1-1-2013

Impacts of a measles outbreak in western Sydney on public health resources

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Keywords

Measles, disease outbreaks, contact tracing, measles vaccine, health costs, immunisation programs

Disciplines

Medicine and Health Sciences | Social and Behavioral Sciences

Publication Details

Flego, K. L., Belshaw, D. A., Sheppeard, V. & Weston, K. M. (2013). Impacts of a measles outbreak in western Sydney on public health resources. Communicable Diseases Intelligence Quarterly Report, 37 (3), E240-E245.

Original articles

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Abstract

During February and March 2011, an outbreak of 26 confirmed cases of measles was reported to the Parramatta Public Health Unit (PHU) in western Sydney. This paper describes the impact of the outbreak on PHU resources. A retrospective review of information obtained from case notification forms and associated contact tracing records was carried out for each of the confirmed cases. Seven cases (27%) required hospital admission for more than 1 day and 10 (38%) cases required management within a hospital emergency department. There were no cases of encephalitis or death. The number of contacts was determined for each case as well as the number who required post-exposure prophylaxis. In total, 1,395 contacts were identified in this outbreak. Of these, 79 (5.7%) required normal human immunoglobulin and 90 (6.5%) were recommended to receive the measles-mumps-rubella vaccine. A case study detailing the PHU costs associated with the contact management of a hospitalised measles case with 75 identified contacts is also included and the estimated total cost to the PHU of containing this particular case of measles was A$2,433, with staff time comprising the major cost component. Considerable effort and resources are required to manage measles outbreaks. The total cost of this outbreak to the PHU alone is likely to have exceeded A$48,000. *Commun Dis Intell* 2013;37(3):E240–E245.

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Introduction

Although Australia has declared itself to have eliminated measles,[1] imported cases continue to occur with occasional outbreaks involving local transmission amongst under-immunised groups. An outbreak of 26 cases of measles occurred within 1 local government area in western Sydney, New South Wales in February and March of 2011.

This paper describes the impact of a measles outbreak on public health unit (PHU) resources. A case study that estimates the monetary costs to the PHU associated with contact management for 1 measles case is included.

Background

On 4 February 2011, a case of measles in a 12-year-old girl was reported to the Parramatta PHU. She had not travelled recently and no source case was identified; however guests from Samoa had stayed with her family in the preceding weeks. Eleven days later, measles was notified in an 18-month-old girl, also of Samoan background but without recent travel, and with whom the index case had occasional social contact although apparently not within the estimated infectious period for the index case. Two additional cases were notified at this time; one was a 20-year-old non-Samoan woman with no recent travel history and the other was a 15-year-old boy of Samoan background. Neither of these cases reported any epidemiological connection to either of the other 2 cases.

During the next 5 weeks a further 22 confirmed cases of measles were reported, three of which were acquired overseas (Philippines). None of the cases had documented evidence of having received 2 doses of a measles-containing vaccine (MCV). Two cases were recorded on the Australian Childhood Immunisation Register (ACIR) as having received 1 dose of the measles-mumps-rubella (MMR) vaccine. In 4 other cases, a parent stated that their child had been vaccinated against measles but this could not be verified.[2]

Methods

A review of the notification and case-investigation records for each confirmed case and their contacts was conducted, specifically examining the impact on public health resources. According to the NSW Health guidelines, a confirmed case of measles requires laboratory evidence (measles virus isolation or detection by nucleic acid testing or measles IgG seroconversion or measles-virus specific IgM antibody detection) or clinical evidence and an epidemiological link.[3]

The Measles Investigation Forms completed for each case during the outbreak were reviewed. The forms contained information obtained from cases, their carers, other associated contacts, and clinicians. Details recorded included patient demographics, symptoms and onset dates, illness outcomes

(hospitalisation or death), potential exposures, and details of contacts (usually household) and their management. Complication and hospitalisation rates for cases were calculated using information recorded on the Measles Investigation Form.

Contact tracing records were also reviewed. Contact tracing and management was performed by PHU staff as per the NSW Health guidelines.[3] Whenever a healthcare setting was identified as the site of exposure, any person who shared a waiting area with a case or was in the waiting or consultation room up to 2 hours after the case during the infectious period for the case was classified as a contact. Names and contact details for staff and patients meeting the above definition were collected by staff from the healthcare setting and provided to the PHU.

Contacts were telephoned and asked about their measles vaccination status and any history of measles infection. Those born after 1965 who were not age-appropriately vaccinated against measles and who had not previously been infected with measles virus were offered post-exposure prophylaxis (PEP). This was either the MMR vaccine (up to 72 hours post-exposure) or normal human immunoglobulin (NHIG) (4 to 6 days post-exposure or for contacts with contraindications to MMR vaccine). PEP is not considered effective after 6 days (144 hours) post-exposure and so generally is not offered after this time[4] but efforts were still made to inform all contacts about their potential exposure regardless of whether prophylaxis was warranted. For infants under 6 months of age whose mother's measles immunity status was unclear, a maternal measles serum immunoglobulin G (IgG) level was urgently requested and results followed-up by PHU staff. A positive measles IgG negated the use of NHIG in both mother and child.

The total number of contacts for each case (including household contacts) and the number who required NHIG were recorded. PHU staff followed-up each contact to ensure that PEP was administered as per the protocol. An estimate of the number of contacts for whom MMR was recommended is provided; but some contacts chose the option of double-checking their vaccination history before seeking MMR vaccination. In these cases, there was no follow-up to confirm receipt of the vaccine. Wherever possible, NHIG and MMR were provided at the place where contacts were exposed to the infectious case (i.e. hospital emergency department or general practice).

Contacts that were unable to be contacted by phone were sent a letter informing them of their potential exposure to measles, advising on measles signs and symptoms and what to do if they suspected they were developing the disease.

A case study was conducted to describe the costs of following up contacts of 1 particular hospitalised case of measles. Data were prospectively gathered on the time spent by PHU staff identifying and telephoning contacts, arranging testing and PEP, and other tasks associated with contact tracing. Staff costs were calculated according to their level and it was assumed that all staff members were paid at the top increment for their award. A log of letters, faxes, and phone calls was kept and costed according to the standard rate charged by the local health district. Pathology costs were actual costs billed by the laboratory for tests ordered by the PHU. A follow-up telephone call to each contact was made 2 weeks later to determine whether any illness had arisen. Hospital medical records were reviewed to identify any visit to hospital made by contacts who could not be reached for follow-up by telephone.

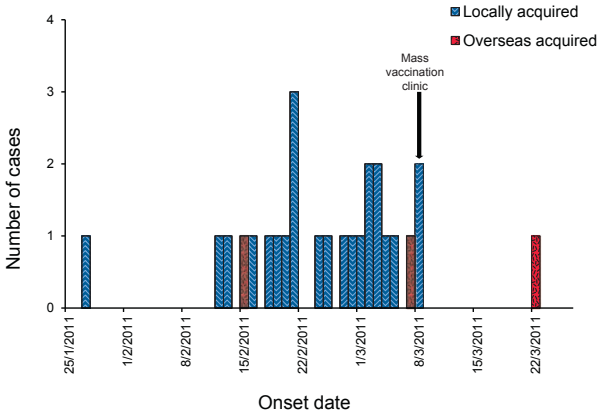
The cost to follow up 1 contact was estimated by dividing the costs for following up contacts of this case by the number of contacts for the case. The total cost of contact follow up to the PHU for the outbreak was estimated by multiplying the cost for 1 contact by the total number of identified contacts and adding the staffing cost for a high school vaccination clinic that formed part of the outbreak response.

As this work was conducted as part of routine public health control activities, review by a human research ethics committee was not required.

Results

Twenty-six confirmed cases of measles were reported to the PHU between 4 February and 29 March 2011 (Figure). The age of cases ranged between 8 months and 35 years and all cases resided within a single local government area of New South Wales. The mean and median delay

Figure: Epidemic curve of measles outbreak, western Sydney, January to March 2011, by onset date and place of acquisition



between onset of rash and notification was 2 days (range 2–8 days) and the mean and median delay between onset of illness and notification was 5 days (range 1–9 days).

Seven (27%) cases required admission to hospital for longer than 1 day. A further 10 (38%) cases were managed within a hospital emergency department. For all cases, the most common presenting symptom in addition to fever, cough, coryza, conjunctivitis and rash, was diarrhoea (23%). One case was diagnosed with pneumonitis. Another case experienced recurrent epistaxis requiring nasal packing although this was a pre-existing problem and was most likely exacerbated by, rather than a direct consequence of, measles. There were no other serious complications, including no deaths.

In total, 1,395 contacts were identified and managed by PHU staff. The average number of contacts per case was 54 (median 28). The maximum number of contacts for a single case was 206. Most contacts resulted from cases visiting large and busy general practice clinics, often on multiple occasions. Many contacts attended healthcare facilities with one or more companions, increasing the total number of contacts beyond those included on the initial list supplied by the healthcare facility (Table 1).

Table 1: Number of contacts identified during the measles outbreak, by exposure category

Household	General practice	Emergency department	Other*	Total
161	889	283	62	1,395

*

Other includes settings such as airplane and social.

Of the identified contacts, 1,241 were contacted by telephone and 154 who could not be contacted by telephone were sent a letter. Interviews identified 169 potentially susceptible contacts, of whom 79 were given NHIG and 90 were recommended to receive the MMR vaccine. There were no secondary cases amongst the contacts given PEP.

Ten cases attended a single high school and had onset dates covering a 15-day period. The absence of any other epidemiological link between these cases suggested that the entire school population was at risk. Further, none of these cases had documentation of having received a MCV, raising concern that under-vaccination was widespread in this population. In collaboration with the school, a decision was made after notification of the 4th case to hold a mass MMR immunisation clinic at the school for all staff and students who did not have documented evidence of 2 doses of a MCV. The clinic was held 7 days later and was run by 10 nursing staff and 2 medical staff from the PHU. Of the total population of 1,150 students and 100 staff, 492 students (43%) and 42 staff (42%) were vaccinated. The major cost of this clinic from the PHU perspective was attributed to nursing staff salaries (A$2,590) although the total cost of vaccine was almost 3 times this figure. However, the cost of the vaccine was not met by the PHU as it was funded by the NSW Ministry of Health.

A case study conducted for a single case estimated that the cost to the PHU of following this case was A$2,433 (Box). It can be estimated that the total cost to the PHU of contact management for the entire outbreak was at least A$48,000.

Box: Case study on Public Health Unit costs for responding to a single case of measles

The PHU received a call at 15:15 hours, 8 March 2011 about a 35-year-old pregnant patient with measles serology IgM positive and IgG negative, who had been an inpatient on the antenatal ward for the past 7 days. Six PHU staff were assigned to manage the response to the case. Seventy-five patient contacts were identified by the hospital for follow-up by PHU staff.

All contacts of the case were notified through: telephone (42), letter (25), email (7) and fax (1). Five contacts required serology to confirm current immunity, 1 contact required MMR vaccine and two required urgent NHIG. A total of 49 hours personnel time over 3 days was spent to follow-up the contacts of this single case of measles. This ranged from 3.5 hours to 17 hours per staff member assigned to the case. The average time spent per contact was 38 minutes.

Seventy per cent of the 75 contacts (n=52) were reached by a follow-up telephone call 2 weeks later. The medical records of the remaining 30% were reviewed. No secondary cases of measles were identified among the contacts.

The costs of all components of the response are listed in Table 2. Only costs borne by the PHU are included and other costs such as MMR vaccine and NHIG which are borne by other parts of the health sector (New South Wales Government) are excluded. Staff represented 90% of the total cost to the PHU of responding to this case. This is similar to the estimate derived in Iowa in 2004, where once overheads and the costs of the MMR vaccine and NHIG were removed, over 90% of measles containment costs to the PHU were attributed to staff.[5]

The cost to the PHU for this 1 case of measles was A$2,433 with staff representing the major cost component of a public health response.

Table 2: Public health unit costs for responding to a single case of measles

Item	Cost (A$2011)	% of total
Pathology	158	6.5
Telephone/mobile	59	2.4
Stationery and mail	24	1.0
Staff	2,194	90.1
Total	2,434	100.0

Genotyping of measles viruses was performed by the Victorian Infectious Diseases Research Laboratory in Melbourne, Australia. The D9 genotype (prevalent in South East Asia, Japan and Turkey in 2011[6]) was isolated from 7 cases, all of whom had definite epidemiological links to 15 other cases where genotyping was not requested. D8 (prevalent in India and the Arabian peninsula in 2011[6]) was isolated from 1 case, indicating it was an unrelated sporadic case. No source could be identified for this case, and no secondary cases arose. None of the imported cases (all from The Philippines) were able to be genotyped.

Following containment of this outbreak in March 2011, no further cases of measles were notified in western Sydney until measles was re-introduced by a returning traveller in April 2012.

Discussion

This outbreak was largely sustained by the clustering of susceptible people within a single high school. The lack of evidence of any doses of a MCV for most cases underscores the importance of MMR vaccine in controlling this disease.

Timeliness of notification, and in some cases, the time required to prepare lists of contacts directly impacted the type of control measures that could be undertaken. Late notifications increased the potential need for NHIG and very late notifications precluded the use of any PEP. The poor specificity of prodromal signs and symptoms coupled with clinician inexperience with measles resulted in delayed notification, whilst the moderately severe nature of the illness resulted in recurrent presentations to healthcare facilities, generating more potential contacts.

A significant issue for PHU management was poor documentation of vaccination history as well as confusion arising from changes to the measles vaccination schedule over the past 3 decades. Since 1996, the ACIR has been used to record the vaccination history of all Australian children up to their 7th birthday, and this was used to check the vaccination history of all contacts up to 15 years of age.[7] No centralised vaccination recording system exists for older individuals, including for vaccines administered in school-based measles control programs. Contacts may have remembered 'getting all their needles at school' but their immunisation documents were not always accessible to PHU staff. A reported history of measles infection was assumed to be correct. Contacts born before 1966 were assumed to have experienced natural infection but still needed to be contacted to determine whether they might be immunosuppressed and whether they had been accompanied by younger (and potentially susceptible) people at the time. With the frequent lack of documentation, it is possible that some recipients of measles PEP had previously received 2 doses of a MCV.

There has been recent discussion in Australia about considering the use of childcare and primary school entry as a trigger to review vaccination status. Such a measure may be helpful in future measles contact tracing activities, as children who had attended childcare or school in New South Wales would be more likely to have up-to-date ACIR records.

A 2-dose MMR schedule has been officially recommended in Australia since 1992.[8] In addition, between 1992 and 2000 a number of schedule changes and catch-up programs targeting school-aged children and young adults were undertaken. These programs complicated the risk assessment for contacts who could not provide written vaccination records. A useful tool for assessing vaccination status was a table that listed annual birth cohorts from 1966 until 1994 and which drew on historical knowledge of vaccination policy to predict whether a 2nd dose of a MCV had been offered and in which setting. If a contact stated that they received all of their school vaccinations and a 2nd dose MMR vaccine had been offered to their birth cohort when they were in school then receipt of a 2nd dose of a MCV was assumed. These strategies of assuming 2-dose vaccination or a history of disease appeared to be justified when evidenced by the lack of secondary cases reported amongst identified contacts that were assessed as not requiring PEP.

On several occasions, pregnant contacts required PEP. Measles infection during pregnancy has been associated with an increased risk of maternal and foetal complications including pre-term delivery and foetal loss.[9] Pregnant women who have received 2 doses of a MCV in their lifetime are considered protected and do not require any form of PEP under normal circumstances; however, for those with uncertain vaccination history or known susceptibility to measles, NHIG is indicated as MCVs are contraindicated in pregnancy.

Since many women of childbearing age are in the age group that is most likely to be susceptible to measles in Australia (born after 1965, but prior to introduction of the 2-dose schedule), the addition of routine antenatal testing for measles immune status along with rubella immunity, would be useful. If undertaken prior to pregnancy, vaccination could then be provided if required.

One hundred and fifty-four contacts (11%) required a letter to inform them of measles exposure. The delay in providing these contacts with information would have excluded them from the possibility of receiving PEP if it was required. Despite this, no secondary cases amongst this group were notified to the PHU, probably reflecting high levels of immunity in the general population.

The case study provides an approximation of the monetary costs incurred by the PHU in response to a single case of measles. By calculating a 'cost per contact' and multiplying this figure by the total number of contacts, then adding the cost of staffing the mass vaccination clinic held at the high school, it can be estimated that the total cost of contact management for the entire outbreak was in excess of A$48,000 (2011 A$) from the PHU perspective alone. In reality, the 'cost per contact' as calculated from this case study probably underestimates the true 'cost per contact' compared with situations where exposure occurred at a general practice or hospital emergency department. This is because many of the contacts were antenatal patients and would have been vaccinated previously or discussed vaccination. The hospital was more likely to have up-to-date contact details. Contacts may have been more co-operative and receptive to advice given that they were pregnant and have an ongoing relationship with the hospital. This contrasts with the more usual situation where contacts of measles cases are identified from an emergency department or waiting room exposure or, for instance, airplane contact. In such situations it can take considerable time to obtain lists of contacts, then even more time for PHU staff to follow–up. Such contacts may be less willing or able to cooperate with public health measures than those in this case study, as they may not have an established relationship with the health service, or they may not have a particular focus on possible risks to their health, compared with that experienced by pregnant women.

The total cost of containment efforts of an Iowa measles outbreak was US$142,452 (2004 US$). Excluding costs that were not accounted for in this case study (overheads, MMR vaccine and NHIG, transport, the costs of the public information campaign and the costs incurred by the Public Health Laboratory for Iowa) the figure for Iowa comes to US$78 734.[5] Contributors to this high cost were 2 secondary cases and 3 vaccination clinics. Over 1,000 potential contacts were traced compared with almost 1,400 contacts for the western Sydney outbreak. Although no direct comparison can be made, this calculation does suggest that the figure of A$48,000 is an underestimate. The costs did not include incident control team meetings, vehicle and transport, overtime and time-in-lieu, liaison with public health staff in other offices, preparation of clinician and media alerts, time liaising with infection control, clinical or laboratory staff, nor the costs associated with post-outbreak activities to finalise the investigations. Moreover, the total figure would be much higher if the costs incurred by all sectors of the health system including general practitioners, maternity unit staff, hospital infection control, laboratory staff and emergency departments contributing to the identification and management of contacts were included.

Enhanced surveillance contributes to the increased workload (and cost) created by a measles outbreak. During the period 25 February to 16 April 2011, 16 suspected but subsequently excluded cases of measles were reported to the Parramatta PHU. In the context of enhanced surveillance, these were considered sufficiently suspicious to be extensively followed-up. In addition, it is worth noting that many other suspected cases were reported to the Parramatta PHU (as well as to the Penrith PHU, which services the immediately adjacent population) but were excluded after initial investigation. The time taken to deal with the results of the increased awareness and reporting of suspect cases adds to the overall costs of the outbreak, particularly as heightened awareness can last for some time beyond the final case.

Neither this case study nor the Iowa study investigated opportunity costs in regards to resources utilised in responding to an infectious disease outbreak. Clinical staff administering PEP were removed from attending to other patients and PHU infectious diseases staff were occupied with measles cases and contact management with little time to work on other tasks or projects.

Conclusions

Costs associated with public health interventions should be assessed to ensure value for money, appropriate resource allocation and value for the community. Measles is a re-emerging disease of public health significance in Australia and considerable time and resources are invested in striving to control an outbreak. Maintaining Australia's measles elimination status requires extensive effort in outbreak control to reduce the number of secondary cases, their consequent morbidity and health care costs. However, of much more importance is

a robust measles vaccination strategy that achieves high level coverage, thus preventing outbreaks in the event of an imported case. Recent initiatives to improve 2-dose measles vaccine coverage, including amendments to the *Public Health Act 2010* in New South Wales to require the presentation of immunisation documentation for entry into childcare and bringing forward the 2nd MMR dose to 18 months of age should improve population immunity for measles and reduce the risk of future outbreaks.

The PHU was unable to immediately contact more than 10 per cent of the notified contacts, but through examining records of hospital admission and attendance it was determined that there were no secondary cases amongst these contacts during the period in which PEP would have been effective, suggesting that current population immunity is high enough to prevent sustained transmission. One benefit of the outbreak has been collaboration between members of the local Pacific Islander community and the PHU to provide catch-up vaccination and community education about immunisation in Australia.

Acknowledgements

We would like to thank all surveillance and immunisation staff at the Parramatta and the Penrith PHUs for their work in containing this outbreak and collecting and recording the data required for this paper. We would also like to thank the laboratory, emergency department and infection control staff in Western Sydney and Nepean Blue Mountains hospitals for their cooperation.

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