, you may need to create narrower sub-categories and then aggregate these into categories.

Task 6:

To review text excerpts with the same codes in NVivo, double click on one of the nodes. A list of all of the text you have selected relevant to that code will display in the detail view. This is one of the most useful parts of NVivo in that it collates all the codes/themes from your data in one spot. You can also look to see where each piece of text is located in the transcript by clicking on the link at the top of the codes.

Review your codes and group them into categories. List your categories along with the relevant codes below:

Code name	Category name

NVivo: creating a hierarchy of nodes

You can create a hierarchy of nodes in NVivo to help manage your codes and categories. To create a new node for a category:

1. Select the **create** tab
2. Select **node**
3. Type the name of your category in the name field
4. Ensure you tick the box 'aggregate coding from child nodes' then **ok**.

To file all of the codes relevant to that category, select the relevant code and drag and drop it into your category node (it can be a little temperamental sometimes). You can expand the selection from the + sign.

Note: the top level node is called a 'parent node', the next level a 'child node' and if you create another level down it would be a 'grandchild node.'

Step 5

The fifth step in content analysis is to create themes from your categories. Themes are a way to express underlying meaning of your data on a more interpretative level. They summarise overarching findings across two or more categories. Theme names can be quite descriptive as they answer questions such as why, how, in what way or by what means?

Task 7:

Provide a theme that emerges from the codes and categories you have created. Include the related codes and categories below

Theme	Code	Category

Step 6

An important step in qualitative research is to review and revise your coding system. This is not a linear process and should be done at each step of coding, categorising and creating themes. Once you have finished analysing your data, you should compare your results with another researcher who also undertook the same analysis independently. The aim is to assess concordance of codes, categories and themes which would indicate that at least two people drew the same conclusions from the data. Differences in opinion can be resolved through discussion between the two researchers, with a revised consensus code, category, or theme then applied to the data. If you can't agree on a particular aspect, a third researcher can be brought in for another perspective. This process is referred to as researcher triangulation and is important in qualitative research to ensure reliability in your data.

Step 7

The final step is to write up your results.

Other: pre-understandings

It's important that you maintain an awareness of your pre-understandings, such as assumptions, previous experience and knowledge on the subject matter during qualitative analysis as this can affect how you analysed the text and bias your findings.

Task 8:

During the analysis, did you find that your previous knowledge and experience affected how you analysed the text? If so, in what way?

Appendix 6.B: Lesson from the field survey results

Question	Response
1. The purpose and objectives of the LFF were clear*	Strongly agree: 100% (4/4)
2. The LFF met its purpose and objectives*	Strongly agree: 100% (4/4)
3. The tasks outlined in the LFF were easy to understand*	Strongly agree: 75% (3/4) Agree: 25% (1/4)
4. There was sufficient information provided to complete the tasks*	Strongly agree: 100% (4/4)
5. The time to complete the LFF was reasonable*	Strongly agree: 75% (3/4) Agree: 25% (1/4)
6. I have a better understanding of how to undertake qualitative content analysis*	Strongly agree: 100% (4/4)
7. Name at least one thing you learnt from the content analysis LFF	Participant 1: That qualitative analysis can be very structured and reproducible. Participant 2: How to do nodes and codes in Nvivo Participant 3: The coding and categorisation process. Participant 4: How to code.
8. Name at least one thing that could be improved in the content analysis LFF	Participant 1: It is a hard topic, especially if you have never worked with it before. Aurysia did a great job both with the task itself, but also in providing appropriate reading. I can't think of anything that was missing. Participant 2: I have nothing. I really liked how it was run. Participant 3: I thought it was really informative and well put together. Participant 4: Nothing, it was great!
9. Overall, I enjoyed the LFF*	Strongly agree: 100% (4/4)

*A five-point likert scale was used for questions 1-6 and 9. Response options included strongly agree, agree, neither agree nor disagree, disagree, strongly disagree.

Appendix 6.C: MAE teaching session presentation

Communicating as a Field Epi during Public Health Emergencies



Learning objectives

1. **Understand** your role as a Field Epidemiologist investigating an outbreak within the context of a complex, fast evolving, humanitarian emergency.
2. **Communicate** to different audiences as a part of your role as Field Epidemiologist.
3. **Work and deliver** relevant information under time pressure.

Scenario

You are the Field Epi on deployment to a post disaster zone. **There has been a cholera outbreak following a tsunami in a coastal urban centre in a Western Pacific country.**

Today, you have three stakeholders that you need to communicate to:

1. Interagency members at daily Situation Report meeting
2. Data collectors at local health care clinic
3. Your incoming replacement Field Epi (another GOARN volunteer)

Lead Field Epi presenting at a daily interagency Situation Report meeting

1. Recent data (24 hours)
2. Any problems? Eg increase in cases in clinic 4 (they have asked for help), no reporting from clinic 2.
3. In-country situation (is there still an influx of people?)

Method: short talk, use PowerPoint/whiteboard to assist if available

Field Epi discussing data collection with local clinic staff (who have stopped reporting)

1. Ask what is going on, and discuss what additional support would be helpful
2. Explain the significance of the outbreak in terms of how it is affecting their local area (local stats so far), and how important their data is in contributing to the bigger picture of solving the outbreak.
3. Develop a feedback loop so they can see how their data is contributing to the big picture (ie brief 1 page epi report disseminated among health care clinics)

Method: Arrange a field visit to discuss in person. Be aware of cultural faux pas!

Handover to the next Field Epi

1. Contact details of MoH, WASH, etc people you were dealing with
2. Explain what stage the work is at
3. Hard and soft copies of all documents

Method: meet in person, connect over email prior if possible, leave soft/hardcopy backups if you can.

Appendix 6.D: MAE teaching session evaluation results

Question	Response options	Number (n=27)	%
Please rate how you found the format of the session:	Not of use	0	0
	Minimal use	1	4
	Neutral	1	4
	Useful	12	44
	Highly useful	13	48
Please rate how you found the presenter's style	Not of use	0	0
	Minimal use	0	0
	Neutral	2	7
	Useful	12	45
	Highly useful	13	48
Please rate how you found the session content	Not of use	0	0
	Minimal use	1	4
	Neutral	2	7
	Useful	14	52
	Highly useful	10	37