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NSW PUBLIC HEALTH BULLETIN

Transition of the *NSW Public Health Bulletin* to *Public Health Research & Practice*

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The *NSW Public Health Bulletin* has achieved much over the past 24 years[1] and there is a great deal to celebrate. To support an agile, contemporary, public health environment the *Bulletin* is about to enter a new phase in its evolution – one that builds on its proud history and strongly positions public health for the future. The *Bulletin* will be renamed *Public Health Research & Practice* and will strengthen its focus on supporting knowledge-driven policies and the provision of best practice public/population health services and programs in NSW and across Australia. This will be underpinned by original, policy-relevant research and articles on implementing and evaluating innovative NSW policies, services and programs. Editorial management and production will move to the Sax Institute and be overseen by an Editorial Board (Box 1).

Both the NSW Health and Medical Research Strategic Review[2] and the NSW Government Evaluation Framework[3] emphasise the potential for research and evaluation to strengthen policy and practice across health. For this potential to be realised, new approaches to designing and conducting research and to sharing our findings will be required. We intend that *Public Health Research & Practice* will become a key platform in using research to inform public health policy and practice across NSW and Australia more broadly.

The optimal generation and use of evidence will require many things. For example, strong evaluation embedded into the rollout of policies and programs will make the most of opportunities to learn what works and under what conditions. The NSW Government Evaluation Framework[3] makes this clear saying:

> Evaluation is a key tool to support evidence based policy and decision making in government, to help government learn and adapt to changing environments and as a tool for communicating and sharing valuable information. When planned, designed and conducted in accordance with good practice standards, evaluation can provide the necessary evidence to improve services and guide better resource allocation decisions.

Better tools and methods for the kinds of research that can inform practice will also be required – for example, how can we best consider factors like scalability[4] and reproducibility? How do we best estimate likely real world costs and benefits? How can we harness technology to respond to emerging public health threats? And what can be done to provide control or comparison groups when randomised trials are not possible?

Co-creation of research where researchers, policy makers and practitioners work together to design, implement, interpret and disseminate research will be crucial to this effort. Each has important expertise to bring to the collaborative effort. Co-creation of research has the potential to result in rigorous tests of strategies in a timely way that could feasibly be implemented at the state or national levels.

Public Health Research & Practice will strengthen the connection between research, policy and practice and support the population health workforce in NSW to find and use the best available evidence in the time available.[5] We will actively seek papers describing research that has used a co-creation approach and is based in a 'real world' setting, and will be particularly interested in papers

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Box 1. ***Public Health Research & Practice*** **Editorial Board**

describing the evaluation of innovative policies and programs in the field. This will instigate a new stream of discussion to drive forward the development of methods that work more effectively to understand the impact of health issues, policies and programs in the field. NSW Health and the Sax Institute are excited about this new phase in the development of the journal and we are looking forward to working with researchers, policy makers and practitioners to further strengthen our investment into evidence-informed policy and practice.

References

1. Thackway S, Goldsworthy KM, Stickney B, Milat AJ. Reflections on 24 years of the *NSW Public Health Bulletin*. *N S W Public Health Bull* 2014; 24(4): 151–2.
2. Population Health Division, NSW Ministry of Health. NSW Health and Medical Research Strategic Review 2012. Available at: http://www0.health.nsw.gov.au/pubs/2012/pdf/medical_strategic_review_.pdf (Cited 14 April 2014).
3. Department of Premier and Cabinet. NSW Government. NSW Government Evaluation Framework August 2013. Available at: http://www.dpc.nsw.gov.au/__data/assets/pdf_file/0009/155844/NSW_Government_Evaluation_Framework_August_2013.pdf (Cited 14 April 2014).
4. Milat AJ, King L, Bauman AE, Redman S. The concept of scalability: increasing the scale and potential adoption of health promotion interventions into policy and practice. *Health Promot Int* 2013; 28(3): 285–98. doi:10.1093/heapro/dar097
5. Lavis JN, Oxman AD, Lewin S, Fretheim A. SUPPORT Tools for evidence-informed health Policymaking (STP). *Health Res Policy Syst* 2009; 7(Suppl 1): I1. doi:10.1186/1478-4505-7-S1-I1

Reflections on 24 years of the *NSW Public Health Bulletin*

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The birth of the *Bulletin*

The year 1990 was a landmark for public health in New South Wales (NSW). The Public Health Division at the then NSW Department of Health was in its infancy, having been formed at the end of 1989, and funding for a program to enhance public health in NSW led to the establishment of a network of Public Health Units and the NSW Public Health Officer Training Program.[1] The *NSW Public Health Bulletin* was established in May 1990 to disseminate accurate and timely information among this newly formed public health network and to provide regular feedback to practitioners on notifiable conditions. It was hoped that the *Bulletin* would assist in "the development of a vibrant public health network in NSW",[2] and "provide a useful mechanism for exchange of information and ideas on investigations, programs, and evaluations that (may) affect the health of the citizens of NSW".[1]

From its inception, the aim of the *Bulletin* was to provide its readers with population health information and data to inform effective public health action. Early editions were of variable length (although generally short) and consisted of practical information for the public health network: short reports, news and comment, letters to the Editor, summaries of infectious disease notifications, and public health abstracts. Copies were distributed in collaboration with the new Public Health Units to the then Area Health Services, hospitals, major laboratories, universities, medical practitioners, and other state health departments.

Enhancement of content, rigour, role and recognition

By 1995, the landscape was changing: issues of the *Bulletin* were becoming longer and the papers more academically rigorous. Infectious disease content still featured strongly but a broader range of topics was being covered. Special editions focusing on a specific area of public health significance commenced, with guest editorials authored by experts in the field. Peer review was introduced to maintain standards and ensure rigour and relevance. At the beginning of 1996, the *Bulletin* began to be published in an online format as well as in print.

The transformation of the *Bulletin* in its first decade culminated in the successful application in early 2002 to the Literature Selection Technical Review Committee (LSTRC) of the National Library of Medicine, National Institutes of Health (Maryland, USA) for indexing in Index Medicus and Medline. As the major international source of citation and the gateway to public health and biomedical journals, the decision by the LSTRC to accept the *Bulletin* for indexing was to be celebrated. At the time, around 120 journals were reviewed each year by the LSTRC and only 15–20% of those were successful in their applications to be accepted for indexing. Criteria for acceptance related to: scope and coverage (relevance to the biomedical field); quality of content (scientific merit of the papers); quality of the editorial work (including processes such as peer review); production quality (layout, design and graphics); audience (intended for health professionals); and types of content (with statistical compilations and critical reviews preferred).[3] A survey of a sample of the *Bulletin*'s readership in 2005 indicated that the inclusion of the *Bulletin* in Medline was highly valued:

> [It] is seen as a measure of the journal's quality and thereby adds status to the Bulletin; increases the accessibility and international exposure for articles published; and helps showcase public health issues and endeavours in NSW.[4]

The 2005 readership review also found substantial support and respect for the *Bulletin*, along with a strong sense of 'ownership' amongst its stakeholders.[4] A valued aspect was the workforce development role of the *Bulletin*: it was not just another avenue for established authors to publish, but an opportunity for those new to writing for publication to develop their skills in a supportive environment.

Improved reach, processes and promotion

In 2007 the *Bulletin* entered into a publishing partnership with CSIRO Publishing. This was the next phase in the *Bulletin*'s evolution, taking it to a larger, more professional publication with a broader reach. A new design was unveiled, and an enhanced website hosted by CSIRO Publishing was launched. The new website allowed for PDF and HTML versions to be uploaded in advance of the hard copy distribution and for the introduction of a

subscription-based 'Early Alert' service to facilitate immediate access to each new issue as it was published online. New resources were developed for reviewers, including guidelines designed to foster the development of critical peer review skills and a standard reviewer report form to guide reviewers through the process. Guidelines for authors were also updated to reflect best publishing practice. The partnership with CSIRO Publishing also led to increased exposure and promotion at relevant health conferences. Free access, a cornerstone of the publication, was preserved: work published in the *Bulletin* remained freely available, without any subscription barriers. This will continue to be the case as the Sax Institute takes over from CSIRO Publishing as the publisher of the journal.[5]

Achievements and contributors

Of the past Editors of the *Bulletin*, three were largely responsible for its growth and evolution: Professor George Rubin (May 1990–May 1994), Professor Michael Frommer (June 1994–March 1998), and the longest running Editor, Associate Professor Lynne Madden (April 1998–October 2012, with two sabbaticals in this period). While ultimately rewarding, the role of Editor is a challenging one; the past Editors are gratefully acknowledged for their commitment and contribution to the *Bulletin*. There have been many editorial support staff during the *Bulletin*'s lifetime, the longest serving of these being Dr Michael Giffin (November 1998–January 2005), who played an integral role in shaping the *Bulletin*, establishing many of its editorial processes, and securing indexing in Index Medicus and Medline.

At the completion of Volume 24, close to 1500 items have been published and an average of 220 000 papers are downloaded per year. These downloads are from all volumes, indicating that the *Bulletin*, as a body of work, is contributing to a culture of evidence-based practice. The *Bulletin*'s Scopus SCImago Journal Rank (SJR), which measures citations to a publication and weights them according to the SJR score of the citing journal, has been rising since 2008, showing that the *Bulletin* is well positioned in relation to comparable journals. While the majority of the readership remains local, download and access statistics show that the *Bulletin* is read widely: within Australia, readership from Victoria and Queensland is strong, and internationally, numbers from the USA, Canada and the United Kingdom are consistent.

On behalf of the editorial team we would like to sincerely thank the many contributors to the *Bulletin* over the past 24 years. The strength of the journal has always been the large investment of time and effort by authors, reviewers, and editors, all of whom have generously contributed their expertise.

The future: *Public Health Research & Practice*

As we enter the next exciting phase in the journal's history,[5] we hope that the 24 volumes published under the title '*NSW Public Health Bulletin*' leave a lasting legacy and will continue to be referred to, both as an important historical record of public health in NSW and as sources of evidence for future practice.

References

1. Rubin G. Improved public health. *N S W Public Health Bull* 1990; 1: 2.
2. Morey S. New Public Health Bulletin for NSW. *N S W Public Health Bull* 1990; 1: 1.
3. Madden D, Giffin M. Index Medicus and Medline recognise *NSW Public Health Bulletin. N S W Public Health Bull* 2002; 13: 1–2. doi:10.1071/NB02001
4. Madden DL. Tailoring the Bulletin to meet readership needs. *N S W Public Health Bull* 2006; 17(11–12): 161–2.
5. Thackway S, Redman S. Transition of the *NSW Public Health Bulletin* to *Public Health Research and Practice. N S W Public Health Bull* 2014; 24(4): 149–50.

Reporting postpartum haemorrhage with transfusion: a comparison of NSW birth and hospital data

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Abstract: Aim: Postpartum haemorrhage rates have been increasing in NSW and internationally, and blood transfusion is required in severe cases. Using routinely collected administrative data provides a convenient method with which to monitor trends in both postpartum haemorrhage and associated transfusion use. In order for this to be feasible however, the reliability of reporting of the conditions needs to be assessed. **Methods:** This study used linked data to compare the reporting of postpartum haemorrhage with transfusion as reported in the NSW Admitted Patient Data Collection (hospital data), with the same information obtained from the Perinatal Data Collection (birth data), for births in NSW from 2007 to 2010. **Results:** The rate of postpartum haemorrhage requiring blood transfusion was 1.0% based on the hospital data and 1.1% based on the birth data, with a rate of 1.7% if identifying cases from either source. Agreement between the two sources improved from fair to moderate over the time period. **Conclusion:** Postpartum haemorrhage requiring transfusion recorded in the birth data shows only moderate agreement with hospital data, so caution is recommended when using this variable for analysis. Linkage of both datasets is recommended to identify birth information from birth data and postpartum haemorrhage with transfusion from hospital data until further validation work has been undertaken.

An important application of population health data is identifying and monitoring trends in adverse outcomes which may require further investigation or intervention.[1–3] In maternal health, one commonly monitored adverse outcome of childbirth is severe postpartum haemorrhage (PPH). Postpartum haemorrhage involves excessive blood loss post-childbirth, and affects about 6% of women in NSW,[4] with rates increasing locally and internationally.[5] Severity of PPH is commonly defined by quantity of blood lost, however this can be difficult to estimate,[6] so blood product transfusion has become widely used as a marker of severe maternal morbidity associated with childbirth. In combination with routinely collected population data collections this marker has been used to monitor changes in morbidity over time, providing a timely and cost-effective way of monitoring trends.[7,8] In order for a marker to be a good indicator of the health of the population it needs to be reported reliably and in a timely fashion.[9–12]

Currently, local studies reporting PPH requiring transfusion use hospital diagnosis and procedure codes recorded in hospital separation data.[4] Ascertainment of both PPH (sensitivity 73.8%, specificity 98.9%) and transfusion (sensitivity 83.1%, specificity 99.9%) is relatively high, and the sensitivity of PPH in women requiring transfusion is 92.5% when compared with medical records.[13] However, hospital data are not the best source of birth data. Identifying birth admissions from hospital records relies on the presence of a diagnosis code identifying a live or stillbirth, which differs in reliability when there are multiple births and according to birth outcome and has been shown to miss some births identified in legislated birth data.[14,15] Additionally, hospital data lack detail on parity, gestation and obstetric history, which are important risk factors for PPH. Use of hospital records requires linkage to birth data to accurately identify hospitalisations related to a pregnancy or birth. This affects the timeliness of the data, with linked birth and hospital data available 12–18 months later than birth data alone. Birth records, collected by midwives at the time of birth, are more timely, available after 12 months, and do not require linkage in order to identify births. Until recently, no data on blood transfusion was collected in these birth records. In 2007, New South Wales (NSW) birth data collections included a new variable 'PPH requiring transfusion'. The reliability of this variable has not yet been assessed. This project compared

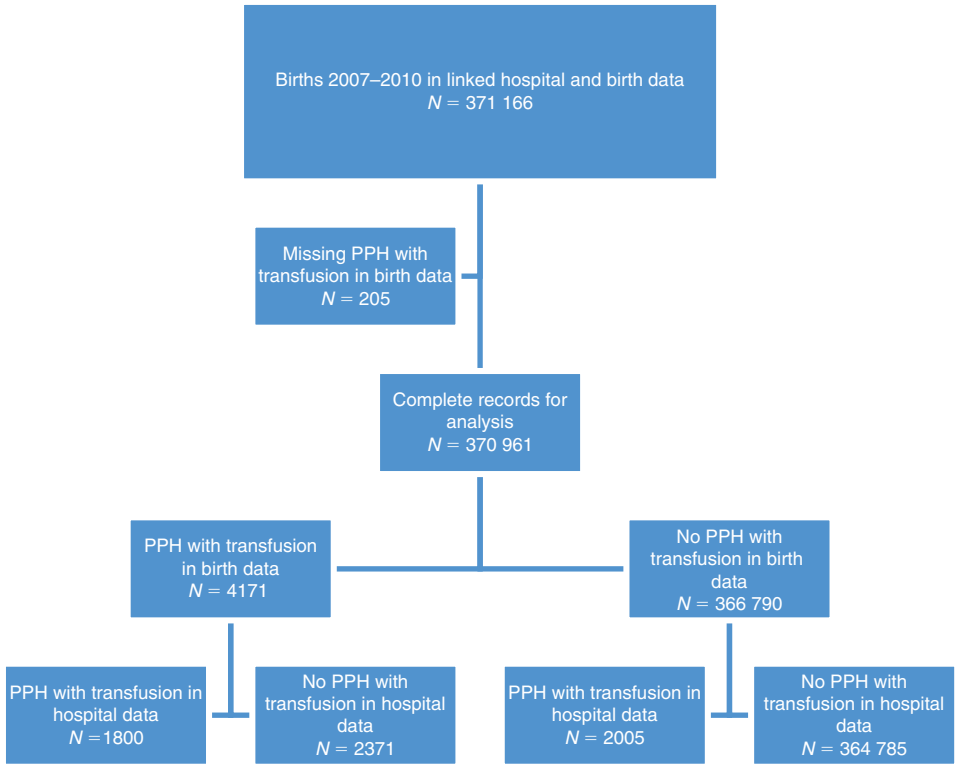

Figure 1. Study population for comparison of reporting of postpartum haemorrhage (PPH) with transfusion between birth and hospital data, NSW, 2007–2010.
Source: New South Wales (NSW) Perinatal Data Collection and NSW Admitted Patient Data Collection, NSW Ministry of Health.

the reporting of PPH with blood transfusion in the hospital records to the new variable in the birth data.

Methods

Births were identified from the Perinatal Data Collection ('birth data'), a statutory collection of all births in NSW of at least 20 weeks gestation or 400 g birthweight. Hospital birth admissions were identified from the Admitted Patient Data Collection ('hospital data') which is a census of all public and private hospital separations in NSW, containing information on procedures and diagnoses, coded according to the 10th revision of the International Classification of Diseases, Australian Modification (ICD10-AM),[16] and the Australian Classification of Health Interventions.[17] Probabilistic record linkage between the birth and hospital data was carried out by the NSW Centre for Health Record Linkage. All women giving birth in NSW hospitals from 1 January 2007 to 31 December 2010, where a corresponding hospital birth record was available, were included in this study.

The birth data, including demographic and medical information on the mother, as well as information on the labour, delivery and infant, is collected by the attending midwife or medical practitioner. PPH requiring transfusion is recorded if there was a "postpartum haemorrhage requiring transfusion of whole blood or packed cells".[18] In the hospital data, blood transfusion was defined as a record of transfusion of packed cells or whole blood in any of the first 20 procedure codes in the maternal birth admission. Similarly, PPH according to the hospital data was defined as a diagnosis of PPH in any of the first 20 diagnosis fields.[19] Hospitals were categorised by hospital type and annual number of deliveries (grouped to reflect similarity of practice by hospital size).

As neither hospital nor birth data could be considered a 'gold standard' for PPH with transfusion reporting, we assessed agreement based on kappa statistics, and compared characteristics of discordant cases. Kappa statistics were classified as follows: near perfect (0.81–1), excellent (0.61–0.80), moderate (0.41–0.60), fair (0.21–0.40), slight (0.01–0.21) and no agreement (<0.01).[20]

Results

From 2007 to 2010 there were 371 166 births recorded in the linked hospital and birth data: 205 (0.1%) were missing the birth data field for PPH requiring transfusion, leaving 370 961 births for analysis (Figure 1). Based on the hospital data the rate of PPH was 7.6%, and the rate of transfusion of packed cells was 1.4%. The rate of PPH with blood transfusion was 1.0% based on the hospital data and 1.1% according to the birth data (Table 1). In the hospital data, blood transfusion rates increased from 1.4% in 2007 to 1.5% in 2010 ($p = 0.006$), PPH rates increased from 7.1% to 7.8% ($p < 0.0001$) and the combination of PPH with transfusion increased from 1.0% to 1.1% ($p = 0.02$). In the birth data,

Table 1. Concordance of postpartum haemorrhage (PPH) with transfusion cases identified from hospital data and birth data, NSW, 2007–2010

		Hospital data		
		PPH with transfusion recorded *n* (%)	PPH with transfusion not recorded *n* (%)	Total *n* (%)
Birth data	PPH with transfusion recorded	1800 (0.5)	2371 (0.6)	4171 (1.1)
	PPH with transfusion not recorded	2005 (0.5)	364 785 (98.3)	366 790 (98.9)
	Total	3805 (1.0)	367 156 (99.0)	370 961 (100.0)

Source: New South Wales (NSW) Perinatal Data Collection and NSW Admitted Patient Data Collection, NSW Ministry of Health.

Table 2. Agreement in reporting of postpartum haemorrhage between birth data and hospital data, NSW, 2007–2010

	Kappa (95% CI)	Agreement
Overall	0.45 (0.43–0.46)	Moderate
Mode of delivery		
Vaginal	0.44 (0.43–0.46)	Moderate
Caesarean	0.45 (0.43–0.47)	Moderate
Year		
2007	0.37 (0.34–0.39)	Fair
2008	0.36 (0.33–0.39)	Fair
2009	0.44 (0.41–0.47)	Moderate
2010	0.59 (0.57–0.62)	Moderate
Hospital type		
Tertiary obstetric	0.49 (0.47–0.51)	Moderate
Regional	0.47 (0.44–0.49)	Moderate
Urban/other	0.36 (0.32–0.40)	Fair
Private	0.37 (0.34–0.40)	Fair
Annual delivery volume		
20–499	0.45 (0.42–0.49)	Moderate
500–999	0.46 (0.43–0.50)	Moderate
1000+	0.44 (0.43–0.46)	Moderate

Source: New South Wales (NSW) Perinatal Data Collection and NSW Admitted Patient Data Collection, NSW Ministry of Health.

PPH with transfusion increased from 1.2% to 1.3% ($p = 0.03$), despite lower rates in 2008–2009. When considering identification from either source, the rate of PPH with blood transfusion was 1.7%. In hospitals with an average of over 50 births per year, the rates of women experiencing PPH with transfusion as recorded in the birth data ranged between 0.13% and 5.63%, and in the hospital data between 0% and 2.31%. The range of differences between birth data and hospital data was −1.33% and 4.24% (data not shown). Sensitivity analysis was undertaken to determine if concordance differed between vaginal and caesarean births, however rates were similar (data not shown).

Overall, the PPH with transfusion as ascertained from the hospital and birth data had moderate agreement (kappa = 0.45) (Table 2). Agreement tended to increase from 2007 to 2010 (Table 2). Twenty (17%) of the 116 hospitals reported PPH with transfusion with near perfect agreement. The proportion of hospitals reporting near perfect agreement increased from 15% in 2007 to 31% in 2010, while those reporting fair agreement decreased from 30% in 2007 to 15% in 2010. This increase in agreement was due to increased reporting in the birth data, with the proportion of PPH with transfusion identified in the hospital data alone decreasing from 33.3% in 2007 to 22.3% in 2010, and those reported in both data sources increasing from 22.9% to 42.5% (Table 3).

PPH with transfusion was more likely to be reported only in the birth data than only in hospital data for primiparae (29.4% vs 24.9%), pre-labour caesarean sections (17.5% vs 11.8%) and for births in regional (47.4% vs 9.7%) or private (31.5% vs 8.4%) hospitals (Table 3), and less likely to be reported for multiple births (2.7% vs 4.3%), caesarean section with labour (11.2% vs 14.8%) and births at tertiary obstetric hospitals (13.9% vs 63.3%).

Of the 4171 women reported in the birth data to have had a PPH with transfusion, 68% of women were recorded in the hospital data as having a PPH, and 53% were recorded in the hospital data as having received a blood transfusion. Both PPH and blood transfusion were recorded for 43.2% of these women (concordant cases). Further investigation of hospital data reporting indicated that 236 (10.0%) of the 2371 discordant birth data records indicating a PPH with transfusion may have been for haematomas or antepartum/intrapartum bleeding. Sixty-eight (2.9%) records identified as PPH with transfusion in the birth data had a record of transfusion of another blood product recorded in the hospital data.

Discussion

We compared the new 'PPH requiring transfusion' variable reported in the birth data with the previously validated 'PPH with transfusion' variable from the hospital data and demonstrated moderate agreement. PPH with transfusion in the hospital data is known to have sensitivity of 92.5%.[13] Assuming this rate of underreporting in the hospital data, having observed 3805 admissions with PPH and transfusion, we would expect the true number to be around 4114, resulting in a PPH with transfusion rate of 1.1%. In the birth data we observed a rate of 1.1%. As there is only

Table 3. Characteristics of women with postpartum haemorrhage (PPH) with transfusion identified in either the birth data alone, hospital data alone, or both, NSW, 2007–2010

Variable		Source of identification of PPH with transfusion			
		Both *n* (%)	Hospital data only *n* (%)	Birth data only *n* (%)	*p*-value
Overall		1800 (100.0)	2005 (100.0)	2371 (100.0)	
Year[a]					
	2007	376 (20.9, 22.9)	546 (27.2, 33.3)	719 (30.3, 43.8)	<.0001
	2008	335 (18.6, 22.7)	556 (27.7, 37.6)	589 (24.8, 39.7)	
	2009	432 (24.0, 28.6)	559 (27.9, 37.0)	519 (21.9, 34.4)	
	2010	657 (36.5, 42.5)	344 (17.2, 22.3)	544 (22.9, 35.2)	
Age (years)					
	<20	100 (5.6)	95 (4.7)	124 (5.2)	0.0371
	20–24	259 (14.4)	330 (16.5)	335 (14.1)	
	25–29	460 (25.6)	532 (26.5)	609 (25.7)	
	30–34	530 (29.4)	573 (28.6)	740 (31.2)	
	35–39	357 (19.8)	373 (18.6)	480 (20.2)	
	40+	94 (5.2)	102 (5.1)	83 (3.5)	
Multiple birth					
	Yes	78 (4.3)	87 (4.3)	63 (2.7)	0.003
	No	1722 (95.7)	1918 (95.7)	2308 (97.3)	
Primiparae					
	Yes	468 (26.0)	500 (24.9)	696 (29.4)	0.0026
	No	1332 (74.0)	1505 (75.1)	1675 (70.6)	
Gestational age (weeks)	20–32	77 (4.3)	82 (4.1)	67 (2.8)	0.0059
	33–36	142 (7.9)	159 (7.9)	149 (6.3)	
	37+	1560 (86.7)	1732 (86.4)	2130 (89.8)	
Delivery type					
	Normal vaginal	894 (49.7)	996 (49.7)	1238 (52.2)	0.1512
	Caesarean section (CS) (total)	512 (28.4)	533 (26.6)	680 (28.7)	0.2586
	CS – No labour	234 (13.0)	237 (11.8)	415 (17.5)	<.0001
	CS – Labour	278 (15.4)	296 (14.8)	265 (11.2)	<.0001
	Instrumental (total)	404 (22.4)	472 (23.5)	465 (19.6)	0.0048
	Forceps	198 (11.0)	222 (11.1)	192 (8.1)	0.0008
	Vacuum	206 (11.4)	250 (12.5)	273 (11.5)	0.531
Private patient in public hospital					
	Yes	172 (9.6)	210 (10.5)	193 (8.1)	0.0275
	No	1628 (90.4)	1795 (89.5)	2178 (91.9)	
Hospital type					
	Tertiary obstetric	779 (43.3)	1269 (63.3)	330 (13.9)	<.0001
	Regional	594 (33.0)	195 (9.7)	1125 (47.4)	
	Urban/other	154 (8.6)	373 (18.6)	169 (7.1)	
	Private	273 (15.2)	168 (8.4)	747 (31.5)	
Annual delivery volume					
	20–499	256 (14.2)	51 (2.5)	551 (23.2)	<.0001
	500–999	281 (15.6)	126 (6.3)	521 (22.0)	
	1000+	1263 (70.2)	1828 (91.2)	1293 (54.5)	

[a]Column (first) and row (second) percentages are presented. All other reported percentages are column percentages.
Source: New South Wales (NSW) Perinatal Data Collection and NSW Admitted Patient Data Collection, NSW Ministry of Health.

moderate agreement observed between the two sources, however, considering identification from either source (1.7%) would lead to a possible 55% overestimation. We also noted an increase in reliability of the birth data in later years. This was associated with improved reliability in a small number of hospitals, particularly in hospitals with a research interest around postpartum haemorrhage or transfusion.

Differences in the collection of data may explain some of the variation. Birth data is collected by the midwives and clinicians attending the birth, with the variable 'PPH requiring transfusion' being recorded as a check box on an electronic data entry form. In the hospital data, both transfusion and PPH are coded by hospital coders based on notes written in the medical record. PPH can only be coded from the medical record if it is specifically written as such in the notes.

The lower reporting of PPH with transfusion in birth data following more complex birth situations (multiple births, after caesarean section following labour, and at tertiary obstetric facilities) may be related to differences in data recording. Obstetric staff compiling birth data may not have details available of events occurring outside the labour ward, whereas medical coding departments may have additional information from operation reports. Validation studies have demonstrated that birth data more accurately report labour and delivery factors than subsequent events,[9] and that procedures (e.g. transfusion) are well ascertained in hospital data.[9]

Some of the discordant records may relate to misclassification of transfusion type or timing. A French study compared the reporting of transfusion in a birth database with records from the blood bank,[21] treating the blood bank data as the gold standard, finding sensitivity of 61.4%, and positive predictive value of 82.2%, with kappa 0.7. In their study, birth records misclassified as blood transfusion were typically transfusion of another blood product (other than red cells) or other product for bleeding. This was also the case in our study. In the French study, transfusions not recorded in the birth record were for transfusions outside of the obstetric department (intensive care unit, during transfers between hospitals) or were miscoding. Importantly, the birth data imply that a transfusion occurred post-haemorrhage, however the timing of diagnoses and procedures recorded in the hospital data cannot be ascertained. It is possible that some of the transfusions recorded in the hospital data occurred for antepartum rather than postpartum haemorrhage. An earlier study using NSW hospital data indicated that 75% of obstetric transfusions were for postpartum haemorrhage and a further 8% were for antepartum haemorrhage (occurring prior to birth).[22]

Population health datasets can provide a rich source of data for research, but their usefulness is limited by the quality of the data they contain.[10–13] Previous studies have shown that accepting diagnoses from more than one data source can increase ascertainment, without increasing false positives,[10,23,24] however this is not always the case, and this study suggests that identifying PPH with transfusion from either birth or hospital data would result in over-ascertainment of around 55%.

This study used one dataset (hospital data) to validate another dataset (birth data). While this allows for an initial assessment of the reliability of the birth data variable, an ideal assessment would have been to use a 'gold standard' such as medical record review for validation. However, such validation studies are resource intensive and difficult to justify for single, relatively rare outcomes. Previous validation studies have shown that PPH and transfusion are underreported in the hospital data.[13]

Conclusion

We have shown that the new variable 'PPH requiring transfusion' being collected on the birth data shows only moderate agreement with hospital data. We would therefore recommend that researchers use the birth data variable with caution until further validation has been undertaken. Where possible, birth data linked with hospital data can be used to identify PPH with transfusion. An advantage of this approach is that, although there is some under-ascertainment, these data have already been validated. The changes in ascertainment over time in the birth data indicate that early years of data collected on PPH requiring transfusion should be excluded from trend analysis, to prevent improved ascertainment being interpreted as a change in incidence.

Acknowledgments

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References

1. Callaghan WM, Mackay AP, Berg CJ. Identification of severe maternal morbidity during delivery hospitalizations, United States, 1991-2003. *Am J Obstet Gynecol* 2008; 199(2): 133. doi:10.1016/j.ajog.2007.12.020

2. Joseph KS, Rouleau J, Kramer MS, Young DC, Liston RM, Baskett TF. Investigation of an increase in postpartum haemorrhage in Canada. *BJOG* 2007; 114(6): 751–9. doi:10.1111/j.1471-0528.2007.01316.x

3. Kuklina EV, Meikle SF, Jamieson DJ, Whiteman MK, Barfield WD, Hillis SD et al. Severe obstetric morbidity in the United States: 1998-2005. *Obstet Gynecol* 2009; 113: 293–9. doi:10.1097/AOG.0b013e3181954e5b

4. Ford JB, Roberts CL, Simpson JM, Vaughan J, Cameron CA. Increased postpartum hemorrhage rates in Australia. *Int J Gynaecol Obstet* 2007; 98(3): 237–43. doi:10.1016/j.ijgo.2007.03.011

5. Knight M, Callaghan WM, Berg C, Alexander S, Bouvier-Colle MH, Ford JB et al. Trends in postpartum hemorrhage in high resource countries: a review and recommendations from the International Postpartum Hemorrhage Collaborative Group. *BMC Pregnancy Childbirth* 2009; 9: 55. doi:10.1186/1471-2393-9-55

6. Stafford I, Dildy GA, Clark SL, Belfort MA. Visually estimated and calculated blood loss in vaginal and cesarean

delivery. *Am J Obstet Gynecol* 2008; 199(5): 519. doi:10.1016/j.ajog.2008.04.049

7. Quan H, Parsons GA, Ghali WA. Validity of procedure codes in International Classification of Diseases, 9th revision, clinical modification administrative data. *Med Care* 2004; 42(8): 801–9. doi:10.1097/01.mlr.0000132391.59713.0d
8. Singleton S. Data sources and performance measurement. *BMJ* 2007; 335(7623): 730. doi:10.1136/bmj.39356.610544.BE
9. Lain SJ, Hadfield RM, Raynes-Greenow CH, Ford JB, Mealing NM, Algert CS et al. Quality of data in perinatal population health databases: a systematic review. *Med Care* 2012; 50(4): e7–20. doi:10.1097/MLR.0b013e31821d2b1d
10. Lydon-Rochelle MT, Holt VL, Nelson JC, Cárdenas V, Gardella C, Easterling TR et al. Accuracy of reporting maternal in-hospital diagnoses and intrapartum procedures in Washington State linked birth records. *Paediatr Perinat Epidemiol* 2005; 19(6): 460–71. doi:10.1111/j.1365-3016.2005.00682.x
11. Schoendorf KC, Branum AM. The use of United States vital statistics in perinatal and obstetric research. *Am J Obstet Gynecol* 2006; 194(4): 911–5. doi:10.1016/j.ajog.2005.11.020
12. Yasmeen S, Romano PS, Schembri ME, Keyzer JM, Gilbert WM. Accuracy of obstetric diagnoses and procedures in hospital discharge data. *Am J Obstet Gynecol* 2006; 194(4): 992–1001. doi:10.1016/j.ajog.2005.08.058
13. Lain SJ, Roberts CL, Hadfield RM, Bell JC, Morris JM. How accurate is the reporting of obstetric haemorrhage in hospital discharge data? A validation study. *Aust N Z J Obstet Gynaecol* 2008; 48(5): 481–4. doi:10.1111/j.1479-828X.2008.00910.x
14. Bentley JP, Ford JB, Taylor LK, Irvine KA, Roberts CL. Investigating linkage rates among probabilistically linked birth and hospitalization records. *BMC Med Res Methodol* 2012; 12: 149. doi:10.1186/1471-2288-12-149
15. Taylor LK, Travis S, Pym M, Olive E, Henderson-Smart DJ. How useful are hospital morbidity data for monitoring conditions occurring in the perinatal period? *Aust N Z J Obstet Gynaecol* 2005; 45(1): 36–41. doi:10.1111/j.1479-828X.2005.00339.x
16. National Centre for Classification in Health. Tabular list of diseases ICD 10 AM. Sydney: National Centre for Classification in Health; 2006.
17. National Centre for Classification in Health. Australian classification of Health Interventions. Sydney: National Centre for Classification in Health; 2006.
18. New South Wales Perinatal Data Collection Manual. 2011 Edition. Available at: http://www0.health.nsw.gov.au/resources/publichealth/mph/pdc_manual_2011.asp (Cited 23 January 2014).
19. Patterson JA, Roberts CL, Bowen JR, Irving DO, Isbister JP, Morris JM et al. Blood transfusion during pregnancy, birth and the postnatal period. *Obstet Gynecol* 2014; 123(1): 126–33. doi:10.1097/AOG.0000000000000054
20. Landis JR, Koch GG. The measurement of observer agreement for categorical data. *Biometrics* 1977; 33(1): 159–74. doi:10.2307/2529310
21. Sagot P, Mourtialon P, Benzenine E, Bardou M, Ferdynus C, Morel P et al. Accuracy of blood transfusion in postpartum hemorrhage to assess maternal morbidity. *Eur J Obstet Gynecol Reprod Biol* 2012; 162(2): 160–4. doi:10.1016/j.ejogrb.2012.02.021
22. Roberts CL, Ford JB, Thompson JF, Morris JM. Population rates of haemorrhage and transfusions among obstetric patients in NSW: a short communication. *Aust N Z J Obstet Gynaecol* 2009; 49(3): 296–8. doi:10.1111/j.1479-828X.2009.00985.x
23. Callaghan WM, Kuklina EV, Berg CJ. Trends in postpartum hemorrhage: United States, 1994-2006. *Am J Obstet Gynecol* 2010; 202(4): 353. doi:10.1016/j.ajog.2010.01.011
24. Roberts CL, Bell JC, Ford JB, Morris JM. Monitoring the quality of maternity care: how well are labour and delivery events reported in population health data? *Paediatr Perinat Epidemiol* 2009; 23(2): 144–52. doi:10.1111/j.1365-3016.2008.00980.x

Timeliness of *Salmonella* Typhimurium notifications after the introduction of routine MLVA typing in NSW

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Abstract: *Salmonella* Typhimurium is the most common bacterial cause of gastrointestinal disease in NSW. Regular review of surveillance procedures ensures system objectives are met and informs improvements in system utility and efficiency. This paper assesses the timeliness and data completeness of NSW *Salmonella* Typhimurium surveillance after the routine introduction of multilocus variable repeat analysis (MLVA), a rapid sub-typing technique. MLVA results were available significantly earlier than alternate sub-typing techniques over the 2 years of this review. Accordingly, from a timeliness perspective, MLVA offers a favourable *Salmonella* Typhimurium sub-typing option in NSW. Further opportunities to improve timeliness and data completeness are identified. This paper was produced as part of a review of *Salmonella* Typhimurium surveillance in NSW for the period 2008–2009 by members of OzFoodNet based at Hunter New England Population Health. OzFoodNet is a national network established by the then Commonwealth Department of Health and Ageing in 2000 to enhance foodborne disease surveillance in Australia.

Salmonella Typhimurium (STm) is the most common *Salmonella* serotype in New South Wales (NSW); in 2009 STm accounted for 54% of all NSW *Salmonella* notifications[1] and 77% of Australian foodborne outbreaks with an identified causative agent.[2] STm is a heterogeneous *Salmonella* serovar, requiring additional sub-typing to identify outbreak-specific strains. Research exploring sub-typing techniques proffers multilocus variable repeat analysis (MLVA) as a rapid alternative to phage typing,[3,4] the sub-typing technique historically used in Australia. MLVA typing has been shown to successfully differentiate strains within phage types 135a and 170 that comprise more than half the STm isolates in NSW.[5] In 2006 and 2007, routine STm MLVA sub-typing was implemented in Queensland and NSW, respectively.

Regular review of public health surveillance determines the success of system objectives and informs refinement of system utility and efficiency.[6,7] The NSW *Salmonella* surveillance system involves a complex network of local and interstate laboratories and notification processes. Local primary laboratories identify *Salmonella* species (spp.), while serovar confirmation and MLVA typing occur at the closest reference laboratory, and phage typing at one of the two national phage typing laboratories (Institute of Medical and Veterinary Science (IMVS), Adelaide and Medical Diagnostic Unit (MDU), Melbourne). The NSW *Public Health Act 1991 (*and its subsequent revision in 2010) mandates laboratories to notify all confirmed *Salmonella* cases. In 2008 and 2009 notifications were entered into the NSW Notifiable Diseases Database (NDD) by Public Health Units (PHUs) for data collation, timely outbreak detection and disease control, key objectives of the NSW surveillance system.[8]

This paper assesses the timeliness and completeness of NSW *Salmonella* Typhimurium surveillance data after the routine introduction of MLVA. Serovar and MLVA notifications received in 2008 and 2009 were reviewed to identify opportunities for minimising delays.

Methods

The Centers for Disease Control and Prevention's Updated Guidelines for Evaluating Public Health Surveillance Systems[6] were used as an evaluation framework for this investigation.

Data sources

STm notifications of NSW residents with a specimen collection date from 1 January 2008 to 31 December 2009 were identified and extracted in August 2010. As a

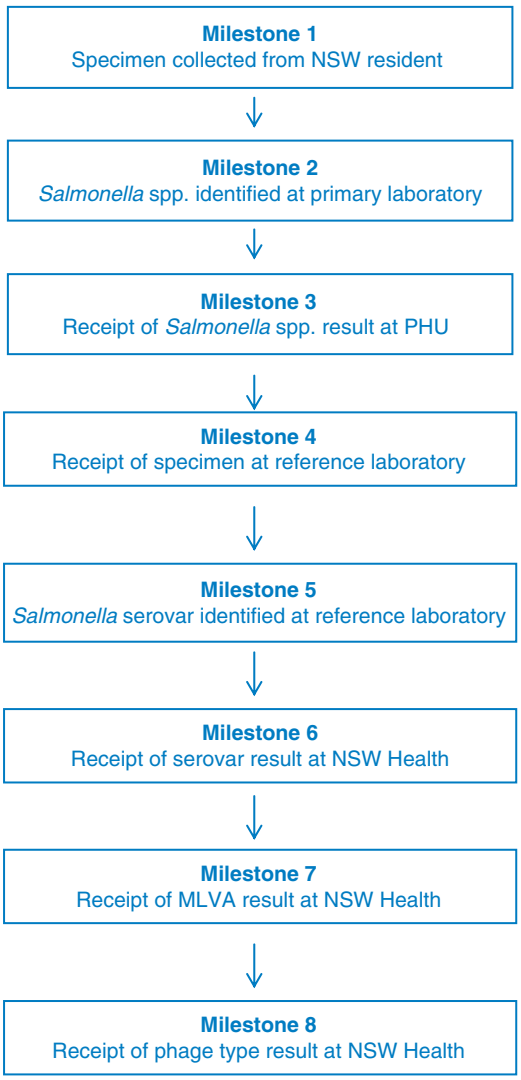

Figure 1. Milestones in the NSW *Salmonella* Typhimurium surveillance system

MLVA: multilocus variable repeat analysis; PHU: Public Health Unit.

new data management system (Notifiable Conditions Information Management System (NCIMS)) was instituted in May 2010, notifications were entered into the NDD during 2008 and 2009, but data were extracted from NCIMS in 2010. Additional milestone dates were obtained from the Institute for Clinical Pathology and Medical Research (ICPMR) electronic notifications and Queensland Health Forensic and Scientific Services (QHFSS), the NSW and Queensland reference laboratories, respectively. Other state reference laboratories were excluded as MLVA typing was not routinely conducted during the period of interest. NDD data comprised primary laboratory name and the date of *Salmonella* spp. receipt at the relevant PHU. ICPMR data included the following dates: specimen collection, *Salmonella* spp. identification, isolate receipt at ICPMR, and the electronic notification of serovar, MLVA and phage typing. The QHFSS dataset provided specimen collection date and the electronic notification dates of serovar and MLVA typing.

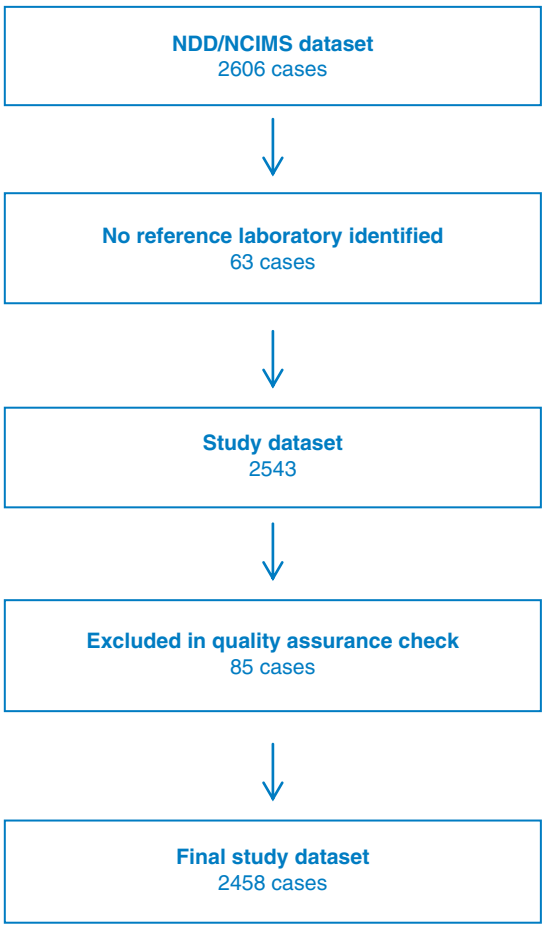

Figure 2. Timeliness review of the NSW *Salmonella* Typhimurium surveillance system, 2008–2009: dataset derivation and case exclusion

NCIMS: Notifiable Conditions Information Management System; NDD: Notifiable Diseases Database.

Data management and analysis

The relevant ICPMR and QHFSS dates were added to the NDD data extraction using SAS software (version 9.2, SAS Institute, Cary, NC, USA).

Eight milestones of public health importance were used in the analysis (Figure 1). Completeness and accuracy of milestones affected the number of cases available for timeliness evaluation; accordingly, a review of data completeness was conducted. Data cleaning verified the accuracy of extracted data and guided exclusion of duplicate cases and repeat specimens (specimens less than 14 days apart).[8] Additional quality assurance checks involved scrutiny and possible exclusion of unexpected dates, established by negative time between sequential surveillance milestones. Time intervals greater than 365 days were reviewed to determine validity and excluded where appropriate. A total of 2458 cases (94.3% of all STm notifications) were included in the analysis (Figure 2).

SAS software and Microsoft Excel 2010 were used for quality assurance checks, calculation of time intervals between milestones, and significance testing, using Wilcoxon rank sum test methodology.

Table 1. Elapsed days from specimen collection to *Salmonella* Typhimurium surveillance milestones, NSW residents, 2008–2009

Milestone	2008		2009	
	Available records (*n*)	Median days (range)	Available records (*n*)	Median days (range)
Salmonella spp. identified at primary laboratory	1047	3 (1–31)	1364	3 (1–13)
Salmonella spp. result received by PHU	812	7 (3–156)	1168	6[a] (3–69)
Specimen received by reference laboratory	1036	6 (3–13)	1358	6 (3–39)
Salmonella serovar identification	1039	8 (4–32)	1274	7[a] (4–41)
Salmonella serovar result received[b]	1060[c]	10 (4–377)	1380[c]	9 (5–54)
MLVA result received[b]	1047	23 (8–384)	1377	21[a] (7–376)
Phage type result received[b]	1007	46 (21–786)	1362	65[a] (20–307)

MLVA: multilocus variable repeat analysis; PHU: Public Health Unit.
[a]Difference in 2008 and 2009 median (days), $p < 0.001$.
[b]Reference laboratory results are emailed to NSW Health; subsequent dissemination to the relevant PHU.
[c]Includes Queensland Health Forensic and Scientific Services (QHFSS) specimens where earlier milestone dates unavailable (QHFSS results notified on serovar identification).
Source: Notifiable Conditions Information Management System (SAPHaRI), NSW Ministry of Health.

Table 2. Missing and invalid *Salmonella* Typhimurium surveillance milestones, NSW residents, 2008–2009

Milestone	Missing dates		Invalid entries[a]	
	n	(%)	*n*	(%)
Specimen collection date	0	0.0	0	0.0
Salmonella spp. identified at primary laboratory	41	1.7	6	0.2
Salmonella spp. result received by PHU	405	16.5	32	1.3
Specimen received by reference laboratory	0	0	17	0.7
Salmonella serovar identification	133	5.4	12	0.5
Salmonella serovar result received[b]	17	0.7	1	0.0
MLVA result received[b]	33	1.3	1	0.0
Phage type result received[b]	88	3.6	1	0.0

MLVA: multilocus variable repeat analysis; PHU: Public Health Unit.
[a]Data determined to be impossible values and excluded from analysis.
[b]Reference laboratory results are emailed to NSW Health, with subsequent dissemination to the relevant PHU.
Source: Notifiable Conditions Information Management System (SAPHaRI), NSW Ministry of Health.

Results

Timeliness

The timeliness of all STm milestones, determined by the median interval in days, with the exception of receipt of phage typing, remained relatively consistent over time (Table 1). MLVA notification occurred 23 days earlier than phage typing in 2008 ($p < 0.001$) and 44 days earlier in 2009 ($p < 0.001$). The median time interval for MLVA notifications decreased significantly from 23 days in 2008 to 21 days in 2009 (2 days' decrease, $p < 0.001$).

Data completeness

Missing or invalid data were infrequent for most milestones, with a few notable exceptions (Table 2). The receipt of the initial *Salmonella* spp. report at PHU level was missing in 16.5% of cases and invalid in 1.3% of cases. Serovar identification date was missing in 5.4% of cases. Sub-typing was not recorded for a small number of STm cases, including 17 serovar, 33 MLVA and 88 phage type results.

Anomalies in sequential notification

Given the consecutive nature of STm typing, milestone notification for MLVA and phage typing are expected to occur after serovar availability. Time interval analysis indicated this was not always the case. Serovar and MLVA typing results were received simultaneously in 1% of cases in 2008 and 6% of cases in 2009.

Discussion

Regular evaluation of public health surveillance is important to confirm system utility and efficiency.[6] To our knowledge, this is the first report of MLVA timeliness in

the context of a population level STm surveillance system. MLVA results were available significantly earlier than phage typing results over the 2 years of this review. The availability of NSW MLVA results in 2008 (median 23 days) and 2009 (median 21 days) was also fast in comparison to phage typing in a similar timeliness study conducted in Ireland (median 25 days).[9] Notably, median time to MLVA availability was shorter in 2009 than in 2008. This reduction during the third year of routine MLVA typing may be driven by increased efficiency as key players become accustomed to the MLVA process.

MLVA and phage typing notification was absent for a small number of cases. It is unclear whether typing was available but not reported or if typing was not conducted. One possible explanation is informed cessation of sub-typing when cases are epidemiologically linked to a known outbreak. However, as NDD data entry capabilities did not include case or outbreak linking during the study period, we cannot assess the impact of outbreak resolution on missing results.

Occasionally, laboratories did not notify sub-typing results at the earliest opportunity, as indicated by simultaneous or non-sequential notification of serovar, MLVA or phage typing results. While electronic notification via email is undoubtedly faster than postal mail, human errors in data collation and transmission between organisations are challenging to eliminate. Missing dates and notification sequence anomalies indicated notification lapses by primary laboratories. These data quality issues impact the day-to-day operational processes of outbreak identification, investigation and control. However, due to the complex nature of NDD data entry and extraction from NCIMS, further exploration of this issue was not possible.

Resourcing impacts the time interval from specimen collection to result availability. Phage typing is particularly affected as two reference laboratories (IMVS and MDU) service all Australian states. Phage type result timeliness may also be impacted by isolate 'batching', where isolate dispatch to the reference laboratory is delayed until a sufficient number of isolates are collated. Batching may have become more commonplace in NSW after the introduction of routine MLVA and an accompanying reduction in urgency for phage typing results. A previous study identified *Salmonella* spp. identification as the 'bottle neck' in the surveillance system,[7] yet we found that the majority of *Salmonella* spp. identification occurred within 3 days. Also, the time interval from specimen collection to *Salmonella* spp. PHU notification was similar to a previous international timeliness study.[9] Nonetheless, the additional median 4- (2008) or 3- (2009) day time interval from *Salmonella* spp. identification to PHU receipt provides an opportunity to reduce notification delays.

In 2010, the NDD was replaced with NCIMS, an updated data capture system with enhanced foodborne disease surveillance capacities. NCIMS capabilities include date stamping (identifying the date and time of data entry), outbreak case linking, and recording MLVA and phage typing results. NCIMS performance enhancements are expected to improve outbreak identification, establish historical sub-typing data banks, and advance future surveillance system evaluations through superior data quality. Indeed, capacity for real-time electronic importation of notifications directly into NCIMS (electronic laboratory reporting (ELR)) has been partially realised. In 2013, ELR was implemented by four laboratories conducting a substantial proportion of *Salmonella* spp. identification. The elimination of transmission delay and human error inherent in multiple data entry points may have already reduced time from *Salmonella* spp. identification to PHU receipt. However, an efficient data extraction method, to facilitate future timeliness and data quality evaluations, has not yet been developed.

Further opportunities to improve timeliness and data completeness include:

1. Dissemination of ELR across all laboratories, thereby reducing duplication of data entry and expediting data delivery.
2. Development of NCIMS capability for efficient data extraction and reporting relevant to future data completeness and timeliness evaluations. This would enable evaluation of NCIMS capacity to enhance the NSW STm surveillance system.

Limitations

Interpretation of our findings requires consideration of data limitations, including the use of secondary data collated for operational purposes. NDD data entry and NCIMS data extraction capabilities, surveillance system reliance on manual data entry at multiple laboratories and PHUs, and manual result dispatch from laboratories to health services, impacted data quality. To minimise this bias, staff scrutinised each record to assess data for exclusion as necessary.

Conclusion

Given the importance of rapid typing in outbreak responses and the endemic presence of STm in NSW, timely receipt of STm sub-typing is of public health importance. From a timeliness perspective, MLVA offers a favourable STm sub-typing option in NSW. Further, this project identified additional opportunities to enhance the STm surveillance system and improve enteric outbreak detection and control.

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Health and Ageing to enhance foodborne disease surveillance in Australia. We wish to acknowledge the contribution of Tracey Findlay for her role in data collation and cleaning. We would also like to thank our public health reference laboratory colleagues at ICPMR and QHFSS for their enthusiasm for MLVA typing and the provision of additional milestone data, as well as our colleagues at MDU and IMVS for phage typing.

References

1. Kardamandis K, Heilbronn C, Munnoch S, McWeeny C, Stephens N. NSW 2009 OzFoodNet Annual Report. Available at: http://www.health.nsw.gov.au/Infectious/diseases/Documents/ofn_annual_report_2009.pdf (Cited 14 April 2014).
2. OzFoodNet Working Group. Monitoring the incidence and causes of diseases potentially transmitted by food in Australia: Annual report of the OzFoodNet Network, 2009. *Commun Dis Intell* 2010; 34: 396–426.
3. Lindstedt BA, Vardund T, Aas L, Kapperud G. Multiple-locus variable-number tandem-repeats analysis of *Salmonella* enterica subsp. enterica serovar Typhimurium using PCR multiplexing and multicolor capillary electrophoresis. *J Microbiol Methods* 2004; 59: 163–72. doi:10.1016/j.mimet.2004.06.014
4. Wang Q, Chiew R, Howard P, Gilbert G. *Salmonella* typing in New South Wales: current methods and application of improved epidemiological tools. *N S W Public Health Bull* 2008; 19: 24–8. doi:10.1071/NB07036
5. Sintchenko V, Wang Q, Howard P, Ha CW, Kardamanidis K, Musto J et al. Improving resolution of public health surveillance for human *Salmonella* enterica serovar Typhimurium infection: 3 years of prospective multiple-locus variable-number tandem-repeat analysis (MLVA). *BMC Infect Dis* 2012; 12: 78. doi:10.1186/1471-2334-12-78
6. CDC; the Guidelines Working Group. Updated Guidelines for Evaluating Public Health Surveillance Systems. *MMWR* 2001; 50: 1–35.
7. Takahashi T, Koehler J, Swenson P, Duchin J. Evaluation of a public health *Salmonella* surveillance system in King County, Washington. *Am J Infect Control* 2004; 32: 7–11. doi:10.1016/j.ajic.2003.06.003
8. Communicable Diseases Surveillance and Control Unit. NSW Notifiable Diseases Database Manual. 6th ed. Sydney: NSW Department of Health; 2002.
9. Nicolay N, Garvey P, Delappe N, Cormican M, McKeown P. Completeness and timeliness of *Salmonella* notifications in Ireland in 2008: a cross sectional study. *BMC Public Health* 2010; 10: 568. doi:10.1186/1471-2458-10-568

Public and private dental services in NSW: a geographic information system analysis of access to care for 7 million Australians

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Abstract: Aim: To investigate the distribution of public and private dental practices in NSW in relation to population distribution and socioeconomic status. **Methods:** Dental practices (public and private) were mapped and overlayed with Census data on Collection District population and Socio-Economic Indexes for Areas (SEIFA). **Results:** Overall, there was an uneven geographic distribution of public and private dental practices across NSW. When the geographic distribution was compared to population socioeconomics it was found that in rural NSW, 12% of the most disadvantaged residents lived further than 50 km from a public dental practice, compared to 0% of the least disadvantaged. In Sydney, 9% of the three most disadvantaged groups lived greater than 7.5 km from a public dental practice, compared to 21% of the three least disadvantaged groups. **Conclusion:** The findings of this study can contribute to informing decisions to determine future areas for focus of dental resource development (infrastructure and workforce) and identifying subgroups in the population (who are geographically isolated from accessing care) where public health initiatives focused on amelioration of disease consequences should be a focus.

Access to health care, and the relationship between variables associated with service need and the attributes of the service delivery system, are important because they affect peoples' ability to utilise health services when needed.[1,2] One key aspect of accessibility is the physical location of health services relative to the population they serve.[3] The spatial dimension of access is a critical issue in health care. Recent studies have used spatial analysis to measure potential accessibility to primary and secondary health services in order to identify geographic inequalities in health care delivery.[4,5] Australians are one of the healthiest populations in the world, however there is evidence of inequalities and inequities in accessing oral health services.[6,7]

Universal healthcare coverage in Australia excludes dental care; most dental services (80–90%) are delivered by the private sector on a fee-per-item basis. The public sector exists with varying eligibility criteria, and is mostly directed at children, low-income individuals, pensioners and defined disadvantaged groups.[7] Despite the reduction in dental decay in children and tooth loss in adults, oral diseases and disorders remain prevalent and are a substantial burden to the Australian population. Poor oral health is evident in Indigenous communities, and amongst low income earners, rural and remote area dwellers, and the elderly;[8] evidence exists that access to dental care in Australia has a strong socioeconomic dimension, as well as a strong rural–urban dimension.[7]

Against this backdrop, the aim of this study was to investigate the distribution of public and private dental practices in New South Wales (NSW) to test the hypothesis that the distribution of dental practices reflects the geographic, demographic and socioeconomic features of the population and therefore the known gradient of oral disease.

Methods

This study used a cross-sectional study design. All the data were collected from open access web-based sources; no ethics approval was therefore necessary. Microsoft Excel 2003 was used for database storage.

Public dental practice locations

The address of each public dental practice in NSW was obtained from government websites. These were cross-checked against the Yellow Pages telephone directory as at June 2011 and entered into the Excel database. The public dental practices mapped in this study were adult service

10.1071/NB13004

practices and Aboriginal Medical Services. The NSW Government operates an integrated child and adult service predominately through shared site facilities (and continues to extend this position). The small number of practices which remain embedded in schools were not included in the sample.

Private dental practice locations

The address for each private dental practice in NSW was obtained from various sources (e.g. phone books, professional lists, Google maps, web searches) and cross-checked against the Yellow Pages as at June 2011.

Population statistics

Population data were obtained from the Australian Census of Population and Housing of 2006.[9] The population data were divided by Census Collection District (CD), defined by geographic boundaries. The geographic boundaries were also obtained from the Australian Bureau of Statistics (ABS) website.

Socioeconomic status

The Socio-Economic Indexes for Areas (SEIFA) at CD level formed the basis of the measure of socioeconomic disadvantage by geographic areas. SEIFA is a suite of four summary measures that have been created from Census information.[10] SEIFA values are ranked into deciles. The most disadvantaged 10% of areas in Australia are given a decile number of one; the second most disadvantaged 10% of areas are given a decile number of two, and so on up to the least disadvantaged 10% of areas which are given a decile of 10.[11]

Outcome measures

The main outcome measures for this study were the distribution of public and private dental practices in NSW, the distance from CD of residence to these services, and the differences in access to these services for groups of different socioeconomic status. Data were analysed for the Sydney metropolitan area and the rest of NSW (henceforth rural) separately. The primary post office (GPO) of NSW (based in Sydney) was used as a central datum point and metropolitan areas were nominally defined as the area within 50 km of the GPO. This 50 km area was chosen as it encompasses most of the densely populated regions of Sydney, but at the same time remains a relatively simple shape for clarity. It also encompasses the various definitions of metropolitan areas that are in use (e.g. the Commonwealth Government's definitions of city vs rural).[12] Using geographic information system technology, CDs with a centroid outside of 2.5 km, 5 km, and 7.5 km from a public dental practice in the city were identified and further analysed by socioeconomic status. The same was done for private practices in the city, except that CDs with a centroid of 1.0 km and 2.5 km were identified and further analysed by socioeconomic status. Different distances were used for public and private practices as the number of public practices is much lower than the number of private practices and thus they have to cover populations distributed across far larger geographical areas than the private practices. CDs with a centroid greater than 12.5 km, 25 km and 50 km from a public dental practice for rural NSW were also identified and further analysed by socioeconomic status. All distance classifications were cumulative and not mutually exclusive. Straight-line distances were used as a proxy measure of access. As discussed by Phibbs and Luft,[13] the correlation between travel time and straight-line distance is high in most cases, lowering for shorter distances and in dense urban areas with high traffic congestion and reliance on surface roads.

No distance or socioeconomic analyses were conducted for the private dental practices in rural NSW as the density of practices was low (out of a total of 3289 private practices, only 683 were distributed across rural NSW). As private practice locations are determined by the market and economic drivers, practices outside of capital metropolitan areas have previously been found to be located in higher population density, large regional centres.[14] In addition, public dental practices play a strategic role for the wider geographic regions of NSW.

Geocoding

All dental practices were geocoded using Google maps. The geographic boundary data for each CD were obtained from the ABS. These were integrated with the population and socioeconomic data, and the geocoded practices using ArcGIS (version 9, ESRI, Redlands, California, USA). The geographic measures analysis was also completed using ArcGIS.

Results

The total number of public dental practices that were geocoded in NSW was 170 and the total number of private practices was 3289, of which 2606 (80%) were in city areas. NSW had a total of 11 811 CDs, representing 10% of the Australian total land mass, and with a total population of 7.2 million (which represents one-third of Australia's total population). There was an uneven distribution of public and private dental practices across NSW, with a high concentration of both in the city (Figure 1). The majority of public dental practices in the city were located in similar areas as the private dental practices.

Public dental practices

Public dental practices were widely scattered in rural areas (Figure 1). In population terms, in rural NSW, 2.1 million people lived within 50 km of a public dental practice; of

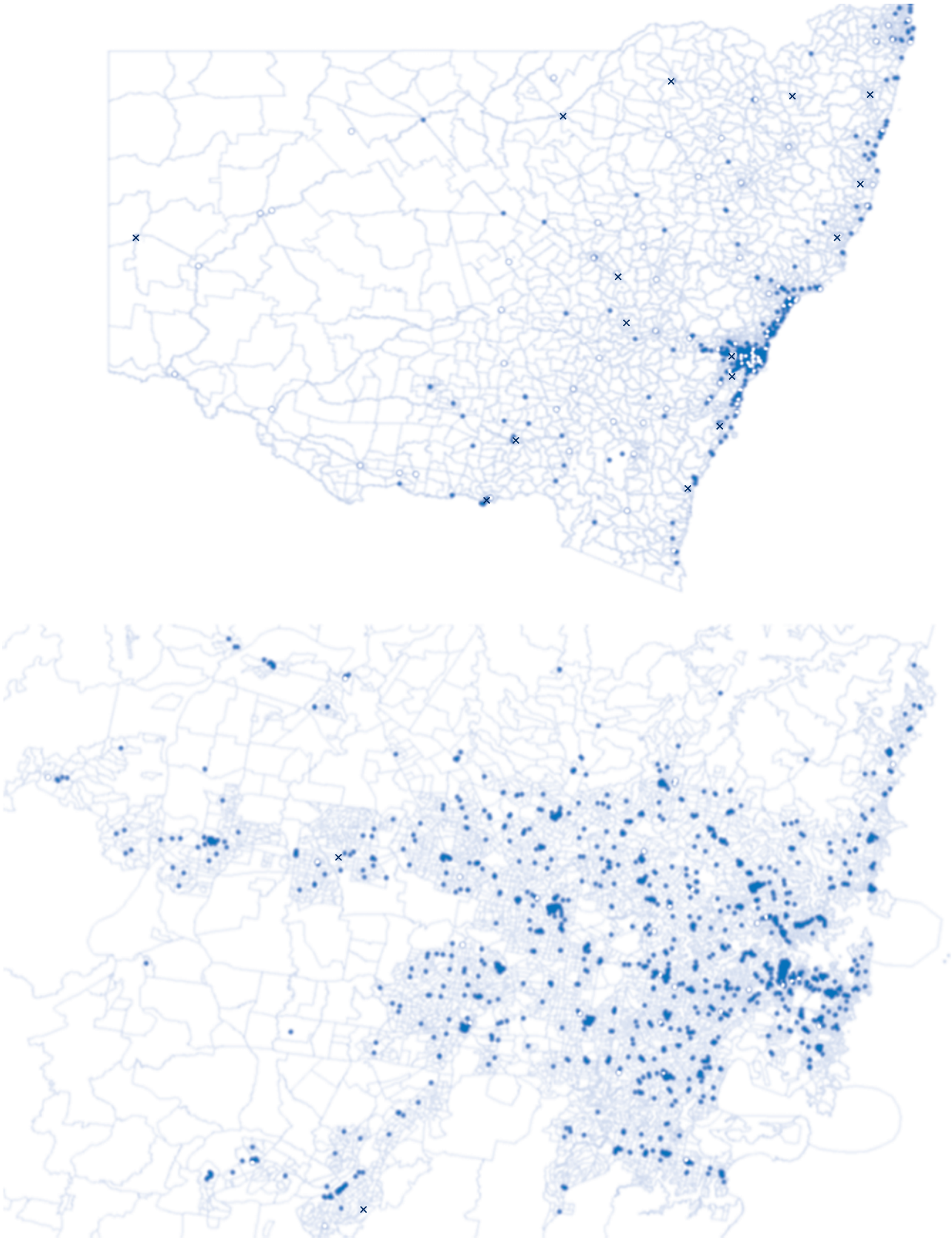

Figure 1. Distribution of public (○), private (•) and Aboriginal Medical Service (×) based dental practices in NSW (top) and at higher magnification for Sydney (bottom), 2011

these, 1.4 million people lived within 12.5 km. In metropolitan Sydney the number of people who lived within 7.5 km of a public dental practice was 3.4 million; of these, 1.3 million people lived within 2.5 km.

Twelve percent of the population in the most disadvantaged SEIFA decile lived greater than 50 km from a public dental practice in rural NSW (Figure 2). SEIFAs 1–6 had 8–12% of the population living greater than 50 km from a

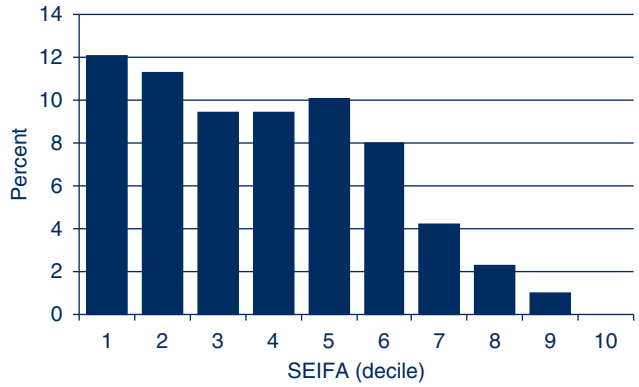

Figure 2. Proportion of people in rural NSW who live greater than 50 km from a public dental practice, by SEIFA decile, 2011

SEIFA: Socio-Economic Indexes for Areas
Decile 1 is the most disadvantaged 10% of the population; decile 10 is the most advantaged 10% of the population.

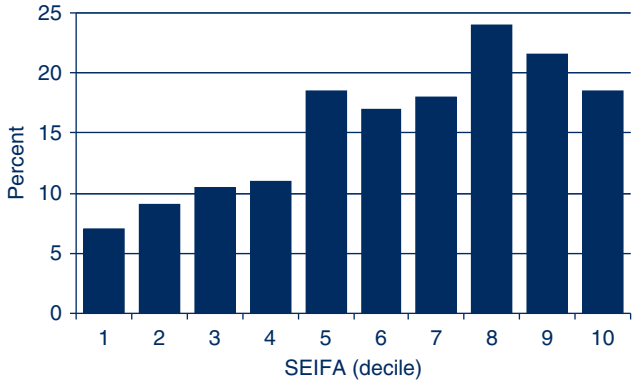

Figure 3. Proportion of people in Sydney, NSW, who live greater than 7.5 km from a public dental practice, by SEIFA decile, 2011

SEIFA: Socio-Economic Indexes for Areas
Decile 1 is the most disadvantaged 10% of the population; decile 10 is the most advantaged 10% of the population.

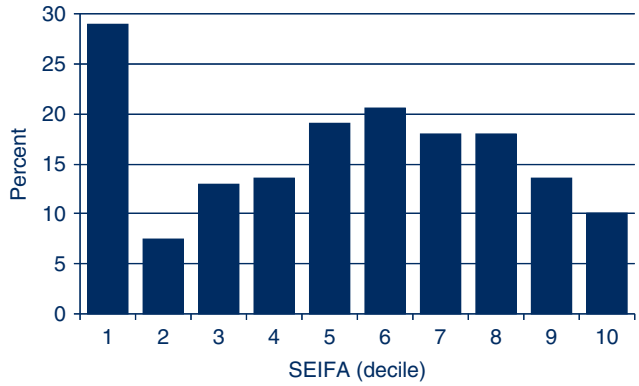

Figure 4. Proportion of people in Sydney, NSW, who live greater than 2.5 km from a private dental practice, by SEIFA decile, 2011

SEIFA: Socio-Economic Indexes for Areas
Decile 1 is the most disadvantaged 10% of the population; decile 10 is the most advantaged 10% of the population.

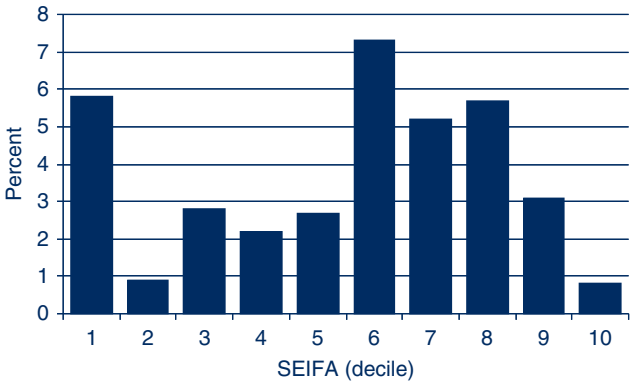

Figure 5. Proportion of people in Sydney, NSW, who live greater than 1 km from a private dental practice, by SEIFA decile, 2011

SEIFA: Socio-Economic Indexes for Areas
Decile 1 is the most disadvantaged 10% of the population; decile 10 is the most advantaged 10% of the population.

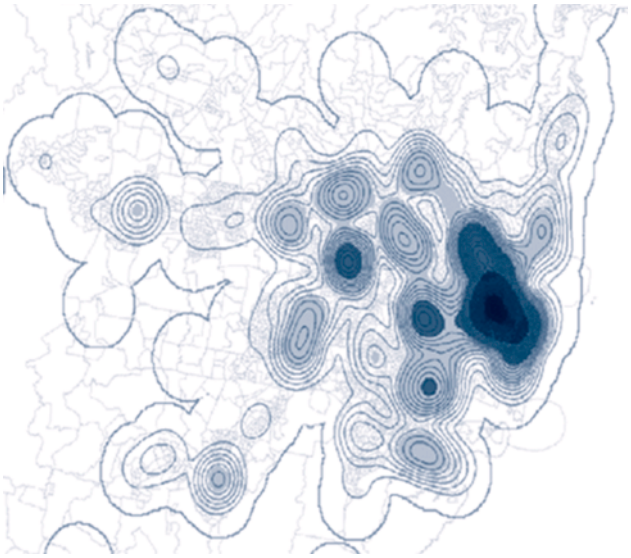

Figure 6. An iso-density map of the number of private dental practices in Sydney, NSW, and surrounding areas (approximately 50 km), 2011

Areas highlighted in darker shades have the highest densities.

public dental practice. However, the percentage of the population was low for SEIFA deciles 7–9, and no-one in SEIFA 10 lived more than 50 km from a public practice.

In the city the reverse was true; 9% of the three most disadvantaged groups lived greater than 7.5 km from a public dental practice while the three least disadvantaged SEIFA deciles had a higher percentage (21%) who lived greater than 7.5 km from a public dental practice. SEIFAs 1–4 had a lower percentage of the population living greater than 7.5 km from a public practice than SEIFAs 5–10 (Figure 3).

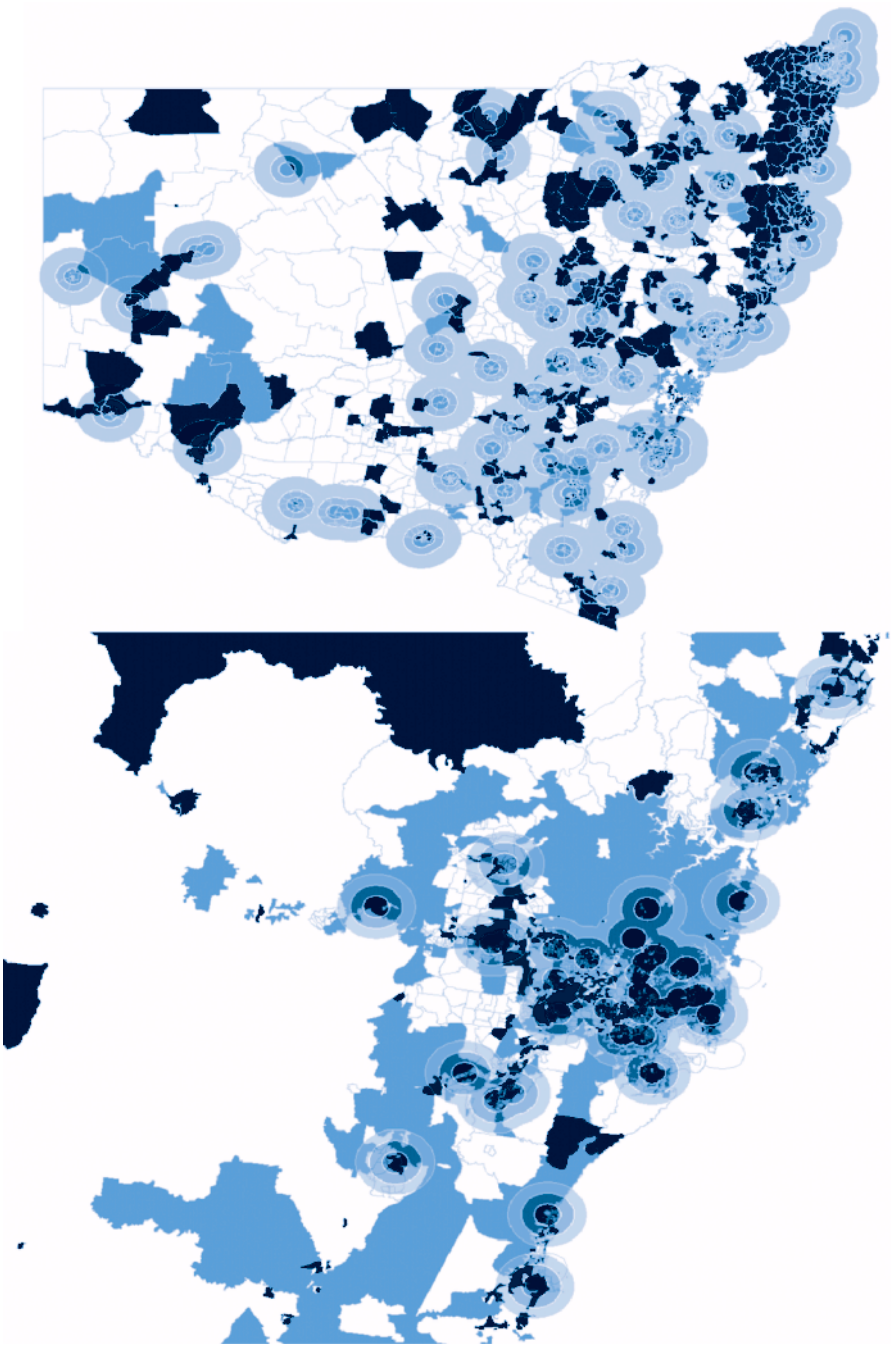

Figure 7. Public dental practices overlaying SEIFA deciles, NSW, 2011

Buffers for rural NSW (top) were 12.5, 25 and 50 km and were 2.5, 5 and 7.5 km for metropolitan Sydney (bottom).
Dark blue (deciles 1, 2 and 3; most disadvantaged) and light blue (deciles 8, 9 and 10; least disadvantaged).

Private practices

There were far fewer private practices in rural NSW; the vast majority were concentrated in the city (Figure 1). In Sydney, people in SEIFAs 1 and 5–8 were more likely to live greater than 2.5 km from a private dental practice (Figure 4). Further analysis of the distribution by SEIFA found that SEIFAs 1 and 6–8 had the highest proportion of people living greater than 1.0 km from a private dental practice in the city (Figure 5). The density of private dental practices increased closer to the centre of the city (Figure 1).

Further distributional analyses

Sydney has a high population density and the majority of residents living in the city belonged to the least disadvantaged groups (SEIFA 8, 9, 10), while the minority were from the most disadvantaged groups (SEIFA 1, 2, 3). Figure 6 shows the density of private practices across Sydney. There was also a very high density of public dentists in the city. Figure 7 shows the relative density of public dental practices across NSW. Coverage of metropolitan Sydney by the "catchment zones" is dense and even.

Discussion

Despite the reduction in dental decay in children and tooth loss in adults, oral diseases and disorders remain prevalent and a substantial burden in the Australian population.[8] Accessing health care is not equal across the population[15] and this is reflected in accessing oral health care in Australia.[7]

The overall findings of this study demonstrate that the distribution of public and private dental practices does not entirely reflect the population characteristics and the burden of oral health diseases. The drivers of economic sustainability complicate the picture of clinical distribution, especially in private practice. In general, private dental practices in Sydney were distributed according to population density and income distribution.

An uneven distribution of dental practices relative to population can also be seen in other countries. A similar situation to NSW is found in Ohio in terms of the distribution of private dentists.[16] Geographic information system research using spatial analysis was used to explore access to community-based oral health care services in Manhattan and the Bronx for adults aged 65 years and over by race/ethnicity and poverty status. The study revealed that race/ethnicity and poverty status co-occurs spatially among seniors in the two areas, with poorer and minority ethnic groups having less access to oral health services.[17] Location-based accessibility to dental services was also assessed using the spatial approach, in a second study from Ohio, again finding similar distribution patterns as the current study.[1] Spatial analysis has also been used to assess the distribution of fixed public dental practices in three Australian states (Western Australia, Queensland and Victoria) by CDs and socioeconomic status and private practices in Western Australia, and these studies found similar distribution patterns to the present study.[18,19]

It is known that the locations of private dental practices are driven by market forces and economy.[20] Private dental services cannot be sustained in many rural and remote areas in part due to lack of dentists, high costs and low population density. These communities are reliant on state governments to fund or provide dental health services. Public dental practices are widely scattered in rural NSW.[21–24] This study extended on these findings to also report a gradient of accessibility based on socioeconomic status: the greatest numbers of those who reside outside 50 km from a public dental practice were from lower socioeconomic communities. These findings confirm the situation where people from lower socioeconomic backgrounds in rural areas carry a higher burden of oral disease but have less access to dental care compared to higher socioeconomic groups; this may contribute to widening oral health inequalities among Australians.[6,24–26] These results also agree with Susi and Mascarenhas'[16] findings that socioeconomic and access disparities are obvious in rural areas.

Most of the wealthier residents in this study (SEIFA 8, 9, 10) lived in the city, where the majority of private dental practices were also located. This finding supports previous research that per capita income is a good predictor of dentists' location in the private sector.[27,28] With private practice remuneration being a core of the small business free market economic model of private dental practice this is not an unreasonable outcome. The number of dental clinicians per practice was not investigated in the study but the effects of workforce shortage and maldistribution are likely to magnify the results of this study, as the shortage of workforce is mainly experienced by the public sector and in rural areas.

Conclusion

The distribution of public and private dental practices did not entirely reflect the population characteristics and the burden of oral health diseases. The findings of this study can contribute to policy makers' determination of areas where additional resources are required and areas where incentive programs can be created that will attract dentists to rural and remote areas. The results can inform decisions to determine practice locations and identify such subgroups in the population that need significant attention for public health initiatives, reflecting the population characteristics and the burden of oral diseases. This will be a foundation that will help narrow the gap of inequalities and inequities in oral health care services in the Australian population.

Acknowledgment

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References

1. Horner MW, Mascarenhas AK. Analyzing location-based accessibility to dental services: an Ohio case study. *J Public Health Dent* 2007; 67(2): 113–8. doi:10.1111/j.1752-7325.2007.00027.x
2. Cromley EK, McLafferty SL. GIS and Public Health. New York: Guilford Press; 2002.
3. Nykiforuk CI, Flaman LM. Geographic information systems (GIS) for Health Promotion and Public Health: a review. *Health Promot Pract* 2011; 12(1): 63–73. doi:10.1177/1524839909334624
4. McLafferty SL. GIS and health care. *Annu Rev Public Health* 2003; 24: 25–42. doi:10.1146/annurev.publhealth.24.012902.141012
5. Phillips RL Jr, Kinman EL, Schintzer PG, Lindbloom EJ, Ewigman B. Using geographic information systems to understand health care access. *Arch Fam Med* 2000; 9(10): 971–8. doi:10.1001/archfami.9.10.971
6. Spencer AJ. Narrowing the inequality gap in oral health and dental care in Australia. University of Sydney: Australian Health Policy Institute; 2004.

7. Schwarz E. Access to oral health care – an Australian perspective. *Community Dent Oral Epidemiol* 2006; 34(3): 225–31. doi:10.1111/j.1600-0528.2006.00301.x

8. Oral health of Australians. In: National Planning for oral health improvement: Final report. Adelaide: South Australian Department of Human Services; 2001.

9. Australian Bureau of Statistics. Census: for a brighter future. Available at: http://www.abs.gov.au/websitedbs/censushome.nsf/home/Census (Cited 21 June 2011).

10. Australian Bureau of Statistics. Census Dictionary Australia (Reissue). Catalogue No. 2901.0.2006. Canberra: ABS; 2006.

11. Australian Bureau of Statistics. Socio-Economic Indexes for Areas. Available at: http://www.abs.gov.au/websitedbs/censushome.nsf/home/seifa (Cited 31 January 2014).

12. Almado H, Kruger E, Tennant M. Application of spatial analysis technology to planning access to oral health care for at-risk populations in Australian capital cities. *Aust J Primary Health,* In press.

13. Phibbs CS, Luft HS. Correlation of travel time on roads versus straight line distance. *Med Care Res Rev* 1995; 52(4): 532–42. doi:10.1177/107755879505200406

14. Tennant M, Kruger E, Shiyha J. Dentist-to-population and practice-to-population ratios: in a shortage environment with gross mal-distribution what should rural and remote communities focus their attention on? *Rural Remote Health* 2013; 13(4): 2518.

15. Public Health Division. The health of the people of New South Wales – Report of the Chief Health Officer. Sydney; NSW Department of Health; 2004.

16. Susi L, Mascarenhas AK. Using a geographical information system to map the distribution of dentists in Ohio. *J Am Dent Assoc* 2002; 133(5): 636–42. doi:10.14219/jada.archive.2002.0239

17. Borrell LN, Northridge ME, Miller DB, Golembeski CA, Spielman SE, Sclar ED et al. Oral health and health care for older adults: a spatial approach for addressing disparities and planning services. *Spec Care Dentist* 2006; 26(6): 252–6. doi:10.1111/j.1754-4505.2006.tb01663.x

18. Perera I, Kruger E, Tennant M. Rural public dental clinic distribution in three states of Australia: using spatial analysis to inform management and planning of services. *Asia Pac J Health Management* 2010; 5(1): 40–6.

19. Kruger E, Tennant M, George R. Application of geographic information systems to the analysis of private dental practices distribution in Western Australia. *Rural Remote Health* 2011; 11(3): 1736.

20. Leake JL, Birch S. Public policy and the market for dental services. *Community Dent Oral Epidemiol* 2008; 36(4): 287–95. doi:10.1111/j.1600-0528.2008.00438.x

21. Teusner DN, Spencer AJ. Dental Labour Force, Australia 2000. Dental Statistics and Research Series No. 28. Cat. no. DEN 116. Canberra: Australian Institute of Health and Welfare; 2003.

22. Teusner DN, Chrisopoulos S, Brennan DS. Geographic distribution of the Australian dental labour force, 2003. Dental Statistics and Research Series No. 37. Cat. no. DEN 168. Canberra: Australian Institute of Health and Welfare; 2007.

23. Chrisopoulos S, Nguyen T. Trends in the Australian dental labour force, 2000 to 2009: Dental labour force collection, 2009. Dental Statistics and Research Series No. 61. Cat. no. DEN 218. Canberra: Australian Institute of Health and Welfare; 2012.

24. Slade GD, Spencer AJ, Roberts-Thomson K, eds. Australia's dental generations: the National Survey of Adult Oral Health 2004–06. AIHW cat. no. DEN 165. Canberra: AIHW; 2007.

25. Healthy Mouths, Healthy Lives. Australia's National Oral Health Plan 2004–2013. National Advisory Committee on Oral Health, South Australian Department of Health: Adelaide; 2004.

26. Rural Dental Action Group. Dental Health Survey 2006. Available at: http://www.ncoss.org.au/bookshelf/health/submissions/RDAG%20summary%202006.pdf (Cited 19 December 2013).

27. Beazoglou TJ, Crakes GM, Doherty NJ, Heffley DR. Determinants of dentists' geographic distribution. *J Dent Educ* 1992; 56(11): 735–40.

28. Bailit HL, Beazoglou TJ. State financing of dental education: impact on supply of dentists. *J Dent Educ* 2003; 67(12): 1278–85.

Infectious diseases in returned travellers, NSW, 2010–2011

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Abstract: Aim: To quantify the proportion of selected notified diseases in NSW attributable to overseas travel and assess the quality of data on travel-associated risk factors, to inform prevention strategies. **Methods:** 2010 and 2011 notification data for dengue, hepatitis A, hepatitis E, malaria, paratyphoid fever, shigellosis and typhoid fever were extracted from the NSW Notifiable Conditions Information Management System and analysed for travel-associated risk factors. **Results:** Where place of acquisition was known, the proportion of cases for whom the disease was acquired overseas ranged from 48.7% for shigellosis to 100% for hepatitis E, malaria and typhoid. Over half of hepatitis A (53.3%), hepatitis E (74.2%), malaria (54.5%), paratyphoid (53.3%) and typhoid (65.7%) cases were associated with travel to the person's country of birth. Hepatitis A vaccination rates were significantly lower among overseas-acquired than locally-acquired cases (4.8% vs 22.2%, $X^2 = 6.58$, $p < 0.02$). **Conclusion:** A large proportion of selected enteric and vectorborne disease case notifications were associated with overseas travel. All potential travellers should be made aware of the risks and available preventive measures, such as vaccination against hepatitis A and typhoid fever, taking precautions with food and water and use of malaria chemoprophylaxis, where appropriate. Improvements in data on risk factors, reason for travel and barriers to the use of preventive measures would better inform prevention strategies.

Evidence from developed countries suggests that many case notifications for particular infectious diseases are associated with overseas travel. For example, a review of typhoid fever surveillance data indicated that most case notifications in developed countries are imported.[1] Malaria surveillance in the United Kingdom (UK) (1987–2006) and the United States (2011) also showed a consistently high number of case notifications, all of which are believed to have been acquired overseas.[2,3]

Analysis of notifiable diseases data in Australia has also highlighted travel as a risk factor for a range of infections. Over half of all cases of enteric fever in Queensland from 2006 to 2008, and half of all cases of hepatitis A in New South Wales (NSW) from 2002 to 2006, had travel as a risk factor.[4,5] Australia-wide in 2008 and 2009, all malaria case notifications and almost half of dengue case notifications were acquired overseas.[6]

The destination and reason for travel have implications for disease risk. A relationship exists between travel to an area where a particular disease is endemic and risk of that disease, with data showing that malaria diagnoses are most common in travellers to sub-Saharan Africa, while dengue diagnoses are associated with travel to South-East Asia and hepatitis E diagnoses with travel to South Asia.[7–9]

Also critical is the reason for travel, with travellers visiting friends and relatives (VFR) found to be at greater risk of some diseases compared to tourist travellers. For example, a UK study showed that where the reason for travel was known, 76% of malaria infections and 88% of typhoid and paratyphoid infections were acquired during VFR travel.[10] Data from the GeoSentinel Surveillance database collected from 210 sites in several countries showed similar results.[11]

Short-term international departures (with a duration of less than 1 year) amongst NSW residents increased by 50% from 1.8 million in 2005 to 2.7 million in 2011.[12] This study sought to quantify the proportion of selected notified diseases attributable to overseas travel and to assess the quality of data on travel-associated risk factors such as place of acquisition, in order to inform the development of appropriately targeted prevention strategies.

Methods

Under the NSW *Public Health Act 2010*, doctors, hospitals and laboratories must notify cases of selected infectious diseases to NSW Health. Seven of these notifiable

Table 1. Selected infectious diseases by place of acquisition, NSW, 2010–2011

Place of acquisition	Dengue *N* = 345 (%)	HAV *N* = 138 (%)	HEV *N* = 35 (%)	Malaria *N* = 196 (%)	Paratyphoid *N* = 56 (%)	Shigellosis *N* = 248 (%)	Typhoid *N* = 71 (%)
Acquired in Australia	2 (0.6)	41 (29.7)	0 (0.0)	0 (0.0)	4 (7.1)	79 (31.9)	0 (0.0)
Acquired overseas	342 (99.1)	95 (68.8)	31 (88.6)	196 (100.0)	52 (92.9)	75 (30.2)	71 (100.0)
Missing	1 (0.3)	2 (1.4)	4 (11.4)	0 (0.0)	0 (0.0)	94 (37.9)	0 (0.0)

HAV: hepatitis A virus; HEV: hepatitis E virus.
Source: Notifiable Conditions Information Management System, NSW Ministry of Health.

diseases – dengue, hepatitis A, hepatitis E, malaria, paratyphoid fever (excluding that which is caused by *Salmonella* paratyphi B Java, which is believed to be mainly locally acquired), shigellosis and typhoid fever – were chosen for analysis on the basis that: (i) a significant proportion of cases were expected to be overseas acquired; and (ii) these diseases are easily preventable and could be the target of public health action with high-risk groups.

In NSW, Public Health Unit staff investigate notified cases and record demographic, clinical and risk information in the NSW Notifiable Conditions Information Management System (NCIMS) as per response protocols for individual diseases in the NSW Notifiable Diseases Manual.[13]

Notification data for confirmed cases (and probable cases for hepatitis A) of each of the seven diseases with an onset date from 1 January 2010 to 31 December 2011 were exported from NCIMS and reviewed for quality and completeness. Completeness of data on travel-associated variables and the use of preventive measures was increased by cross-referencing data fields with free text information recorded in the 'Notes' field, and working with responsible PHUs to fill missing data fields where possible. Specifically, whether an infection was locally or overseas acquired was derived from the 'Import Status' data field or 'Notes' field for the majority of case notifications for all diseases.

Descriptive analyses were performed using Microsoft Excel for demographic variables (age, sex, country of birth), travel-associated variables (percentage acquired overseas or reporting recent travel, country acquired), and use of preventive measures (vaccination for hepatitis A or typhoid, anti-malarial medication). Epi-Info 7 (Centers for Disease Control and Prevention, Atlanta, USA) was used to calculate proportions and to perform X^2 tests for significance for hepatitis A vaccination. Significance was set at the 5% level. Numbers for other preventive measures were too small to warrant testing for statistical significance.

Data on country of birth and country of disease acquisition were grouped into regions using the World Bank classification system, with Australia and New Zealand extracted as a separate category.[14] Rates were calculated using population figures taken from Australian Bureau of Statistics (ABS) estimates and averaged over 2010 and 2011.[15]

Results

The quality of data available on travel-associated risk factors and use of preventive measures varied by disease. Information on place of acquisition was largely complete, with the exception of shigellosis where this remained unknown for 37.9% of case notifications. Country of birth was missing for 10% or more of overseas-acquired cases with dengue, malaria, paratyphoid or shigellosis. Information on the use of prophylaxis was missing in one-third of malaria case notifications, and on use of vaccines for over 10% of hepatitis A case notifications and over 20% of typhoid fever case notifications. Reason for travel was not routinely recorded.

Case notifications for the selected diseases by place of acquisition are presented in Table 1. For case notifications where place of acquisition was known, the proportion acquired overseas ranged from 48.7% for shigellosis to 100% for hepatitis E, malaria and typhoid. Males accounted for a higher proportion of overseas-acquired infections for all diseases, from 51.5% of dengue case notifications to 68.7% of malaria case notifications. The age distribution of overseas-acquired case notifications differed by disease. Age-specific rates were highest in the 5–9 and 10–14-year age groups for hepatitis A (4.5 and 4.6 per 100 000 population respectively), the 25–29-year age group for hepatitis E (1.6 per 100 000 population), malaria (4.8 per 100 000 population), paratyphoid (2.4 per 100 000 population) and typhoid (4.4 per 100 000 population) and the 30–34-year age group for shigellosis (2.4 per 100 000 population).

For the majority of case notifications, the country where the disease was most likely acquired was reported (Table 2). Overseas-acquired hepatitis E, paratyphoid fever and typhoid fever were predominantly from South Asia. East and South-East Asia accounted for the largest proportion of

Table 2. Selected infectious diseases acquired outside Australia by likely region of acquisition, NSW, 2010–2011

Region of acquisition	Dengue N = 342 (%)	HAV N = 95 (%)	HEV N = 31 (%)	Malaria N = 196 (%)	Paratyphoid N = 52 (%)	Shigellosis N = 75 (%)	Typhoid N = 71 (%)
East and South East Asia	269 (78.7)	20 (21.1)	5 (16.1)	13 (6.6)	5 (9.6)	29 (38.7)	7 (9.9)
Europe and Central Asia	0 (0.0)	2 (2.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Latin America and Caribbean	13 (3.8)	0 (0.0)	0 (0.0)	1 (0.5)	2 (3.8)	4 (5.3)	0 (0.0)
Middle East and North Africa	0 (0.0)	11 (11.6)	0 (0.0)	0 (0.0)	1 (1.9)	8 (10.7)	1 (1.4)
Pacific	9 (2.6)	20 (21.1)	1 (3.2)	50 (25.5)	0 (0.0)	14 (18.7)	8 (11.3)
South Asia	48 (14.0)	31(32.6)	24 (77.4)	38 (19.4)	43 (82.7)	16 (21.3)	55 (77.5)
Sub-Saharan Africa	1 (0.3)	10 (10.5)	1 (3.2)	90 (45.9)	0 (0.0)	3 (4.0)	0 (0.0)
Missing	2 (0.6)	1 (1.1)	0 (0.0)	4 (2.0)	1 (1.9)	1 (1.3)	0 (0.0)

HAV: hepatitis A virus; HEV: hepatitis E virus.
Source: Notifiable Conditions Incident Management System, NSW Ministry of Health.

Table 3. Selected infectious diseases acquired outside Australia by region of birth, NSW, 2010–2011

Region of birth	Dengue N = 342 (%)	HAV N = 95 (%)	HEV N = 31 (%)	Malaria N = 196 (%)	Paratyphoid N = 52 (%)	Shigellosis N = 75 (%)	Typhoid N = 71 (%)
Australia and New Zealand	149 (43.6)	34 (35.8)	4 (12.9)	45 (23.0)	13 (25.0)	36 (48.0)	16 (22.5)
East and South East Asia	29 (8.5)	12 (12.6)	3(9.7)	3 (1.5)	3 (5.8)	1 (1.3)	4 (5.6)
Europe and Central Asia	16 (4.7)	3 (3.2)	1 (3.2)	6 (3.1)	3 (5.8)	4 (5.3)	1 (1.4)
Latin America and Caribbean	1 (0.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (2.7)	0 (0.0)
Middle East and North Africa	1 (0.3)	9 (9.5)	2 (6.5)	1 (0.5)	2 (3.8)	1 (1.3)	0 (0.0)
North America	1 (0.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Pacific	1 (0.3)	5 (5.3)	0 (0.0)	10 (5.1)	1 (1.9)	3 (4.0)	7 (9.9)
South Asia	24 (7.0)	23 (24.2)	21 (67.7)	32 (16.3)	23 (44.2)	1 (1.3)	39 (54.9)
Sub-Saharan Africa	2 (0.6)	4 (4.2)	0 (0.0)	59 (30.1)	0 (0.0)	2 (2.7)	0 (0.0)
Missing	118 (34.5)	5 (5.3)	0 (0.0)	40 (20.4)	6 (11.5)	25 (33.3)	4 (5.6)

HAV: hepatitis A virus; HEV: hepatitis E virus.
Source: Notifiable Conditions Incident Management System, NSW Ministry of Health.

imported dengue and shigellosis case notifications, with almost half of dengue case notifications being acquired in Indonesia in particular. Just under half of malaria infections were acquired in sub-Saharan Africa, with another quarter acquired in the Pacific.

The proportion of overseas-acquired diseases by country of birth, where information on country of birth was available, is presented in Table 3. At least half of overseas-acquired hepatitis E, paratyphoid and typhoid fever infections, where country of birth was known, were in people born in South Asia, while over one-third of malaria cases were born in sub-Saharan Africa.

For overseas-acquired diseases where country of birth was known, over half of hepatitis A (53.3%), hepatitis E (74.2%), malaria (54.5%), paratyphoid (53.3%) and typhoid (65.7%) cases were associated with travel to, and disease acquisition in, the person's country of birth. Dengue and shigellosis cases were more likely to be born in Australia or New Zealand, so the proportion of case notifications associated with travel to country of birth was lower, at 22.3% and 10.0% respectively.

The proportion of cases requiring hospitalisation was high for typhoid (94.2%), malaria (60.6%) and hepatitis E (67.7%), and lower but still substantial for hepatitis A (41.9%), dengue (34.6%) and shigellosis (24.0%). Hospitalisation was uncommon for paratyphoid fever (0.8%).

Information on vaccination status was available for 121 (87.7%) hepatitis A cases and 55 (77.5%) typhoid cases. For hepatitis A, both locally and overseas-acquired cases were unlikely to be vaccinated, however locally-acquired cases (22.2%) were significantly more likely than overseas-acquired cases (4.8%) to have received at least one dose of the hepatitis A vaccine ($X^2 = 6.58$, $p < 0.02$). For typhoid, 92.9% of cases – all overseas acquired – had not been vaccinated.

Information on the use of chemoprophylaxis was available for 147 (75.0%) malaria cases. Of these, 27 (67.5%)

Australian and New Zealand-born cases reported using chemoprophylaxis, compared to 45 (50.5%) cases born in other countries. Information on the extent to which chemoprophylaxis was used correctly was unavailable.

Discussion

This study confirms that a large number of selected enteric and vectorborne disease case notifications are associated with overseas travel. Males and travellers in the 25–34-year age group are most likely to be affected. Australia-wide data suggests these are also the groups most likely to travel.[16] Uptake of vaccination was poor amongst typhoid fever and hepatitis A cases, and use of chemoprophylaxis for malaria was low, particularly among cases born outside Australia or New Zealand.

Similar to other studies, this analysis indicates that case notifications of hepatitis A, hepatitis E, paratyphoid and typhoid are strongly associated with return to the person's country of birth in South Asia, and case notifications of malaria with return to the person's country of birth in sub-Saharan Africa. Visiting friends and family is a likely reason for travel in these instances. Dengue and shigellosis case notifications are perhaps more likely found among tourists and other types of travellers but existing surveillance information cannot illustrate this definitively. A recent review of typhoid fever case notifications in NSW found information on reason for travel available in the 'Notes' field in NCIMS, but this is limited and cannot be used to assess if VFR travellers in NSW are at significantly higher risk than other types of travellers.[17]

Reason for travel is important as VFR travellers have specific risk factors. These include longer stays, incomplete childhood vaccination, not seeking pre-travel advice and not taking appropriate preventive measures such as chemoprophylaxis.[18–21] While overseas, they may also adopt the practices of the local community such as drinking untreated water, or not perceive themselves to be at risk due to the familiarity of the surroundings.[18–20]

All people travelling to endemic areas should be made aware of the risks and encouraged to take preventive measures. For foodborne and waterborne diseases, these measures include vaccination for hepatitis A and typhoid, only using boiled or bottled water, not eating uncooked foods, and washing hands thoroughly after going to the toilet and before eating. For vectorborne diseases, chemoprophylaxis where appropriate should be taken (for malaria), and mosquito bites avoided through the use of insect repellent (for dengue and malaria).[22,23] Sleeping under bed nets at night is also recommended to avoid malaria.[23]

There are several limitations to this study. Firstly, there was a substantial amount of missing data on travel-associated risk factors, particularly for dengue, malaria and shigellosis. Country of acquisition was missing for over one-third of shigellosis case notifications, though shigellosis follow-up became mandatory for Public Health Units in 2012, which should improve completeness. Of cases known to be overseas acquired, country of birth was missing for 34.5% of dengue case notifications, 20.4% of malaria case notifications and 33.3% of shigellosis case notifications.

Data on vaccination status and use of malaria chemoprophylaxis were incomplete, and available information was based on self-report, which can be unreliable. Data on vaccination amongst hepatitis A case notifications particularly should be interpreted with caution as vaccine failures are rare, and misreporting or confusion about vaccination status possible.[22]

Finally, information on reason for travel is not routinely collected. Assuming return to country of birth is associated with VFR travel is a proxy measure for the number of case notifications associated with this reason for travel, but incorrectly excludes people who may be born in Australia but travel to a country of their ethnic origin for VFR purposes, and includes people who return to their country of birth for another reason, such as business.

Improved completeness of data is required before routine surveillance can be used to reliably monitor trends in disease importation or target particular communities which may be at risk. Enhanced surveillance, periodic studies and/or targeted surveys could also gather information on the association between reason for travel and disease risk, risk perception and risk behaviours, and barriers to the use of preventive measures. With this information it may be possible to develop novel strategies to reduce the incidence of these important travel-acquired infections among NSW residents.

Conclusion

A large proportion of selected enteric and vectorborne disease case notifications in NSW are associated with overseas travel. Improvements in data on risk factors, reason for travel and barriers to the use of preventive measures would better inform targeted prevention strategies.

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References

1. Connor BA, Schwartz E. Typhoid and paratyphoid fever in travellers. *Lancet Infect Dis* 2005; 5(10): 623–8. doi:10.1016/S1473-3099(05)70239-5

2. Smith AD, Bradley DJ, Smith V, Blaze M, Behrens RH, Chiodini PL et al. Imported malaria and high risk groups: observational study using UK surveillance data 1987–2006. *BMJ* 2008; 337: a120. doi:10.1136/bmj.a120
3. Cullen KA, Arguin PM. Malaria surveillance – United States, 2011. *MMWR Surveill Summ* 2013; 62(5): 1–17.
4. Slinko VG, Jarvinen KA, Beard FH, McCall BJ. Notifications of enteric diseases in returning travellers who visit friends and relative overseas: a call for action. *Commun Dis Intell Q Rep* 2008; 32(3): 333–4.
5. Ward K, McAnulty J. Hepatitis A: who in NSW is most at risk of infection? *N S W Public Health Bull* 2008; 19(1–2): 32–5. doi:10.1071/NB07100
6. Fitzsimmons GJ, Wright P, Johansen CA, Whelan PI. National Arbovirus and Malaria Advisory Committee. Arboviral diseases and malaria in Australia, 2008–09: annual report of the National Arbovirus and Malaria Advisory Committee. *Commun Dis Intell Q Rep* 2010; 34(3): 225–40.
7. Field V, Gautret P, Schlagenhauf P, Burchard GD, Caumes E, Jensenius M et al. Travel and migration associated infectious diseases morbidity in Europe, 2008. *BMC Infect Dis* 2010; 10: 330. doi:10.1186/1471-2334-10-330
8. Freedman DO, Weld LH, Kozarsky PE, Fisk T, Robins R, von Sonnenburg F et al. Spectrum of disease and relation to place of exposure among ill returned travellers. *N Engl J Med* 2006; 354(2): 119–30. doi:10.1056/NEJMoa051331
9. O'Brien DP, Leder K, Matchett E, Brown GV, Torresi J. Illness in returned travellers and immigrants/refugees: the 6-year experience of two Australian infectious diseases units. *J Travel Med* 2006; 13(3): 145–52. doi:10.1111/j.1708-8305.2006.00033.x
10. Health Protection Agency UK. Foreign travel-associated illness – a focus on those visiting friends and relatives: 2008 report. Available at: http://www.hpa.org.uk/Publications/InfectiousDiseases/TravelHealth/0812Foreigntravelassociated illness/ (Cited 14 March 2014).
11. Leder K, Tong S, Weld L, Kain KC, Wilder-Smith A, von Sonnenburg F et al. Illness in travellers visiting friends and relatives: a review of the GeoSentinel surveillance network. *Clin Infect Dis* 2006; 43(9): 1185–93. doi:10.1086/507893
12. Australian Bureau of Statistics. Overseas Arrivals and Departures – Customised Data Report. 12 March 2012.
13. Communicable Diseases Branch. NSW Notifiable Diseases Manual. Sydney: NSW Health; 2008.
14. World Bank Country and Lending Groups. Available at: http://data.worldbank.org/about/country-classifications/country-and-lending-groups (Cited 16 April 2014).
15. Australian Bureau of Statistics. Australian Demographic Statistics. Publication No 3101.0.
16. Australian Bureau of Statistics. Overseas Arrivals and Departures, Australia, Dec 2011. Cat No 3401.0.
17. Gunaratnam P, Tobin S, Seale H, Musto J. Typhoid fever, NSW, 2005–2011. *N S W Public Health Bull* 2013; 24(2): 87–91. doi:10.1071/NB12125
18. Angell SY, Cetron MS. Health disparities among travellers visiting friends and relatives abroad. *Ann Intern Med* 2005; 142(1): 67–72. doi:10.7326/0003-4819-142-1-200501040-00013
19. Bacaner N, Stauffer B, Boulware DR, Walker PF, Keystone JS. Travel medicine considerations for North American immigrants visiting friends and relatives. *JAMA* 2004; 291(23): 2856–64. doi:10.1001/jama.291.23.2856
20. Fulford M, Keyston JS. Health risks associated with visiting friends and relatives in developing countries. *Curr Infect Dis Rep* 2005; 7(1): 48–53. doi:10.1007/s11908-005-0023-z
21. Zwar N, Streeton CL. Travel Health Advisory Group. Pretravel advice and hepatitis A immunization among Australian travellers. *J Travel Med* 2007; 14(1): 31–6. doi:10.1111/j.1708-8305.2006.00088.x
22. National Health and Medical Research Council. The Australian Immunisation Handbook. 9th ed. Canberra: Australian Government Department of Health and Ageing; 2008.
23. NSW Health. Infectious Diseases. Available at: http://www.health.nsw.gov.au/infectious/Pages/default.aspx (Cited 12 March 2014).

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Cyanobacteria: health and research possibilities

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Cyanobacteria are a subset of prokaryotic bacteria (also known as blue-green algae) possessing a cell wall and chlorophyll A, contributing about 35% of global photosynthesis. Cyanobacteria are found on all continents in soils and fresh, brackish and salt water, living independently or in symbiosis.[1] As cyanobacteria are found in all water bodies, they have the potential to affect the quality of drinking and recreational water and pose a potential health risk to the public.

Cyanobacteria can produce blooms under particular environmental conditions (e.g. nutrient run off, low or no water flow, low or minimal wind, and consistent warm temperatures).[2] Blooms decrease oxygenation of water, which can suffocate fish, and can produce cyanotoxins that can lead to animal and human sickness or death.

Cyanotoxins are secondary metabolic products. Various cyanobacteria can produce cyanotoxins that may be hepatotoxic or neurotoxic.[1] Other molecules may affect the colour, taste and smell of water. Humans can ingest cyanotoxins when drinking contaminated water or through recreational water use. Symptoms in humans include gastroenteritis, skin irritation, ear and eye irritation, fever and in severe cases, weakness, staggering, muscle twitching and gasping.[1,2]

In New South Wales, the three most common species of cyanobacteria, *Microcystis auruginosa; Anabaena circinalis* and *Cylindrospermopsis raciborskii*, can all produce cyanotoxins.[1]

Microcystins are produced by the cyanobacterial genera *Microcystis*, *Anabaena* and *Planktothrix*, among others. There are approximately 90 known isoforms of microcystins, varying in toxicity. The most toxic isoform is Microcystin-LR. Microcystins are hepatotoxins that inhibit protein phosphatases, damaging hepatocyte cytoskeletal structures, causing cells to shrink and blood to seep into liver structures.[1]

The *Australian Drinking Water Guidelines* (2004) and the Australian *Guidelines for Managing Risk in Recreational Water* (2008) provide water quality criteria to protect the public from contaminated drinking water and recreational exposure. To achieve this, a three-level alert system has been developed. Both guidelines acknowledge a paucity of epidemiological evidence on the relationship between cyanobacteria and human health.[3,4]

Potential for future research

The genes encoding biosynthesis of the major cyanobacterial toxins have been identified and characterised in the past 11 years. This has opened up possibilities to use advanced molecular biology techniques to gain a better understanding of environmental factors that influence the toxicity of cyanobacterial genera. Research is being conducted to identify how cyanobacterial cells sense their environment via the production of regulatory proteins. These proteins bind to DNA regions associated with toxin genes resulting in an increase or decrease in the transcription of genes and the amount of toxin biosynthetic enzymes within the cell. Outcomes of this research will make it possible to predict changes in toxicity of a bloom based on the chemistry of the water.[5]

Penrith Lakes assessment

The Penrith Lakes, located 60 km west of the Sydney CBD, are rehabilitated quarries forming a closed system from the nearby Nepean River. The Lakes offer various recreational activities at Penrith Whitewater Stadium and Sydney International Regatta Centre. The Penrith Lakes Development Corporation (PLDC) is responsible for managing and testing the water within the Lakes.

Public Health Units have a role in advising water managers about potential health effects of cyanobacteria-affected water. The Nepean Blue Mountains Public Health Unit (NBMPHU), together with the PLDC and staff from Whitewater Stadium and the Regatta Centre, has developed a public health response to cyanobacterial blooms at the Lakes which may impact on the health of recreational users. The NBMPHU, in consultation with the PLDC, has developed site-specific cyanobacteria and cyanotoxin guidelines for cylindrospermopsin and saxitoxins to protect recreational users of the Lakes. Both guidelines have been endorsed by the NSW State Algal Authority.

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References

1. Carmichael WW. Cyanobacteria secondary metabolites – the cyanotoxins. *J Appl Bacteriol* 1992; 72(6): 445–59. doi:10.1111/j.1365-2672.1992.tb01858.x
2. Pilotto LS, Douglas RM, Burch DB, Cameron S, Beers M, Rouch GJ et al. Health effects of exposure to cyanobacteria (blue-green algae) during recreational water-related activities. *Aust N Z J Public Health* 1997; 21: 562–6. doi:10.1111/j.1467-842X.1997.tb01755.x
3. National Health and Medical Research Council. Australian Drinking Water Guidelines. Canberra: Australian Government Natural Resource Management Ministerial Council; 2004.
4. National Health and Medical Research Council. Guidelines for Managing Risks in Recreational Water. Canberra: Australian Government Department of Health and Ageing; 2008.
5. Pearson LA, Moffitt MC, Ginn HP, Neilan BA. The molecular genetics and regulation of cyanobacterial peptide hepatotoxin biosynthesis. *Crit Rev Toxicol* 2008; 38(10): 847–56. doi:10.1080/10408440802291513

Communicable Diseases Report, NSW, July–September 2013

Communicable Diseases Branch
Health Protection NSW

This will be the final edition of the Communicable Diseases Report published in the *NSW Public Health Bulletin*. Further reports and updated data will be available at: www.health.nsw.gov.au/Infectious/reports/Pages/default.aspx.

Figure 1 and Table 2 show notifications of communicable diseases with onset between July and September 2013 in New South Wales (NSW).

Enteric infections

Outbreaks of suspected foodborne disease

There were nine outbreaks of foodborne or suspected foodborne disease reported by members of the public or identified through routine surveillance of *Salmonella* data in the third quarter of 2013, affecting at least 97 people. One outbreak was due to *Campylobacter*, two were due to norovirus, and the other six were due to unknown pathogens.

Only one foodborne outbreak investigation was able to provide sufficient evidence to identify the source of the infection. This outbreak occurred in a group who attended a wedding reception in July 2013. A cohort study was conducted and 30 of the 50 attendees were interviewed. Seventeen of these people reported illness and the only food with a significant association with illness was a duck liver parfait entree. One stool specimen was collected and was positive for *Campylobacter*. The NSW Food Authority inspected the premises and reviewed the handling of foods served. No foods were available for sampling but the chefs were advised of the proper cooking method required to render poultry livers free from bacterial pathogens with which they are known to be infected.

Another outbreak associated with a wedding at a restaurant occurred in July 2013. Thirty of the 94 guests were reported to be unwell with symptoms of vomiting, diarrhoea, fever, headache, lethargy and myalgia/arthralgia. One household reported secondary transmission. A cohort study was initiated using an online survey. Two stool specimens were collected and one was positive for norovirus. No one food item showed evidence of being the vehicle for contamination. The premises were inspected by the local council. No food safety issues or reports of gastrointestinal illness in staff were identified by council officers. This was a point source norovirus outbreak likely due to contaminated food, but the introduction mechanism of the pathogen could not be identified. This often occurs during periods of high norovirus activity. Due to the highly infectious nature of the disease, contamination of more than one source is common if a sick food handler does not have stringent hand hygiene standards.

Viral gastrointestinal disease

There were 212 reported outbreaks of (suspected) viral gastrointestinal disease in institutions in the third quarter of 2013. Of these, 106 (50%) occurred in aged-care facilities, 58 (27%) occurred in childcare centres, 40 (19%) in hospitals and eight (4%) in other facilities. The outbreaks affected a total of 3356 people.

In 57% ($n = 120$) of institutional outbreaks, one or more stool specimens were laboratory tested to identify a possible cause of the outbreak. Norovirus was identified in 56% ($n = 67$) of these outbreaks and rotavirus was identified in 4% ($n = 5$). In seven outbreaks, one or more pathogens were detected alongside norovirus (rotavirus in one outbreak, and *Clostridium difficile* in six outbreaks). Also, in two other outbreaks *C. difficile* was detected alongside rotavirus. In seven other outbreaks a single stool detected *C. difficile* (five outbreaks), *Campylobacter* (one outbreak) and giardia (one outbreak). These results in single stools were thought to be coincidental findings during viral gastroenteritis outbreaks. Of the 120 outbreaks where one or more stool specimens were tested, 34% ($n = 41$) of all results were negative for any pathogens.

There was also one gastrointestinal illness outbreak in a non-institutional setting. A Public Health Unit was notified that 26 people from a tour group of 40 reported vomiting and abdominal pain with some diarrhoea on a return flight from Santiago, Chile to Sydney, arriving on 1 August 2013. One or more people experienced some abdominal pain prior to boarding the plane with other onsets of illness from 1 to 8 hours into the flight. Illness did not last longer than 24 hours. Fifteen people were taken to emergency departments upon landing in Sydney and one sample was

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collected which was initially negative for all pathogens. The group had been travelling and eating together, and had staggered onsets of symptoms, so person-to-person spread of a viral pathogen was suspected. The one stool sample collected was sent for toxin testing and tested again for norovirus by polymerase chain reaction; this was negative for bacterial toxins but was positive for norovirus. The finding of norovirus is consistent with the clinical and epidemiological features of the outbreak.

Respiratory infections

Influenza

Influenza activity increased to moderate levels during the third quarter of 2013, with a peak in late August. There was evidence of co-circulation of influenza A(H1N1) pdm2009, influenza A(H3N2), and influenza B strains. The number of influenza cases notified in this quarter was much higher than for the same period in the previous year, which had an earlier start to its influenza season.

For a more detailed report on respiratory activity in NSW see: http://www.health.nsw.gov.au/PublicHealth/Infectious/influenza_reports.asp

Legionellosis

There were 15 cases of legionellosis due to *Legionella pneumophila* strains notified in the third quarter of 2013, an increase from the six cases notified for the same period in 2012. No clusters or common sources of infection were identified during public health follow-up. There were also 12 notifications of legionellosis due to *L. longbeachae* strains, compared with seven in the same period in the previous year.

Vaccine-preventable diseases

Meningococcal disease

Eighteen cases of meningococcal disease were notified in NSW in the third quarter of 2013 (four in July, nine in August and five in September), a decrease from 27 notified for the same period in 2012. The age of the cases ranged from 8 months to 92 years, with five cases aged less than 5 years. Of the 18 notifications, eight (44%) were due to serogroup B (for which there is no vaccine), five (28%) were due to serogroup W135, and four (22%) were due to serogroup Y. No serogroup was detected for the remaining notification.

Immunisation against meningococcal C disease is recommended for all children at the age of 12 months, as well as people at high risk of disease.

Measles

There were eight measles notifications in NSW in the third quarter of 2013 (two in July, one in August and five in September), a decline from the 130 reported in the same period in 2012. Two cases were acquired overseas: one in Europe (measles virus genotype D8) and the other in Bali, Indonesia. One case was linked to an overseas-acquired case and was likely infected at Melbourne airport. Five locally-acquired cases in young adults were reported in inner metropolitan Sydney; four were due to measles virus genotype D9.

Two doses of measles-containing vaccine are recommended for all children at 12 and 18 months age. All young adults planning international travel should ensure they have had two doses of measles-containing vaccine in their lifetime before they travel. Infants aged 9–12 months travelling to an area with ongoing measles transmission should also be vaccinated prior to departure.

Pertussis

There were 560 pertussis cases notified in NSW during the third quarter of 2013 (184 in July, 181 in August and 195 in September). This is less than half of the 1205 notifications for the same period in 2012, and represents the lowest number of notifications for a third quarter since 2002. Most cases were in the 5–9-year age group ($n = 128$), followed by the 10–14-year ($n = 79$) and 0–4-year age groups ($n = 75$).

Direct protection for young infants remains available through free vaccination for pertussis that is administered at 2, 4 and 6 months of age. The first dose can be provided as early as 6 weeks of age, with a booster dose at 3½ to 4 years. Whooping cough vaccination is strongly recommended for adults in contact with young babies too young to be vaccinated. Women planning a pregnancy or in their third trimester are encouraged to receive a whooping cough vaccine on prescription to protect their very young babies.

Sexually transmissible infections and bloodborne viruses

Chlamydia

There were 5088 chlamydia cases notified in NSW during the third quarter of 2013, similar to the number notified in the same period in 2012 ($n = 5048$). Fifty-four percent of the cases were female. More than half (56%) of all cases were aged 15–24 years and a further 38% were aged 25–44 years.

Gonorrhoea

There were 1060 gonorrhoea cases notified in NSW during the third quarter of 2013, a 2.5% increase compared with the same period in 2012. Just over half (52%) of gonococcal infections were in men aged 25–44 years, and a further 21% were in younger men aged 15–24 years.

Syphilis

There were 252 syphilis cases notified in NSW during the third quarter of 2013, a 10% increase compared with the same period in 2012. Eighty-six percent of the cases were men. Most cases (54%) were aged 25–44 years, followed by 45–64 years (26%).

Lymphogranuloma venereum (LGV)

There were five cases of LGV notified in NSW during the third quarter of 2013, a decrease from nine notified in the same period in 2012. All of the cases were men aged 25–44 years living in inner Sydney.

HIV

In the first 9 months of 2013, 271 people newly diagnosed with HIV infection were notified in NSW. This compares with 308 notifications for the same period in 2012, a decrease in 2013 of 12%. In 2011, there were 263 notifications during the same period. The decrease in the number of new diagnoses to date in 2013 compared to 2012 has occurred in the context of an overall small increase in testing for HIV infection, and increases in testing at publicly funded sexual health clinics and among high-risk groups, suggesting that the lower number of notifications in 2013 is not due to a reduction in testing.

Ninety-four percent of people newly diagnosed with HIV infection in the first three quarters of 2013 were male and 6% were females, a gender breakdown consistent with previous years. Most of the infections reported were in gay and homosexually active men (82%), with heterosexual contact accounting for 15% and injecting drug use for 1% of notifications. This is also similar to previous years.

A summary of HIV notification data for the third quarter of 2013 is available at: www.health.nsw.gov.au/endinghiv/Pages/tools-and-data.aspx

Arboviral infections

Ross River virus

There were 85 cases of Ross River virus infection notified in NSW in the third quarter of 2013, an increase from the same period in 2012 ($n = 65$). Notifications of Ross River virus infection continued to be highest in coastal regions, particularly along the north coast of NSW.

Barmah Forest virus

There were 75 cases of Barmah Forest virus infection notified in NSW in the third quarter of 2013, an increase from the same period in 2012 ($n = 59$). However, there continue to be concerns about false-positive laboratory reports for Barmah Forest virus and so the figures for 2013 should be interpreted with caution.

Dengue virus

There were 82 cases of dengue virus infection notified in NSW in the third quarter of 2013, an increase from the same period in 2012 ($n = 57$). All cases were overseas-acquired infections; 43% of all cases are believed to have acquired the infection in Indonesia, and 21% of all cases are believed to have acquired the infection in Thailand.

NSW Denominator Data Project

Notifications of positive laboratory results for notifiable conditions provide information about the number of new cases of disease. Data on the level of testing is useful to indicate whether an apparent increase in notifications may be due to increased testing.

The NSW Denominator Data Project commenced in January 2012 to collect the total number of tests performed per month (the denominator data) for 10 selected notifiable conditions for which the testing rate might impact the notification rate. Data provided each month from 14 public and private laboratories in NSW is collated to give monthly aggregated data per condition. No demographic information is provided.

The positivity rate for all conditions from January 2012 to September 2013 ranged from 0.07% (shigellosis) to 5.52% (chlamydia) (Table 1). Notifications for chlamydia and gonorrhoea were well correlated with testing, while the incidence of enteric conditions suggests that seasonal factors rather than testing patterns influence notification rates.

Trends in testing and notification are best identified by comparing similar periods to avoid seasonal variation. For the third quarter (July–September 2013), the positivity rates overall were similar to the same period in 2012, and ranged from 0.07% (shigellosis) to 5.24% (chlamydia). Exceptions for this period were Ross River virus (up to 2.55% from 1.87% in 2012) and pertussis (down to 1.56% from 2.66% in 2012). Pertussis has shown a generally downward trend in both notifications and positivity since 2012.

Table 1. Number and positivity (%) of tests performed for selected notifiable conditions, NSW, quarter 3 of 2012 and quarter 3 of 2013

Condition	Test	Jan 2012 to Sep 2013		Quarter 3 of 2012		Quarter 3 of 2013	
		Number of tests	Positivity (%)	Number of tests	Positivity (%)	Number of tests	Positivity (%)
Chlamydia	*C. trachomatis* nucleic acid test (NAT)	668 433	5.52	93 456	5.41	97 032	5.24
Gonorrhoea	*Neisseria gonorrhoea* NAT, culture	820 863	0.9	113 606	0.91	121 001	0.88
HIV[a]	Serology	703 608	–	96 496	–	102 773	–
Ross River virus infection	Serology	29 402	3.33	3467	1.87	3258	2.55
Barmah Forest virus infection	Serology	22 731	3.25	2721	2.13	2645	2.83
Pertussis	NAT, serology, culture	229 072	3.38	44 513	2.66	35 464	1.56
Salmonellosis	NAT, culture	329 235	1.66	44 481	1.22	46 245	1.16
Shigellosis			0.07		0.06		0.07
Cryptosporidiosis	Antigen, microscopy	279 565	0.59	38 396	0.23	42 098	0.18
Giardiasis			1.66		0.99		1.12

[a]Analysis of positivity rates for HIV is not possible due to the impact of repeat testing.

Seeing spots: does a poster displayed at an airport raise awareness of measles among incoming travellers?

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Measles vaccination has been available in Australia since 1969, but some groups remain at risk through inadequate vaccination. There were 90 measles notifications in New South Wales (NSW) in 2011, of which 10% were imported from overseas; the remainder were either linked to these cases or locally acquired. The number of cases recorded was the highest since 1998, the year of the Australian Measles Control Campaign.[1] Lack of awareness of measles among both the public and clinicians can lead to delayed presentation and diagnosis, increasing the transmission risk.[2] We sought to evaluate whether the awareness of incoming travellers of the risk of measles was increased by using a poster campaign at Sydney International Airport.

Methods

A poster (0.57 m × 0.97 m) was placed in a rotating display (as one of three different posters each displayed for 10 seconds at a time) for 4 weeks in October 2011 above the baggage collection carousels at Sydney International Airport. All international arrivals could view the poster, including travellers returning from New Zealand, which was experiencing measles outbreaks at the time.[3] The poster was eye-catching (brightly coloured, showing a human figure covered with red spots) with six key messages about measles, including: alerting the public to the presence of the disease and the serious risk to health posed by measles, risk to travellers, typical symptoms, advice to phone ahead before visiting a doctor, and to tell your doctor of your overseas travel. The cost of displaying the poster for 4 weeks was approximately $12 000.

Two interviewers conducted a survey of travellers at the public arrivals gate for 2 hours on a mid-week morning, using a brief questionnaire to assess recall of the poster. Travellers were chosen by alternating genders, at the two international arrival gates, until a sufficient sample was collected. Travellers were asked if they saw any health messages, and were prompted once about the measles poster. Those who recalled the poster were asked if they remembered any of the messages. The interviewers recorded the gender and approximate age of the interviewees (18–30, 31–65 and over 65 years). People with limited spoken English were excluded.

Results

Ninety-six people were approached; 83 (86%) agreed and were eligible to participate (Table A).

Nine interviewees (11%) recalled seeing the poster; five (6%) could recall any messages, and the maximum number of messages recalled was two out of six. Fifty percent of those who recalled seeing the poster recalled the poster title, 'measles is about'. No-one recalled the advice to phone ahead if developing symptoms, important in minimising spread to others. One person recalled a message not on the poster ('no spitting'). No interviewees aged over 65 years recalled the poster.

Likelihood of seeing the poster was increased with shorter flights but this difference was not statistically significant (RR 1.5 (CI 0.5–4.7)) (Table B). The likelihood of having seen the poster did not differ by gender (M:F) RR 1.1 (CI 0.6–2.0).

Table B. Flight length and people who saw the poster, measles poster campaign, Sydney International Airport, 2011

Length of flight (hours)	Saw the poster *n* (%)*
<10	3 (30)
>10	6 (19)

*Of those for whom 'length of flight' data were available.

Table A. Study participants by gender and estimated age group, measles poster campaign, Sydney International Airport, 2011

Age group (years)	Male *n*	Female *n*	Gender not recorded *n*	Total *n*	Total %
18–30	15	15		30	36
31–65	20	20	1	41	49
Over 65	6	3		9	11
Age and gender not recorded			3	3	4
Total	41 (49%)	38 (46%)	4 (5%)	83	100

Discussion

Posters are used to provide health alerts as well as health information. Previous evaluations have shown that posters have varying success in conveying health messages.[4–6] The setting and length of time between seeing the poster and acting on the messages, as well as the length of time the poster is displayed, appear to affect recall and behaviour change. Posters have been less successful than other media in multimedia campaigns.[7–9]

Our survey found that a low percentage of people remembered a poster about measles located above the baggage collection carousels at Sydney International Airport, even shortly after exposure. It is possible that the distraction of identifying and collecting luggage, and fatigue, reduced receptivity to the information, as well as the rotation of the poster with two other unrelated posters. Limitations of the survey method include using a convenience sample: for instance, recall and age of arrivals could have been different at other times of the day, or on other days of the week. The questionnaire was deliberately brief to increase participation but this limited the information collected.

Conclusion

Posters displaying health alerts to incoming airline passengers did not appear to be an effective method for increasing awareness of the risk of measles.

Acknowledgment

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References

1. Centre for Health Protection. Year in review: health protection in NSW, 2011. *N S W Public Health Bull* 2012; 23(7–8): 129–41.
2. Weston KM, Dwyer DE, Ratnamohan M, McPhie K, Chan SW, Branley JM et al. Nosocomial and community transmission of measles virus genotype D8 imported by a returning traveller from Nepal. *Commun Dis Intell* 2006; 30(3): 358–65.
3. The Institute of Environmental Science and Research Ltd. Notifiable and other Diseases in New Zealand: Annual Report 2011. Porirua, New Zealand; pp. 38–40. Available at: https://surv.esr.cri.nz/PDF_surveillance/AnnualRpt/AnnualSurv/2011/2011AnnualSurvRpt.pdf (Cited 10 January 2014).
4. Soler RE, Leeks KD, Buchanan LR, Brownson RC, Heath GW, Hopkins DH et al. Point-of-decision prompts to increase stair use. A systematic review update. *Am J Prev Med* 2010; 38(2): S292–300. doi:10.1016/j.amepre.2009.10.028.
5. Ward K, Hawthorne K. Do patients read health promotion posters in the waiting room? A study in one general practice. *Br J Gen Pract* 1994; 44(389): 583–5.
6. Wicke DM, Lorge RE, Coppin RJ, Jones KP. The effectiveness of waiting room notice-boards as a vehicle for health education. *Fam Pract* 1994; 11(3): 292–5. doi:10.1093/fampra/11.3.292
7. John-Leader F, Van Beurden E, Barnett L, Hughes K, Newman B, Sternberg J et al. Multimedia campaign on a shoestring: promoting 'Stay Active – Stay Independent' among seniors. *Health Promot J Austr* 2008; 19(1): 22–8.
8. Pless IB, Hagel B, Patel H, Leduc D, Magdalinos H. Preventing product-related injuries: a randomized controlled trial of poster alerts. *Can J Public Health* 2007; 98(4): 271–5.
9. Oakman T, Byles-Drage H, Pope R, Pritchard J. Beat the Heat: don't forget your drink – a brief public education program. *Aust N Z J Public Health* 2010; 34(4): 346–50. doi:10.1111/j.1753-6405.2010.00564.x

Figure 1. Reports of selected communicable diseases, NSW, Jan 2005 to Sept 2013, by month of onset.
Preliminary data: case-counts in recent months may increase because of reporting delays.
Laboratory-confirmed cases only, except for measles, meningococcal disease and pertussis.
NB: Multiple series in graphs are stacked, except gastroenteritis outbreaks.
NB: Outbreaks are more likely to be reported by nursing homes and hospitals than by other institutions.

NSW Population	
Male	50%
<5 y	7%
5–24 y	27%
25–64 y	53%
65+ y	13%
Rural	46%

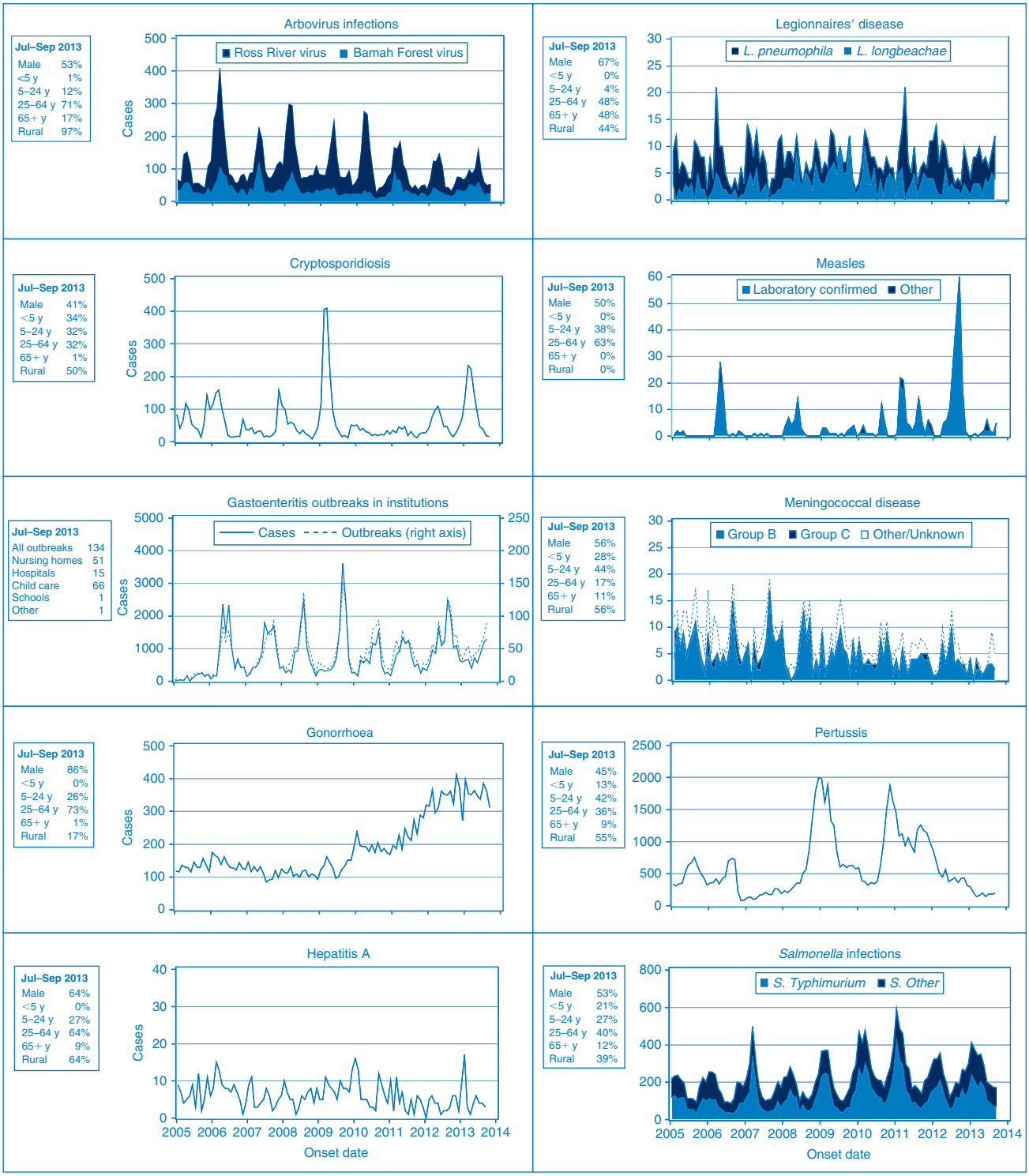

Table 2. Notifications of scheduled medical conditions with an onset date from July to September 2013 by Local Health District, NSW

Condition	Local Health District																Total		Total 2012	
	Murrumbidgee	Southern NSW	Western NSW	Far West	Hunter New England	Northern NSW	Mid North Coast	Central Coast	Northern Sydney	South Eastern Sydney	Illawarra Shoalhaven	Sydney	South Western Sydney	Western Sydney	Nepean Blue Mountains	Justice Health	Jul-Sep[b]	Year to date[b]	Jul-Sep[b]	Year to date[b]
Bloodborne and sexually transmissible																				
Chlamydia (genital)[a]	179	94	241	24	723	201	106	181	505	810	238	545	457	473	203	95	5088	15530	5048	16079
Gonorrhoea[a]	10	9	28	1	65	23	7	18	62	341	17	258	96	82	23	18	1060	3210	1034	3040
Hepatitis B – acute viral[a]	1	–	–	–	2	1	–	1	–	–	–	–	–	–	–	–	5	25	5	19
Hepatitis B – other[a]	5	4	13	3	16	–	6	7	115	108	11	103	137	148	7	20	707	1819	596	1754
Hepatitis C – acute viral[a]	–	–	4	–	9	1	–	–	–	–	2	–	–	1	–	1	18	35	11	34
Hepatitis C – other[a]	34	21	68	2	117	52	41	38	44	84	24	70	93	107	39	88	923	2564	817	2471
Hepatitis D – unspecified[a]	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	2	7	–	3
Lymphogranuloma venereum	–	–	–	–	–	–	–	–	–	3	–	2	–	–	–	–	5	24	9	14
Syphilis	4	–	4	–	7	4	5	–	9	46	8	85	38	32	7	1	252	749	230	625
Vectorborne																				
Barmah Forest virus[a]	2	1	1	1	9	39	15	3	–	–	–	–	–	–	–	4	75	365	59	244
Ross River virus[a]	9	2	10	2	24	20	6	2	1	1	2	1	1	–	1	3	85	404	65	492
Arboviral infection (other)[a]	1	3	1	–	8	3	4	3	8	19	9	10	3	10	1	1	84	220	57	223
Malaria[a]	–	1	–	–	3	–	1	–	1	2	3	8	1	4	–	2	26	65	24	54
Zoonoses																				
Brucellosis[a]	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1	1	2	5
Leptospirosis[a]	1	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	3	8	1	20
Psittacosis[a]	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	1	6	4	16
Q fever[a]	2	1	3	–	14	7	–	–	–	–	–	–	–	–	1	–	28	105	24	88
Respiratory and other																				
Blood lead level[a]	6	–	18	7	6	2	1	4	1	8	9	5	7	8	11	1	94	370	116	399
Influenza[a]	90	82	132	3	309	132	35	48	792	1031	165	538	1006	1360	457	103	6287	7310	4876	7499
Invasive pneumococcal infection[a]	7	6	6	–	29	8	3	7	16	18	9	9	21	21	8	4	172	373	217	458
Legionella longbeachae infection[a]	–	–	–	–	2	2	–	–	–	–	1	1	–	4	2	–	12	27	7	23
Legionella pneumophila infection[a]	3	–	3	–	–	–	–	–	1	–	1	–	4	3	–	–	15	45	6	49
Legionnaires' disease (other)[a]	–	–	–	–	1	–	–	1	–	–	–	–	–	1	1	–	4	8	4	9
Leprosy	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1	2	–	–
Meningococcal infection (invasive)[a]	1	–	1	–	4	3	–	1	2	2	–	–	1	3	–	–	18	32	27	55
Tuberculosis	2	4	–	–	3	2	–	3	7	11	3	19	24	24	5	0	110	298	129	336
Vaccine-preventable																				
Adverse event after immunisation[c]	4	7	–	–	5	1	–	2	9	2	4	–	1	18	5	–	58	441	51	219
H. influenzae b infection (invasive)[a]	–	–	–	–	–	1	–	–	–	1	–	–	–	–	–	1	3	7	2	2
Measles	–	–	–	–	–	–	–	–	2	1	–	4	1	–	–	–	8	18	130	152
Mumps[a]	–	–	–	–	–	–	–	–	1	–	1	2	2	3	2	–	11	70	26	93
Pertussis	76	35	17	1	62	25	22	4	96	57	61	13	41	29	11	10	560	1699	1205	4654
Rubella[a]	–	–	–	–	–	5	–	–	–	–	–	–	2	–	–	–	7	12	4	10
Tetanus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–
Enteric																				
Cholera[a]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	2
Cryptosporidiosis[a]	4	–	2	–	16	5	3	2	13	11	5	1	3	5	4	–	74	958	90	539
Giardiasis[a]	16	8	30	–	74	3	13	12	57	90	22	38	32	36	24	14	469	1710	378	1581
Haemolytic uraemic syndrome	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	1	4	2	9
Hepatitis A[a]	2	–	–	–	3	–	–	2	–	–	–	1	–	2	1	–	11	51	7	27
Hepatitis E[a]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	11	2	6
Listeriosis[a]	–	–	–	–	–	–	–	1	–	1	–	1	1	3	–	–	7	25	6	26
Rotavirus[a]	5	2	2	–	15	15	2	1	24	31	4	3	12	20	3	2	141	324	924	1260
Salmonellosis[a]	16	12	16	1	53	35	18	21	78	68	28	33	49	62	29	13	532	2503	539	2106
Shigellosis[a]	–	–	1	–	1	–	1	–	10	8	1	10	2	2	3	–	39	96	25	89
Typhoid[a]	–	–	–	–	–	–	–	–	–	1	–	3	1	1	–	–	6	46	4	31
Verotoxin-producing *E. coli*[a]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	16	2	10
Miscellaneous																				
Creutzfeldt–Jakob disease	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	1	7	1	3
Meningococcal conjunctivitis	–	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	2	2	–	–

[a]Laboratory-confirmed cases only. [b]Includes cases with unknown postcode. [c]Data for 'Adverse Event Following Immunisation' category refer to suspected cases only. These reports are referred to the Therapeutic Goods Administration (TGA) for assessment. Data on adverse events following immunisation is available online from the TGA Database of Adverse Event Notifications.

NB: Data are current and accurate as at the preparation date. The number of cases reported is, however, subject to change, as cases may be entered at a later date or retracted upon further investigation.

Data are reported by Local Health District of residence (geocoded to 2011 boundaries).

Source: Notifiable Conditions Information Management System, NSW Ministry of Health.

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