Australian vaccine preventable disease epidemiological review series: mumps 2008-2012

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Abstract

In 2007, Australia recorded the highest notification rate (2.8 per 100,000) for mumps since it became notifiable, with outbreaks in Western Australia and the Northern Territory. Of particular concern was the number of cases seen in vaccinated individuals. The aim of this study was to review subsequent epidemiological data. Notification, hospitalisation and mortality data from the National Notifiable Diseases Surveillance System, the National Hospital Morbidity Database and Australian Bureau of Statistics (ABS) respectively, from 2008 to 2012 for notifications and 2008 to 2011 for hospitalisations and deaths, were analysed by age, year and jurisdiction. ABS population data were used to calculate rates. National mumps notification rates decreased from 1.3 per 100,000 in 2008 to 0.4 per 100,000 in 2010, but then increased to 0.9 per 100,000 in 2012, predominantly due to increased notifications in New South Wales (1.4 per 100,000). Hospitalisation rates remained stable at 0.4 per 100,000 over the 2008–2011 period. The median age of notified cases was 30 years and for hospitalisations, 27 years. The highest rate of notifications and hospitalisations was in the 25–34 years age group. Completeness of vaccination status ranged from 16% to 39%. The increasing trend in mumps notifications needs to be closely monitored. Improved data quality, in particular on vaccination status, is needed to inform the monitoring of vaccine effectiveness. In March 2014 the World Health Organization certified that Australia had achieved measles elimination. Greater availability of case history (vaccination status and place of acquisition) and genotyping data would facilitate an assessment of Australia's progress in relation to mumps elimination. *Commun Dis Intell* 2015;39(1):E10–E18.

Keywords: mumps, disease surveillance, immunisation

Introduction

Mumps is a paramyxovirus in the genus Rubulavirus. Humans are the only known reservoir for the virus. Symptoms of the disease include fever and other non-specific symptoms including headache, malaise, myalgia and anorexia. One-third of infected individuals have subclinical disease.[1,2] The characteristic feature of mumps is swelling and inflammation of one or more salivary glands, most commonly the parotid gland.[1] Up to 10% of cases develop meningitis and 0.1% encephalitis. The case fatality rate for encephalitis is around 1.5%.[1,2] Unilateral orchitis occurs in 25% of post-pubertal males with clinical mumps, however, infertility is rare.[1] In early pregnancy, mumps can cause spontaneous abortion, but there is no evidence of infection leading to increased risk of congenital malformation or low birth weight.[2]

The incubation period of mumps is usually 16–18 days but can range from 12–25 days.[3] Transmission occurs mainly through contact with respiratory droplets or saliva, with peak infectiousness just before or at the onset of parotitis.[1]

A single dose of mumps (as measles-mumps) vaccine was funded for all children aged 12 months of age on the national immunisation schedule in 1982.[4] In 1989, the vaccine was changed to the measles-mumps-rubella (MMR) vaccine. A 2nd dose of MMR was introduced at 10–14 years of age in 1992. This dose was brought forward to 4–5 years of age in 1998, and then to 4 years in 2000. There were 2 major MMR catch-up campaigns. The Measles Control Campaign in 1998 targeted primary school children. A young adult MMR vaccination campaign in 2001 targeted individuals born in the late 1960s to the mid-1980s who may have missed being vaccinated or acquiring measles, mumps and rubella infection as an infant.[4] While the Measles Control Campaign reached 96% of the target age group,[5] the uptake in the young adult campaign was likely to have been poor, based on the lack of any significant improvement in immunity in this age group in pre– and post-serosurvey data.[6,7]

Since the introduction of universal childhood vaccination, a shift in the age distribution of mumps cases from younger children to adolescents and young adults occurred in Australia and overseas from the 1980s to the early 2000s, with the exact period of age shift varying from country to country.[8–10]

Previous reviews of mumps epidemiology in Australia documented an increase in mumps notifications from 2003 to 2007, contributed to by epidemiologically-linked outbreaks in Indigenous communities in the Northern Territory and

Western Australia in 2007.[11,12] Concerns were raised about the number of cases seen in vaccinated individuals.[11] Increasing numbers of mumps notifications were also observed in the United States of America and the United Kingdom in the first half of the 2000s,[13–15] and in some countries in the World Health Organization Western Pacific Region, including China, Japan, Mongolia and Korea, to 2007.[16]

This study aims to review subsequent Australian mumps epidemiology for the 2008 to 2012 period, analysing by age, gender, state or territory, Indigenous status and vaccination status, and to place this in historical and international context by comparison with published data.

Methods

Study period

For notifications, we analysed data from 1 January 2008 to 31 December 2012. For hospitalisations and deaths, we analysed data from 1 January 2008 to 31 December 2011 (the latest data available at the time of analysis). We reviewed published data from the pre-2008 period for comparison purposes.[10–12,17]

Data sources

Notifications

In Australia, cases of mumps are notified under the public health legislation in each state and territory. De-identified data on confirmed cases are submitted to the National Notifiable Diseases Surveillance System (NNDSS). The NNDSS was established in 1991, with regular reporting by all 8 states and territories on a consistent basis occurring from mid-2001 onwards. A national case definition has been in place since 2004, which includes a combination of laboratory, clinical and epidemiological evidence.[18]

For this analysis, notifications with a diagnosis date between 1 January 2008 and 31 December 2012 were obtained from the NNDSS for all Australian jurisdictions. The diagnosis date is derived from the date of onset, or, where not supplied, the earliest date recorded among these fields: date of specimen, date of notification, or date when the notification was received.[11] Vaccination status was only assessed for individuals born after 31 December 1980 i.e. the population eligible for mumps vaccination under the National Immunisation Program (NIP) since it was introduced onto the NIP in 1982. Vaccination status is categorised as fully or partially vaccinated for age, unvaccinated, unknown or missing.[19]

Hospitalisations

Hospital admissions to public and private hospitals in Australia are captured through an administrative database, the National Hospital Morbidity Database, maintained by the Australian Institute of Health and Welfare (AIHW). Demographic and clinical information about patients are captured. For this analysis, all hospitalisations with admission dates between 1 January 2008 and 31 December 2011 were included. Eligible hospitalisation admissions were identified using the International Statistical Classification of Diseases and Related Health Problems, 10th revision, Australian Modification (ICD-10-AM) code B26 (mumps), where listed as principal or other diagnosis. Hospitalisations from Tasmania and the Australian Capital Territory were excluded from the analysis of Indigenous status, as recommended by the AIHW on the basis that completeness in these jurisdictions is below the level (80%) considered acceptable for inclusion in national analysis.[20]

Mortality

Deaths are registered with the Registry of Births, Deaths and Marriages in each state and territory. Data from the registries and state and territory coroners are collated by the Australian Bureau of Statistics (ABS). Mortality data for mumps were obtained from the ABS for the period 2008 to 2011. Data where the underlying cause of death was recorded as mumps, using ICD-10-AM code B26, were included in this analysis.

Population estimates

National, jurisdictional and age-specific mid-year estimated resident population data were obtained from the ABS.[21]

Data analysis

For notifications, variables extracted for analysis included year of diagnosis, age, sex, state or territory of residence, vaccination status, Indigenous status and place of acquisition. For hospitalisations, variables extracted for analysis included primary or other diagnosis, date of admission, age, sex, state or territory of residence, Indigenous status, complications and length of stay (bed days). Data fields were assessed for completeness. Notification and hospitalisation rates were calculated using ABS population data, and are presented as average annual rates per 100,000 total population or population in age, sex or geographical subgroups as appropriate, with age groups selected based on epidemiological relevance and usage in previous published reports. Summary statistics including median and range were calculated for age and length of hospital stay.

P-values were derived using t-test for proportions. Analysis was conducted using Microsoft Excel 2010 and SAS version 9.3 (SAS Institute Inc, Cary, NC, USA).

Results

Secular trends

Nine hundred and four mumps notifications were recorded in the NNDSS between 2008 and 2012. The number of notifications decreased progressively from a peak of 582 in 2007 (notification rate 2.8 per 100,000) to 98 (0.4 per 100,000; $P<0.001$) in 2010 but then increased to 155 (0.7 per 100,000; $P<0.001$) in 2011 and 200 (0.9 per 100,000; $P<0.001$) in 2012 (Figure 1).

There were 356 hospitalisations between 2008 and 2011. Following the 2007 peak (104 hospitalisations; 0.5 per 100,000), the number of hospitalisations and hospitalisation rate remained stable at around 89 and 0.4 per 100,000, respectively, over the 2008 to 2011 period (Figure 2).

During the 2008 to 2011 period, there were twice as many notifications of mumps (704) as there were hospitalisations (356). The ratio of notifications to hospitalisations declined from 5.7 in 2007 to 3.2 in 2008 and 1.1 in 2010 (Figure 3).

No deaths with mumps coded as the underlying cause of death were recorded during the 2008 to 2011 period.

Age and sex distribution

The age distribution for notifications from 2008 to 2012 was similar to that in the preceding 3-year period (Figure 1). The highest age-specific notification rate was in the 25–34 years age group (1.7 per 100,000), and the lowest in the 0–4 years age group (0.5 per 100,000; data not shown). The median age of notifications was 30 years (range: 0–88 years). The overall male:female ratio over the 5–year period was 1.2:1 with some variation by year (lowest 0.7:1 in 2010; highest 1.5:1 in 2009) but without notable variation by age group.

The age distribution for hospitalisations from 2008 to 2011 was similar to that in the preceding 3-year period (Figure 2). The highest age specific hospitalisation rate was in the 15–24 years and 25–34 years age groups (0.6 per 100,000), and the lowest in the ≥35 year age group (0.3 per 100,000). The median age for hospitalisations was 27 years (range: 0–97 years). The overall male:female ratio was 1:1, with variation by year (lowest 0.6:1 in 2010; highest 1.4:1 in 2009)

Figure 1: Mumps notification rates, Australia, 1999 to 2012, by age group and year of diagnosis

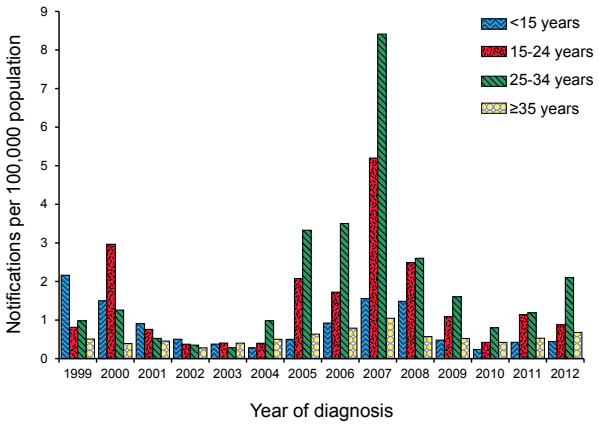


Figure 2: Mumps hospitalisation rates, Australia, 1999 to 2011, by age group and year of admission

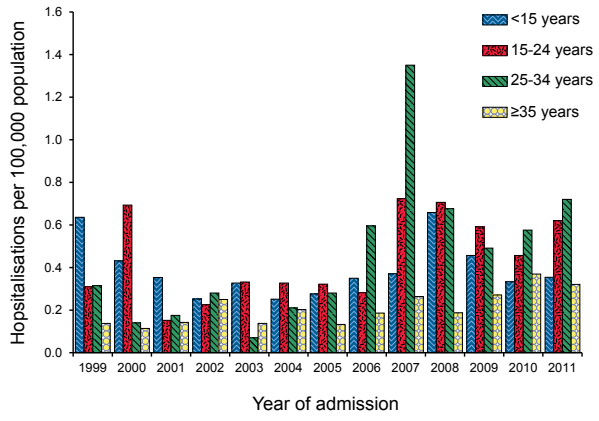
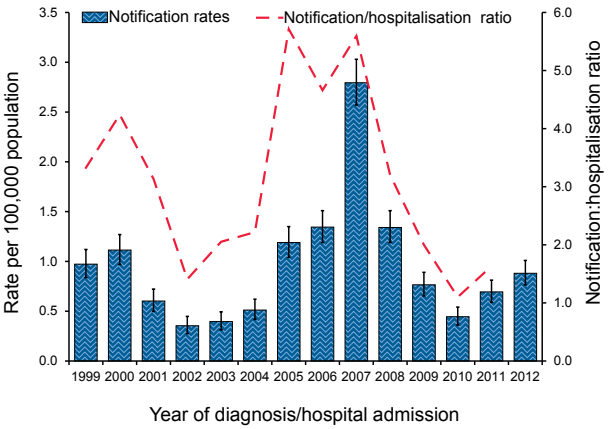


Figure 3: Mumps notifications and notification:hospitalisation ratio, Australia,* 1999 to 2012†



* From July 1999 until June 2001 mumps was not notifiable in Queensland.

† Hospitalisation data available to 2011.

and age group (1.6:1 in 0–4 years age group;1.4:1 in 5–14 years age group; 0.8:1 in 15–34 years age group; 0.9:1 in ≥35 years age group).

Seasonality

No seasonal pattern was apparent over the 2008 to 2012 period (data not shown).

Indigenous status

During the 2008 to 2012 period, 52% (468/904) of notifications were recorded as non-Indigenous, 14% (127/904) as Indigenous, and 34% (309/904) had unknown or missing Indigenous status. Completeness of Indigenous status was highest in 2008 (77%), and varied between 51% and 63% in subsequent years. The proportion of notifications recorded as Indigenous was highest in 2008 (39%, 110/285), decreasing to 7% (11/166) in 2009 and 1% (1/200) in 2012.

From 2008 to 2011, 88% (306/349) of hospitalisations (Tasmania and the Australian Capital Territory excluded) were recorded as non-Indigenous, 10% (36/349) as Indigenous, and 2% (7/349) had unknown or missing Indigenous status. Completeness of Indigenous status varied between 97% and 99% by year. The proportion of hospitalisations recorded as Indigenous decreased from 24% (21/88) in 2008 to 2% (2/92) in 2011.

State and territory variations

Notification and hospitalisation rate trends varied across states and territories (Figure 4). The highest average annual notification rate was in the Northern Territory (5.9 per 100,000), with the 2nd highest in Western Australia (1.4 per 100,000). Average annual notification rates were below 1.0 per 100,000 in all other states and territories. Of note, 96% (106/110) of the notifications recorded as Indigenous in 2008 were notified in either Western Australia or the Northern Territory. The number of notifications in the Northern Territory decreased from 52 in 2008 (23.7 per 100,000) to 2 (0.9 per 100,000) in 2010 ($P<0.001$), while the number of notifications in Western Australia decreased from 95 in 2008 (4.4 per 100,000) to 20 in 2009 (0.9 per 100,000; $P<0.001$). The number of notifications in New South Wales increased from 40 (0.6 per 100,000) in 2010 to 105 (1.4 per 100,000) in 2012 ($P<0.001$).

The highest average annual hospitalisation rate was in the Northern Territory (2.4 per 100,000, 22/356). The average annual hospitalisation rate in all other states and territories was below 0.5 per 100,000. The number of hospitalisations in the Northern Territory decreased from 11 in 2008 (5.0 per 100,000) to 1 in 2011 (0.4 per 100,000; $P<0.001$). Ninety-five per cent (20/21) of the hospitalisations recorded as Indigenous in 2008 were notified in either Western Australia or the Northern Territory.

Vaccination status

Between 2008 and 2012, there were 435 notifications in individuals born after 31 December 1980. Of these individuals, 410 were aged ≥4 years, who should have received 2 doses of mumps-containing vaccine according to current recommendations. Of these, 18% (74/410) were reported as fully vaccinated, 4% (15/410) as partially vaccinated for age, and 6% (24/410) as unvaccinated; vaccination status was missing or unknown for most (72%, 297/410). Completeness of vaccination status in individuals born after 31 December 1980 and aged ≥4 years was highest in 2008 (39%) and varied between 16% and 28% in subsequent years.

Between 2008 and 2012, there were 119 notifications in individuals born after 31 December 1995, eligible to have their immunisation information recorded on the Australian Childhood Immunisation Register. Of the 94 of these aged ≥4 years, 28% (26/94) were reported as fully vaccinated, 5% (5/94) as partially vaccinated for age and 10% (9/94) as unvaccinated, with 57% (54/94) having missing or unknown vaccination status. Completeness of vaccination status in individuals born after 31 December 1995 and aged ≥4 years was highest in 2008 (53%), and varied between 27% to 41% in subsequent years.

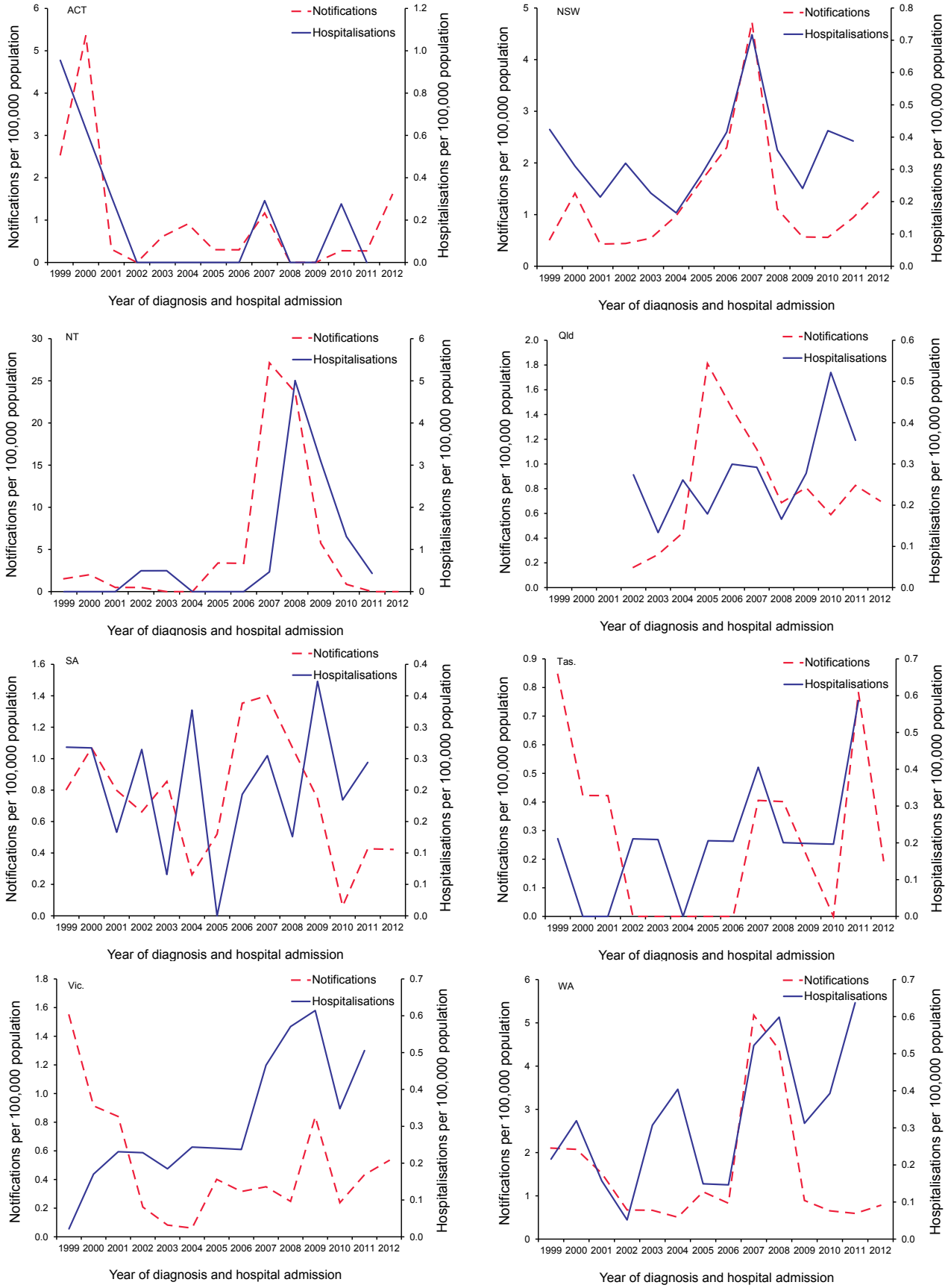
Place of acquisition

Place of acquisition was missing or unknown for 97% (879/904) of notifications between 2008 and 2012. As data quality was poor, further data analysis was not conducted.

Severe morbidity

One thousand four hundred and ninety-three hospital bed days (average 373.3 per year) were recorded for patients with an ICD-10-AM code for mumps. The median length of stay per admission ranged from 1 to 3 days, and was longest (3 days) in the ≥35 years age group. The overall median length of stay was 2 days (range: 1–119 days) (Table 1). Complications arising from mumps infection were recorded for 45 hospitalisations (12.6%). The most common complication recorded was orchitis (23 hospitalisations), predominantly in individuals aged ≥15 years (Table 2). There was 1 hospitalisation coded as mumps meningitis and two coded as pancreatitis. Nineteen hospitalisations were coded as 'other complications', with most of these in individuals aged ≥15 years (Table 2).

Figure 4: Mumps notification and hospitalisation rates, Australia, 1999 to 2012,* by state or territory† and year of diagnosis or admission



Scales vary between jurisdictions.

* From July 1999 until June 2001 mumps was not notifiable in Queensland.

† Hospitalisation data available to 2011.

Table 1: Mumps notification and hospitalisation counts and rates, and hospitalisation length of stay, Australia, 2008 to 2012,* by age group

Age (years)	Notifications (2008–2012)		Hospitalisations (2008–2011)			
					Length of stay (bed days)	
	n	Rate	n	Rate	Median	Total
0–4	38	0.53	31	0.54	1	60
5–14	107	0.78	44	0.40	2	189
15–24	182	1.20	72	0.59	1	131
25–34	258	1.65	76	0.62	1	171
≥35	318	0.55	133	0.29	3	942
Missing	1		0			
All ages	904	0.82	356	0.41	2	1,493

* Hospitalisation and death data not available for 2012.

Table 2: Indicators of severe morbidity in hospitalised cases of mumps,* Australia, 2008 to 2011, by age group

Age group (years)	Mumps orchitis		Mumps meningitis		Mumps encephalitis		Mumps pancreatitis		Mumps with other complications†	
	n	%‡	n	%‡	n	%‡	n	%‡	n	%‡
0–4	1	3.2	0	0.0	0	0.0	0	0.0	0	0.0
5–14	3	6.8	0	0.0	0	0.0	0	0.0	1	2.3
15–24	7	9.7	0	0.0	0	0.0	0	0.0	4	5.6
25–34	6	7.9	0	0.0	0	0.0	0	0.0	4	5.3
≥35	6	4.5	1	0.8	0	0.0	2	1.5	10	7.5
All ages	23	6.5	1	0.3	0	0.0	2	0.6	19	5.3

* From the Australian Institute of Health and Welfare hospitalisation data based on ICD-AM-10 codes.

† Other complications include mumps associated arthritis, myocarditis, neuritis and polyneuropathy.

‡ Percentage of total in the age group

Discussion

After 2007, when the highest number of annual mumps notifications was recorded since mumps became notifiable across all states and territories from July 2001,[17] mumps notifications in Australia decreased between 2008 and 2010 but then increased in 2011 and 2012, predominantly due to increased notifications in New South Wales. Age distribution during the 2008 to 2012 period was broadly similar to the preceding 3-year period, with approximately half of notifications in adolescents and young adults aged 15–34 years compared with greater than 60% during the 2005 to 2007 period.[10] The highest age-specific notification rate during the 2008 to 2012 period was in the 25–34 years age group. Serosurveillance data have highlighted the susceptibility of individuals in this age group i.e. those born in the 1980s when exposure to wild type virus was decreasing but before good levels of vaccine coverage were achieved.[22]

For hospitalisations, following the 2007 peak, the annual number and rate of hospitalisations in Australia remained stable during the 2008 to 2011 period. While the average annual number of hospitalisations was higher for the 2008 to 2012 period compared with the previous 3-year period, the proportion with complications recorded was lower. The average number of hospital bed days (373) was considerably higher for the 2008 to 2011 period compared with the previous 3-year period (171.5).[11] The reason for these differences is unclear. No deaths were recorded from mumps during the 2008 to 2011 period.

The notification:hospitalisation ratio in Australia decreased from 2007 to 2011. This is consistent with increased identification of cases with mild disease during outbreaks, due to active case finding by public health authorities.

There were no reports of large mumps outbreaks in Australia between 2008 and 2012. Several small outbreaks involving 2 to 10 cases were reported in Victoria, in 2009, 2011 and 2012; however, limited information is available on age and vaccination status for the majority of these.[23–27] Following on

from the epidemiologically-linked outbreaks in Indigenous communities in the Northern Territory and Western Australia in 2007, higher numbers of notifications in the Northern Territory continued into 2008 and 2009. These were predominantly in Indigenous people, although it is not definitively known whether these cases were linked to the 2007 outbreak (Peter Markey, Public Health Physician, Communicable Diseases Centre, Darwin, personal communication December 2013). It is also not clear whether the higher number of notifications in Western Australia in 2008, predominantly in Indigenous people, was linked to the 2007 outbreak. However, this possible linkage may account for the decrease in the proportion of notifications and hospitalisations recorded as Indigenous in Australia. From 1984 to 1998, the Northern Territory vaccinated Indigenous infants with a mumps-containing vaccine at 9 months of age, due to their higher risk of measles at the time. This is thought to have played an important role in the 2007 Northern Territory outbreak, as immune response is poorer in infants immunised at under 12 months of age due to interference from maternal antibodies.[28,29]

Concerns about high rates of mumps in fully vaccinated individuals have been raised in relation to recent outbreaks, both in Australia[11] and overseas.[30–33] However, poor completeness of vaccination status in NNDSS data limits the ability to assess vaccine effectiveness. During the 2008 to 2012 period, vaccination status was known for less than a third of notifications in individuals born after 31 December 1980 and aged ≥4 years, with over two-thirds of these recorded to be fully vaccinated. For notifications in individuals born after 31 December 1995 and aged ≥4 years, for whom Australian Childhood Immunisation Register data are potentially available, vaccination status was known for less than half, with over two-thirds of these recorded as fully vaccinated.

Infection in fully vaccinated individuals can be due to a range of reasons including primary vaccine failure, waning immunity, and immune escape.[34–36] Clinical trials of MMR vaccine have shown 95% mumps seroconversion after 1 dose and up to 100% after 2 doses.[37] However, outbreak investigations and post-marketing studies have reported 1-dose vaccine effectiveness (VE) to be between 60% and 90%.[38,39] In some recent outbreaks cases in 2-dose vaccine recipients have been reported to be common, particularly in young adults who were vaccinated more than 10 years earlier.[33,40,41] Two-dose VE, while higher than 1-dose VE,[35] has been shown to decline over time, suggesting waning immunity.[35,42] Whether immune escape of the mumps virus, in response to vaccine-related selection pressure, has been an issue in Australia is difficult to assess due to the paucity of genotyping data, which are only available from outbreak reports.[27,28,34] It is also difficult to assess the relative contributions to mumps disease of suboptimal 2-dose vaccine coverage and primary vaccine failure in 2-dose recipients, given the poor completeness of vaccination status in mumps notification data.

Australia has recently been certified by the World Health Organization as having eliminated endemic measles transmission, on the basis of documented interruption of endemic measles virus transmission for more than three years in the presence of a well-performing surveillance system and supportive genotyping evidence.[43] Available data also suggest that Australia may be close to elimination of rubella.[44] It is therefore of interest to ask what the situation is in regards to mumps. The threshold for herd immunity for mumps has been estimated as 75%–86%, compared with 92%–94% for measles and 83%–85% for rubella.[45] While Australia has achieved high vaccination coverage for MMR (94% for the 1st dose and 90% for the 2nd dose in 201146) vaccine effectiveness is considerably lower for mumps than measles.[40,47] Finland is the only country to have reported elimination of endemic mumps transmission (in the mid-1990s, along with measles and rubella), on the basis of sustained high (>95%) 2-dose MMR vaccine coverage and enhanced surveillance showing the vast majority of cases confirmed to be imported.[48,49] However, it is possible that other countries such as Australia may also have achieved or come close to mumps elimination, and that sporadic outbreaks in highly vaccinated populations may be due to the force of infection after virus introduction from an endemic area into high-density, high contact environments.[42] Greater availability of case history (vaccination status and place of acquisition) and genotyping data would assist in answering this question. Nationally standardised methods of data collection, follow-up and reporting could help to facilitate improved completeness of key data fields.

The figures presented in this report are likely to underestimate the true burden of mumps in Australia, as not all mumps cases are diagnosed and notified. A limitation of notification data is that they may be affected by changes in diagnostic and public health follow-up practices, particularly in outbreak settings, over time and across jurisdictions. Data quality was poor for a number of fields in notification data, including Indigenous status, vaccination status and place of acquisition, presumably reflecting variable levels of follow-up by public health authorities with clinicians and patients. Hospitalisation data may be influenced by access to hospitals and changes in admission practices. ICD-10-AM codes used to identify cases of mumps in the National Hospital Morbidity Database were

assigned for hospital billing purposes, have not been validated to clinical diagnoses or case definitions, and may be susceptible to misclassification.

In conclusion, after peaking in 2007 at their highest level since 2001, mumps notifications in Australia decreased progressively through to 2010, but then increased in 2011 and 2012, while hospitalisations remained stable over the 2008 to 2011 period. The increasing trend in mumps notifications will require continued close monitoring to determine if it is sustained. Improvements in data quality, particularly in terms of completeness of vaccination status and place of acquisition, are required to inform monitoring of vaccine effectiveness. Along with greater availability of genotyping data, this would also facilitate assessment of Australia's progress in relation to mumps elimination.

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