A brief overview of influenza surveillance systems in Australia, 2015

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Introduction

The World Health Organization (WHO) has estimated that worldwide 5% to 15% of the population is affected by influenza each year, with between three and 5 million cases of severe illness and about 250,000 to 500,000 deaths.[1] In Australia, it has been estimated that the disease is associated with 366 respiratory and 1,400 all-cause deaths,[2] 18,000 hospitalisations and over 300,000 general practice consultations[3] each year. The morbidity, mortality and consequent economic burden of influenza epidemics vary annually. Although typically falling within the winter months in Australia, the onset and severity of annual epidemics varies. Therefore, robust surveillance is needed to guide prevention and controls efforts.

In Australia, the National Influenza Surveillance Scheme[4] (the Scheme) began in 1994 and its objectives are to:

- ensure the early detection of influenza epidemics;
- trigger public health prevention and control activities;
- characterise the epidemic, especially identification of risk groups and disease severity;
- estimate the impact of the epidemic;
- characterise the circulating viruses to inform vaccine virus selection and assess the effectiveness of influenza vaccines and antiviral medications; and
- ensure flexibility to enable adaptability for responding to additional surveillance requirements during a pandemic or particularly severe season.

The Scheme is currently guided by the *Enhanced Influenza Surveillance Framework for Australia* (unpublished) developed by the Communicable Diseases Network Australia (CDNA) after the moderately severe 2007 influenza season. Ongoing monitoring and enhancement of the Framework is co-ordinated by the National Influenza Surveillance Committee, a subcommittee of CDNA. The Scheme is supported by a number of government and other surveillance systems which are combined to enable monitoring of influenza incidence, severity, transmission and virology. These systems capture influenza activity in the community, general practice (GP) clinics, emergency departments and hospitals, as well as influenza-associated mortality.

This paper provides a brief overview of the range of influenza surveillance systems that formed the Scheme in 2015 and describes their respective strengths and limitations in describing the epidemiology of influenza. The Scheme is coordinated by the Australian Government Department of Health (DoH). Influenza activity monitored through its systems is reported in the Australian Influenza Surveillance Report, which is published fortnightly on the DoH web site during the influenza season, and an annual surveillance report, which is published in the *Communicable Diseases Intelligence* journal.[5] For a more detailed description and analysis of the Scheme, including surveillance systems that function outside of the Scheme, readers are referred to the paper *A Summary of Influenza Surveillance Systems in Australia, 2015,*[6] which is available on the DoH web site.

National notifiable diseases

Under state and territory public health legislation, notifications of laboratory-confirmed influenza are initially made to jurisdictional health authorities by laboratories and, in some states, medical practitioners. These data are forwarded to the National Notifiable Diseases Surveillance System (NNDSS) on a daily basis and are the primary source of national influenza activity data. Aggregated data are available online and more detailed data can be requested from CDNA. An agreed surveillance case definition and core data specifications ensure national consistency in case counting and quality of data by person, place and time.

The system is considered acceptable, simple and valuable by stakeholder groups.[7] The quality and completeness of these data are affected by a range of factors including healthcare seeking behaviours of patients, clinician testing propensity, notification practises and case follow-up by jurisdictional health departments. The impact of these factors on the notified fraction (the cases notified as a proportion of all cases occurring in the community) is likely to vary over time and across jurisdictions, making year-on-year comparisons difficult.[8]

Community self-report surveillance

Influenza-like illness (ILI) is widely used as a surrogate measure for influenza infection. Definitions vary, but typically include fever, cough, fatigue, sore throat or some combination of these symptoms.[9,10]

Two self-report based systems in Australia monitor ILI in the community: Flutracking and the National Health Call Centre Network (NHCCN).

Flutracking, established in 2006, is an online health surveillance system in which volunteer participants are surveyed weekly, via email. Surveillance is conducted during the influenza season to capture ILI episodes self-reported by participants or nominated household members.[11,12] The information collected includes specific symptoms, absence from normal duties, medical consultation, clinical or laboratory diagnosis of influenza and influenza vaccination status. During 2015 there were about 27,000 participants, with over 23,000 completing the survey each week.

The NHCCN has provided free, 24-hour health triage advice and information services by telephone since 2007. The network services all states and territories, except Victoria and Queensland. Registered nurses use electronic decision support software to provide advice to roughly 640,000 callers per annum. Data collected include demographic details of the patients, presenting issue, diagnosis and final triage disposition. Selected diagnoses are used to monitor ILI. Since 2009, NHCCN data were routinely provided to DoH; however, due to system changes and associated incompatibilities, data transmissions could no longer be received after mid-2015.

Flutracking surveillance of ILI was used during the 2009 H1N1 influenza pandemic to demonstrate that community attack rates were no higher than most other years and suggested that much of the increase in influenza notifications was due to an increased health care seeking behaviour coupled with increased testing of those patients.[13]

Whilst ILI surveillance is only a surrogate indicator for influenza, as it is based on a non-specific set of symptoms that may be caused by a number of respiratory pathogens, ILI activity tends to correlate well with laboratory confirmed influenza reports.[14] Although there are some discrepancies between the NHCCN and Flutracking ILI surveillance systems, such as differing ILI case definitions, and geographic and demographic representativeness, which limit direct comparison and interpretations; as they have been collected in a relatively consistent manner over a number of seasons, they do offer reference to ILI activity at the community level.

General practice sentinel surveillance

General practice based sentinel surveillance systems capture data on medically-attended ILI and influenza activity trends. The largest GP-based ILI surveillance system in Australia is the Australian Sentinel Practices Research Network (ASPREN). Established in 1991, ASPREN collects de-identified information on ILI and other conditions seen in general practice. All patients presenting with ILI at participating practices are enumerated, and, since 2010 samples have been collected from around 20% of these patients for laboratory testing for a range of respiratory pathogens, including influenza. GPs submit data using a web-based form, paper form or a data extraction tool that utilises practice management software to extract information on ILI cases, including demographics, vaccination status, and total number of consultations. ASPREN aims to achieve a participant rate of one GP per 200,000 population in urban settings and one GP per 50,000 population in rural and remote settings.

Victoria and Western Australia manage separate systems: the Victorian Sentinel Practice Influenza Network, established in 1993 with swab testing since 2007; and the Sentinel Practitioners Network of Western Australia, based on a system originally established in 2000. More than 70% of ILI patients in these 2 systems are swabbed for laboratory confirmation.

All 3 systems collect information from swabbed patients, including vaccination status and high risk conditions, to enable calculation of vaccine effectiveness. A current limitation in enhancing the representativeness of vaccine effectiveness calculations through data pooling across the 3 systems relates to their differing participation targets, laboratory testing practices and data collection methods.

Emergency department surveillance

Emergency department (ED) surveillance systems for influenza that inform the national Scheme operate in New South Wales, the Northern Territory and Western Australia. Additionally, data from Queensland and South Australia's ED surveillance systems are monitored to inform local influenza activity trends.[7] Like GP ILI surveillance, ED surveillance is an indicator of the ILI burden in the community, severity of a season and may capture groups in the community that are under-represented in GP surveillance, especially the very young.[15,16]

ED surveillance in New South Wales commenced in 2003 and includes 59 urban and rural hospitals. Influenza is monitored using provisional diagnosis codes recorded by either an International Classification of Diseases 9th or 10th revision (ICD-9 or ICD-10)[17,18] code or a Systematized Nomenclature of Medicine – Clinical Terminology[19] concept identifier. Although not necessarily laboratory confirmed, these presentations correlate well with laboratory-confirmed influenza reports.[20] Incidents of related conditions including pneumonia, respiratory illness and fever or unspecified infections, are also monitored. Statistical signals trigger when indicators exceed expected thresholds.

In the Northern Territory, ED surveillance commenced in 2007 and is conducted across the Royal Darwin, Gove District, Katherine District, Tennant Creek and Alice Springs hospitals. These hospitals use the same information system from which the data are transmitted nightly to a data warehouse. Business intelligence software is then used to analyse information on presenting complaints and discharge diagnoses. The presenting complaints included in the ILI definition are: 'febrile illness', 'cough', 'respiratory infection' and 'viral illness'. Trends are analysed using CuSum techniques to determine activity changes for each hospital site.

Western Australia uses the Emergency Department Information System for ED surveillance in 9 public Perth metropolitan EDs and one regional hospital ED. Data on respiratory viral presentations (upper respiratory tract infection and viraemia) are extracted weekly. These diagnoses were chosen as they best correlated with notification and laboratory data for influenza. Respiratory viral presentation data are also used to monitor the number and rate of ILI hospital admissions through EDs.

In its current form, ED surveillance in Australia has limited capacity to build a nation-wide picture of ILI activity. Each jurisdiction bases their definition of ILI on different presentation codes, and may have a different method of data collection or abstraction. Some jurisdictions (Australian Capital Territory, Tasmania and Victoria) do not carry out ED surveillance, limiting representativeness. Year-on-year comparisons can be hindered by upgrades to hospital information systems and the absence of reliable denominator data. Harmonisation of the diagnostic case definitions used and the methods of data extraction could enable pooling of data and comparison of activity among jurisdictions, including those currently not formally included in the national Scheme.

Hospital surveillance

Surveillance for hospitalised cases of influenza is useful for gauging the severity of a season and measuring the burden placed on health services. Three main hospital based systems operate as part of the national Scheme: the Influenza Complications Alert Network (FluCAN), Queensland EpiLog and the Australian Paediatric Surveillance Unit (APSU). Additionally, data from New South Wales and Western Australia's hospital admission surveillance systems are monitored to inform local influenza activity trends.[6] While a field for hospitalisation is included in the NNDSS dataset, these data are currently not easily captured or of sufficient completeness for routine analysis.

FluCAN was established in 2009 and provides national, sentinel, hospital-based surveillance for severe influenza.[21,22] In 2015 there were 17 participating hospitals that represented 12% of national hospital bed capacity. FluCAN also includes information about paediatric patients from 2 paediatric hospital sites, with data on paediatric patients also collected from 4 of the community-based hospital sites. Extensive information on all laboratory-confirmed influenza-positive patients admitted to participating sites is collected, including demographics, comorbidities, vaccination status, intensive care unit admission and mortality. The collection of vaccination status and comorbidities also permit the calculation of influenza vaccine effectiveness estimates against hospitalisation and can provide information on nosocomial influenza infections.

In 2009, Queensland introduced EpiLog; a system of near-real-time surveillance of public hospital admissions for ILI. Patients admitted with influenza are identified through the linkage of laboratory test results with admissions data. These data include patients diagnosed with influenza prior to admission, but do not capture patients admitted to private hospitals.

The APSU has monitored children (<15 years) hospitalised with severe complications of influenza since 2008. Data are reported by paediatricians and other child health clinicians, who report demographics, diagnosis, treatments and short-term outcomes.

Enhanced surveillance of hospitalised cases provides useful information on the severity of an influenza season and its burden on hospitals. FluCAN, with its use of standard case definitions, facilitates uniform national reporting of hospital data, with influenza status confirmed by polymerase chain reaction (PCR) testing. In addition, during epidemics with high severity or other significance, 2 additional systems have historically been accessed to provide additional information: the Australian New Zealand Intensive Care Society and the Paediatric Active Enhanced Disease Surveillance system.

The current limitations to hospital data, include the lack of denominator (i.e. source population) data to calculate incidence rates. Additionally, while Queensland and Western Australia have the capacity to track patients through the public hospital system, it is currently not easy to track a patient's journey from community care (e.g. GP consultations) into the hospital system. This information would facilitate routine estimation of the risk of hospitalisation among patients with confirmed clinical disease.

Mortality surveillance

Influenza-related mortality surveillance also provides an important indicator of the severity of a season. Three main sources of national influenza

mortality data are utilised: notified laboratory confirmed influenza deaths, official coding of influenza related deaths from national vital statistics reporting, and estimates of excess mortality associated with influenza epidemics using time series analysis.

The NNDSS is able to record deaths associated with a laboratory-confirmed case of influenza. While these data are not easily captured at the time of notification, to improve the completeness of the died status field of notified cases, a range of variably applied methods have been employed by jurisdictional health departments. These methods include: cross-matching of notifications with local death registration data; reporting by doctors; linkage to hospitalisation records; and reporting of deaths detected by sentinel hospital surveillance systems to jurisdictional health departments. Current limitations to these methods include: the variability in the methods used to improve the completeness of the died status field; the timeliness of which the information is available; and the potential discrepancies in the methods applied to determine the relatedness of a death to an influenza notification.

National death data compiled by the Australian Bureau of Statistics and the National Death Index report coded or all-cause death registrations, but these data are not timely enough for public health response or reporting throughout the influenza season. However, retrospective analysis of mortality data can provide an estimate for the severity of an influenza season, and can be used to validate real-time analyses.

Timely death registration data and analyses are reported through the New South Wales Ministry of Health's Influenza Surveillance Reports.[23] Although jurisdictionally based, these data can be utilised to inform mortality trends through comparisons of influenza and pneumonia deaths to previous years' data and trends.

Laboratory surveillance

Laboratory-based surveillance provides information on the extent and characteristics of circulating influenza. Some types of laboratory surveillance are useful for developing baselines and thresholds to indicate the start and end of a season as well as inform severity assessment, while others are used to monitor antigenic drift, antiviral drug susceptibility and inform vaccine effectiveness.

National influenza centres (NICs) are part of the WHO Global Influenza Surveillance and Response System, a network tasked with monitoring changes in influenza viruses with the aim of informing influenza vaccine composition. NICs collect virus specimens, perform preliminary analysis (usually by reverse transcription PCR (RT-PCR) and ship representative and unusual clinical specimens and isolated viruses to WHO collaborating centres for advanced antigenic and genetic analysis. Australia has 3 NICs; PathWest Laboratory Medicine (Perth, WA), the Victorian Infectious Diseases Reference Laboratory (Melbourne, Victoria) and Pathology West (Sydney, NSW); and 1 collaborating centre (Melbourne, Victoria).

The WHO Collaborating Centre receives influenza virus samples from NICs and other public and private health laboratories around Australia for virus characterisation. Viruses undergo various assays to assess antigenic and genetic drift, as well as sensitivity to antiviral drugs. These data are reported weekly to the DoH.

The proportion of requested respiratory tests positive for influenza provides a further indicator of influenza activity. This method is less biased than simply counting positive cases (as in the NNDSS notified cases), as it provides a denominator for controlling annual fluctuations in testing behaviours. 'Laboratory per cent positive' data are reported as part of the national Scheme by the NICs, and Tasmanian laboratories.

The timing, severity and economic burden of influenza seasons depends on the dominant circulating strain, so there is a compelling need to consider the A subtypes and B lineages separately. Many laboratories now use RT-PCR to confirm influenza infection. However few provide A subtypes and only the WHO collaborating centre, PathWest and Pathology West are able to the provide lineage of type B viruses. Thus there is variable determination of subtypes or lineages between jurisdictions, which is a limitation of laboratory surveillance.

Conclusion

Australia's National Influenza Surveillance Scheme generally provides timely syndromic and laboratory surveillance of influenza from the community through to hospitalisation and death, but each system has its own inherent limitations and no system is completely accurate. Therefore, limitations of the Scheme's component surveillance systems must be taken into consideration when interpreting their outputs, and conclusions are best based on a considered assessment of all the indicators. Overall, the components of the Scheme combine to meet the stated goals of the system in informing control measures to lessen the burden of influenza in the Australian community and ensure that decision makers have access to the best available and timely information on which to base their decisions.

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