

FluCAN 2009: initial results from sentinel surveillance for adult influenza and pneumonia in eight Australian hospitals

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The emergence of pandemic (H1N1) 2009 influenza posed challenges to the Australian health system.^{1,2} Soon after the first locally acquired cases were recognised in Australia in May 2009, it became clear that, despite the presence of pandemic plans and a variety of surveillance systems for influenza,³ there was a gap in surveillance at the severe end of the clinical spectrum.

Data on severity are important because an increase in severe respiratory complications such as pneumonia in adults could signal a change in the virulence of pandemic viral strains. Although some newly emerged influenza strains, such as H5N1, have been associated with direct viral-associated lung disease,⁴ it has been suggested that mortality in previous pandemics was associated with secondary bacterial pneumonia,^{5,6} emphasising the importance of surveillance for pneumonia as well as influenza during a pandemic. This gap in surveillance was common in many countries, and a variety of systems were rapidly set up or augmented during 2009 to gather information on hospitalisations.^{1,7-12}

In Australia, existing systems were rapidly scaled up to meet the challenge, while state and territory health departments provided data from hospitals to the Australian Government Department of Health and Ageing.¹³ Other sources of influenza surveillance data were limited to patients in intensive care units (ICUs) or hospitalised children.^{14,15} A variety of systems were set up in jurisdictional health departments, but these relied on personal networks of public health physicians, laboratory data and automated reporting systems.^{13,16}

Thus, at the onset of the H1N1 pandemic in 2009, there were no reliable, comprehensive, consistent and rapidly available data on adult acute respiratory hospitalisations outside the ICU setting in Australia. The Influenza Complications Alert Network (FluCAN) was designed to fill this gap by providing data from sentinel hospitals on acute respiratory hospitalisations, including ICU admissions. Here, we present its initial findings for the first 6 months, and compare FluCAN data on pandemic (H1N1) 2009 influenza with publicly available data from

ABSTRACT

Objective: To describe the epidemiology of adult patients hospitalised with influenza or pneumonia during a pandemic season in a sentinel network in Australia.

Design, participants and setting: Prospective case series of adult hospital admissions to eight acute care general public hospitals (Influenza Complications Alert Network [FluCAN] sentinel hospitals) in six Australian jurisdictions, 1 July to 4 December 2009.

Main outcome measures: Demographic, clinical and outcome measures in patients admitted with laboratory-confirmed pandemic (H1N1) 2009 influenza in the sentinel hospitals compared with data from national notifications and intensive care unit (ICU) surveillance; admissions for influenza and pneumonia over time in each jurisdiction.

Results: During 190 hospital-weeks of observation, there were 538 influenza admissions. Of these, 465 patients (86.4%) had the pandemic strain, representing 9.3% of total admissions with pandemic (H1N1) 2009 influenza ($n = 4992$) recorded nationally in 2009. Of these patients, 250/465 (53.8%) were women, 67/453 (14.8%) were Indigenous, and the median age was 46 years (interquartile range, 29–58 years). Comorbidities were present in 354/464 patients (76.3%), and 40 were pregnant (30.3% of women aged 15–49 years). FluCAN reported that 102 patients (21.9%) were admitted to ICUs, and of patients admitted to hospital, 26 (5.6%) died. FluCAN results were very similar to national notification data and published ICU admissions data. Of those who were followed to 30 days after discharge, 30 (6.5%) were readmitted. Of 1468 patients hospitalised with pneumonia, 718 (48.9%) were tested for influenza and 163 (11.1%) were co-infected with the pandemic strain.

Conclusions: Sentinel surveillance systems can provide important and reliable information in a timely fashion and can monitor changes in severity of influenza during a pandemic season.

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the national surveillance system¹³ and published data from the Australian and New Zealand Intensive Care Society (ANZICS) surveillance system.^{14,17}

METHODS

In 2009, FluCAN had two aims:

- Rapid collection and reporting of data on adult patients with laboratory-confirmed influenza hospitalised at 10 sentinel sites (nine in Australia and one in New Zealand);
- Detailed data collection on adult patients admitted to the same hospitals with laboratory-confirmed influenza or community-acquired pneumonia (with or without influenza).

The network of sentinel hospitals was established based on a pre-existing coalition of thoracic physicians who were members of the Thoracic Society of Australia and New Zealand Pandemic (H1N1) 2009 Task Force and representatives of the Australasian Soci-

ety for Infectious Diseases. While the network predominantly represented tertiary care adult hospitals in capital cities, two non-urban hospitals with specifically high caseloads of Indigenous patients were also included.

One of the non-urban hospitals was unable to commence data collection due to logistical issues, and the Waikato Hospital in New Zealand is excluded from this report, leaving eight Australian hospitals providing data for this analysis.

Data collection and analysis

Patients over 18 years of age were recruited within 48 hours of admission through active surveillance of emergency departments, infection control, pathology and radiology results, and medical admissions by designated research staff in each of the participating hospitals. Using a standard collection instrument, detailed clinical, radiological

1 Patients admitted to Australian FluCAN hospitals with influenza and pneumonia, July to December 2009

State	Hospitals*	Beds			Influenza		Pneumonia with influenza			Pneumonia without influenza
		Wards	ICU†	Total	Pandemic (H1N1) 2009	Seasonal	Pandemic (H1N1) 2009	Seasonal	All influenza	
New South Wales	1	432	17	449	24 (5.2%)	13 (17.8%)	8 (4.9%)	9 (29.0%)	17 (8.8%)	60 (4.7%)
Queensland	2	551	21	572	92 (19.8%)	17 (23.3%)	39 (23.9%)	9 (29.0%)	48 (24.7%)	204 (16.0%)
South Australia	1	650	34	684	98 (21.1%)	3 (4.1%)	29 (17.8%)	2 (6.5%)	31 (16.0%)	295 (23.2%)
Tasmania	1	282	29	311	66 (14.2%)	19 (26.0%)	17 (10.4%)	2 (6.5%)	19 (9.8%)	163 (12.8%)
Victoria	2	795	73	868	41 (8.8%)	6 (8.2%)	20 (12.3%)	1 (3.2%)	21 (10.8%)	315 (24.7%)
Western Australia	1	547	30	577	144 (31.0%)	15 (20.5%)	50 (30.7%)	8 (25.8%)	58 (29.9%)	237 (18.6%)
Total	8	3257	204	3461	465	73	163	31	194	1274

FluCAN = Influenza Complications Alert Network. ICU = intensive care unit. * NSW: Concord Hospital, Sydney; Qld: Cairns Base Hospital and The Mater Hospital, Brisbane; SA: Royal Adelaide Hospital; Tas: Royal Hobart Hospital; Vic: The Alfred Hospital, Melbourne, and Royal Melbourne Hospital; WA: Royal Perth Hospital. † In some hospitals, ICU bed number includes some high-dependency beds without ventilator capacity. ◆

and laboratory data on all patients hospitalised with laboratory-confirmed influenza or community-acquired pneumonia (with or without influenza) were collected.

Standard case definitions were used for community-acquired pneumonia,¹⁸ influenza and comorbidities. Influenza testing was initiated by local clinicians based on clinical indications and was not funded by FluCAN. All influenza cases were confirmed using real-time reverse transcriptase polymerase chain reaction (PCR) assays using standard primers. All tests were performed in local or referral laboratories accredited by the National Association of Testing Authorities. Patients with community-acquired pneumonia were included if they exhibited clinical features suggestive of lower respiratory tract infection, had a chest x-ray demonstrating a new infiltrate consistent with pneumonia, and had onset in a community setting. Comorbidities were recorded if they were documented in the clinical notes, medical sources or via self-report by the patient.

Data collected included demographic characteristics, primary diagnosis, comorbidities, illness severity (including ICU admission), complication profile, length of stay, and outcome of treatment (including death). Where possible, we used the same definitions as in the national notification and ANZICS surveillance systems to allow for comparisons. Follow-up data were obtained 30 days after hospital discharge by contacting patients or, in the case of their death, their nearest available relative, by phone.

The first Australian FluCAN site began prospective data collection on 31 July 2009, and all hospitals had commenced by 4 September 2009. Data on patients admitted

before this time were gathered retrospectively from medical records dating back to 1 July 2009. Patients continued to be enrolled until the end of November 2009. Data from the standardised case report forms were entered into a specially designed database stored at each site. Each week, beginning 7 August 2009, a subset of important epidemiological information was extracted, and de-identified data were transmitted to the Australian National University (ANU) for collation and reporting. At the end of the study period, all data were cleaned, an audit of 10% of cases was performed by medical specialists at each site, and the comprehensive de-identified data were transferred to the central study coordinators (PMK and ACC) in January 2010 for detailed analysis. Simple frequency tables were constructed to allow comparison with other data sources.

Other data sources

National notifications of hospital admissions, ICU admissions and deaths related to pandemic (H1N1) 2009 influenza were obtained from the Australian Influenza Surveillance Report.¹³ In addition, data on ICU admissions were obtained from publications arising from the ANZICS surveillance system.^{14,17} Hospital bed capacities were derived from local sources and official hospital statistics for use as denominator data.¹⁹

Ethics approval

Ethics approval for the FluCAN surveillance system was obtained from the human research ethics committees at each site and the ANU. Verbal consent was obtained to follow up patients by telephone after discharge from hospital. Approval was also

given at all sites to collect retrospective data from medical records.

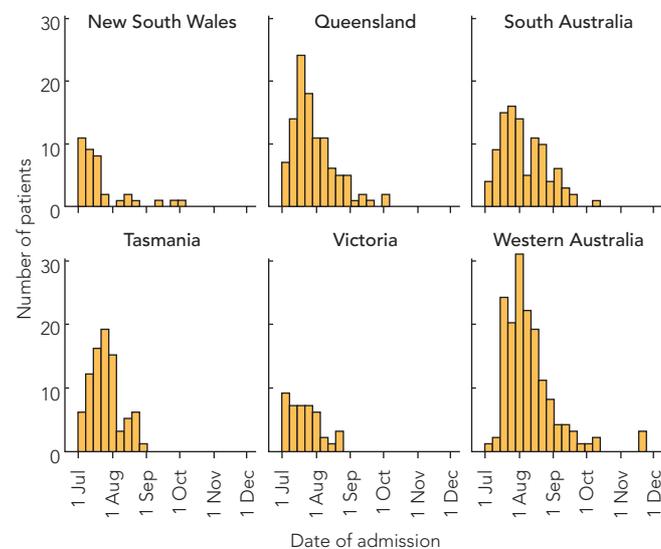
RESULTS

The eight public acute care hospitals in six Australian jurisdictions reporting FluCAN data in 2009 (Box 1) represented 10% of all Australian hospitals with over 200 beds ($n=79$). The 3461 beds in the sentinel hospitals represent 6.4% of national bed capacity ($n=54\,338$).¹⁹ All but one hospital was in a major urban area. From 1 July to 4 December 2009, 190 hospital-weeks of observation were undertaken (136 [71.6%] prospectively).

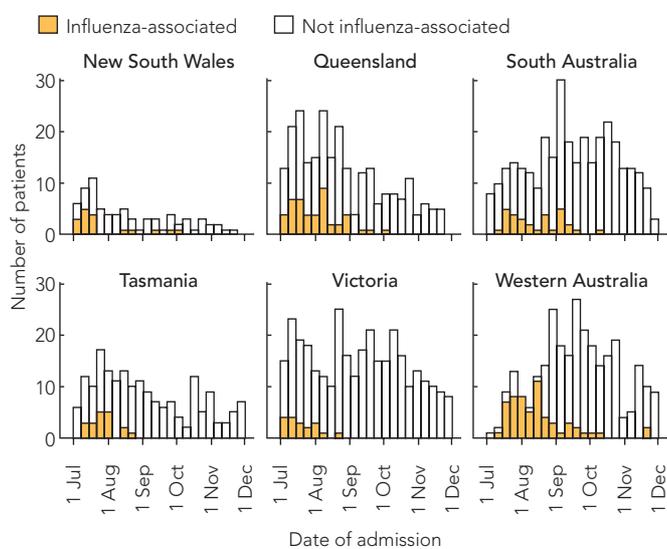
A total of 538 patients were recorded as being hospitalised with PCR-confirmed influenza; of these cases, 465 (86.4%) were due to pandemic (H1N1) 2009 influenza (representing 9.3% of the 4992 admissions for the pandemic strain notified nationally), with the remainder due to seasonal strains of influenza A. There were also 1468 patients hospitalised with radiologically confirmed community-acquired pneumonia, 718 (48.9%) of whom were tested for influenza; 194 cases (13.2%) were found to be associated with influenza, mostly the pandemic strain (163, 11.1%) (Box 1).

There was marked geographic variation in the distribution of the 538 influenza cases, with lower than expected caseloads in Victoria (which had 25.1% of total beds in the sentinel hospitals, but only 8.7% of the total influenza cases) and New South Wales (13.0% of beds and 6.9% of influenza cases), and higher than expected caseloads in the other states, especially Western Australia (16.7% of beds and 29.6% of influenza cases) (Box 1). This was mainly due to the timing of data collection, which com-

2 Pandemic (H1N1) 2009 influenza admissions to Australian FluCAN hospitals in 2009, by state



3 Pneumonia (with or without influenza) admissions to Australian FluCAN hospitals in 2009, by state



menced after the peak of cases in Victoria in mid to late June 2009²⁰ but before the majority of cases in WA (Box 2). This timing issue was also evident in the proportion of pandemic (H1N1) 2009 influenza cases in each state, which was as low as 64.9% in NSW and as high as 97.0% in South Australia (Box 1).

The epidemiology of pneumonia was less affected by the timing of data collection, except for higher than expected numbers of admissions in Tasmania and lower than expected numbers of admissions in NSW (Box 1 and Box 3). Compared with influenza patients, a similar proportion of patients with pneumonia were men, but patients were older, with a median age of 69 years (interquartile range, 18–101 years). There were 107 Indigenous patients admitted with pneumonia (7.3%).

Box 4 compares pandemic (H1N1) 2009 influenza cases recorded in FluCAN with national notifications¹³ and intensive care admissions.^{14,17} As a proportion of nationally notified hospitalisations, the number of FluCAN-reported cases was higher than expected (465/4992, 9.3%), based on the number of beds in the sentinel hospitals and the limited period of observation. FluCAN reported 102 ICU admissions (15.0% of the nationally reported number), again more than expected given the proportion of national ICU bed capacity in the sentinel hospitals.

Compared with national notifications, FluCAN-reported hospitalised patients had a higher median age, a similar proportion of

women, and a higher proportion of pregnant women (Box 4). Most pregnant women (29, 72.5%) were in their third trimester. Of note, 40% of pregnant women (16/40) admitted to FluCAN hospitals with pandemic (H1N1) 2009 influenza were over the age of 45 years; these women are not included in the national notifications of women of childbearing age (age range, 15–44 years). FluCAN reported a lower proportion of admitted Indigenous patients but a higher ascertainment rate for Indigenous status (96.8% v 80.7%), and a higher rate of at least one comorbidity. Prominent comorbidities included asthma, obesity and immunosuppression. Almost 30% of admitted patients for whom information was available were current smokers. Median length of stay and death rate were slightly higher in FluCAN, although the latter can be partly explained by FluCAN's inclusion of data on post-discharge deaths.

Compared with the national notifications, FluCAN reported a higher proportion of patients with pandemic (H1N1) 2009 influenza admitted to ICUs (Box 4). For ICU patients, demographic and risk factor data were generally similar between patients reported in FluCAN and both the national notifications and ANZICS data — median age, proportion of women, and the proportion of patients with at least one comorbidity were very similar. FluCAN reported a higher proportion of pregnant women admitted to ICUs than both other systems. Specific comorbidities available from ANZICS data were very similar to those

reported by FluCAN, as were the proportion of patients with pneumonia, length of stay and death rate. This level of detail was not available from the national notification data.

DISCUSSION

The FluCAN system was established during the peak of the 2009 influenza pandemic and provided real-time surveillance data on patients with influenza and pneumonia admitted to Australian hospitals. Reported case numbers for influenza were higher than expected, given the number of beds in the sentinel hospitals. The demographic, comorbidity and outcome data for FluCAN patients were broadly similar to those from national notifications and ANZICS ICU admissions data, demonstrating the representative nature of the sentinel surveillance. It should be noted that both of the non-FluCAN datasets collected relatively minimal data from all hospitals and all age groups throughout the 2009 influenza season, whereas the FluCAN dataset was more detailed but restricted to adults aged over 18 years in sentinel hospitals and commenced 2 months after diagnosis of the first Australian pandemic cases. The high ascertainment rate, accuracy of diagnosis and level of detail in FluCAN reinforce the utility of a strategically established sentinel surveillance system for hospital admissions.

Initial information from Australia and overseas on the severity of pandemic (H1N1) 2009 influenza infection suggested that the illness was relatively mild and

4 Hospitalisations and intensive care unit (ICU) admissions for pandemic (H1N1) 2009 influenza in Australia in 2009: a comparison of FluCAN data, nationally notified cases¹³ and ICU admissions reported by ANZICS^{17*}

Characteristic	Hospitalisations		ICU admissions		
	FluCAN	National notifications	FluCAN	National notifications	ANZICS
Number	465	4992	102/465 (21.9%)	681/4992 (13.6%)	722
Demographics					
Age in years, median (IQR) [†]	46 (29–58)	31	44 (29–55)	44	40 (26–54)
Female	250/465 (53.8%)	2528/4992 (50.6%)	58/102 (56.9%)	364/681 (53.5%)	376/722 (52.1%)
Risk factors					
Indigenous	67/453 (14.8%)	808/4048 (20.0%)	13/99 (13.1%)	102/533 (19.1%)	61/683 (8.9%)
Pregnant					
Proportion of all admissions	40/465 (8.6%)	287/4992 (5.7%)	16/102 (15.7%)	47/681 (6.9%)	66/722 (9.1%)
Proportion of women of childbearing age [‡]	40/132 (30.3%)	287/1056 (27.2%)	16/44 (36.4%)	47/289 (16.3%)	na
≥ 1 Comorbidity [§]	354/464 (76.3%)	2303/4992 (46.1%)	75/102 (73.5%)	457/681 (67.1%)	493/722 (68.3%)
Asthma	135/459 (29.4%)	na	25/99 (25.3%) [¶]	na	231/707 (32.7%) ^{¶¶}
COPD	72/457 (15.8%)	na			
Obesity**	66/264 (25.0%)	na	24/70 (34.3%)	na	172/601 (28.6%)
Cardiac disease ^{††}	84/458 (18.3%)	na	17/101 (16.8%)	na	na
Cardiac failure	31/460 (6.7%)	na	7/101 (6.9%)	na	74/703 (10.5%)
Diabetes	81/463 (17.5%)	na	18/101 (17.8%)	na	112/700 (16.0%)
Immunosuppression	89/462 (19.3%)	na	16/101 (15.8%)	na	na
Malignancy	42/461 (9.1%)	na	8/101 (7.9%)	na	na
Renal disease	33/460 (7.2%)	na	8/100 (8.0%)	na	na
Hepatic disease	29/462 (6.3%)	na	11/102 (10.8%)	na	na
Vulnerable group ^{‡‡}	384/464 (82.8%)	2892/4992 (57.9%)	85/102 (83.3%)	504/681 (74.0%)	na
Current smoker	106/354 (29.9%)	na	23/77 (29.9%)	na	na
Outcomes					
Pneumonia	163/465 (35.1%)	na	74/102 (72.5%)	na	476/689 (69.1%) ^{§§}
Length of stay in days, median (IQR) ^{¶¶¶}	5 (3–10)	3	14 (7–24)	na	12 (6–22)
Readmitted ^{***}	30/465 (6.5%)	na	6/102 (5.9%)	na	na
Died	26/465 (5.6%)	191/4992 (3.8%)	16/102 (15.7%)	na	103/578 (17.8%)
In hospital	22/26 (84.6%)	na			
After discharge ^{***}	4/26 (15.4%)	na			

FluCAN = Influenza Complications Alert Network. ANZICS = Australian and New Zealand Intensive Care Society. IQR = interquartile range. na = not available. COPD = chronic obstructive pulmonary disease.

* FluCAN and national data include only Australian admissions; ANZICS data include Australia and New Zealand. FluCAN reporting period is from 1 July to 4 December 2009; national data reporting period is from April to December 2009; and ANZICS reporting period is from June to August 2009.

† IQR for age unavailable for national data.

‡ Childbearing age is 15–49 years for FluCAN, and 15–44 years for national data.

§ Comorbidity in FluCAN concurs with national definition: one or more of chronic respiratory, renal, cardiac, hepatic or neurological disease; immunosuppression; malignancy; obesity (body mass index [BMI] > 30 kg/m²); or diabetes.

¶ Asthma and COPD combined.

** Very limited data for obesity reported by FluCAN: 16/45 hospitalised patients (35.6%) and 4/9 admitted to intensive care had a confirmed BMI > 35 kg/m².

†† Cardiac disease includes ischaemic heart disease, rheumatic fever and congestive cardiac failure.

‡‡ Vulnerable groups are pregnant women, Indigenous people, and individuals with at least one comorbidity.

§§ Pneumonia in ANZICS data includes viral pneumonitis or acute respiratory distress syndrome and confirmed or probable bacterial pneumonia.¹⁷

¶¶¶ National length-of-stay data reported by Bishop et al (IQR unavailable).² ANZICS length-of-stay data include 114 patients still in hospital at time of analysis.

*** Within 30 days of discharge.

mainly affected children and young adults. Pregnancy, obesity, asthma, chronic obstructive pulmonary disease and some other non-respiratory comorbidities appeared to be associated with more severe disease in a

minority of patients.^{21–23} Subsequent reports have shown a range of estimates for underlying comorbidities and particular populations at greater risk of severe disease. A recent report reviewed hospitalisation data

globally,⁸ and there have been Australian reports of hospitalisations in single hospitals in Sydney²⁴ and Darwin,²⁵ or clusters of hospitals in specific geographic regions.^{16,26} FluCAN data are broadly in agreement with

the estimates of frequency of vulnerable groups, proportion admitted to ICUs, and mortality in these other studies. Only FluCAN has thus far included estimates of post-discharge health service use and deaths.

Any differences between the data reported by FluCAN and those in Australian Government reports can mainly be explained by FluCAN being confined to adult hospitalisations (for median age, proportion of pregnant women), the location of the Flu CAN hospitals (lower proportion of Indigenous patients due to a concentration in southern metropolitan hospitals), and more accurate and detailed ascertainment of clinical status in Flu CAN data (higher proportion of comorbidities and detailed information on a wider range of underlying diseases and other risk factors). ICU admissions captured by FluCAN were broadly similar to population-level ANZICS data and national data, demonstrating the representative nature of FluCAN for this more severely affected group.

Data on pneumonia admissions in Australia are provided from routinely collected sources that are not timely and generally lack specificity in diagnosis and details of comorbidities. The Australian Community-Acquired Pneumonia Study (ACAPS) reported more detailed information on pneumonia from six hospitals (including two that contributed to FluCAN) in three states.¹⁸ Compared with patients with pneumonia in FluCAN, ACAPS patients were similar in age and the proportion of female patients was similar. There were large differences in Indigenous status and underlying comorbidities, perhaps because almost half of all ACAPS patients were admitted to a single tertiary referral hospital in Melbourne.¹⁸

There were several limitations to the FluCAN surveillance system. For a variety of reasons, influenza PCR tests were not done routinely for all patients with respiratory illnesses in some hospitals, despite national guidelines encouraging testing for hospitalised and high-risk patients with influenza-like illness.²⁷ Thus, an unknown number of admissions during this period may have been due to influenza but not diagnosed and therefore not included in the data presented here. In its first year, FluCAN attempted to collect as much relevant information as possible, but there was a surprising lack of consistent recording of important variables such as smoking, vaccination status, weight and height. Ongoing surveillance will provide a comparison during a non-pandemic

season and hopefully address some of the limitations of data collection in 2009.^{1,8,14}

Accurate, rapidly available and country-specific data on severity are essential for health authorities to appropriately respond to pandemic threats. Due to difficulties in collecting such information from hospitals, particularly in a pandemic situation, sentinel surveillance systems are an alternative to whole-of-system approaches. Despite the increased workload inherent in the 2009 pandemic, our group of clinicians and public health practitioners was able to establish a hospital-based sentinel surveillance system relatively quickly. FluCAN was able to capture representative information comparable to more comprehensive surveillance systems in a more timely manner and with high-quality clinical data. This suggests that a strategically selected sentinel network can augment whole-of-system surveillance and provide data that are representative of the wider hospital system in Australia.

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COMPETING INTERESTS

Allen Cheng is an investigator on a surveillance study of the safety of influenza vaccine funded by CSL Ltd. The Thoracic Society of Australia and New Zealand provided support for Paul Kelly to travel to its annual scientific conference to present findings related to this paper. Bob Hancox is a board member of the Asthma Foundation (New Zealand) and has received royalties from McGraw-Hill for a book on lung function. Richard Wood-Baker has conducted research sponsored by GlaxoSmith-Kline (GSK) and Gilead and had travel expenses paid by Boehringer Ingelheim for a presentation at

Airways 2008. Louis Irving has received payment for lectures and development of educational presentations from GSK and AstraZeneca, and has had travel expenses paid by AstraZeneca for attendance at a European Respiratory Society conference. Mark Holmes is a Novartis board member, for which he receives payment and reimbursement of travel expenses, and he has received payment for lectures from Medimark International, AstraZeneca, Pfizer and Boehringer Ingelheim.

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Recognising and remembering . . .

The *MJA* would like to encourage its readers to submit obituaries of doctors who have died within the past 6 months so that we can acknowledge their contribution to the medical community. The obituaries should consist of approximately 350 words and include biographical details such as last position held, place and date of

birth, place of qualification and date (if possible), postgraduate qualifications and personal interests. An electronic photograph should accompany the obituary, preferably 300 dpi, jpeg or tiff file. The obituary may be published in print and online, or online only. The article may be truncated in the print version.

If you wish to submit an obituary please email it as a Word file to our librarian, Jackie Treadaway (jackie@ampco.com.au).