Australian Government
Australian Institute of Health and Welfare

# A collaborative approach to national surveillance for respiratory epidemics, including thunderstorm asthma epidemics

AIHW

Australian Government
Australian Institute of Health and Welfare

# A collaborative approach to national surveillance for respiratory epidemics, including thunderstorm asthma epidemics

**Summary of a workshop held on 3 May 2017 in Canberra entitled ‘Developing a national surveillance approach for respiratory epidemics’**

**Hosted by the Australian Centre for Airways disease Monitoring (ACAM) and the Australian Institute of Health and Welfare (AIHW)**

Australian Institute of Health and Welfare
Canberra
Cat. no. ACM 34

**The Australian Institute of Health and Welfare is a major national agency whose purpose is to create authoritative and accessible information and statistics that inform decisions and improve the health and welfare of all Australians.**



A complete list of the Institute's publications is available from the Institute's website <www.aihw.gov.au>.

ISBN 978-1-76054-400-3 (PDF)
ISBN 978-1-76054-401-0 (Print)

**Suggested citation**

Australian Institute of Health and Welfare 2018. A collaborative approach to national surveillance for respiratory epidemics, including thunderstorm asthma epidemics. Cat. no. ACM 34. Canberra: AIHW.



Any enquiries relating to copyright or comments on this publication should be directed to:
Australian Institute of Health and Welfare
GPO Box 570
Canberra ACT 2601
Tel: (02) 6244 1000
Email: info@aihw.gov.au

Published by the Australian Institute of Health and Welfare

This publication is printed in accordance with ISO 14001 (Environmental Management Systems) and ISO 9001 (Quality Management Systems). The paper is sourced from sustainably managed certified forests.

MIX
From responsible sources
FSC® C017269
FSC
www.fsc.org

**Please note that there is the potential for minor revisions of data in this report. Please check the online version at <www.aihw.gov.au> for any amendments.**

# Contents

# Acknowledgments

The authors of this working paper were Guy Marks, Helen Reddel, Leanne Poulos and Rose Ampon from the Australian Centre for Airways disease Monitoring (ACAM). Thanks are due to the medical writer, Beejal Vyas-Price, who helped to prepare this working paper.

The support of David Muscatello and Tim Churches in sharing their experiences by presenting on the day, chairing sessions and helping to identify other experts, speakers and participants is gratefully acknowledged.

The speakers and the participants are thanked for giving their time to attend the workshop and for sharing their expertise.

The assistance of Peta Craig, Claire Sparke, Naila Rahman, Lynelle Moon, Fleur de Crespigny, Sophie Lindquist, Miriam Lum On, Katherine Faulks, Richard Juckes and Lucinda Macdonald (Australian Institute of Health and Welfare) is also acknowledged.

The Department of Health funded this work.

### Disclaimer

# Abbreviations

| | |
|---|---|
| ACAM | Australian Centre for Airways disease Monitoring |
| AIHW | Australian Institute of Health and Welfare |
| app | application |
| CDNA | Communicable Diseases Network Australia |
| CD Plan | Emergency Response Plan for Communicable Disease Incidents of National Significance |
| COPD | chronic obstructive pulmonary disease |
| CSIRO | Commonwealth Scientific and Industrial Research Organisation |
| CUSUM | cumulative sum |
| DHS | Department of Human Services |
| ED | Emergency Department |
| ELR | electronic laboratory reporting |
| EWMA | exponentially weighted moving average |
| GP | general practitioner |
| HIV | human immunodeficiency virus |
| HL7 | Health Level 7 |
| HTML | Hypertext Markup Language |
| ICD-10 | International Classification of Diseases and Related Diseases, 10th Revision |
| ICU | intensive care unit |
| ILI | influenza-like illness |
| IT | information technology |
| MPDS | Medical Priority Dispatch System |
| NCIMS | Notifiable Conditions Information Management System |
| NHMRC | National Health and Medical Research Council |
| OTC | over-the-counter |
| PBS | Pharmaceutical Benefits Scheme |
| PHREDSS | Public Health Rapid, Emergency, Disease and Syndromic Surveillance |
| POLAR | Population Level Analysis and Reporting |
| SNOMED—CT | Systematized Nomenclature of Medicine—clinical terms |
| STT | speech-to-text |
| TC | text classification |
| UNSW | University of New South Wales |

# Overview

This document outlines the content of the workshop titled ‘Developing a national surveillance approach for respiratory epidemics’ (held in Canberra on 3 May 2017) and provides a summary of workshop proceedings.

Workshop participants included various expert stakeholders involved in health protection (such as departmental representatives, both state and national), statisticians, data custodians, environmental experts, health advocacy group representatives, clinicians, hospital administrators and researchers.

The expert advice provided by this large array of participants is outlined in full summaries of every presentation on the day. Also described are issues for further consideration that were discussed on the day.

The appendixes present the workshop program, speaker biographies and a list of workshop participants.

This document is intended as a resource for policymakers, hospital administrators, clinicians, researchers and peak organisations.

A great deal of work was carried out by the Victorian Government, the National Asthma Council Australia and other authorities after the epidemic thunderstorm asthma event on 21–22 November 2016, including the introduction of a forecasting system on 1 October 2017. Details of relevant media releases, reports and other internet resources are in Appendix A.

# 1 Background

Respiratory illnesses commonly occur in clusters or epidemics and may be attributed to a diverse range of exposures. These exposures include communicable diseases such as influenza, severe acute respiratory syndrome, *Legionella pneumophila*, rhinovirus and other infectious pathogens. They also include non-communicable conditions caused by exposure to agents such as sulphur dioxide and other oxidants, smoke and other particulates, volatile organic hydrocarbons, soybean dust, *Alternaria* and other moulds, pollens and other allergens. Agents released in a bioterrorism episode could also potentially cause outbreaks of respiratory illness. It is important to recognise, though, that in many cases the cause of outbreaks of respiratory illness is unknown, at least initially.

The tragic events in Victoria on 21 November 2016, when 10 people died and several thousand were hospitalised due to 'thunderstorm asthma' focused attention on respiratory epidemics, including those related to asthma. This event highlighted the largely unpredictable nature of epidemics and the need for better monitoring and surveillance not only to be prepared for them, but also to identify them and to respond rapidly and appropriately when they occur.

## Thunderstorm asthma—example of a respiratory epidemic

An epidemic is an unusually high occurrence of a disease or illness in a population or area. Often associated with infectious conditions such as influenza, the term is also appropriate to describe a sudden increase in the prevalence of non-communicable diseases, such as asthma. The term 'outbreak' has essentially the same definition as 'epidemic', but tends to be used to describe a sudden increase in the number of cases of a disease in a more limited geographic area.

Thunderstorm asthma is a type of asthma 'epidemic' or 'outbreak' that is triggered by a specific type of thunderstorm, coupled with high pollen or fungal allergen levels. In Australia, these outbreaks have been observed when a thunderstorm occurs during the pollen season (late spring to early summer)—when conditions are hot and windy and there are high levels of rye grass pollen in the air. The storm front causes the pollen grains to absorb moisture until they burst into tiny, inhalable particles that are blown down to ground level in the outflow preceding the thunderstorm. At ground level, people in the path of the thunderstorm inhale these particles into the airways within the lungs. In sensitised (allergic) individuals with twitchy airways (that is, pre-existing asthma or a predisposition to asthma), this triggers bronchoconstriction (narrowing of the airways), which causes symptoms such as chest tightness, shortness of breath, coughing and wheezing. In severe cases, it may cause severe respiratory distress and, rarely, death.

### How predictable is thunderstorm asthma?

Prediction of thunderstorm asthma is complex since it involves interactions between meteorological factors, airborne allergens and human factors. Several factors need to align for a thunderstorm asthma epidemic to occur, namely:

- allergenic material in high concentrations (high pollen count or high spore count)
- outflow of colder air producing a high concentration of respirable allergenic particles
- strong multicellular thunderstorm system producing a downdraught

- exposure of people who are allergic to the relevant allergen and/or have asthma to the downdraught carrying the allergenic particles.

Several other factors that may be important in predicting thunderstorm asthma are rainfall during winter, the timing of the pollen season, the temperature/humidity/pollen count in the preceding days, the temperature/humidity/wind speed and direction/pollen forecast on the day, characteristics of the thunderstorm (including the type of thunderstorm and the direction of movement) as well as information on the exposure (such as the time of day and location of the gust front).

Thunderstorm asthma events are unusual in terms of the severity of their effects (compared with other environmental hazards) and the speed of their onset (compared with, for example, an influenza epidemic). They may affect a large area and hence a large population.

The thunderstorm asthma event that occurred in Victoria on 21 November 2016 affected thousands of people, including many who had not previously experienced asthma or had a diagnosis of asthma. At the time of the event, the health system was flooded with people seeking urgent medical care due to respiratory distress and reports of ‘shortness of breath’ or ‘chest tightness’, which may have been due to other acute conditions.

As stated in the Chief Health Officer’s report examining the health impacts of the event, thousands of people developed breathing difficulties in a very short time, creating an extraordinary and unparalleled demand across the health service system (Victorian Department of Health and Human Services 2017). The rapidity of onset of the event, its geographical extent and the severity of the clinical consequences had not been seen before in Australia. Furthermore, as the epidemic developed, there was limited information available to health and emergency management sectors about the scale and nature of the event, including its cause.

The combination of all these factors placed a major stress on the capacity of the emergency services to respond adequately. As identified in the report of the Inspector-General for Emergency Management, organisations relied on informal processes to access a range of different resources to meet the urgent needs of the community (Inspector-General for Emergency Management 2017).

This thunderstorm asthma event can be considered as an exemplar of an environmentally induced event that is diffuse, severe and largely unpredictable. Examples of other such events include bushfires, dust storms and heatwaves, which can cause respiratory distress in those with asthma and chronic obstructive pulmonary disease (COPD).

The response to this thunderstorm asthma epidemic in Melbourne has lessons both for predicting and responding to thunderstorm asthma, and for more generalised surveillance for epidemics of respiratory illness, such as influenza, new microbial infections (for example, severe acute respiratory syndrome) and bioterrorism. The surveillance system must be *syndromic* in nature; that is, based on respiratory symptoms (rather than on requiring a diagnosis of asthma) and on early detection of a surge of patients into the health system.

# Need for syndromic respiratory surveillance

For surveillance itself, identifying and accurately characterising ‘clusters’ or ‘epidemics’ of respiratory illness in a timely manner allows:

- health services to achieve situational awareness and activate appropriate responses to deal with the increased number of cases effectively to prevent death and morbidity
- health protection epidemiologists to identify the cause of the event, and to try to mitigate it by controlling exposure (for example, warning people to stay indoors before and during thunderstorms in the grass pollen season) or by limiting its impact
- effective public communication.

In many cases, epidemics involve a lot of people who have not previously experienced or been diagnosed with a particular condition. This was a key feature of the Melbourne 2016 thunderstorm asthma epidemic for which the initial signal was not necessarily a surge in cases of ‘asthma’, but rather of reports of ‘shortness of breath’ or ‘chest tightness’, which could have been due to a variety of other acute conditions. This highlights the need for the surveillance system to be *syndromic* in nature; that is, based on respiratory symptoms, rather than on requiring a diagnosis of asthma.

Syndromic surveillance describes the analysis of health-related data to detect or anticipate disease outbreaks, usually before a diagnosis is made. It is important to identify ‘clusters’ or ‘epidemics’ of respiratory illness using syndromic surveillance because:

- in many cases, the environmental cause of the outbreak is not immediately known
- many events cannot be predicted by monitoring exposures
- the nature of the respiratory illness (symptoms consistent with asthma, pneumonitis, tracheobronchitis, or upper respiratory tract illness) may provide clues to the aetiology.

Rapid detection and response/emergency management is a state/territory responsibility and these jurisdictions operate independently. However, respiratory epidemics know no jurisdictional boundaries. Hence, there is interest in a broader approach to syndromic surveillance that would encourage collaboration and communication between *all* jurisdictions (including the Australian Government) and in using common data standards to enable comparability.

# Respiratory epidemics workshop

The workshop was convened to bring together a range of stakeholders to facilitate the exchange of knowledge between experts in the relevant fields (including health professionals, statisticians, data custodians, environmental experts and policymakers) and to pinpoint the key issues.

The focus of the workshop, using thunderstorm asthma as a case study, was to explore opportunities and challenges in working towards more nationally consistent and connected approaches to surveillance and monitoring of respiratory outbreaks. The focus was on data sources, access, quality and timeliness, analytical approaches, modelling approaches, linkage with relevant exposure data, and communication.

A key theme was understanding the diverse sources of available information. This information includes health system data (from hospitals, emergency departments or EDs, the ambulance service, pathology laboratories, general practitioners or GPs, and pharmacists) as well as data unrelated to the health system from other sources (such as social media) that could contain information relevant to early detection of clusters of respiratory illness.

Another theme of the workshop was the barriers that would need to be overcome to realise this potential, and suggested approaches to overcoming these barriers.

Expert perspectives on tools for analysing, reporting and interpreting these data to inform surveillance, along with the communication network required to convey the information to the key actors, were discussed at the workshop. Facilitating effective flows of information within and between agencies and jurisdictions, between the public and private sectors, and with the general public, health care consumers and other stakeholders represents a key challenge.

The objectives for this workshop were to share knowledge and identify the issues for further consideration, regarding:

1. national surveillance and monitoring for clusters or epidemics of respiratory illness, including both communicable and non-communicable aetiology
2. improved flow of information about these events to relevant stakeholders (including, where appropriate, the general public).

This information could be used by policymakers as a resource to inform potential future discussions in developing a nationally consistent and connected approach to surveillance for real-time identification of respiratory epidemics in Australia.

# 2 Workshop introduction

## Barry Sandison, Director, Australian Institute of Health and Welfare

Mr Barry Sandison opened the workshop proceedings. He acknowledged that the Melbourne thunderstorm event was shocking, and surprising to some. While data and evidence are available, it is important to work on ways to bring that information together to inform us and to respond to issues, not only respiratory monitoring but also a range of different health issues.

Participants were advised that the role of the Australian Institute of Health and Welfare (AIHW) is to inform, rather than to influence in a specific way. The AIHW compiles the data to create an evidence base that helps to inform those who make decisions. The Department of Health funds the AIHW National Centre for Monitoring Chronic Conditions for this respiratory condition monitoring work. The AIHW works with the National Asthma and Other Chronic Respiratory Conditions Advisory Group.

He highlighted that the issue under investigation at the workshop was the development of a system to better manage future respiratory epidemics; integral to this is the help of workshop participants. The mix of experts and people with background knowledge and experience will be the key to looking at how we might take this event forward.

Drawing on different data sources is one of the key areas for the Institute—how we look at data sources from a variety of different areas and bring them together to create a new information source that will provide the right kind of support to the area being looked at.

Understanding communication needs at the time of epidemics and respiratory events was also vital to informing service delivery and policy in the future. While the workshop focuses on a particular area, there may be opportunities to use its outcomes to inform what we might be able to do in a number of other areas.

Mr Sandison concluded by saying that collaboration is seen as fundamental to progressing potential initiatives further.

## Professor Guy Marks, Australian Centre for Airways disease Monitoring (ACAM)

### Respiratory system as a major disease target

A major trigger for this workshop was the tragic thunderstorm-associated asthma event that occurred in Melbourne on 21 November 2016.

Many respiratory problems occur as a result of airborne exposures to infectious or non-infectious toxins, which enter the body via the lungs. As well as exposure to air, the entire circulating blood volume passes through the lungs, further increasing their exposure to potential toxins. The respiratory system thus presents a major target for many of the toxic manifestations of such exposures, whether in the form of pneumonitis; inflammation; acute lung injury; asthma; bronchitis; or upper respiratory tract effects such as rhinitis, laryngitis and pharyngitis.

Respiratory disease is a major cause of morbidity and mortality in the community at large. Globally, 20% of primary care attendance is associated with respiratory complaints (WHO 2004). Furthermore, 3 of the top 10 causes of death are related to respiratory disease: lung cancer, lung infections and COPD. Due to a causal association with environmental exposures, respiratory disease is at the interface of health protection challenges.

### Respiratory epidemics: from the obvious to the not-so-obvious

Some respiratory events are obvious, such as pandemic and epidemic influenza, adverse events associated with dust storms and bushfires, air pollution emergencies and clusters of disease transmission, such as tuberculosis; others are less so.

One obvious event associated with environmental exposure occurred almost 20 years ago in Wagga Wagga, New South Wales. On 30 October 1997, automatic weather stations signified the arrival of a thunderstorm outflow. At around 21:30, changes in wind speed, wind direction and a decline in temperature were recorded. Hourly counts of intact and ruptured pollen grains, measured between midday and midnight on that day, showed a 12-fold increase at the time of the thunderstorm outflow and the onset of a thunderstorm asthma epidemic.

Following this event, daily data on asthma admissions from six EDs in central western New South Wales were collected over 4 years. A total of 48 days were identified as having a large excess number of asthma-related admissions at one or more of the six locations (asthma epidemic days). Meteorological data revealed that thunderstorm outflows typically occurred fewer than one time a month. However, one-third of the asthma epidemic days coincided with thunderstorm outflows in the vicinity. Half of the asthma epidemics that occurred in spring or summer were associated with thunderstorm outflows. Only 1 of the 48 days had been previously recognised as an epidemic (that is, the Wagga Wagga event described earlier).

Other events, while recognised as epidemics, are taken for granted, such as with seasonal epidemics of COPD exacerbations. ACAM–AIHW data on hospital admissions due to COPD exacerbations show an excess number of admissions during winter. Preventing these excess hospitalisations would substantially reduce the overall burden of COPD.

### Moving forward: health protection strategies

Three separate strategies can be employed to counter these epidemics. These are to:

1. mitigate effects of known adverse environmental exposure, such as by controlling air pollution and the spread of infectious diseases
2. build resistance in exposed populations. Traditionally, protection focuses on vaccination of vulnerable individuals; however, in the context of asthma, other approaches such as the use of inhaled corticosteroids could be considered
3. identify and treat adverse health effects of exposure, or tertiary prevention.

Importantly, none of these approaches is satisfactory in isolation.

### Importance of syndromic surveillance

It is important to identify ‘clusters’ or ‘epidemics’ of respiratory illness using syndromic surveillance because, in many cases, the cause of the outbreak is not immediately known, and many events cannot be predicted by monitoring exposures. Moreover, the exact nature of the respiratory illness (for example, asthma, pneumonitis, tracheobronchitis, or upper respiratory tract illness) may provide clues to the aetiology of the outbreak.

Syndromic surveillance helps to inform whether a clustered event has occurred and the nature of the event, which, in turn, will help to drive investigation of the cause of the event and mobilisation of the appropriate response. Specifically, it will enable the health services to achieve situational awareness and activate appropriate responses to deal effectively with the increased number of cases. It will also allow health protection epidemiologists to identify the cause and attempt to mitigate the event by controlling the exposure or limiting its impact. As well, it will facilitate effective public communication.

## Assessing the needs of a national surveillance approach to respiratory epidemics

The focus of this workshop is to explore approaches to how the health system could act quickly to identify and mitigate the adverse health effects of toxic exposures in vulnerable populations in the context of respiratory epidemics.

Understanding the diverse sources of available information that include health system-based data (from hospitals, EDs, the ambulance service, pathology laboratories, GPs and pharmacists) and, non-health-based system sources, such as social media that could contain information relevant to early detection of clusters of respiratory illness, was important. Moreover, the barriers that would need to be overcome to realise this potential and suggested approaches to overcoming such barriers were also key goals of the meeting.

Expert reviews of various analytical tools for analysing, reporting and interpreting these data to inform surveillance, along with the communication framework required to convey the information to the key actors, were also sought. This presents a challenge and requires effective flows of information within and between agencies and jurisdictions; between the public and private sectors; and with the general public, health care consumers and other stakeholders.

## Objectives of the workshop

The objectives for this workshop are, therefore, to share knowledge and to recommend actions and further research leading to:

- improved national real-time, or near real-time, surveillance, for respiratory epidemics
- improved flow of information about these events to relevant stakeholders (including, where appropriate, the general public).

# 3 Workshop session 1: data sources

The first session of the workshop focused on the various sources of data that could potentially contain information relevant to early detection of clusters of respiratory illness. These sources include both health system data (from hospitals, EDs, ambulance services, pathology laboratories, GPs and pharmacists) and sources unrelated to the health system, including social media. The potential of these data sources to inform surveillance, the barriers that would need to be overcome to realise this potential, and suggested approaches to overcoming these barriers were explored.

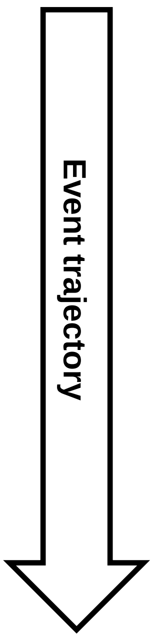
## Data opportunities for respiratory surveillance, and ambulance, hospital and mortality data overview

### Dr David Muscatello, School of Public Health and Community Medicine, UNSW

*Dr Muscatello opened the session by providing an overview of the disease event trajectory and the opportunities for data collection at each of the stages within this trajectory. He then explored EDs, ambulance and death registrations as data sources and suggested some key elements for a successful surveillance system.*

**Data capture: potential opportunities**

Many opportunities for data collection become apparent during epidemic/pandemic disease trajectories. These stages are identified as:




- *very pre-event:* Defined as a period of disease stability, but in which there is a need for preparedness in case of a possible event (for example, inter-epidemic period for influenza)
- *pre-event (ongoing):* A continuing stage of stability and preparedness, representing an important point for data collection to document what is 'usual'
- *start of exposure event:* Point at which exposure enters environment or population but ongoing transmission or multiple exposure events has not started (for example, an infected traveller entering a country, presence of allergenic particles in atmosphere)
- *exposed but pre-symptomatic:* A period of latency following exposure to a trigger or agent
- *early symptoms (prodromal):* A stage of emerging signs and symptoms and onset of disease
- *characteristic disease (syndrome):* Disease becomes fully characterised
- *severe disease:* Disease develops and complications arise
- *death.*

The objectives of collecting data, identifying the most appropriate settings for data collection and the sources of available data at each of these stages are outlined in Table 3.1. The key purposes for data capture are centred on risk assessment, preparedness, epidemiology and forecasting. Multiple settings for data collection are available and the types of data sources are varied and wide.

**Table 3.1: Data sources and settings during disease event trajectory**

| Stage | Purpose | Data setting | Data source |
|---|---|---|---|
| **Very pre-event** | Risk assessment<br>Preparedness | Health care<br>People<br>Environment<br>Fauna<br>Agriculture<br>Geography<br>International and local authorities | Literature<br>Available data<br>Active data collection<br>Expert opinion |
| **Pre-event (ongoing)** | Risk monitoring of and to population<br>Background, seasonal disease and exposure levels that exist<br>Forecasting risk | Home<br>Travel<br>Work<br>Health care<br>Funeral homes/morgues<br>Agriculture<br>Environment | International surveillance systems as important source of risk<br>Biometrics<br>Online, social media monitoring<br>Population surveys<br>Routine healthcare data<br>Notifiable disease networks<br>Microbiology specimens<br>Pollen, pollution, environmental infectious agent monitoring<br>Remote sensing<br>Meteorology<br>Animal surveillance |
| **Start of exposure event** | Identify changed exposure levels<br>Forecasting risk | Environment | Pollen, pollution, environmental infectious agent monitoring<br>Remote sensing<br>Meteorology |
| **Early symptoms (prodromal)** | Identify change in incidence or epidemiology of early symptoms | Home<br>Travel<br>Work<br>Health care | Population survey<br>Workplace symptom reporting<br>Travel and home symptom monitoring<br>Routine healthcare information systems |
| **Characteristic disease (syndrome)** | Situational awareness:<br>- Impact on population (time, place)<br>- Parameters of spread<br>- Resources required to respond | Home<br>Travel<br>Work<br>Health care | Personal biometrics<br>Microbiology specimen<br>Radiology<br>Routine healthcare data<br>Active surveillance<br>Population data |
| **Severe disease** | Risk assessment<br>Epidemiology | Ambulance<br>EDs, hospital wards, ICU | Ambulance call centre<br>Ambulance medical record<br>Information systems: ED, hospital, ICU<br>ANZICS database<br>Poisons information centres |
| **Death** | Risk assessment<br>Epidemiology | Ambulance<br>EDs, hospital wards, ICU, Funeral homes/morgues | Ambulance call centre<br>Ambulance medical record<br>Information systems: ED, hospital, ICU, National Coronial Information System<br>Vital records<br>National Death Index |

ICU = Intensive Care Unit.

ANZICS = Australian and New Zealand Intensive Care Society.

### Real-time monitoring

Real-time syndromic surveillance has the potential for earlier detection and response to respiratory outbreaks (such as thunderstorm asthma) than the more conventional approaches of diagnostic- and laboratory-based surveillance.

For a system to be responsive to an event in real time, several architectural components are required. Timeliness is a function of the interoperability of all these components. In the data capture setting, information must be available for the data to be captured (for example, diagnostic data). The source system, such as a hospital information system, needs to have the data input, saved and extracted when required. The ability to transport data between systems (inter-system) and to surveillance systems is instrumental. Surveillance systems need to recognise, unpack and save the inputted data. They also need to be able to extract, process and analyse the information so that it can be displayed, reported, interpreted and acted on during the health protection phase.

### Sources of real-time data

In the ambulance setting, the call-centre dispatch database offers real-time data. The 000 call date and time provides the closest available date and time of exposure. Central to its function is the Medical Priority Dispatch System (MPDS), an international standard for emergency prioritisation that sets a 'determinant' code to categorise the call by chief complaint and urgency. The determinant is set through MPDS-guided interaction between the call operator and the caller. This information is recorded in the database and can be harnessed for surveillance.

In the New South Wales ED surveillance system, one approach for data capture employs real-time connectivity. This requires an open connection between the source hospital's electronic medical record information system and a surveillance system listener. Following data entry, the source system can trigger a database query for an individual patient encounter and assembly of a Health Level 7 (HL7) message (parcel of data) that is sent from the source system to the listener. The surveillance system listener program acknowledges receipt of the message and unpacks and saves the data to the surveillance database.

### Opportunities to leverage existing data sets

The AIHW's METeOR database (an online metadata registry) contains a wealth of detail on available national minimum data sets. For example, the Non-admitted Patient Emergency Department Care National Minimum Data Set defines a national standard for recording information used for national reporting of ED care statistics. This information is extremely useful. First, it ensures a degree of national uniformity in the information recorded about ED activity. This uniformity may be leveraged in the development of surveillance system standards that permit interstate interoperability or national aggregation. Second, data collected at the national level, if it were to be available in real time, could be used to develop a national surveillance system. METeOR is accessible here: <http://www.meteor.aihw.gov.au/content/index.phtml/itemId/181414>.

ED data items detail a host of patient information, ranging from basic demographics (age, sex, location) and type of visit to principal diagnosis and episode end status. In New South Wales, there are two additional items that are not standard nationwide—namely, open text fields for triage notes and presenting problem.

The Admitted Patient Care National Minimum Data Set is also an untapped data source. While broadly similar to ED data, these data include additional data items, such as formally coded multiple diagnoses and number of hours in the ICU. However, like most national data sets, its utility is limited by delayed reporting. ICU databases provide another potential data source. In New South Wales, an electronic record for intensive care is being introduced. The Australian and New Zealand Intensive Care Society database is not available in real time, but it provided a platform during the 2009 influenza epidemic for relatively rapid data collection and reporting.

Occurrence of death in various settings is systematically recorded. Ambulance, ED and hospital admissions record patient outcome. State/territory civil registration systems register all deaths and record available medical death certifications, and these data flow up to the AIHW National Death Index and the Australian Bureau of Statistics. Other potential sources of data include morgues and the National Coronial Information System.

### Factors for system success

The key elements for a successful surveillance system are:

- integrating public health information requirements into the development and management of hospital and health information systems
- streamlining public health information with clinical work flow
- having common data standards to facilitate aggregation of multiple data sources.

Recognising limitations and the need for improvements in current systems is also important in developing new systems. Universal challenges include different designs of source systems, periodic changes in source systems (switching or updating existing platforms), changing classifications and categories, and variations in system accuracy and completeness.

# Ambulance data

### Mr Paul Holman, Director, Emergency Management, Ambulance Victoria

*Mr Holman gave an insight into the magnitude of the workload that Ambulance Victoria experienced during the Victorian thunderstorm asthma event in 2016 and the potential of electronic dashboards to integrate different data sources to achieve real-time situational awareness.*

#### Key learnings from the 2009 Victorian heatwave

At the time of the 2009 heatwave, there was a severe lack of awareness of its impact. However, ultimately, it was estimated that, over the course of 3 days, the deaths in the heatwave were 374 more than normal. Many of these patients died during transfer to hospital or were in cardiac arrest on arrival. This meant that the first time the health system began to learn of the severity of the event was when cases reached the morgue—signalling a substantial time delay in reporting the health impact of the event. From an ambulance point of view, it became evident that the service was overloaded, and suffered from a considerable lack of resources and high levels of stress among emergency personnel.

#### Snapshot of thunderstorm asthma: an ambulance perspective

Demands on the 000 system between 6 pm on 21 November and 7 am on 22 November 2016 to do with the Melbourne thunderstorm asthma epidemic were unprecedented—driven by an event that was unpredictable and covered a wide geographical region. Initially, the cause was not known, highlighting the importance of trying to get an indication of cause at the point of call. This provides support for the use of the MPDS as it gives valuable information at the individual point of call, about not only the location but also the potential source of the presenting problem.

During the thunderstorm asthma epidemic, there was a 32% increase in ambulance caseloads on the day of the epidemic, and numbers remained high the following day. During this event, large numbers of patients were also presenting directly to hospital, resulting in a sudden rise in hospital presentations with respiratory problems. There were 9,155 presentations to Victorian public hospital EDs during the 30 hours after 6 pm on 21 November 2016. This represented a 62% increase above the 3-year average of 5,637 presentations.

### Pre-hospital information and communication technology footprint

In Victoria, the emergency service communication system has state-wide coverage and records over 55,000 calls per month. The service is currently equipped with 850 Ultrabook tablets and 900 tablets installed with the Victorian Ambulance Clinical Information System, which allows paramedics to fill in patient care records—a potential source of real-time data.

To ensure that all information received at point of call is also captured, current efforts are exploring ways of integrating different data sources to achieve real-time situational awareness (dashboards). The potential use of a surveillance and analytic tool that interrogates emergency medical services data among others is currently being explored by Ambulance Victoria. The emergency medical services and paramedic services are a rich source of robust data considered to be near real time and geographically specific.

# Sentinal volunteers—AirRater program

## Dr Fay Johnston, Environmental Health Research Group, Menzies Institute for Medical Research

*Dr Johnston described the AirRater integrated surveillance platform, which was developed in Tasmania to allow real-time surveillance of a range of environmental hazards, such as smoke, temperature and pollen. The system also allows capture of symptom information from individuals.*

### Purpose

AirRater <https://airrater.org/> is an integrated surveillance platform designed to understand and respond to environmental hazards in Tasmania. It is the result of a collaboration between the Menzies Institute for Medical Research, the University of Tasmania School of Biological Sciences, the Environmental Protection Agency Tasmania, the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Australian National University. The aim in establishing the AirRater program was to set up a system that would allow real-time surveillance of a range of different environmental hazards such as smoke, temperature and pollen. Through geospatial analysis, the information can be used to alert at-risk individuals whose health may be affected by poor air quality and to enable timely self-management. Information also feeds into various agencies to support public health management.

### Key features

The AirRater platform is made up of a mobile application (app) and a series of data servers, web tools and application programming interfaces. Feeding into these are a host of environmental surveillance data that are based on meteorological information (both real-time and forecast data), airborne allergens (daily pollen and fungi counts) and real-time air quality measures and fire hazards.

Further data feeding into the analytics are respiratory-based symptom reports that are inputted via the AirRater app by the individual. Negotiations are currently underway with

HealthDirect (an agency funded by the Australian Government that provides digital health and telehealth services <www.healthdirect.gov.au>) to allow access to its national *Symptom checker* data <https://www.healthdirect.gov.au/symptom-checker>. Individuals can input their symptoms online, providing the potential to generate a geospatially resolved daily feed. AirRater will be rolled out in the Australian Capital Territory in September 2017; a state-wide rollout is being considered in Victoria in relation to managing smoke from planned burns, in a collaborative project with CSIRO funded by the Victorian Department of Environment Land Water and Planning.

The AirRater app enables collection of individual symptoms and displays environmental data (for example, $PM_{2.5}$, pollens, air temperature) based on the user's time and location. The app also displays statistical models of the individual's symptoms against the data to provide personal feedback and generates automatic notifications when environmental conditions change. Users can set their own thresholds for receiving environmental notifications or turn this function off altogether.

As well as the automated notifications, it is possible to send a special-purpose message to users who are in, or who have a registered location in, a defined geographical area.

**Agency experience**

Public health agencies use the generated information in various ways. Currently, the Tasmanian Department of Health and Human Services primarily uses it for heatwave forecasts (AirRater sends an automated notification of heatwave forecasts), for public messaging and in gauging symptom impacts of planned burns and bushfire smoke. The Environment Protection Authority Tasmania and the Tasmanian Bureau of Meteorology use AirRater to access its air monitoring capabilities. At present, the symptom data are mainly used for retrospective interrogation, but there are moves towards real-time symptom surveillance. For example, the Victorian Department of Environment, Land, Water and Planning plans to use it for smoke and symptom surveillance.

**User experience**

The user can choose to remain anonymous or register and sign up to participate in the health study. If registered, users are asked about their current symptom status before the environmental data are displayed, and every 6 days at random either in the morning or in the afternoon. Users can also input symptoms at any time and place and the system will save the associated environmental conditions at that time and place. The system is set up to receive information on symptom severity (mild, moderate, severe) and areas affected (such as nose, eyes, lungs and throat), although there is an option for individuals to add extras as required. Algorithms showing relationships between environment and symptoms are displayed.

Current uptake of the AirRater app in Tasmania is high, with over 3,000 users. About one-third have chosen to be study participants. This group mostly comprises people who have asthma and/or hayfever, or who care for children with these conditions. Feedback from users via evaluation surveys and direct feedback to the helpdesk has been very positive.

**Factors for success**

Interdisciplinary expertise in ecology; meteorology; palynology; clinical, medical and public health; and IT/software have been crucial, as have the strong agency collaborations. These have enabled exchange of information for technical support, and for developing appropriate content and thresholds for messaging. Another key attribute is that the system is integrated and flexible so it is easy to incorporate additional data feeds at the request of agencies or users. Challenges in establishing surveillance systems such as this are centred on negotiating governance arrangements for data management, privacy, ethics and intellectual property. Such approvals and agreements generally take longer to put in place than the technical set-up.

# Textual analysis: techniques, new data, opportunities and challenges

## Dr Sarvnaz Karimi and Dr Cecile Paris, CSIRO DATA61

*Dr Karimi and Dr Paris explained the processes of text mining and of text acquisition for text mining. They also presented some opportunities and challenges that arise when textual data can be mined.*

### Transcribing text from data sources

A multitude of textual data could be considered for syndromic surveillance. These data include search engine query logs, social media feeds, electronic health records, ED triage notes, clinical notes (such as radiological and pathology reports), death certificates and biomedical literature. Dealing with textual data requires many different techniques and approaches for extracting the data. This is of particular relevance to social media text, which requires finding the information in the first place. The next step is sifting through the data to obtain the most relevant information, followed by a processing step that leads to the 'nugget of gold'. Pulling multiple data sources together would enable more accurate situational awareness. Timing and when to collect the data remain fundamental questions for surveillance systems. For social media, this would need to be a continual process.

### Understanding characteristics of textual data sources

Table 3.2 outlines the characteristics of different textual data sources. While social media platforms and search engine logs are less structured and of lower reliability than other data sources, such as medical reports, they, nonetheless, offer greater opportunities for obtaining real-time information from the community.

**Table 3.2: Data source characteristics**

| Data source | Reliability | Data type |
|---|---|---|
| Pathology reports | High | Semi-structured |
| Electronic records | High | Semi-structured |
| Medical literature | High | Unstructured |
| Social media, including medical forums | Low | Unstructured |
| Search engine logs | Low | Semi-structured |

### Harnessing textual information

Social media provides an enormous amount of potential information, given its wide reach and immediacy (an estimated 42,000 posts/minute). Being a relatively new approach for sharing information, the platform offers opportunities to capture unfiltered public opinion and events. Social media has many other benefits: it is public, interactive, captures ample discussion about health (including emotions, medications and experiences) and has a low barrier to entry.

Query logs represent the activity of web search engine users. During a query session, if a search term fails to retrieve the desired information, the query is reformulated. Query logs and reformulation result in a vast repository of untapped data. As well, it reflects real-time activity and information needs of the population at any given time. By aggregating search data, it may be possible to identify what is happening and where and, therefore, allow events or epidemics to be identified or predicted.

**Challenges to data access**

Despite the plethora of data available on the web, there are inherent challenges in accessing and analysing the information. Not all social media data are accessible. For instance, only a proportion of Facebook users make their profile public, which makes it difficult to collect information automatically. Moreover, member-only forums further complicate data access. Ethics and privacy are also important barriers, while query logs are often propriety to search engine companies.

Other considerations include lack of context and user intent of the observable information from these platforms. The apparent discord between layman language and medical language represents another key challenge in using web-based data, given that not all users are familiar with medical terminology and expression let alone how to spell it correctly.

As well as for access, other challenges relate to the processing of big data in terms of how to capture them, how to store them and how to ensure efficiency of the process.

**Text mining: approaches and applications**

Text mining is the process of discovering previously unknown facts from a large amount of unstructured text using natural language processing and machine learning techniques. It often involves two steps: text analysis and data mining.

During text analysis, the unstructured data are prepared through searches, retrieval and annotation and then processed to yield data in a more structured format. By using various mapping tools and techniques, textual analyses allow concepts to be extracted and inferences to be drawn (for example, the relationships between symptoms, disease and medications; and automatic classification of diseases using the International Statistical Classification of Diseases and Related Health Problems, 10th Revision—or ICD-10—codes). Such approaches help to deal with the limitations of traditional text processing techniques, which are largely inadequate due to common irregularities in written language (for example, misspellings, grammatical errors, use of jargon and unfinished sentences, and the gap between the use of medical versus routine text).

Having extracted information from the text, the next step is to combine it with other data or to perform additional statistical analyses to draw appropriate inferences, such as situational awareness and/or an outbreak of respiratory disease.

# General practice data—MedicineInsight

## Dr Bernie Mullin, NPS MedicineWise

*Dr Mullin described the MedicineInsight data source, providing an overview of the type of data captured and the potential for links between, for example, prescriptions and medical conditions to be explored.*

**MedicineInsight: a primary care data source**

MedicineInsight <https://www.nps.org.au/medicine-insight> is a large-scale general practice data set that collects longitudinal data directly from clinical information systems in general practice. MedicineInsight is funded by the Department of Health for two core activities: to provide data feedback to practices for quality improvement purposes, and for post-marketing surveillance of medications. While NPS MedicineWise (NPS stands for national prescribing service) initially focused on quality use of medicines, it is now moving onto the 'Choosing Wisely Australia' campaign, including quality use of technology. Currently, 630 practices across Australia with 3.8 million active patients have been recruited. MedicineInsight does not collect information from patient progress notes due to the risk of patient identification. Patients can opt out of data collection at any point (although few have done so), and patient-level data are de-identified at source. NPS MedicineWise is working with CSIRO to add Systematized Nomenclature of Medicine—clinical terms (SNOMED—CT) codes.

### MedicineInsight: database outputs

Currently, the database receives weekly downloads from general practices and the data are uploaded monthly to the data warehouse. An extraction tool, called GRHANITE, developed by the University of Melbourne, is used to send encrypted files to a secure databank, then onto the MedicineInsight data warehouse. The data are then available as extracts for researchers, for reporting back to the practices, and as aggregated reports for stakeholders. Importantly, there is a strong data governance process in place to ensure appropriate use of data.

The data captured from the primary care practices are summarised in Table 3.3.

**Table 3.3: MedicineInsight data field examples**

| Data | Field |
|---|---|
| Practice | Location |
| Provider | Consent, profession |
| Patient | Year of birth/death, Indigenous status, sex, location |
| Presentation | Reason for encounter |
| Medical history | Diagnosis |
| Current prescriptions | Details of medications prescribed |
| Tests | Pathology/imaging tests ordered |
| Observations | Routine measures |
| Risk factors | Smoking status, alcohol consumption |
| Management activities | Referrals, management plans |
| Allergies | Details of type |

These data, once received, are then populated into corresponding data tables to provide an overview of activity in general practice. As well, the data are used to derive certain variables. For instance, for asthma, different fields are explored; for example, 'encounters', and 'prescriptions' where indications of an asthma diagnosis exist. Where this occurs, a patient flag is created. MedicineInsight also allows links between prescriptions and conditions to be explored. For example, general practice data from MedicineInsight on antimicrobial use by condition were recently used by the Australian Commission on Safety and Quality in Health Care to inform the report *AURA 2016—First Australian report on antimicrobial use and resistance in human health*.

# General practice data

## Associate Professor Chris Pearce, President, Australasian College of Health Informatics

*Associate Professor Pearce discussed the potential of electronic medical record data, and general practice systems—in particular, to provide real-time monitoring of any condition.*

### Value of general practice data

The Outcome Health primary care database has existed for 15 years. It contains data of relatively high quality that are coded according to SNOMED terms, grouped according to several clinical domains and to GP needs. The system considers clinical hierarchy, as the primary aim of the database is to support clinical practice.

### POLAR GP/POLAR explorer

Outcome Health is an organisation that provides clinical services to primary health networks. It has developed the Population Level Analysis and Reporting (POLAR) tool, which has access to several databases that include Ambulance Victoria, locum services, Victorian hospital admissions and Victorian emergency data sets. Using dashboards, all the information is provided to the primary health networks.

Overall, this general practice system is similar to the MedicineInsight tool in that it provides quality feedback loops to the primary care practices. At present, it is based on 174 clinics with data from 10,000 doctors and 5 million patient records, belonging to around 3 million individual patients. The system is geographically focused, currently involving three primary health networks in Victoria. As it is based on general practice records, the data are longitudinal and not episodic.

### Showcase of POLAR tool applications

The application of the POLAR tool has been explored in three separate settings, described in the following sections.

#### Assessment of care in elderly Australians in Eastern Melbourne

With its linkage of general practice data with ED data, and in having access to the admissions and locum services data sets, POLAR was able to provide an assessment of after-hours use among the population aged 65 and over residing in Eastern Melbourne. This yielded interesting findings, such as a greater likelihood of ED service use among individuals living in more affluent areas than in less affluent areas. Apart from the linkage to ED data described here, there has been no other linking of data. Nevertheless, if funding were available, there would be the potential to map the entire after-hours care in individuals living in this area.

#### Assessment of 2010 paediatric influenza vaccine adverse events

Following reports of adverse events among children receiving an influenza vaccine in 2010, a research group conducted a retrospective review of POLAR data in order to determine the level of detection of such adverse events compared with more conventional approaches. The preliminary data revealed that it would have been possible to detect a safety signal from the POLAR database 3 weeks earlier than from conventional notifications. This finding was based on data using just 50 practices within one Medicare Local (the organisations before primary health networks). This finding also raised the possibility of using POLAR for real-time monitoring.

### Predicting hospital admissions

The POLAR diversion program allowed real-time prediction of risk of hospital admissions. The first step was to link ED data to general practice data and, for the first time in Australia, it was possible to map the patients' prior general practice journey. This involved collecting data on the number of GPs visited, how often, what care was received and what medications were prescribed. This subsequently led to the development of a risk prediction tool that could predict the risk of a patient's being admitted to hospital within the next 30 days with 80% accuracy. Currently, this risk tool is being rolled out to general practices to allow it to be trialled by GPs.

# Pharmacy data

## Mr Chris Flood, Senior Pharmacist and National Manager, PBS Operations and Strategy, The Pharmacy Guild of Australia

*Mr Flood discussed the potential data from community pharmacies that may provide opportunities for early surveillance; namely, prescription data, over-the-counter (OTC) data and the reporting of any unusual levels of activity (for example, unusually high demand for Ventolin) by pharmacists.*

### Role of the community pharmacy

Community pharmacies are at the frontline of patient care, providing consumers with easy access to health care services without the need for appointments. Their accessibility also offers an opportunity for early intervention. During the Melbourne thunderstorm asthma event, more than 300 pharmacies provided patient care, with some treating 300 to 400 patients. Moreover, many of the individuals provided with an inhaler to treat their symptoms had not used one previously, which placed an extra demand on pharmacy resources during this time.

### Identifying data sources for early surveillance

Potential data from community pharmacies that provide opportunities for early surveillance include prescription data, OTC data and pharmacists' reporting of unusual activity. It was highlighted that any potential reporting activity required to be done by the pharmacist in the context of surveillance should not overtly affect the pharmacy work flow.

### Prescription data

A central component of pharmacy work flow includes the routine collection of prescription data for mandatory reporting. Additional sources of prescription data include the Pharmaceutical Benefits Scheme (PBS) database accessed through PBS online, the electronic recording and reporting of controlled drugs initiative, and pharmacy collection of non-PBS prescription data.

### Over-the-counter data

Unlike prescription medications, there are only limited requirements to report OTC sales. The existing Project STOP monitors pseudoephedrine sales (mandatory reporting not required in Victoria, Tasmania and the Australian Capital Territory), while MedsAssist monitors codeine-based medications in real time. The major limitation of further use of these data sources would be the need for investment in information technology (IT). OTC opportunities of data sources include point-of-sale data and clinical intervention data.

While point-of-sale data are captured in real time, there is no central reporting. As well, many pharmacists harbour confidentiality concerns about collecting such data. However, if such a path is sought for surveillance, it may be more appropriate to identify sentinel OTC medications, such as asthma reliever inhalers. Currently, pharmacists are also capturing clinical intervention data; for example, where specific patient education has been provided, although this is not real-time data as the information is often inputted later in the day.

### Pharmacist reporting

In the short term, it could be possible to educate and empower pharmacists to report unusual levels of activity to a designated hotline and to acquaint them with emergency services. Using reminders or alerts before a high-risk time, such as seasons and public events, could also be considered.

### Identifying ways forward

Given the experience of the Melbourne thunderstorm asthma epidemic, prioritising pharmacy reporting arrangements would be deemed appropriate. As well, where data capture is considered advantageous, there is a need to identify the most relevant medications of interest. There is also a need to manage commercial-in-confidence issues and ensure availability of resources and funding for IT platforms. Importantly, pharmacy reporting should not be done in isolation. Having appropriate management strategies in place that feed back to the pharmacists would allow for better understanding of their role during emergency situations.

# PBS data

## Mr Peter Marlton, Australian Institute of Health and Welfare

*Mr Marlton described the purpose of the PBS and gave an overview of the flow of PBS prescription data and the lag time typically observed from when the prescription is written by the prescribing doctor to the loading of data about the dispensed prescription on the Department of Human Services website. He also outlined the information about the dispensed PBS prescription that is available as well as the information that is not collected through this scheme.*

### Purpose of the PBS

The PBS <http://www.pbs.gov.au> was developed to provide timely, reliable and affordable access to necessary medicines for Australians. With a long history, the scheme is run by the Department of Human Services (DHS) on behalf of the Department of Health, and a list of the subsidised medicines (PBS schedule) is published monthly. There are several stakeholders for the PBS, ranging from manufacturers (Medicines Australia); wholesalers (National Pharmaceutical Services Association); retailers, notably community pharmacists (Pharmacy Guild); prescribers (Australian Medical Association); government (Department of Health, the DHS); and consumers (public). Scheme complexities, pricing and decision points for funding all have an impact on the financing of the PBS.

### Understanding the flow of PBS prescription data

The PBS prescription written by the doctor is given to the patient who then presents it to the community pharmacist. The pharmacist logs onto the PBS online portal and enters the prescription claim into the DHS system. The DHS validates and processes the prescription and approves the claim payment. The pharmacist then supplies the medicine either at a subsidised cost or for free, and, in return, is reimbursed by the DHS. All PBS data are collected in real time and are stored by the DHS system. PBS data are transferred each night from the DHS to the Department of Health, but there is a lag of 1–3 months in loading the data onto the Department of Health website.

**Data collection and data sources**

The DHS and the Department of Health collect information on subsidised prescriptions and under co-payment prescriptions, but do not collect data on private prescriptions or OTC sales. The prescription itself, once dispensed, includes pharmacist, patient and prescriber details; information on the drug (for example, dispensed quantity and number of repeats); the date the drug was dispensed; and payment details.

PBS data (item code data by extract data) currently can be accessed via the websites of the DHS and the Department of Health, which provide end-of-month updates. Item code data by supply date are available at the Department of Health website and are also updated monthly, but have a 3-month lag time.

The potential points for PBS data access in real time are:

- the pharmacy (software changes via the software vendors' peak body, Medical Software Industry Association)
- the DHS (in-house software)
- the Department of Health (in-house software).

Efforts have been made to implement real-time monitoring for controlled drugs (S8) and hepatitis C drugs, although progress has yet to be made.

In summary, access to PBS data will require strategy, funding and involvement of the DHS and the Department of Health.

# Laboratory requests and results

### Dr Sean Tobin, Manager, Respiratory and Vector-borne Diseases, Communicable Diseases Branch, Health Protection NSW

*Dr Tobin presented the types of laboratory data that are useful for the purposes of communicable disease control, and the process of electronic laboratory reporting. An example of how laboratory tests can be used to inform the New South Wales health influenza surveillance program by providing information about the number of respiratory virus tests ordered (that is, denominator data) and the type of influenza strain was explored.*

**Laboratory-based data sources**

Currently, a range of laboratory data are used for communicable disease control. These include notifiable disease laboratory reports, aggregate testing denominator data, sentinel respiratory virus testing surveillance, and other laboratory-based measures such as whole-genome sequencing.

For aggregate testing denominator data, there are now agreements with almost all the private laboratories and an increasing number of public laboratories across New South Wales to share information on the total number of tests performed per month (the denominator data) for particular notifiable conditions, such as sexually transmitted infections (chlamydia and gonorrhoea), vector-borne infections (Ross River and Barmah Forest), pertussis, enteric diseases and human immunodeficiency virus (HIV). The value of this approach is that it helps to inform whether any change in trend in the reporting of these notifiable diseases is due to increased testing. A drawback is that it is not timely and there are commercial-in-confidence implications.

Universally, electronic laboratory reporting (ELR) of notifiable disease detections is replacing paper-based reporting. New cases of detected disease are batch loaded onto the Notifiable Conditions Information Management System (NCIMS) three times daily. The benefits of ELR include more timely awareness of new identifications and public health review and response, as well as a reduction in manual data entry. However, a major limitation of laboratory-based data is the absence of real-time capture.

### NSW health influenza surveillance program

The NSW health influenza surveillance program is a tailored respiratory surveillance system with multiple components. It taps into the notifiable disease surveillance system, the ED influenza-like illness (ILI) surveillance system as well as community ILI surveillance, hospital admissions and mortality data sets. Information can also be derived from laboratory test data in terms of the number of tests ordered for respiratory viruses; these constitute denominator data. Information on influenza strain and antiviral testing through reference laboratories can also be informative.

One benefit of the influenza surveillance program is that it allows identification of winter influenza season onset and severity, and enables the impact on the health system to be monitored. As well, it can be used to detect inter-seasonal spikes in influenza activity and novel strains and/or other respiratory pathogens, such as respiratory syncytial virus. However, currently, the overall system is not timely enough for near real-time surveillance.

It remains uncertain as to what value other data, such as pathology-based data (including chest x-rays), would have in detecting a respiratory outbreak. Moreover, these data are not routinely collected in a sufficiently timely way for use in near real-time surveillance. They would also require considerable investment in establishing collaboration with the pathology providers (data custodians), developing IT, monitoring and reporting capabilities.

## Discussion on data sources

*Dr Muscatello led a discussion with all workshop attendees about data sources. This discussion built on the presentations given during the session and largely focused on the timeliness of the different data sources and the potential of these to inform surveillance in real time. The discussion is summarised in Chapter 6.*

# 4 Workshop session 2: analytical issues

The second session of the workshop explored ways of analysing, reporting and interpreting the data discussed in Workshop session 1 to inform surveillance, along with how this information can be presented in a way that is most useful for the needs of health protection, for both communicable and non-communicable conditions.

## The NSW near real-time ED surveillance system took 5 months to establish in 2003. How long should it take us 14 years later?

### Dr Tim Churches, Senior Research Fellow in Health Data Science, Ingham Institute for Applied Medical Research

*Dr Churches described the development of Public Health Rapid, Emergency, Disease and Syndromic Surveillance (PHREDSS), including its design and challenges. Some considerations for implementing a national surveillance system were also presented.*

#### Establishing a public health surveillance system: the 2000 Sydney Olympic Games experience

For the Sydney 2000 Olympic Games, the Department of Health was tasked to establish a comprehensive public health surveillance system that included not-quite real-time ED surveillance. This system, which was semi-manual, was implemented in eight EDs around Sydney and involved around-the-clock abstractors who captured details from free-text notes for every injury and acute disease presentation at the respective EDs, and entered the information into a custom-built database deployed at each ED. These data were uploaded every 4 hours onto a central database at the New South Wales Ministry of Health, with automated analyses on a 4-hour cycle reporting the numbers and rates of ED presentations in various categories. As well, text mining of the free-text data was undertaken using association rule-mining or market basket analysis—approaches now considered outdated—but which nevertheless generated important insights that would have otherwise been missed.

#### Development of PHREDSS

With the 9/11 terrorist attack, followed by the anthrax attacks in the United States and several false alarms of anthrax incidents across Australia, bioterrorism became an important national security threat. With this in mind, the New South Wales Ministry of Health Population Health Division received New South Wales Budget funding to develop and implement a state-of-the art bioterrorism and early detection surveillance system for the 2003 Rugby World Cup in Sydney. Consequently, PHREDSS was established. The design goals were to have a system that provided coverage to 13 EDs that would be fast (latency of data flows of under 5 minutes), reliable with around-the-clock operation, and sustainable given that the investment in the system should have utility beyond providing early warnings of bioterrorism to include other conditions of public health interest.

#### Considerations for system sharing

By 2003, the Australian-designed Emergency Department Information System was running in half of the EDs in New South Wales, which included the target EDs. The Directors of these EDs were approached; once it was explained that the intended use of the proposed ED surveillance system was related to public health and not a means for gauging the ED’s performance, their support was secured. This raised an important point that getting clinicians on board is imperative to the success of any given system.

**PHREDSS design and challenges**

A custom-based data extraction tool for the Emergency Department Information System was commissioned that allowed the extraction of data related to ED time and date of presentation, demographic details, and triage desk free-text; these data were sent as HL7 electronic messages to a central database. The system was designed so that the data were dispatched as soon as the triage nurse clicked the ‘enter’ button on the keyboard, which meant that the latency to database was just a few seconds and so provided real-time data.

Updated HL7 messages were also dispatched later during the ED journey when a coded diagnosis and patient disposition data were entered into the patient’s record. These updates were run as transactions against the central database, which, in turn, was being continuously updated. In terms of software development and IT engineering, this was all done in-house as no other similar or off-the-shelf systems existed at the time.

Automated analysis of triage desk free-text fields proved to be a substantial challenge. Hence, a custom-written natural language processing tool was developed, which allowed automated context-sensitive and adaptive spelling correction and abbreviation expansion and regularisation. Once the text was cleaned and processed, it was converted to a bag-of-words, which, in turn, was processed using a machine-learning naïve Bayes multinomial classifier. Subsequently, the classifier assigned each ED presentation into 0, 1 or more syndromic categories (a total of 35, including asthma and acute respiratory syndromes). This ran in near real time, in around 5-minute cycles. Outputs included automated Hypertext Markup Language (HTML) reports according to cycle times. Depending on detection algorithm findings, alerts in the form of text messaging and emails were dispatched.

However, issues with real-time surveillance systems began to emerge. Issues were centred on staffing of around-the-clock monitoring and the escalation protocols for response mechanisms. By 2008, PHREDSS covered around 70 EDs across New South Wales and around 85% of all ED presentations.

**Considerations for implementing a national surveillance system**

Based on experiences of the past, planning a national surveillance system requires:

- a clear deadline for implementation to be set, otherwise it will take ‘forever’
- state-specific solutions to be identified and aggregation of national data designed-in from the outset
- response and effector arms to be developed in parallel
- continuous evolution of system design
- design and development to involve academic and/or private sector partnerships, rather than buying off-the-shelf systems that may not fit the local context
- strong collaboration involving a multidisciplinary team of experts that include clinicians, epidemiologists, statisticians, data scientists, computer scientists, software engineers, as well as lawyers and community representatives.

# Accessing, exchanging, creating and evaluating research data and analytic methods for clinical language processing

### Adjunct Professor Hanna Suominen, Australian National University, CSIRO

*Adjunct Professor Suominen described the work flows in accessing, exchanging, creating, and evaluating research data and analytic methods for clinical language processing methods. Her presentation used the examples of work flows related to filling out a clinical handover form and performing in-hospital surveillance by using speech recognition, information extraction, document summarisation and text visualisation; it also covered how these relate to interactive social media analytics by Data61.*

#### Identifying communication gaps

Saving, structuring and summarising text can be problematic. It has been reported that during a clinical handover, the risk of verbal information not being captured or documented electronically or lost in translation during documentation is increased following 3–5 shifts. This failure in the flow of information co-occurs in over 10% of preventable adverse events. However, there are machine learning tools available, such as speech-to-text (STT) and text classification (TC) technologies for natural language processing, to support the automatic conversion of verbal information into useful documents; these can be used in conjunction with more traditional paper handover notes and checklists to minimise medical errors.

#### Technology for speech-to-text and text classification

A typical automated approach uses STT and TC software to transcribe verbal information into useful electronic text documents that have headings to structure the narrative content. The benefit of this approach is that the system requires minimal training. For instance, a 30- to 60-minute speech training session results in an accuracy of 90%–99% while a 4-minute session yields an accuracy of 73%–90%. A noise-cancelling lapel microphone is critical for this performance but costs only $15.

The utility of STT–TC technology has been explored in the context of clinical handover management. In a preliminary study, nurses were asked to evaluate the usability of the hardware and software of various systems in collecting verbal information during a clinical handover. The study participants were then interviewed about their experiences. The mobile recording devices used to capture the verbal information included a smartphone, a tablet, a digital voice recorder and an MP3 player. As well, headsets and lapel microphones were compared. Of all the choices, the smartphone was considered the most popular, based on colour, clarity, size and intuition of use. Unanimously, the lapel microphone was preferred over the headset as it was found to be less cumbersome. All five participants responded positively to using this technology in practice.

#### Application of text classification in disease surveillance

Invasive fungal disease presents a major health and financial burden, with an estimated 1,000 deaths and a cost of $100 million dollars to the Australian health system. Surveillance of this disease is, therefore, critical to identifying cases earlier and treating them promptly; this was created from free-text radiology (Computer Tomography—CT) reports. These approaches led to high levels of recall and precision, highlighting the potential utility of using free-form text as a data source for surveillance.

For further information see Dawson et al. 2014; Johnson, Lapkin et al. 2014; Johnson, Sanchez et al. 2014; Martinez et al. 2015; Suominen et al. 2014; Suominen et al. 2015.

# Data analytical approaches to predictive surveillance

## Professor Barry Drake, School of Software, University of Technology Sydney, New South Wales

*Professor Drake explained machine learning by presenting case studies that showcased the challenges associated with the technology and then outlining the elements instrumental to the success of this approach.*

### Machine learning basics

Machine learning is a form of artificial intelligence that 'provides computers with the ability to learn without being explicitly programmed'. Fundamental to machine learning is the use of 'training data', which are based on data from the domain of interest. In place of a traditional programmer, a machine learning algorithm drives the learned function. By using previous examples of relationships between input and output data, the system can predict outcomes. Such a system allows for more complicated analyses and has gained much popularity in recent times with several examples of its successful application, among them image processing and the ability to tag objects in images with high accuracy.

### Challenges with machine learning: case studies

While uptake of machine learning continues to increase, there are challenges associated with the technology. These are outlined in the following two case studies.

### Google photo app

In June 2015, Google released a photo app that automatically tagged content of photos when they were uploaded. However, some images of people of colour were found to be inappropriately tagged with 'gorilla'. Google responded to the sensitivity of the situation and rolled out a fix, which did not work. This highlighted the complexity of the neural networks involved, in that it is almost inconceivable to understand how these visual patterns are recognised and therefore made it impossible to debug the app. The only solution was to remove the 'gorilla' tag altogether.

### Google Flu Trend

This program was designed to provide real-time surveillance of influenza cases. Based on search logs in 2008 related to 'flu' and 'flu-like illness' and comparing it with traditional surveillance systems (Centers for Disease Control and Prevention—CDC), this data mining tool was reported to align accurately with seasonal influenza cases at that time. Moreover, the Google Flu Trend was 2 weeks ahead of the CDC in predicting the volume of influenza cases. However, in 2013, the Google Flu Trend algorithm grossly overestimated the number of influenza cases, leading to the projects being abandoned.

Despite some of these challenges, the field of machine learning is not standing still; algorithms continue to evolve and computer power continues to increase.

### Successful application of machine learning

### University of Technology Sydney perspective

The University of Technology Sydney is currently exploring the use of a machine learning system, based on Twitter feeds and Facebook posts, as an anti-cyber bullying application for children and youth—and to identify new concepts and new trends before they become apparent.

### Key ingredients

Applying machine learning to data processing should be considered only if standard programming or statistical analyses are unavailable. Moreover, it will require large volumes of data with adequate training signals. Understanding the system's strengths and limitations and building evaluation and implementation capabilities are also instrumental to the success of this approach. As showcased by the Google failures, continual evaluation is imperative. Machine learning also provides the opportunity to feed lagged data as training data, thereby allowing continuous updates of detection functions and avoiding the identified potential issues.

# Signalling algorithms

## Dr Ross Sparks, Senior Principal Research Scientist, CSIRO

*Dr Sparks discussed data sources that may be appropriate to inform the development of surveillance systems and the strengths and limitations of various algorithms that can be used to identify non-cluster outbreaks. The role of the forward selection scan in spatio-temporal surveillance was also explored.*

### Establishing an early detection system

The aim of temporal surveillance is to detect, characterise and diagnose unusual disease outbreaks early to ensure that risk management processes are implemented promptly and effectively. Many questions need to be explored to establish that an outbreak has occurred. They are centred on detection, diagnosis, prognosis and control and how current data compare with those for previous events. For seasonal outbreaks, factors to consider include understanding the timing of the outbreak (earlier or later than usual); size of the outbreak (smaller or larger than for previous years); the risks associated with the outbreak, such as number of hospitalisations and deaths; at-risk populations affected; patient burden in terms of symptoms and duration; and socioeconomic implications of the outbreak.

### Identifying the right data sources

There are several data sources that could be used to inform the development of surveillance systems. To identify the most appropriate data source, its timeliness and quality must be assessed. Table 4.1 outlines these characteristics for key data sources.

**Table 4.1: Timeliness and quality of common data sources**

| Data source | Social media | ED/GP visits Counts/time interval | Laboratory results | Death registry |
|---|---|---|---|---|
| **Timeliness** | Nearer to real time | Lagging. Patient likely waits until symptoms are intolerable | Lagging. Test results can take several days | Lagging. Input can be delayed by days to weeks |
| **Quality** | Selection bias in reporting symptoms/target population | Less selection bias. Based on preliminary diagnosis | More accurate diagnosis but only in the more severe cases | Only the most severe cases |

As well, understanding the severity of an event in real time is valuable. These may be captured in the form of work absenteeism (days off work) and measured as time between ED presentations or symptoms presenting; and/or triage category, hospital admissions and death data, measured as counts per non-overlapping time.

**Techniques exploring non-cluster outbreaks**

Identifying the most appropriate algorithm for non-clustering events requires an understanding of the strengths and limitations of each approach in terms of memory and detection properties.

- Shewhart charts are without memory but are helpful in detecting large shifts of events, and less so for small shifts.
- Cumulative sum (CUSUM) charts can accumulate memory based on exceeding a reference value and are useful in detecting small to median increases in events.
- EWMA chart (or exponentially weighted moving average chart) weights samples in geometrically decreasing order so that the most recent observations are weighted the highest. They are helpful in detecting small to median increases in events.
- Moving average charts give the same weights to observations within a moving temporal window and are less efficient at detection than the EWMA chart.

Recently, more robust algorithms, using approaches that allow timelier detection and larger memory capacity, have been developed. These include simultaneous Shewhart and CUSUM charts, several CUSUM charts with different memory capacity, adaptive CUSUM charts, adaptive EWMA charts, and groups of moving average charts. All of these have improved detection ability.

**Role of forward selection scan in spatio-temporal surveillance**

The forward selection scan allows scanning of the target area and time to find regions with disease count higher than expected. This approach helps to:

- reduce the need for multiple testing
- simplify detection as the outbreak is defined by a set of rules
- provide flexibility
- improve sensitivity.

The limitations of this approach are that the lattice structures are restricted to rectangular shapes and it is inefficient for multiple spatially dispersed outbreak regions.

# Discussion on analytical issues

*Dr Churches led the discussion following Workshop session 2, which touched on choosing the right analysis method for the data at hand, false alarms, and the measures (outputs) required to determine the public health actions that should be taken in the case of an event. The discussion is summarised in Chapter 6.*

# 5 Workshop session 3: Communication

In the third session, communicating surveillance information to the key actors responsible for implementing investigation and public health and clinical care interventions was discussed. This session explored the infrastructure and processes around the flow of information. The strengths and limitations of the existing architecture were also reviewed.

## NSW Health perspective

### Ms Lina Persson, Director, Population Health Intelligence Systems, New South Wales Ministry of Health

*Ms Persson provided examples of existing NSW Health surveillance systems, such as the NCIMS and PHREDSS, and suggested factors to consider when building a national surveillance system.*

#### NSW Health surveillance ecosystem

A broad range of active stakeholders are involved in health surveillance across New South Wales. These include Health Protection NSW; the New South Wales Ministry of Health; local health districts; eHealth; the Communicable Disease Network Australia (CDNA); the AIHW; and the broader health system that encompasses clinicians, GPs, ambulance services and pharmacists—all working collaboratively to protect the health of the New South Wales population.

The surveillance ecosystem itself involves three key elements. The first is the processing of multiple data sources, which continue to grow and adapt and include the generation of useful automatic triggers that can create a signal for a response or an effector arm. Secondly, this links to analysis, interpretation, investigation and control, which are supported by existing protocols, a state-wide network of public health units, the CDNA and eHealth. Lastly, the data feed into the communications and response phase.

The definition of ‘real time’ is context specific, depending on the type of risk, expectations, systems used and the understanding of post-processing needs (and what actions could potentially be needed) once the data have been collected.

#### NSW Health influenza surveillance system

In the context of influenza surveillance, influenza notifications data and ED ILIs are pivotal data sources. These are processed using the NCIMS and PHREDSS, respectively.

#### NCIMS

The NCIMS is an operational tool used by public health networks across New South Wales. It captures data from a variety of sources from childcare centres/schools, doctors, hospitals and clinics, to aged care facilities and laboratories.

Currently, there are 56 notifiable diseases. Six laboratories submit their notifications via ELR, which translates into 65% of all notifications. These notifications are processed near real time or in nightly batch feeds, depending on the laboratory and the arrangement with the New South Wales Ministry of Health. In the last 12 months, the system received 115,000 notifications. In terms of investigation and action, the NCIMS analyses surveillance data, collects additional information from cases and monitors contacts; it also provides specific disease control measures, investigates exposure sites and delivers risk communication.

Reporting flows are broad and complex. Generally, however, information flows to local health districts for local action, response and follow-up; state-wide reporting feeds into Health Protection NSW; while national reporting, through the NDSS and the CDNA, flows on to the Department of Health and, subsequently, the World Health Organization.

**PHREDSS**

The information feeding into PHREDSS comes from three key data sources: ambulance data (000 calls), ED data, and the birth/death/marriage registry. From 000 call data, 30 specific 'call problem' categories are currently monitored within New South Wales. Data from 60 EDs provide information on 45,000 visits per week. The resulting data are pulled together and used to help detect early increases in disease activity within the community. As well, the system allows substantial situational awareness and supplements a range of other sources. There is also a continuous improvement cycle threaded into this system to assist in developing and monitoring prevention strategies.

In terms of investigation and reporting, PHREDSS is linked into the operational activities of the broader network through generating statistical reports and alerts to Health Protection NSW and public health units for investigation. The PHREDSS system is used for ED respiratory surveillance—which focuses on ILI, asthma, pneumonia and bronchiolitis as well as less specific symptoms, such as breathing problems, other respiratory infections and cough—which could be useful in an emerging respiratory event.

**Other useful data sources**

Several other data sources could be included in a surveillance system. These include reports of unusual disease activity through alert clinicians, reports from the community (for example, school and aged care facilities) and public health units, reports from other jurisdictions through the CDNA and reports from the International Health Regulations via the Department of Health. Local and international media also play a role in report monitoring, as do dedicated disease tracking websites around the world such as ProMED-mail (Program for Monitoring Emerging Diseases), the Center for Infectious Disease Research and Policy, and FLUtrack.

**Considerations for building a national infrastructure**

Several factors will need to be considered when building a national surveillance system for respiratory epidemics. These include:

- having a broad range of data sources. No single source will give all the information needed for all types of respiratory epidemics
- ensuring that access to new data sources is coupled with capability to analyse and respond appropriately (may require up-skilling and training of personnel)
- from a government perspective, finding a balance between innovation and sustainability
- securing large investments to improve existing surveillance architecture
- acknowledging the challenge of upscaling state-wide ecosystems nationally.

# Lessons learned from the Victorian Emergency Response Plan

## Professor Charles Guest, Chief Health Officer, Victorian Department of Health and Human Services

*Professor Guest gave an overview of the challenges presented on the night of the Victorian thunderstorm asthma epidemic and discussed some of the recommendations subsequently made by the Inspector-General for Emergency Management in Victoria in a report published in April 2017.*

### Challenges presented on the night of the epidemic

Up until the Melbourne thunderstorm asthma event in November 2016, the health system had had little experience of dealing with a disaster of such magnitude. While previous thunderstorm asthma events had occurred in Victoria, they had not raised any major concerns to warrant further investigation. On reviewing the Melbourne incident, it was apparent that the ambulance services functioned to the best of their ability while other areas of the public health response were sub-optimal. This indicated that very little information was available before and during the epidemic. The challenges were that it was an acute event that occurred in the evening, affected a wide geographical area and that general practices and clinics had closed for the day.

### Victorian State Health Emergency Response Plan

Currently, the State Health Emergency Response Plan in Victoria involves complex reporting relationships that are likely to affect its timeliness and implementation during an event. Given that most individuals working in these areas of public health are likely to use and read the plan for the first time at the time of the disaster, a more concise and simplified outline of measures is required. In reality, despite the best intentions, there is very little opportunity for training within the construct of daily work. Moreover, personnel are transient, moving from one role to another or into different departments, further limiting the effectiveness of training.

### Inspector-General for Emergency Management Victoria

In the April 2017 report of the Inspector-General for Emergency Management Victoria, several recommendations were made in light of the November asthma epidemic. Among these were to:

- work with primary care providers and, where appropriate, to integrate community pharmacies into future planning for emergencies
- make every effort for future health emergencies to enable information and issues to be rapidly shared and discussed (early escalation)
- improve guidance of the triggers for activation, responsibilities and escalation and de-escalation processes for Code Brown events.

The report also detailed generic issues relating to the health system that need to be considered. Immediately after this report was published, the report of the Chief Health Officer became available, which outlined approaches taken since the event. The office of the Chief Health Officer is currently focused on issues of forecasting, real-time monitoring and the less well-defined areas of community and clinician engagement and health promotion.

The Chief Health Officer's report can be found at <https://www2.health.vic.gov.au/public-health/environmental-health/climate-weather-and-public-health/thunderstorm-asthma/response>.

The Inspector-General’s report can be found at <https://www2.health.vic.gov.au/about/publications/researchandreports/thunderstorm-asthma-igem-review-final-report-april-2017>.

# National perspective–lessons from OzFoodNet

## Dr Ben Polkinghorne, Coordinating Epidemiologist, OzFoodNet

*Dr Polkinghorne described how an established national surveillance network operates, with some lessons learned from OzFoodNet.*

### Key objectives

OzFoodNet provides a surveillance approach to identify, monitor and report on foodborne diseases across Australia. Its main activities centre on estimating the incidence and cost of foodborne illnesses; investigating the epidemiology of these illnesses through enhanced surveillance and studies of aetiological pathogens; coordinating and collaborating with national bodies to investigate foodborne outbreaks, especially if they cross state, territory and country borders; identifying the source of illness, and providing appropriate information to food safety agencies to support risk assessments; and training personnel to investigate foodborne outbreaks. Having these clearly defined objectives limits the risk of ‘scope creep’, which is a major consideration in establishing national surveillance systems.

### Organisational structure of OzFoodNet

OzFoodNet has a site in each jurisdictional health department. There is also a central site that coordinates national activities (OzFoodNet Central). OzFoodNet is a member of the CDNA and is supported by other member organisations, including the National Centre for Epidemiology and Population Health, Food Standards Australia New Zealand, the Department of Agriculture and Water Resources, and the Public Health Laboratory Network. At a national level, the relationships are complex, with OzFoodNet sitting below several governmental and organisational layers.

### Communication activities

Communication within OzFoodNet is not just about data, but also about people, networking and sharing of information. The major platforms for communication involve emails: the ‘Epis only list’ for in-confidence correspondence, and an ‘OzFoodNet general list’ for items such as FYIs and administrative notifications. Meetings are an important forum for discussions and exchange of information, with monthly teleconferences scheduled and three face-to-face meetings held each year with key stakeholders. Additional teleconferences are arranged where needed, such as in cases of potential or ongoing multi-jurisdictional outbreak investigations. OzFoodNet reports to the CDNA every fortnight and publishes quarterly and annually in the national peer-reviewed journal *Communicable Diseases Intelligence*.

As well, there are informal communications with international organisations, such as the International Food Safety Authorities Network and the Global Foodborne Infections Network.

### Outbreak data sources and reporting

OzFoodNet uses a range of data sources during outbreaks of non-notifiable diseases, such as norovirus. These include consumer complaints and physician reports. Subsequently, all outbreaks of gastrointestinal disease are recorded in the OzFoodNet Outbreak Register and reported in the OzFoodNet quarterly reports, with detailed information on foodborne (including probable foodborne) outbreaks, and summary statistics on non-foodborne outbreaks.

### Identifying and responding to a multi-jurisdictional outbreak

To establish if an outbreak has occurred, trigger questions are investigated. These include assessing whether there are more cases than usual and whether the cases have crossed jurisdictional borders. Other factors are also considered and related to evidence of foodborne transmission, pathogenicity and strain of the offending microorganism, and whether additional laboratory investigations are required to characterise the pathogen. Available resources, the number of stakeholders and an assessment of implications also come into play.

In terms of response, OzFoodNet has guidelines, recently endorsed by the CDNA, for investigating multi-jurisdictional outbreaks. These help to assign roles and to ensure that each multi-jurisdictional outbreak investigation is followed by a structured audit. There is a continuous feedback loop, whereby the outcomes of the structured audit are linked back into the guidelines to provide opportunities for improvement.

### Challenges in foodborne surveillance

For OzFoodNet, the major challenges are the proliferation of culture-independent diagnostic testing due to its faster turnaround time, with a consequent loss of subtyping information; integrating genomic data into routine surveillance; the increasing complexity of national and international food distribution networks; growing antimicrobial resistance in foodborne pathogens; and emerging foodborne pathogens.

# Commonwealth health protection architecture

## Ms Christina Bareja, Assistant Director, Vaccine Preventable Disease Surveillance Section, Epidemiologist, Office of Health Protection, Department of Health

*Ms Bareja described health protection infrastructure from an Australian Government perspective, with the specific example of the National Influenza Surveillance Scheme.*

### Health protection infrastructure in Australia

Health Protection architecture in Australia has been shaped by legislation/politics in response to notable disease events over the past 100 years. Under the Australian Constitution, states and territories have primary responsibility for domestic emergencies and public health issues within their individual jurisdictions that include identifying, controlling and treating human clinical diseases. These activities are underpinned by jurisdictional public health legislation. Each state/territory has systems in place for surveillance, public health laboratory services and control activities. These activities are guided by specific government priorities and health system organisational requirements, and are customised to the specific needs of the population groups within the jurisdiction.

Major events and growing recognition that communicable diseases do not respect international or jurisdictional boundaries have shaped changes to the organisation of communicable disease control in Australia; thus, the *National Health Security Act 2007* established the framework for national surveillance and reporting of public health events of national significance.

Coordination and decision-making responsibility in the broader context of the Australian Health Crisis Management framework sits within this construct, and sets out the responsibilities of ministers and officials managing domestic and international crises that require Australian Government assistance or coordination. Sitting under this framework is the National Health Emergency Response Arrangements, which dictate when a national approach will be adopted. This is further specified in the context of communicable diseases in the Emergency Response Plan for Communicable Disease Incidents of National Significance (the CD Plan). Communicable disease incidents of national significance may be triggered by:

- a notification by an affected jurisdiction that assistance is needed to manage the health aspects of the communicable disease incident
- a requirement for enhanced arrangements to ensure nationally consistent policy, interventions and/or communications because:
  - the number and/or severity of cases is overwhelming the capacity of the affected health system, including the public health sector, and/or
  - consistent public messaging is needed about the incident, and/or
  - national leadership and coordination is needed, and/or
  - there is a Public Health Emergency of International Concern, or an international outbreak or incident, with implications for Australia.

One particular operational plan, specific to influenza, sits under the CD plan: the Australian Health Management Plan for Pandemic Influenza.

In the context of influenza surveillance, the Australian Health Protection Principal Committee is supported by the CDNA and the Public Health Laboratory Network.

- The CDNA provides coordination and investigation of multi-jurisdictional outbreaks and provides leadership and coordination of national technical matters. The Public Health Laboratory Network provides leadership and consultation in all aspects of public health microbiology. In turn, CDNA is supported by sub-committees, relevant to influenza surveillance the National Influenza Surveillance Committee and the National Surveillance Committee.

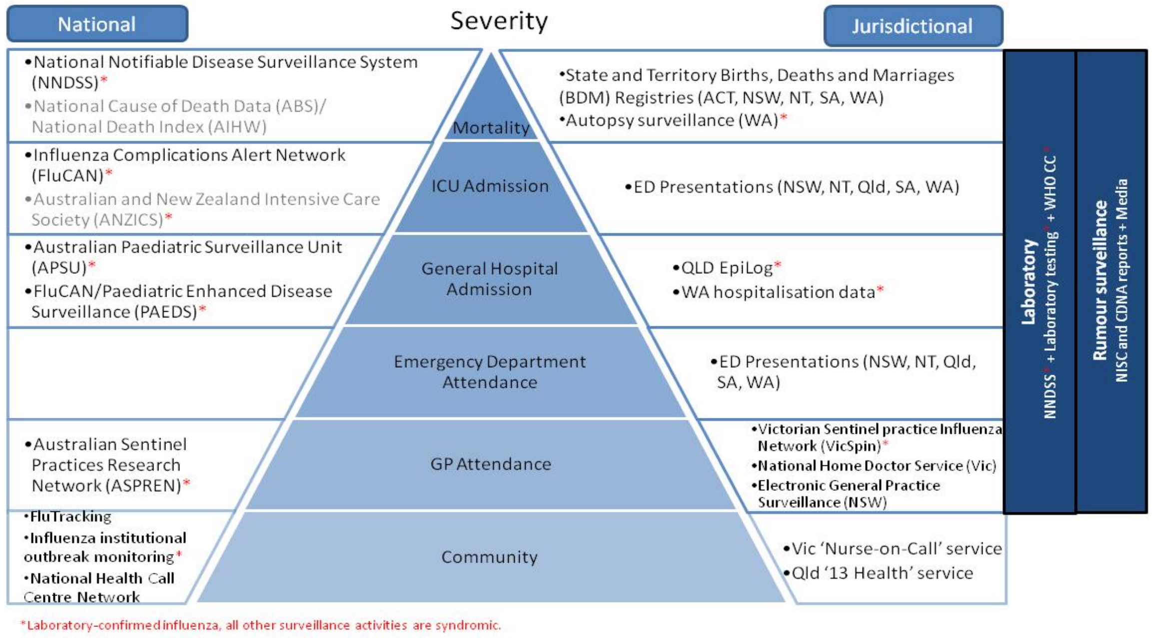
Collectively, health protection is underpinned by legislation; strengthened by established, well-practised coordinating plans and mechanisms; and supported by a strong governance structure, involving Australian, state and territory governments.

**National influenza surveillance**

The objectives of the national influenza surveillance system are focused on establishing baseline and historic trends, and on providing a range of usual and expected values that can be compared with those for outbreaks of new viruses, or with unexpected events related to circulating viruses. Systems that meet these objectives will allow the severity of future pandemics to be rapidly assessed and provide the necessary infrastructure to follow the impact of an event as a novel virus unfolds over time.

Public health-related decisions that can be informed by meeting these objectives include communicating with health care providers to anticipate influenza cases in clinics and hospitals; informing and targeting national prevention and treatment policies, such as vaccination timing; informing choice of vaccine composition locally; and identifying priority groups for vaccination. Not all these objectives can be accomplished by a single surveillance system in Australia, the National Influenza Surveillance Scheme brings together several different systems to help meet these objectives (Figure 5.1). Some challenges have included harmonisation of ED data between states, and the timelines for obtaining mortality data.

The National Influenza Surveillance Scheme was purpose built for influenza, but includes some syndromic systems. For example, an online Flutracking tool has inputs from approximately 26,000 participants, who are regularly asked about flu-like symptoms.




*Source:* Bareja C 2017. 'Health protection architecture in the context of national influenza surveillance: developing a national surveillance approach for respiratory epidemics'. Unpublished paper. Canberra.

**Figure 5.1: National Influenza Surveillance Scheme**

# Discussion on communication

*Professor Marks led the discussion on communication. This discussion canvassed the need for collaboration between relevant stakeholders, the possibility of enhancing established systems to enable syndromic surveillance, and some other factors that need to be considered in establishing a national syndromic surveillance system in Australia.*

A summary of the workshop themes and discussions is provided in Chapter 6.

# 6 Workshop summary

Respiratory conditions are a major contributor to the burden of both acute and chronic disease. In 2011, respiratory conditions accounted for 8.3% of the total burden of disease in Australia (AIHW 2016). It is estimated that around 20% of primary care attendances in Australia are due to respiratory illnesses (Britt et al. 2016). Acute respiratory events often occur in clusters, initiated by a broad range of triggers, including infections and environmental exposures. While many of these events emerge over days or weeks (for example, influenza epidemics), others, such as thunderstorm asthma, develop rapidly over hours or even minutes. Surveillance systems are in place to identify a few specific respiratory illnesses, such as influenza and tuberculosis, but it is desirable to monitor acute respiratory events within a more inclusive approach that encompasses a broader range of triggers and is relevant to rapidly developing epidemics. The workshop summarised in this working paper therefore focused on syndromic surveillance, as opposed to surveillance of events or epidemics caused by specific triggers.

Accurate prediction of future events is obviously challenging, so it is advantageous to know answers to the following questions in a timely manner:

- What is ‘normal’ in terms of the prevalence of respiratory symptoms in people presenting for urgent medical care?
- When is a threshold for action exceeded?
- Is an unexpected cluster of respiratory events occurring?
- What is the cause?

To predict accurately, a surveillance system would need to quantify in real time (or near real time) when an event of significance to emergency service functioning is about to happen or is happening; it would also need to provide information about the nature of the event, and incorporate a probability function to understand the likely magnitude of the threat and the type and level of appropriate response. To be optimally effective, it would ideally incorporate the diverse range of relevant health, social and environmental data from various sectors.

Currently, states and territories are responsible for rapid detection and response, and emergency management. Good surveillance systems are already in place in some states and territories for some specific conditions and exposures, such as air pollution. However, there are challenges in scaling such systems nationally. For example, some data components lie with the states and territories while others are held at a national level and still others are in the private sector or with other non-health agencies (for example, meteorological data, social media). Accessing data relevant to informing health protection requires collaboration across public and private sectors since no one agency or jurisdiction holds all the data needed. The combination can provide a much more comprehensive picture.

## Key issues and challenges for further consideration identified by workshop participants

The three key areas discussed at the workshop were data sources, analytic methods and communication of surveillance information.

## Data sources

Participants noted the large variation in the timeliness and quality of respiratory-relevant data available in Australia. The more traditional data sources for population monitoring of respiratory illnesses are not readily available and are not useful for real-time monitoring. For example, admitted patient hospital data are of relatively high quality, with coding of diagnosis and procedural information, but the diagnosis and subsequent coding is not recorded until after discharge, which makes it too late for real-time monitoring purposes. On the other hand, data from initial points of contact for people seeking care (for example, ambulance calls, EDs, general practices and pharmacies) may be less accurate with respect to diagnosis but are more immediately available. If the focus is on diagnostic accuracy, there will be a delay in identifying epidemics; surveillance for respiratory epidemics may therefore require a trade-off between the quality and timeliness of data. Hence, *syndromic* surveillance, with its potential for early detection, is more suited to the detection of respiratory epidemics from a range of triggers than *diagnostic-based* surveillance.

Simultaneous analysis of data from several sources to build a picture would enhance detection and characterisation of a range of respiratory epidemics. The approach would not need to be 'perfect'. Alerts could be formulated based on several early indicators, rather than on highly accurate data. For example, an alert could be signalled when there is a surge in 000 calls for which patients report similar symptoms. This would allow, for example, emergency response management to escalate an early response to a rapidly developing or severe event. The elements of emergency response management relevant here include the internal direction of resources and personnel (for example, overtime arrangements, use of multi-skilled operators), as well as the overall direction of response activities in the case of an emergency both within and between agencies (for example, review and reprioritising of resources as required, deployment of additional resources or requesting assistance from partner agencies). If the event did not eventuate, the emergency response could be scaled down. This concept is consistent with the process called 'now-casting' (a short-term forecast), which essentially involves a real-time assessment process.

### Key issues for further consideration for data sources and data development

- **Real-time syndromic surveillance** has the potential for earlier detection and response to respiratory outbreaks than the more conventional approaches of diagnosis-based and laboratory-based surveillance. There is no single trigger for respiratory disease. It is therefore important to consider it in a more holistic framework that embodies a broad range of triggers.
- In evaluating systems of surveillance, it is important to **recognise and learn from the limitations of current systems** and to consider the **ethical and legal implications** of data sources.
- **Identify the best combination of data sources and measures to facilitate rapid mobilisation of emergency management services in the event of an emerging signal**. To avoid delays in recognising rapidly emerging epidemics, a system would not rely on highly accurate data, but would be based on several proxies. While individually these may not be highly accurate, together they could provide greater confidence that an epidemic was developing. Information from the initial point of care may be the most relevant and timely. Ambulance, ED check-in (triage), and sentinel GP data are likely to be the most suitable data sources for this purpose. However, the other data sources identified, such as from pharmacies, PBS databases, sentinel patients, environmental agencies and social media (for example, Twitter feeds), may also be considered.
  A **broad range of data sources** may be needed. No single source is likely to give all the information required to monitor respiratory epidemics.

- **Collaboration across public and private sectors** is likely to be needed to access relevant data. A holistic assessment of data relevant for surveillance for health protection requires access to information held by the Australian, state and territory governments and by private companies. A mixture of real-time and delayed health-related data—from EDs, hospitals, death certificates, laboratories, pharmacies, private prescriptions, PBS, GPs, specialists, social media, and other sources (such as environmental and meteorological data)—are all relevant and valuable sources of information. More specific data available from delayed data sets can help to validate predictions based on (less specific) real-time data.
- **Improve consistency and timeliness of data sources** by using standard terminology/classifications, improving IT infrastructure and reducing the complexity of reporting relationships and/or communication pathways.
- **Consider the scope and mechanisms for upscaling existing surveillance systems into a nationally consistent and coordinated approach**. Given that rapid detection and response/emergency management is a state/territory responsibility, existing surveillance systems could, potentially, operate independently, while communicating with other states/territories and the Australian Government.
- **Other ideas** included:
  - extraction of sentinel information from GPs (for example, through primary care software or electronic health records)
  - more information on the use of pharmaceuticals (OTC and so on) from pharmacy-held data
  - the role of 'now-casting' whereby a perfect system is not needed, but incomplete data are collected to model what the data would have revealed were they complete. Now-casting enables real-time data generation
  - patient/community input (for example, AirRater) where people input data on a regular basis
  - analysis of social media.

## Analytic methods

Three measures are required from surveillance analyses: (1) quantification that an event is happening, (2) some description about the nature of the event and (3) a probability function to indicate how likely it is that an event is happening. All three outputs will determine the actions that should be taken. For example, if an event appears catastrophic, some action should be taken even if the probability is low, but if it appears that an event is not serious, action can wait for greater certainty. The models and analyses employed should provide all these measures.

There has been a substantial recent evolution in the power and sophistication of Bayesian, machine learning and related analytical techniques. There is potential for surveillance and health protection agencies to collaborate with experts in these statistical analytical methods. For situations in which the nature of an emerging event may not be known, machine learning appears to be a promising approach to quickly detect anomalies. Signals would need to be sensitive and specific enough to build the trust of health and emergency services in terms of their reliability. However, false alarms would be a challenge and would require dedicated resources to investigate.

Alternative methods, such as the use of recursive partitioning algorithms that incorporate all available data, would provide information on the severity and geography of an outbreak to help make informed decisions. A key factor in establishing how unusual and/or severe the event is will be assessing the signal: noise ratio.

### Key issues for further consideration for analysis

- **The analyses would be best performed by experts**. Analytical techniques have evolved in recent times. There is a need to ensure that individuals are appropriately skilled and experienced in interpreting the information and outputs from these models.
- **Identify analysis methods that will improve real-time detection of respiratory epidemics**. Different analysis methods may be suited to different types of data. For example, to analyse unstructured data, such as data extracted from GP records and from social media, machine learning methods may be the most appropriate method, provided the potential for false alarms is recognised. For structured data, such as coded diagnostic data, the use of signalling algorithms, where available, may be more appropriate.
- **False alarms in detecting anomalies may be a challenge**; however, if a system was put in place and an event was missed or there was a false alarm, valuable lessons could be learned. As discussed earlier, assessing the signal: noise ratio will be one of the key factors in establishing how unusual and/or severe an event is. Recursive partitioning algorithms with all available characteristics inputted will provide information on the severity and geography of outbreaks to help inform decisions.

## Communication of surveillance information

Many stakeholders are involved in responding to respiratory epidemics. These include state and territory public health departments, ambulance services and other first responders, hospitals, pharmacists, doctors in private practice, patients and the general community. Others, such as schools, industry and commerce, and other government services, are indirectly affected. Each stakeholder needs access to information about emerging events to initiate their appropriate responses. Currently, few have timely access to these data in a usable form. Existing approaches to dissemination tend to be limited by state and territory or disease-specific. It is desirable that information gained is shared in a timely and accessible manner, with not only the health protection agencies that will act to contain and respond to the emerging problem, but also the other stakeholders.

Governance issues were alluded to at the workshop but not discussed in detail. It was recognised that states and territories have primary responsibility for detecting and controlling communicable diseases and managing the impact of domestic emergencies in their respective jurisdictions. The Australian Government is responsible for providing leadership and national health sector coordination in the event of an emergency of national consequence and for managing the risk of imported communicable diseases. These arrangements are underpinned by legislation that is strengthened through established, well-practised coordinating plans and mechanisms and supported by a strong governance structure, involving the Australian, state and territory governments. Some examples of governance structures for existing state/national surveillance systems, such as OzFoodNet, are described earlier in this paper.

### Key issues regarding communication of surveillance information

- Structural, organisational and constitutional issues are relevant to how collaboration and consensus making is achieved between the Australian and state/territory governments.
- A system needs to be **simple and effective** with simple plans that are well documented.

- Relevant information should be **made available at a wide level**, including to primary care and community pharmacies.
- Work with primary care providers and integrate community pharmacies into future planning for emergencies.

# Additional issues for consideration

Further targeted consultation would be required to inform a nationally consistent and coordinated approach for surveillance of respiratory epidemics. This consultation would identify:

- the objectives of the approach
- the most appropriate methods of surveillance
- the type of respiratory events to be monitored and the parties responsible for monitoring these events and taking action
- the governance arrangements
- how the strategy will fit into existing health emergency and health protection frameworks.

The workshop did not represent all jurisdictions, and participants were largely from New South Wales and Victoria. The needs and experiences of other jurisdictions should be considered in any further consultation.

The discussion sessions at the workshop highlighted some of the issues pertinent to establishing a nationally coordinated and consistent surveillance approach for respiratory epidemics in Australia, whereby jurisdictions would operate independently while collaborating and communicating with each other. Further work and discussion are needed to determine which issues are of highest priority to overcome and where the responsibility lies for doing this. However, the discussion sessions did provide a starting point for considering what the critical elements of nationally coordinated surveillance for respiratory epidemic could be.

# Appendix A: Media releases, reports and internet resources following the epidemic thunderstorm asthma event, 21–22 November 2016

## Media

### Inspector-General for Emergency Management Victoria

Inspector-General for Emergency Management 2016. Communities to have a say in review of thunderstorm asthma response, media release, Melbourne, 15 December 2016. Viewed 8 May 2018, <https://www.igem.vic.gov.au/reports-and-publications/media-releases/communities-to-have-a-say-in-review-of-thunderstorm-asthma>.

### National Asthma Council

National Asthma Council 2016. Thunderstorm asthma advice—those who 'wheeze and sneeze' urged to take extra care, media release, Melbourne, 3 December 2016. Viewed 8 May 2018, <https://www.nationalasthma.org.au/news/2016/thunderstorm-asthma-advice>.

National Asthma Council 2016. Thunderstorm asthma advice—South Australians who 'wheeze and sneeze' urged to take extra care, media release, Melbourne, 23 December 2016. Viewed 8 May 2018, <https://www.nationalasthma.org.au/news/2016/thunderstorm-asthma-advice-south-australians-who-wheeze-and-sneeze-urged-to-take-extra-care>.

National Asthma Council 2017. Be prepared for thunderstorm asthma, media release, Melbourne, 6 September 2017. Viewed 8 May 2018, <https://www.nationalasthma.org.au/news/2017/thunderstorm-asthma-news-for-health-professionals>.

National Asthma Council 2017. Prepare your pharmacy for thunderstorm asthma, media release, Melbourne, 6 September 2017. Viewed 8 May 2018, <https://www.nationalasthma.org.au/news/2017/prepare-your-pharmacy-for-thunderstorm-asthma>.

### Victorian Department of Premier and Cabinet

Victorian Department of Premier and Cabinet Government 2016. State-wide review into thunderstorm asthma emergency, media release, Melbourne, 23 November 2016. Viewed 8 May 2018, <https://www.premier.vic.gov.au/state-wide-review-into-thunderstorm-asthma-emergency/>.

Victorian Department of Premier and Cabinet 2017. New funding for pollen monitoring and thunderstorm asthma research, media release, Melbourne, 1 February 2017. Viewed 8 May 2018, <https://www.premier.vic.gov.au/new-funding-for-pollen-monitoring-and-thunderstorm-asthma-research/>.

Victorian Department of Premier and Cabinet 2017. Thunderstorm asthma: new systems, training and resources to better prepare and respond, media release, Melbourne, 27 April 2017. Viewed 8 May 2018, <https://www.premier.vic.gov.au/thunderstorm-asthma-new-systems-training-and-resources-to-better-prepare-and-respond/>.

Victorian Department of Premier and Cabinet 2017. Protecting Victorians from thunderstorm asthma, media release, Melbourne, 1 September 2017. Viewed 8 May 2018, <https://www.premier.vic.gov.au/protecting-victorians-during-thunderstorm-asthma/>.

Victorian Department of Premier and Cabinet 2017. New asthma forecasting system, media release, Melbourne, 1 October 2017. Viewed 8 May 2018, <https://www.premier.vic.gov.au/new-thunderstorm-asthma-forecasting-system/>.

## Victorian Government

Victorian Government 2017. Final report thunderstorm asthma, media release, Melbourne, 27 April 2017. Viewed 8 May 2018, <https://www.vic.gov.au/news/final-report-thunderstorm-asthma.html>.

# Reports

## Asthma Australia

Asthma Australia 2017. Thunderstorm asthma—what have we learnt? Chatswood: Asthma Australia. Viewed 8 May 2018, <https://www.asthmaaustralia.org.au/nt/about-asthma/resources/social-media-articles/thunderstorm-asthma-survey-results>.

The George Institute for Global Health Australia (Respiratory Division) 2017. Asthma Australia's thunderstorm asthma consumer survey report. Newtown: The George Institute for Global Health. Viewed 8 May 2018, <https://www.asthmaaustralia.org.au/sa/about-asthma/manage-your-asthma/triggers/epidemic-thunderstorm-asthma>.

## Inspector-General for Emergency Management Victoria

Inspector-General for Emergency Management 2017. Review of response to the thunderstorm asthma event of 21–22 November 2016—preliminary report. Melbourne: Victorian Department of Justice and Regulation. Viewed 8 May 2018, <https://www.igem.vic.gov.au/reports-and-publications/igem-reports/review-of-response-to-the-thunderstorm-asthma-event-of-21-22>.

Inspector-General for Emergency Management 2017. Review of response to the thunderstorm asthma event of 21–22 November 2016—final report. Melbourne: Victorian Department of Justice and Regulation. Viewed 8 May 2018, <https://www2.health.vic.gov.au/about/publications/researchandreports/thunderstorm-asthma-igem-review-final-report-april-2017>.

## Victorian Department of Health and Human Services

Victorian Department of Health and Human Services 2017. The November 2016 Victorian epidemic thunderstorm asthma event: an assessment of the health impacts. The Chief Health Officer's Report. Melbourne: Victorian Department of Health and Human Services. Viewed 8 May 2018, <https://www2.health.vic.gov.au/emergencies/thunderstorm-asthma-event>.

Victorian Department of Health and Human Services 2017. Emergency department checklist for epidemic thunderstorm asthma. Melbourne: Victorian Department of Health and Human Services. Viewed 8 May 2018, <https://www2.health.vic.gov.au/about/publications/FormsAndTemplates/emergency-department-checklist-for-epidemic-thunderstorm-asthma-preparedness>.

Victorian Department of Health and Human Services 2017. Government response to the ‘Review of response to the thunderstorm asthma event of 21–22 November 2016’. Melbourne: Victorian Department of Health and Human Services. Viewed 8 May 2018, <https://www2.health.vic.gov.au/about/publications/ResearchAndReports/government-response-to-review-of-response-to-thunderstorm-asthma-event-of-november-2016>.

Victorian Department of Health and Human Services 2018. Epidemic thunderstorm asthma—frequently asked questions. Melbourne: Victorian Department of Health and Human Services. Viewed 8 May 2018, <https://www2.health.vic.gov.au/public-health/environmental-health/climate-weather-and-public-health/thunderstorm-asthma/program>.

### Reports prepared for the Victorian Department of Health and Human Services

National Asthma Council Australia 2017. Epidemic thunderstorm asthma. Melbourne: National Asthma Council Australia. Viewed 8 May 2018, <https://www.nationalasthma.org.au/living-with-asthma/resources/health-professionals/information-paper/thunderstorm-asthma>.

National Asthma Council Australia 2017. Managing allergic rhinitis in people with asthma. Melbourne: National Asthma Council Australia. Viewed 8 May 2018, <https://www.nationalasthma.org.au/living-with-asthma/resources/health-professionals/information-paper/allergic-rhinitis>.

National Asthma Council Australia 2017. Thunderstorm asthma: prepare your patients for spring. Melbourne: National Asthma Council Australia. Viewed 8 May 2018, <https://www.nationalasthma.org.au/living-with-asthma/resources/health-professionals/information-paper/thunderstorm-asthma-pharmacy>.

Queensland University of Technology 2017. Literature review on thunderstorm asthma and its implications for public health advice. Melbourne: Victorian Department of Health and Human Services. Viewed 8 May 2018, <https://www2.health.vic.gov.au/about/publications/ResearchAndReports/thunderstorm-asthma-literature-review-may-2107>.

## Other Internet resources

### Asthma Australia

Asthma Australia 2017. Epidemic thunderstorm asthma. Chatswood: Asthma Australia. Viewed 8 May 2018, <https://www.asthmaaustralia.org.au/sa/about-asthma/manage-your-asthma/triggers/epidemic-thunderstorm-asthma>.

Asthma Australia 2017. Thunderstorm asthma. Chatswood: Asthma Australia. Viewed 8 May 2018, <https://www.asthmaaustralia.org.au/sa/about-asthma/resources/onair/2017/feb/thunderstorm-asthma>.

### Australian Society of Clinical Immunology and Allergy

Australia Society of Clinical Immunology and Allergy 2016. Thunderstorm asthma. Brookvale: Australian Society of Clinical Immunology and Allergy. Viewed 8 May 2018, <https://www.allergy.org.au/patients/asthma-and-allergy/thunderstorm-asthma>.

## Better Health Channel

Victorian Department of Health and Human Services 2017. Epidemic thunderstorm asthma. Melbourne: Victorian Department of Health and Human Services. Viewed 8 May 2018, <https://www.betterhealth.vic.gov.au/health/ConditionsAndTreatments/thunderstorm-asthma>.

Victorian Department of Health and Human Services 2017. Thunderstorm asthma. Melbourne: Victorian Department of Health and Human Services. Viewed 8 May 2018, <https://www.betterhealth.vic.gov.au/campaigns/thunderstorm-asthma>.

## Inspector-General for Emergency Management Victoria

Inspector-General for Emergency Management 2017. Review of the thunderstorm asthma emergency response. Melbourne: Inspector-General for Emergency Management. Viewed 8 May 2018, <https://www.igem.vic.gov.au/our-work/evaluation-and-review/review-of-the-thunderstorm-asthma-emergency-response>.

## National Asthma Council

National Asthma Council 2017. Thunderstorm asthma community information sessions, article, Melbourne, 30 January 2017. Viewed 8 May 2018, <https://www.nationalasthma.org.au/news/2017/thunderstorm-asthma-community-information-sessions>.

National Asthma Council 2017. Thunderstorm asthma news for health professionals. newsletter, Melbourne, 19 July 2017. Viewed 8 May 2018, <https://www.nationalasthma.org.au/news/2017/thunderstorm-asthma-news-for-health-professionals>.

National Asthma Council 2017. Thunderstorm asthma resource centre, article, Melbourne, 6 September 2017. Viewed 8 May 2018, <https://www.nationalasthma.org.au/news/2017/thunderstorm-asthma-resource-centre_sep17>.

National Asthma Council Australia 2017. Thunderstorm asthma. Melbourne: National Asthma Council Australia. Viewed 8 May 2018, <https://www.nationalasthma.org.au/living-with-asthma/resources/patients-carers/factsheets/thunderstorm-asthma>.

## New South Wales Ministry of Health

New South Wales Ministry of Health 2017. Thunderstorm asthma. North Sydney: New South Wales Ministry of Health. Viewed 8 May 2018, <http://www.health.nsw.gov.au/environment/factsheets/Pages/thunderstorm-asthma.aspx>.

## The Royal Australian College of General Practitioners

The Royal Australian College of General Practitioners 2017. Identifying and managing risk factors for thunderstorm asthma. East Melbourne: The Royal Australian College of General Practitioners. Viewed 8 May 2018, <https://gplearning.racgp.org.au/Content/Tempo/201708ETA.html>.

## Vic Emergency

Vic Emergency 2017. Preparing for thunderstorm asthma. Melbourne: Victorian Government. Viewed 8 May 2018, <http://www.emergency.vic.gov.au/prepare/#thunderstorm-asthma/preparing-for-thunderstorm-asthma>.

Vic Emergency 2017. Thunderstorm asthma forecast. Melbourne: Victorian Government. Viewed 8 May 2018, <http://www.emergency.vic.gov.au/prepare/#thunderstorm-asthma-forecast>.

## Victorian Department of Health and Human Services

Victorian Department of Health and Human Services 2017. Epidemic thunderstorm asthma. Melbourne: Victorian Department of Health and Human Services. Viewed 8 May 2018, <https://www2.health.vic.gov.au/public-health/environmental-health/climate-weather-and-public-health/thunderstorm-asthma>.

Victorian Department of Health and Human Services 2017. Epidemic thunderstorm asthma forecasting. Melbourne: Victorian Department of Health and Human Services. Viewed 8 May 2018, <https://www2.health.vic.gov.au/public-health/environmental-health/climate-weather-and-public-health/thunderstorm-asthma/forecasting>.

Victorian Department of Health and Human Services 2017. Epidemic thunderstorm asthma program. Melbourne: Victorian Department of Health and Human Services. Viewed 8 May 2018, <https://www2.health.vic.gov.au/public-health/environmental-health/climate-weather-and-public-health/thunderstorm-asthma/program>.

Victorian Department of Health and Human Services 2017. FAQs about the epidemic thunderstorm asthma forecasting system. Melbourne: Victorian Department of Health and Human Services. Viewed 8 May 2018, <https://www2.health.vic.gov.au/public-health/environmental-health/climate-weather-and-public-health/thunderstorm-asthma/forecasting-faqs>.

Victorian Department of Health and Human Services 2017. Response to the November 2016 thunderstorm asthma event. Melbourne: Victorian Department of Health and Human Services. Viewed 8 May 2018, <https://www2.health.vic.gov.au/public-health/environmental-health/climate-weather-and-public-health/thunderstorm-asthma/response>.

Victorian Department of Health and Human Services 2017. Resources for health professionals. Melbourne: Victorian Department of Health and Human Services. Viewed 8 May 2018, <https://www2.health.vic.gov.au/public-health/environmental-health/climate-weather-and-public-health/thunderstorm-asthma/professionals>.

Victorian Department of Health and Human Services 2017. Forecasting thunderstorm asthma. Melbourne: Victorian Department of Health and Human Services. Viewed 8 May 2018, <https://www.dhhs.vic.gov.au/news-media/news/forecasting-thunderstorm-asthma>.

# Appendix B: Workshop program

## Workshop: Developing a national surveillance approach for respiratory epidemics

**3 May 2017**

**10:00 am–4:30 pm (arrival from 9:30 am)**

**Australian Institute of Health and Welfare**
**1 Thynne Street, Fern Hill Park, Bruce, ACT**

Tea and coffee will be served on arrival. Lunch will be provided.

### AGENDA

| Time | No | Agenda item | Presenter |
|---|---|---|---|
| 10:00–10:05 | 1. | Welcome | Mr Barry Sandison, Director, AIHW |
| 10:05–10:20 | 2. | Introduction: rationale, scope and objectives for the day | Professor Guy Marks, Director, ACAM |
| **SESSION 1: DATA SOURCES (CHAIR: Dr David Muscatello)**<br>**Sources of information that could contribute to surveillance of respiratory illness and opportunities and barriers to accessing data from these sources** | | | |
| 10:20–10:50 | 3. | Data opportunities for respiratory surveillance, and ambulance, hospital and mortality data overview | Dr David Muscatello<br>School of Public Health and Community Medicine, UNSW |
| 10.50–11:00 | 4. | Ambulance data | Mr Paul Holman<br>Director, Emergency Management, Ambulance Victoria |
| 11:00–11:10 | 5. | Sentinel volunteers – AirRater program | Dr Fay Johnston<br>Environmental Health Research Group, Menzies Institute for Medical Research |
| 11:10–11:25 | 6. | Textual analysis: Techniques, new data, opportunities and challenges | Dr Sarvnaz Karimi and Dr Cecile Paris<br>CSIRO Data61 |
| 11:25–11:35 | 7. | General Practice data - MedicineInsight | Dr Bernie Mullin<br>NPS MedicineWise |
| 11:35–11:45 | 8. | General Practice data | Associate Professor Chris Pearce<br>President, Australasian College of Health Informatics |
| 11:45–11:55 | 9. | Pharmacy data | Mr Chris Flood<br>Senior Pharmacist and National Manager PBS Operations and Strategy<br>The Pharmacy Guild of Australia |
| 11:55–12:05 | 10. | PBS data | Mr Peter Marlton<br>Australian Institute of Health and Welfare |
| 12:05–12:15 | 11. | Laboratory requests and results | Dr Sean Tobin<br>Manager, Respiratory and Vector-borne Diseases, Communicable Diseases Branch, Health Protection NSW |
| 12:15–12:35 | 12. | Discussion on data sources | CHAIR: Dr David Muscatello |
| **12:35–1:20** | | **LUNCH** | |

| Time | No | Agenda item | Presenter |
|---|---|---|---|
| **SESSION 2: ANALYTICAL ISSUES (CHAIR: Dr Tim Churches)**<br>**Methods and approaches to compile, combine and translate available data into diagnostic and actionable information** | | | |
| 1.20–1:35 | 13. | The NSW near real-time ED surveillance system took just 5 months to establish in 2003. How long should it take us, 14 years later? | Dr Tim Churches<br>Senior Research Fellow in Health Data Science, Ingham Institute for Applied Medical Research |
| 1:35–1:50 | 14. | Accessing, exchanging, creating and evaluating research data and analytic methods for clinical language processing | Adjunct Professor Hanna Suominen<br>ANU/CSIRO Data61 |
| 1:50–2:05 | 15. | Data analytical approaches to predictive surveillance | Professor Barry Drake<br>School of Software, University of Technology Sydney |
| 2:05–2:20 | 16. | Signalling algorithms | Dr Ross Sparks<br>Real time modelling and monitoring, CSIRO |
| 2:20–2:40 | 17. | Discussion on analytical issues | CHAIR: Dr Tim Churches |
| **2:40–2:55** | | **TEA/COFFEE BREAK** | |
| **SESSION 3: COMMUNICATION (CHAIR: Professor Guy Marks)**<br>**Infrastructure and processes around the flow of information, including data, within and between jurisdictions** | | | |
| 2:55–3:10 | 18. | NSW Health perspective | Ms Lina Persson<br>Director, Population Health Intelligence Systems, NSW Ministry of Health |
| 3:10–3:20 | 19. | Lessons learned from the Victorian Emergency Response Plan | Professor Charles Guest<br>Chief Health Officer<br>Department of Health and Human Services, Victoria |
| 3:20–3:30 | 20. | National perspective – lessons from OzFoodNet | Dr Ben Polkinghorne<br>Coordinating Epidemiologist, OzFoodNet |
| 3:30–3:45 | 21. | Commonwealth health protection architecture | Ms Christina Bareja<br>Assistant Director, Vaccine Preventable Disease Surveillance Section, Australian Government Department of Health |
| 3:45–4:00 | 22. | Discussion and next steps | CHAIR: Professor Guy Marks |
| 4:00–4:30 | 23. | **RECOMMENDATIONS: ACTIONS AND FURTHER RESEARCH** | Ms Sharon Appleyard<br>First Assistant Secretary<br>Office of Health Protection<br>Australian Government Department of Health<br>Professor Charles Guest<br>Chief Health Officer<br>Department of Health and Human Services, Victoria |
| 4:30 | | **CLOSE** | |

# Appendix C: Speaker biographies

**Ms Christina BAREJA** is an epidemiologist and Assistant Director in the Vaccine Preventable Diseases Surveillance Section of the Office of Health Protection. Her role includes managing the National Influenza Surveillance Scheme and working with the National Influenza Surveillance Committee to develop and maintain effective, responsible and scalable national influenza surveillance systems.

**Doctor Tim CHURCHES** managed the design, building and operation of the New South Wales PHREDSS near real-time ED surveillance system and its precursors from 1999 to 2008. He is now a Senior Research Fellow in Health Data Science at the Ingham Institute for Applied Medical Research at Liverpool Hospital and the South Western Sydney Clinical School.

**Professor Barry DRAKE** is an Industry Professor in the Faculty of Engineering and Information Technology at the University of Technology Sydney. Professor Drake’s research career started at the University of New South Wales in 1998 in the field of artificial intelligence. Informally, his research stretches before then where he applied optimisation techniques to complex capacity planning problems for Telstra before creating, in the ’80s and ’90s, artificial intelligence game playing algorithms. His expertise covers both the application and theory of artificial intelligence, knowledge engineering and machine learning. This expertise has been applied to multiple technologies, including understanding images, videos and documents. Thirteen years of industrial research experience with Canon resulted in him being inventor on 20 filed patents. He aims to make a substantial positive impact translating Australian research into effective technology in business and government. He presently focuses on applications of artificial intelligence and machine learning to the domain of public health.

**Mr Chris FLOOD** is the Guild’s National Manager for PBS Operations and Strategy and Senior Pharmacist on the National Secretariat of the Pharmacy Guild of Australia. Mr Flood manages the development and implementation of the Guild’s policy and strategy relating to the operations of the PBS for Guild members. His role also includes developing strategic partnerships to (1) support health policy and community pharmacy matters, (2) inform and communicate Guild policy positions and (3) communicate the value of and opportunities with community pharmacy and the Guild. Mr Flood has worked in community pharmacy for over 25 years as well as for several years in private and military hospital pharmacies.

**Mr Paul HOLMAN, ASM** has a broad and diverse operational background and management experience in the ambulance industry over 40 years. He has operational experience as a paramedic in Mobile Intensive Care Ambulance, Air Ambulance, Helicopter, Communications and Senior Management. Mr Holman is the State Health Commander in Victoria and is responsible for the Emergency Management Department that delivers all emergency management, planning and response to major incidents. He managed all the major incidents of the last 10 years, including the Black Saturday bushfires and the floods of 2010–11 and 2012, the Bourke Street car incident and thunderstorm asthma in Victoria. Mr Holman is a member of Paramedics Australasia and holds a Graduate Diploma in Administration (Health). He was awarded the Ambulance Service Medal (ASM) in 2007 and The National Emergency Medal in 2011 for the Black Saturday bushfire response.

**Doctor Fay JOHNSTON** is a public health physician and environmental epidemiologist from the Menzies Institute for Medical Research and the Tasmanian Department of Health and Human Services. She is recognised for her expertise in the health impacts of outdoor smoke and other environmental hazards. She works closely with government agencies and practitioners to develop and implement applied, policy relevant research.

**Doctor Sarvnaz KARIMI** is a Senior Researcher, with expertise in Information Retrieval, Natural Language Processing, Text and Data Mining and Machine Learning. Dr Karimi has worked in the medical domain for 10 years. Before joining CSIRO in 2012, she worked at National ICT Australia in the Biomedical Text Team in Melbourne. Dr Karimi is very active in the research community in both Natural Language Processing and Information Retrieval, here and internationally. She completed a PhD in Natural Language Processing at the RMIT (Melbourne).

**Professor Guy MARKS** is a respiratory physician and respiratory and environmental epidemiologist with long-standing interest in research, care, prevention and public policy. His main focus has been asthma and COPD, tuberculosis, air pollution, allergens, global lung health, research methodology and research training. Professor Marks has been the Director of ACAM (an AIHW collaborating centre) since its inception in 2002. He is a Senior Principal Research Fellow of the National Health and Medical Research Council (NHMRC), Principal Investigator for the NHMRC Centre for Research Excellence on Air Quality, Research and Evaluation, and the Chief Investigator for both the NHMRC Centre for Research Excellence on Severe Asthma and the NHMRC Centre for Research Excellence on Tuberculosis. Professor Marks is the Chair of the NSW Health Environmental Health Expert Advisory Panel and the NSW Health Tuberculosis Advisory Committee, Editor-in-Chief of the *International journal of tuberculosis and lung disease* and the Vice-President of the International Union Against Tuberculosis and Lung Disease. Professor Marks was formerly (1994–2007) the Director of the Department of Respiratory Medicine at Liverpool Hospital (Sydney), with responsibility for organising and delivering care for patients with acute episodes of respiratory illness and with long-term (chronic) respiratory disease. He was recently (2016) adviser at the World Health Organization (headquartered in Geneva) on managing chronic lung disease.

**Mr Peter MARLTON** has worked for several years as a data analyst at the Department of Health, in particular working with PBS data. In recent years, Mr Marlton has been involved in several projects involving the PBS, including the development of a new web-based monthly Schedule of Pharmaceutical Benefits and projects to improve both the accessibility and timeliness of PBS data at the Department of Health. Currently, he is working on the development of a PBS data resource at the AIHW to promote the use of PBS data for research and statistical purposes.

**Doctor Bernie MULLIN** is a Public Health Physician and Client Relationship Manager working for NPS MedicineWise on the MedicineInsight database. Dr Mullin has a background in using health data to inform health policy, program evaluation, disease surveillance and quality improvement.

**Doctor David MUSCATELLO** is a Senior Lecturer in infectious disease epidemiology. He has a PhD in the epidemiology of pandemic and seasonal influenza. His research interests include the use of time series analysis for real-time estimation and forecasting of mortality and morbidity attributable to infectious and other diseases, as well as assessing the impact of health policies on populations. He also has many years of experience in government as an epidemiologist, specialising in acute disease surveillance using administrative databases, public health intelligence and biostatistics (including time series analysis). He played a major surveillance role in the New South Wales Government’s response to pandemic influenza in 2009 and has served on the Australian National Influenza Surveillance Committee.

Dr Muscatello is a graduate of the New South Wales Public Health Officer Training Program and has supervised and trained numerous Public Health Officer and Biostatistical trainees.

**Doctor Cecile PARIS** is the Science Leader for the Knowledge Discover and Management Research Group at Data61, CSIRO. Her expertise is in Natural Language Processing, User Modelling, and Social Media Analytics. Dr Paris received her PhD from Columbia University (New York) in Natural Language Processing. She is a Fellow of the Australian Academy of Technology and Engineering, and an Adjunct Professor at Macquarie University. Her Group at CSIRO researches and develops systems being used in government and industry, in a wide variety of domains, including health, service delivery, digital libraries, e-research, business intelligence, media monitoring and customer relationships.

**Associate Professor Chris PEARCE** is a practicing clinician in emergency medicine, general practice and anaesthetics. Since the mid '90s he has had a keen interest in health informatics, as he watched the computerisation of general practice. A PhD on the ways computers were changing the consultation followed, and he has written many articles on the social impacts of computing and the change and adoption issues. As Director of Research for Outcome Health, he is exploring the issues of data quality and use for quality improvement purposes. He was the clinical design lead for the Australian national shared record called MyHealthRecord. He is the current President of the Australasian College of Health Informatics—the peak academic body providing leadership in health informatics in Australia—and chairs the digital health committee of the Australian College of Rural and Remote Medicine. He can be contacted at <drchrispearce@mac.com> and is on Twitter <@ChrisMP>.

**Ms Lina PERSSON** is the Director of Population Health Intelligence Systems at the New South Wales Ministry of Health. She is passionate about managing change and driving efficiencies in population health services through using new technology and infrastructure. Ms Persson is an experienced program manager with a notable service delivery record in ICT application development and system implementation in the health sector. Adept at managing a large multi-disciplinary team to deliver complex integration projects, Ms Persson combines excellent financial literacy and strategic planning abilities with strong communication skills to ensure new user-centred business initiatives are delivered on time and within budget.

**Doctor Ben POLKINGHORNE** has been the Coordinating Epidemiologist for OzFoodNet since July 2014. Before that he was the New South Wales OzFoodNet Epidemiologist. Dr Polkinghorne undertook his public health training in New South Wales, where, among other things, he worked on the public health response to the 2009 influenza pandemic.

**Doctor Ross SPARKS** is a statistician with over 38 years of research and teaching experience at universities and research at CSIRO. He is currently based in Data61, CSIRO, Australia where he has been for over 25 years. His role is to lead strategic and tactical research projects in Data61 in the area of multivariate spatio-temporal monitoring and spatio-temporal modelling. He has published 82 papers in refereed journals, 10 book chapters, 19 papers in conference proceedings and 10 articles in trade magazines.
Dr Sparks lectured at the University of Natal, University of Cape Town and the University of Wollongong in Statistics and Applied Mathematics before joining CSIRO Australia. He has made several research contributions in the areas of (multivariate) process monitoring, spatio-temporal modelling and the handling of (partially) missing data. Specifically, he has contributed to topics in the variable selection in multivariate regression models, outlier detection in regression models, model validation and assessment, quality control and assurance, cluster analysis, dimension reduction methods and disease surveillance.
Dr Sparks also spent 18 months seconded to CSIRO Corporate, developing the CSIRO

customer value survey, and he designed the automatically generated monthly reports for all divisions in CSIRO during the organisation's leadership under Geoff Garrett.

**Adjunct Professor Hanna SUOMINEN** was awarded her MSc by Research (including BPhil) in applied mathematics, PhD in computer science, and Adjunct Professor in computer science at the University of Turku, Finland in 2005, 2009, and 2013, respectively. She joined the Australian National University as a Senior Lecturer and Data61 as the Team Leader of Natural Language Processing within the Machine Learning Research Group, after working in Data61/National ICT Australia (NICTA) as a Senior Researcher and Researcher and at the University of Turku as a Graduate Research Assistant, Coordinator and Lecturer at the Turku Centre for Computer Science. Her more than 100 publications have been published in A* journals and won best-paper/10%-elite-PhD/top-method awards. This work also led to real-life products and scored competitive grants, together with business-plan and teaching-excellence awards. Professor Suominen's research interests are developing and evaluating statistical machine learning methods for text analytics and health. Her aspiration is to bridge the gap between computing and heath/social sciences.

**Doctor Sean TOBIN** is a medical epidemiologist and public health physician working on communicable disease surveillance and control in Sydney for Health Protection NSW. His work is focused on respiratory and vector-borne diseases, and in preparedness for emerging diseases, including pandemic influenza planning. In Australia, he has previously worked with both the Australian and Victorian Departments of Health; in the region, he has worked for the World Health Organization in roles supporting the Ministries of Health in Vietnam, Cambodia and East Timor in the area of communicable disease surveillance and response (including International Health Regulations (IHR) capacity building and compliance). Dr Tobin has also undertaken several short-term emergency response assignments with the World Health Organization, such as supporting the response to Typhoon Yolanda in the Philippines, supporting the Ebola outbreak response in Liberia and supporting the Tongan Ministry of Health in its Zika outbreak response.

# Appendix D: List of workshop participants

| | |
|---|---|
| Ms Rose Ampon | ACAM |
| Dr Phil Anderson | AIHW |
| Ms Sharon Appleyard | Department of Health |
| Mr Moe Assoum | NPS MedicineWise |
| Ms Christina Bareja | Department of Health |
| Ms Siobhan Brophy | National Asthma Council Australia |
| Dr Tim Churches | Ingham Institute for Applied Medical Research and South Western Sydney Clinical School, Liverpool Hospital |
| Dr Anna Colwell | Department of Health |
| Ms Peta Craig | AIHW |
| Associate Professor Janet Davies | Queensland University of Technology |
| Professor Barry Drake | University of Technology, Sydney |
| Mr Chris Flood | Pharmacy Guild of Australia |
| Dr Tong Gong | ACAM |
| Ms Alicia Goodwin | Asthma Australia |
| Professor Charles Guest | Victorian Department of Health and Human Services |
| Dr Neil Hime | New South Wales Ministry of Health |
| Mr Paul Holman | Ambulance Victoria |
| Dr Suzanne Huxley | Queensland Health |
| Professor Christine Jenkins | National Asthma and Other Chronic Respiratory Conditions Monitoring Advisory Group; Lung Foundation Australia |
| Dr Fay Johnston | Menzies Institute for Medical Research |
| Dr Sarvnaz Karimi | CSIRO Data61 |
| Associate Professor Stephen Lambert | Queensland Health |
| Professor Guy Marks | ACAM |
| Mr Peter Marlton | AIHW |
| Dr Lynelle Moon | AIHW |
| Dr Bernie Mullin | NPS MedicineWise |
| Ms Paula Murray | Asthma Australia |
| Dr David Muscatello | School of Public Health and Community Medicine, University of New South Wales |

| | |
|---|---|
| Mr John Nairn | Bureau of Meteorology |
| Ms Sarah Norris | Department of Health |
| Dr Nick Osborne | Faculty of Medicine, University of New South Wales |
| Dr Cecile Paris | CSIRO Data61 |
| Associate Professor Chris Pearce | Australasian College of Health Informatics |
| Ms Lina Persson | NSW Health |
| Dr Ben Polkinghorne | Department of Health/OzFoodNet, Office of Health Protection |
| Ms Leanne Poulos | ACAM |
| Dr Naila Rahman | AIHW |
| Professor Helen Reddel | ACAM |
| Ms Pippa Robinson | Department of Health |
| Dr David Rolls | CSIRO |
| Ms Claire Sparke | AIHW |
| Dr Ross Sparks | CSIRO |
| Mr Rhyan Stanley | Pharmaceutical Society of Australia |
| Dr Hanna Suominen | ANU/CSIRO Data61 |
| Dr Sean Tobin | Health Protection NSW |
| Dr Beejal Vyas-Price | Consultant medical writer |

This report is intended as an information resource and the views expressed are not necessarily those of the Department of Health, the AIHW, individual workshop participants or their agencies.

# Glossary

**epidemic:** An unusually high occurrence of a disease or illness in a population or area.

**outbreak:** Bears a very similar definition as ‘epidemic’ (see **epidemic**), but is used to describe a sudden increase in the number of cases of a disease in a more limited geographic area.

**primary health networks:** Organisations set up to increase the efficiency and effectiveness of medical services for patients, particularly those at risk of poor health outcomes, and to improve coordination of care to ensure patients receive the right care in the right place at the right time.

**syndromic surveillance:** The analysis of health-related data to detect or anticipate disease outbreaks before a diagnosis is established. Syndromic surveillance uses a range of data sources to predict and identify trends in health-related measures as they are occurring, such as in the event of a disaster or emergency.

**thunderstorm outflow:** Air that flows outwards from a storm system, at ground level, when a thunderstorm downdraught reaches the earth’s surface and spreads horizontally.

**under co-payment:** Describes prescriptions for which the cost is less than a defined co-payment amount (the amount the consumer pays).

# References

AIHW (Australian Institute of Health and Welfare) 2016. Australian Burden of Disease Study: impact and causes of illness and death in Australia 2011. Australian Burden of Disease Study series no. 3. Cat. no. BOD 4. Canberra: AIHW.

Bareja C 2017. 'Health protection architecture in the context of national influenza surveillance: developing a national surveillance approach for respiratory epidemics'. Unpublished paper. Canberra.

Britt H, Miller GC, Henderson J, Bayram C, Harrison C, Valenti L et al. 2016. General practice activity in Australia 2015–16. General practice series no. 40. Sydney: Sydney University Press. Viewed 16 June 2017, <http://purl.library.usyd.edu.au/sup/9781743325131>.

Dawson L, Johnson M, Suominen H, Basilakis J, Sanchez P, Kelly B et al. 2014. A usability framework for speech recognition technologies in clinical handover: a pre-implementation study. Journal of Medical Systems 38(6):1–9.

Inspector-General for Emergency Management 2017. Review of response to the thunderstorm asthma event of 21–22 November 2016. Final report. Melbourne: Victorian Department of Justice and Regulation.

Johnson M, Lapkin S, Long V, Sanchez P, Suominen H, Basilakis J et al. 2014. A systematic review of speech recognition technology in health care. BMC Medical Informatics and Decision Making 14(94). doi: 10.1186/472-6947-14-94.

Johnson M, Sanchez P, Suominen H, Basilakis J, Dawson L, Kelly B et al. 2014. Comparing nursing handover and documentation: forming one set of patient information. International Nursing Review 61(1):73–81.

Martinez D, Ananda-Rajah MR, Suominen H, Slavin MA, Thursky KA & Cavedon L 2015. Automatic detection of patients with invasive fungal disease from free-text computed tomography (CT) scans. Journal of Biomedical Informatics 53:251–60.

Suominen H, Zhou L, Sanchez P, Sirel R, Basilakis J, Hanlen L, et al. 2014. Capturing patient information at nursing shift changes: methodological evaluation of speech recognition and information extraction. Journal of the American Medical Informatics Association. 22(e1):e41–66.

Suominen H, Zhou L, Hanlen L & Ferraro G 2015. Benchmarking clinical speech recognition and information extraction: new data, methods and evaluations. JMIR Medical Informatics 3(2):e19. doi: 0.2196/medinform.4321.

Victorian Department of Health and Human Services 2017. The November 2016 Victorian epidemic thunderstorm asthma event: an assessment of the health impacts. The Chief Health Officer's Report. Melbourne: Department of Health and Human Services, State Government of Victoria.

WHO (World Health Organization) 2004. Respiratory care in primary care services—a survey in 9 countries. WHO/HTM/TB/2004.333. Geneva: WHO.

# List of tables



# List of figures

This working paper outlines the content of a workshop on Developing a national surveillance approach for respiratory epidemics, which was held in Canberra on 3 May 2017. The expert advice received at the workshop from a large array of stakeholders involved in health protection is outlined by providing full summaries of every presentation on the day, along with issues for further consideration which were discussed on the day. This working paper is intended as a resource for policy makers, hospital administrators, clinicians, researchers and peak organisations.

aihw.gov.au

AIHW

Stronger evidence,
better decisions,
improved health and welfare