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The health of Hunter Valley communities in proximity to coal mining and power generation, general practice data, 1998–2010

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Abstract: Aim: An analysis of general practice data for rural communities in close proximity to coal mining and coal-fired power generation in the Hunter Valley region of NSW was conducted to identify unusual patterns of illness. **Methods:** Bettering the Evaluation and Care of Health general practice consultation data from the Hunter Valley region for 1998–2010 were compared with data from all other rural NSW residents. **Results:** There were no significantly higher rates of problems managed or medications prescribed for Hunter Valley region residents compared with the rest of rural NSW. Rates of respiratory problem management in the Hunter Valley region did not change significantly over time, while for all other rural NSW areas these rates significantly decreased. **Conclusion:** There was no evidence of significantly elevated health issues for residents in the Hunter Valley region of NSW. The diverging trend for respiratory problem management over time is worthy of further exploration.

Coal mining has the potential to impact on the health of nearby residents but there are limited Australian data available.[1,2] The rural communities of Singleton, Muswellbrook and Denman are situated in close proximity to extensive and expanding coal mining and coal-fired power generation activities in the Hunter Valley region of New South Wales (NSW). Raw coal production from open cut coal mines in NSW increased by 81% over the period 1999–2011, with the Hunter Valley region accounting for 76% of all open-cut coal production in NSW in 2011 (unpublished data, Coal Services Pty Ltd, 2012).

In response to health concerns raised by the community, NSW Health reviewed existing health data for the region. Patterns of NSW emergency department presentations and hospital admissions, as well as mortality, cancer incidence and self-reported health survey data for these areas were compared with other parts of NSW and an analysis published in May 2010.[3] Some regions with exposure to open-cut coal mining and power generation were shown to have higher rates of emergency department attendance for asthma and respiratory disease, and higher rates of hospital admission for asthma, respiratory conditions and cardiovascular disease. There was ongoing community concern that hospital data only represented severe disease.

A complementary analysis of general practice data was conducted to determine whether there were any indications of excessive or unusual patterns of illness in these communities which may not have been detected by the May 2010 study.

Methods

Data were obtained from the Bettering the Evaluation and Care of Health (BEACH) program.[4] The BEACH program collects data from approximately 1000 general practitioners

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(GPs) randomly selected from across Australia each year. Each GP contributes details of 100 consecutive patient encounters, including the problems managed and treatment provided. Additional health data are collected on subsamples of these encounters.

Problems managed are classified using the International Classification of Primary Care, version 2 (ICPC-2).[5] This classification system groups health problems into problem chapters and components, and medications into groups and sub-groups.

BEACH GP consultation data for residents of Singleton, Muswellbrook and Denman were compared with data for all other rural (non-metropolitan) NSW residents for three time periods: 1998–2004 and 2005–2010 inclusive, and for both time periods combined. Additionally, data for residents of Singleton, Muswellbrook and Denman for the period 2005–2010 were compared with data from the 1998–2004 period. This represented all available BEACH data for this region.

Patient postcode of residence was used to define their location. The communities of Singleton (postcode 2330), Muswellbrook (postcode 2333) and Denman (postcode 2328) were combined as the communities of interest in the Hunter Valley region for the purposes of this paper. Rural NSW was defined using the Australian Standard Geographic Classification (ARIA+) system of the Australian Bureau of Statistics.[6]

For each of the three time periods, the analyses included a crude analysis, with adjustment for clustering at GP level, and weighted analysis, which included individual-level adjustment for:

- patient sex and age group (0–14, 15–64, and 65 years and over)
- patient's Health Care Card status
- season of encounter date, using four season categories.

Health Care Card status was used as a proxy for socioeconomic status but Veterans' Card status was not available. The weighting procedure used all other rural NSW postcodes, excluding Singleton, Muswellbrook and Denman, as the reference population.

All direct encounters with a GP for both new and existing problems managed were included. The analysis examined the problems managed as recorded by the GP, presented as a rate per 100 encounters, with 95% confidence intervals (CI), for all conditions and diagnostic chapter headings. The analysis also examined the medications prescribed or supplied by the GP per 100 problems managed, with 95% CIs, presented by medication group and sub-group. The medication analysis used problems managed for the denominator because more than one problem could be managed per encounter and the number of problems managed per encounter increased over time. All CI calculations accounted for the clustered sample design.

All available BEACH data were considered. Respiratory and cardiovascular disease, malignancy and mental health issues were of particular interest on the basis of known potential impacts from particulate pollution and local community concerns.

Differences between the Hunter Valley region and rural NSW (excluding the Hunter Valley region) were considered significant when there was no overlap of the 95% CIs between the regions. The clustered sample design and nature of the data prevented further significance testing.

Spearman's rank correlation test was used to detect differences in the ranking of rates of problems managed and medications prescribed between the weighted Hunter Valley region data and the comparison rural NSW data. A $p < 0.05$ was used to reject the null hypothesis (that the rank orders were independent) and indicated that there was no significant difference in the ranking of problems managed or medications prescribed between the two groups.

Individual-level smoking status was not available for all GP encounters, and therefore could not be used to adjust results at individual level. Instead, the sub-sample of BEACH encounters with smoking status information (approximately 33% of encounters) was used to estimate the prevalence of current, previous and never smoked status for residents in the Hunter Valley region and in the rest of rural NSW for the time periods of interest.

The number of different GPs and general practices in the Hunter Valley region that contributed BEACH data during 1998–2010 was examined, as was the proportion of encounters provided by each participating GP.

Ethics approval was not required for this review. The BEACH program provided aggregate de-identified data.

Results

Patient characteristics

During the period April 1998–July 2010, the BEACH survey program included records of 2286 encounters and 3448 problems managed for Hunter Valley region residents. No BEACH data were available for this region prior to 1998. The unweighted Hunter Valley region sample had more patients in the 0–15 and 15–64-year age groups, and fewer Health Care Card holders than the comparison rural NSW sample (Table 1).

Eighteen different GPs from seven general practices contributed data in the Hunter Valley region. The median proportion of encounters with Hunter Valley region residents provided by each GP was 3.9% (range: 1.3–11.4%). Ninety-one percent of consultations for Hunter Valley region residents occurred in the Hunter region.

Table 1. Patient characteristics and season of encounter, Hunter Valley region and rural NSW, 1998–2010

Patient variable		Hunter Valley region % of encounters	Rural NSW (excluding Hunter) % of encounters
Sex	Female	63.2	58.4
	Male	36.4	41.1
	Missing	0.4	0.6
Age group (years)	0–15	14.5	11.3
	15–64	61.6	57.1
	65+	23.3	30.9
	Missing	0.6	0.8
HCC	HCC holder	35.4	48.7
	Non-HCC holder	53.8	44.7
	Missing	10.8	6.7
Season	Jan–Mar	25.6	24.3
	Apr–Jun	29.6	27.8
	Jul–Sep	15.9	26.0
	Oct–Dec	28.8	21.9

HCC: Health Care Card
Source: Bettering the Evaluation and Care of Health program.

There were 89 614 encounters and 140 645 problems managed for residents in the remainder of rural NSW during this period.

Problems managed

When grouped by ICPC-2 chapter, no problem groups were managed at significantly higher rates in the Hunter Valley region (Table 2). Social chapter problems were managed at a significantly lower rate.

There was no significant difference in the ranking of problem chapters (Spearman's rho = 0.998, $p < 0.0001$).

When the most frequently managed problems were compared, none were managed at significantly higher rates in the Hunter Valley region (Table 3). The rate for general check-ups was significantly lower in the Hunter Valley region.

There were no significant differences in management rates of asthma, acute or chronic respiratory tract conditions, depression or anxiety.

There were no significant differences in the ranking of all tabulated problems or for the top 10 problems managed (Spearman's rho = 0.86 ($p < 0.0001$) and 0.71 ($p < 0.02$) respectively) (Table 3).

Medications prescribed or supplied

No medication groups were prescribed or supplied at significantly higher or lower rates in the Hunter Valley region (Table 4).

The rank order was very similar for the two groups (Spearman's rho = 0.98, $p < 0.0001$, Table 4).

Similarly, no medication subgroups were prescribed or supplied at significantly higher or lower rates in the Hunter Valley region (e.g. bronchodilators, asthma preventives, anti-anxiety and antidepressant medicines). The rank order was similar for the two groups (Spearman's rho = 0.95, $p < 0.0001$) (Table 5).

Smoking

In the sub-sample ($n = 743$) with smoking data recorded, a significantly higher proportion of people had never smoked and a significantly lower proportion of people were previous smokers in the Hunter Valley region than in rural NSW ($n = 30\,171$). The prevalence of current smoking was not significantly different (Table 6).

Additional analysis by time period

In addition to the analysis of aggregated data for the period 1998–2010, data were considered separately for the time periods April 1998–March 2004 and April 2004–June 2010. Comparison of Hunter Valley region weighted data with rural NSW for each period separately did not identify any information that differed substantially from the analysis presented for the combined period.

When weighted Hunter Valley region data for the two periods were compared, the only significant increase over time was in the rate of management of benign/uncertain

Table 2. Rate of problems managed by ICPC-2 chapter and rank order, Hunter Valley region and rural NSW patients, 1998–2010

Problem managed	Hunter Valley region[a]		Rural NSW (excluding Hunter)		Hunter Valley region compared with rural NSW[b]
	Rate per 100 encounters (95% CI)	Rank order	Rate per 100 encounters (95% CI)	Rank order	
Musculoskeletal	21.3 (18.7–23.9)	1	19.2 (18.7–19.6)	2	–
Circulatory	19.2 (16.6–21.7)	2	20.0 (19.3–20.6)	1	–
Respiratory	17.8 (14.7–20.9)	3	19.2 (18.6–19.7)	3	–
Skin	15.1 (12.8–17.5)	4	17.9 (17.4–18.5)	4	–
General and unspecified	13.6 (9.9–17.3)	5	16.1 (15.5–16.6)	5	–
Endocrine and metabolic	12.6 (9.0–16.2)	6	12.3 (11.9–12.7)	6	–
Psychological	11.7 (9.3–14.1)	7	12.0 (11.5–12.5)	7	–
Digestive	10.7 (8.7–12.7)	8	10.6 (10.3–10.9)	8	–
Female genital system	7.8 (5.0–10.6)	9	6.7 (6.3–7.1)	9	–
Pregnancy and family planning	6.7 (4.1–9.2)	10	5.0 (4.6–5.3)	10	–
Neurological	4.8 (3.0–6.6)	11	4.0 (3.9–4.2)	11	–
Ear	3.7 (2.7–4.6)	12	3.9 (3.8–4.1)	12	–
Urological	2.8 (2.0–3.7)	13	3.3 (3.1–3.4)	13	–
Blood	2.2 (1.1–3.3)	14	2.4 (2.3–2.5)	14	–
Eye	1.9 (1.3–2.4)	15	1.8 (1.7–1.9)	15	–
Male genital system	1.5 (0.8–2.1)	16	1.8 (1.7–1.9)	16	–
Social	0.4 (0.1–0.6)	17	0.8 (0.8–0.9)	17	↓

[a]Weighted data
[b]↓ Significantly lower; – No difference
Source: Bettering the Evaluation and Care of Health program.

neoplasms and malignant neoplasms, an increase that was also seen over this time period in the remainder of rural NSW.

The rate of management of respiratory chapter problems in the Hunter Valley region did not change significantly over time. By comparison, the rate for the respiratory chapter problem group was significantly lower during the later period in the remainder of rural NSW (Table 7).

Discussion

Community members in the Hunter Valley region have expressed a broad range of health concerns, particularly in relation to perceived negative impacts of industrial activity, coal mining and power generation on respiratory and mental health.

Our analysis of general practice data found no evidence of significantly higher rates of any particular problems managed or medications prescribed or supplied for Hunter Valley region residents compared with the rest of rural NSW during the period 1998–2010.

Consistent with this, when rates of problems and medications were ranked, all rank tests were highly correlated ($rho > 0.85$) except for the top 10 problems managed, which were moderately correlated ($rho = 0.71$). All tests of independence of ranking between the weighted Hunter Valley region and rural NSW data were rejected, indicating no significant difference in ranking between these regions.

If the Hunter Valley region sample had been larger it is possible that significant differences in rates of management between the two regions may have been identified. However, the analysis included 12 years of data from the BEACH program, which were all the data available at the time of the analysis, and represents the only source of data for general practice activity in NSW available for this purpose.

The nature of the BEACH data constrains the statistical options available for further comparison of these groups. Identification of differences relied on the comparison of confidence intervals that take account of the clustering inherent in the data sample and the nature of the underlying data. The rates presented in Tables 2–5 and 7, for example, cannot be considered as proportions, as one encounter or problem can contribute multiple counts within the specific rate under consideration.

It is of interest that comparison of the management rates of respiratory problems (as a group) during the period 2005–2010 with those for 1998–2004 demonstrated no significant change in the Hunter Valley region despite a significant decrease for the remainder of rural NSW over this period. Again, if the Hunter Valley region sample were larger, a significant difference may have been identified.

Table 3. Rate of problems managed by component and rank order, Hunter Valley region and rural NSW patients, 1998–2010

Problem managed	Hunter Valley region[a]		Rural NSW (excluding Hunter)		Hunter Valley region compared with rural NSW[b]
	Rate per 100 encounters (95% CI)	Rank order	Rate per 100 encounters (95% CI)	Rank order	
Hypertension[c]	8.8 (7.1–10.5)	1	10.4 (10.0–10.8)	1	–
Arthritis – all[c]	6.4 (4.7–8.2)	2	4.6 (4.3–4.8)	2	–
Osteoarthritis[c]	5.0 (3.3–6.8)	3	3.1 (2.9–3.3)	7	–
Depression[c]	4.3 (3.2–5.3)	4	4.3 (4.1–4.5)	3	–
Asthma	3.3 (2.3–4.3)	5	2.6 (2.4–2.7)	10	–
Diabetes – non-gestational[c]	3.2 (2.1–4.2)	6	3.7 (3.5–3.8)	4	–
Lipid disorders[c]	3.2 (1.8–4.5)	7	3.2 (3.0–3.4)	6	–
Oesophageal disease	3.2 (1.8–4.5)	8	2.5 (2.4–2.7)	13	–
Preventive immunisation/medication – NOS	3.0 (1.3–4.7)	9	2.9 (2.5–3.3)	9	–
Back complaint[c]	2.8 (1.8–3.7)	10	3.1 (3.0–3.3)	8	–
Upper respiratory infection – acute	2.7 (1.9–3.5)	11	3.7 (3.5–4.0)	5	–
Acute bronchitis/bronchiolitis	2.3 (1.2–3.4)	12	2.6 (2.4–2.8)	11	–
Female genital check-up[c]	2.2 (1.2–3.3)	13	2.2 (2.0–2.4)	14	–
Sinusitis – acute/chronic	2.1 (0.8–3.4)	14	1.3 (1.2–1.4)	25	–
Pregnancy[c]	2.0 (0.7–3.2)	15	1.4 (1.2–1.5)	23	–
Menopausal symptom/complaint	1.9 (1.0–2.8)	16	1.2 (1.1–1.3)	27	–
Pre/postnatal check-up[c]	1.9 (0.6–3.1)	17	1.2 (1.0–1.4)	28	–
Solar keratosis/sunburn	1.8 (0.9–2.8)	18	1.9 (1.6–2.2)	16	–
Anxiety[c]	1.7 (1.0–2.5)	19	1.6 (1.4–1.7)	17	–
Cardiac check-up[c]	1.6 (0.0–3.4)	20	1.2 (1.1–1.3)	29	–
Tonsillitis[c]	1.6 (0.5–2.7)	21	0.9 (0.8–1.0)	40	–
General check-up[c]	1.6 (0.9–2.4)	22	2.6 (2.5–2.8)	12	↓
Sprain/strain[c]	1.5 (0.6–2.4)	23	1.3 (1.2–1.4)	26	–
Preventive immunisation/medication – respiratory	1.5 (0.3–2.7)	24	2.1 (1.9–2.2)	15	–
Hypothyroidism/myxoedema	1.5 (0.3–2.8)	25	0.7 (0.6–0.8)	48	–
Acute otitis media/myringitis	1.4 (0.8–1.9)	26	1.1 (1.1–1.2)	32	–
Ischaemic heart disease[c]	1.3 (0.7–1.9)	27	1.6 (1.5–1.7)	18	–
Malignant neoplasm of skin	1.3 (0.4–2.2)	28	1.6 (1.4–1.7)	19	–
Dermatitis – contact/allergic	1.3 (0.8–1.7)	29	1.5 (1.4–1.6)	21	–
Sleep disturbance	1.3 (0.4–2.2)	30	1.5 (1.4–1.6)	22	–
Injury – musculoskeletal NOS	1.1 (0.2–2.0)	31	1.0 (0.9–1.0)	34	–
Chronic obstructive pulmonary disease	1.1 (0.5–1.7)	32	1.1 (1.0–1.1)	33	–
Anaemia[c]	1.1 (0.1–2.0)	33	0.7 (0.7–0.8)	49	–
Elevated blood pressure	1.0 (0.0–2.0)	34	0.2 (0.2–0.3)	56	–
Arthritis[c]	1.0 (0.3–1.7)	35	0.8 (0.7–0.9)	42	–
Fracture[c]	1.0 (0.5–1.5)	36	1.2 (1.1–1.2)	30	–
Osteoporosis	1.0 (0.5–1.5)	37	0.9 (0.8–0.9)	41	–
Abnormal result – investigation NOS	1.0 (0.1–1.8)	38	0.8 (0.7–0.8)	43	–
Oral contraception[c]	1.0 (0.5–1.5)	39	1.0 (0.9–1.0)	35	–
Urinary tract infection[c]	1.0 (0.5–1.5)	40	1.6 (1.5–1.7)	20	–
Heart failure	0.9 (0.4–1.4)	41	1.0 (0.9–1.1)	36	–
Chronic ulcer – skin	0.9 (0.3–1.5)	42	0.7 (0.6–0.7)	50	–
Atrial fibrillation/flutter	0.8 (0.3–1.3)	43	1.2 (1.0–1.3)	31	–
Laceration/cut	0.8 (0.3–1.2)	44	0.8 (0.7–0.8)	44	–
Dermatophytosis	0.8 (0.3–1.3)	45	0.5 (0.5–0.6)	53	–
Skin check-up[c]	0.8 (0.2–1.5)	46	0.5 (0.4–0.6)	54	–

(*Continued*)

Table 3. (Continued)

Problem managed	Hunter Valley region[a]		Rural NSW (excluding Hunter)		Hunter Valley region compared with rural NSW[b]
	Rate per 100 encounters (95% CI)	Rank order	Rate per 100 encounters (95% CI)	Rank order	
Viral disease – other/NOS	0.8 (0.3–1.4)	47	0.8 (0.7–0.9)	45	–
Vitamin/nutritional deficiency	0.8 (0.3–1.3)	48	0.6 (0.5–0.7)	52	–
Gastroenteritis[c]	0.8 (0.4–1.2)	49	1.0 (0.9–1.1)	37	–
Constipation	0.8 (0.4–1.2)	50	0.5 (0.4–0.5)	55	–
Otitis externa	0.8 (0.2–1.4)	51	0.7 (0.6–0.7)	51	–
Bursitis/tendonitis/synovitis NOS	0.7 (0.3–1.1)	52	1.0 (0.9–1.1)	38	–
Obesity (BMI > 30)	0.7 (0.0–1.5)	53	0.8 (0.7–0.9)	46	–

NOS: not otherwise specified
[a]Weighted data
[b]↓ Significantly lower; – No difference
[c]Includes multiple ICPC-2 codes
Source: Bettering the Evaluation and Care of Health program.

Table 4. Rate of medication group prescription or supply and rank order, Hunter Valley region and rural NSW patients, 1998–2010

Medication group	Hunter Valley region[a]		Rural NSW (excluding Hunter)		Hunter Valley region compared with rural NSW[b]
	Rate per 100 problems (95% CI)	Rank order	Rate per 100 problems (95% CI)	Rank order	
Anti-infections/infestations	10.6 (8.2–13.1)	1	9.1 (8.7–9.4)	2	–
Cardiovascular	10.4 (8.0–12.8)	2	11.4 (11.0–11.8)	1	–
Central nervous system	8.1 (6.1–10.1)	3	7.5 (7.3–7.8)	3	–
Allergy – immune system	6.1 (3.2–9.0)	4	5.0 (4.7–5.4)	5	–
Psychological	5.5 (4.0–6.9)	5	5.4 (5.2–5.7)	4	–
Hormonal	4.5 (3.7–5.3)	6	4.4 (4.2–4.6)	6	–
Musculoskeletal	4.4 (3.0–5.9)	7	3.6 (3.5–3.8)	7	–
Respiratory	4.3 (3.2–5.4)	8	3.5 (3.3–3.7)	8	–
Digestive	3.8 (2.7–4.8)	9	3.2 (3.1–3.3)	9	–
Blood	2.2 (1.4–3.1)	10	2.0 (1.9–2.2)	11	–
Skin	2.0 (1.3–2.7)	11	2.5 (2.4–2.6)	10	–
Urogenital	1.3 (0.8–1.8)	12	1.5 (1.4–1.5)	12	–
Ear, nose – topical	1.3 (0.6–2.0)	13	1.1 (1.0–1.1)	14	–
Nutrition, metabolism	1.1 (0.5–1.7)	14	1.0 (0.9–1.1)	15	–
Eye medications	1.0 (0.6–1.4)	15	1.0 (0.9–1.0)	16	–
Contraceptives	1.0 (0.4–1.5)	16	1.1 (1.0–1.2)	13	–
Surgical preparations	0.5 (0.0–1.2)	17	0.2 (0.2–0.3)	19	–
Miscellaneous	0.5 (0.3–0.8)	18	0.4 (0.3–0.4)	18	–
Antineoplastics	0.2 (0.0–0.6)	19	0.4 (0.4–0.5)	17	–

[a]Weighted data
[b]– No difference
Source: Bettering the Evaluation and Care of Health program.

A recent review of emergency department data found higher rates for asthma and respiratory disease presentations in this region when compared with Sydney residents, however higher rates were also noted for a number of rural communities with no potential mining or power generation exposures.[3] A number of these communities have been affected by drought and the contribution of agricultural activity, meteorological conditions and wood-smoke have all been implicated.[7]

There were no significant differences in management rates of mental health conditions in the Hunter Valley region

Table 5. Rate of medication subgroup prescription or supply and rank order, Hunter Valley region and rural NSW patients, 1998–2010

Medication subgroup	Hunter Valley region[a]		Rural NSW (excluding Hunter)		Hunter Valley region compared with rural NSW[b]
	Rate per 100 problems (95% CI)	Rank order	Rate per 100 problems (95% CI)	Rank order	
Immunisation	6.0 (3.1–8.8)	1	4.7 (4.3–5.0)	2	–
Antihypertensives	5.8 (4.4–7.3)	2	6.4 (6.1–6.6)	1	–
NSAIDs	3.9 (2.5–5.4)	3	2.9 (2.8–3.1)	4	–
Penicillins/cephalosporins	3.9 (2.6–5.2)	4	2.8 (2.7–2.9)	5	–
Broad spectrum penicillins	3.1 (2.0–4.2)	5	2.9 (2.8–3.1)	3	–
Antiulcerants	2.8 (1.8–3.8)	6	2.2 (2.1–2.3)	7	–
Other antibiotics	2.5 (1.6–3.5)	7	1.9 (1.8–2.0)	11	–
Antidepressants	2.5 (2.0–3.1)	8	2.5 (2.4–2.6)	6	–
Simple analgesics	2.4 (1.6–3.2)	9	2.1 (2.0–2.2)	9	–
Compound analgesics	2.3 (1.6–3.0)	10	1.8 (1.7–1.9)	12	–
Narcotic analgesics	2.3 (1.2–3.3)	11	2.1 (2.0–2.2)	10	–
Bronchodilators/spasm relaxants	2.1 (1.3–2.8)	12	1.8 (1.7–1.9)	13	–
Other cardiovascular system	2.0 (1.3–2.8)	13	2.2 (2.1–2.3)	8	–
Asthma preventives	1.9 (1.4–2.5)	14	1.4 (1.3–1.5)	16	–
Sex/anabolic hormones	1.6 (0.9–2.3)	15	1.2 (1.1–1.2)	21	–
Anti-anxiety	1.6 (0.9–2.2)	16	1.3 (1.2–1.4)	19	–
Other blood drugs	1.5 (0.7–2.3)	17	1.4 (1.3–1.5)	18	–
Corticosteroids	1.3 (0.9–1.7)	18	1.2 (1.1–1.2)	20	–
Beta-blockers	1.2 (0.8–1.7)	19	1.4 (1.3–1.5)	17	–
Topical steroids	1.2 (0.7–1.7)	20	1.5 (1.4–1.6)	15	–
Hypoglycaemics	1.1 (0.6–1.6)	21	1.6 (1.4–1.7)	14	–
Sedatives/hypnotics	1.0 (0.4–1.6)	22	1.1 (1.0–1.2)	22	–
Diuretics	0.9 (0.5–1.4)	23	0.9 (0.9–1.0)	24	–
Contraceptives oral/systemic	0.9 (0.4–1.4)	24	1.1 (1.0–1.1)	23	–
Antiemetics/antinauseants	0.9 (0.5–1.3)	25	0.9 (0.8–0.9)	25	–
Anti-infectives – eye	0.8 (0.5–1.0)	26	0.6 (0.5–0.6)	29	–
Topical otic	0.7 (0.4–1.1)	27	0.5 (0.5–0.6)	30	–
Antiangina	0.7 (0.3–1.1)	28	0.8 (0.7–0.8)	26	–
Haemopoietics	0.7 (0.4–1.0)	29	0.6 (0.6–0.7)	27	–
Tetracyclines	0.6 (0.4–0.9)	30	0.6 (0.5–0.6)	28	–

NSAIDs: non-steroidal anti-inflammatory drugs
[a]Weighted data
[b]– No difference
Source: Bettering the Evaluation and Care of Health program.

compared with the rest of rural NSW. Management rates of depression and anxiety were not higher, nor were prescription rates of antidepressants.

It was not possible to adjust for the influence of smoking at individual level during the analysis as this information was only available for 33% of patients. However, smoking prevalence is unlikely to explain any relative increase in the rate of respiratory disease managed in the Hunter Valley region as there was a significantly higher prevalence of adults who had never smoked and significantly fewer adults who were previous smokers compared with the rest of rural NSW.

We note a number of limitations of the data used for this analysis. The Hunter Valley region sample had a higher proportion of younger patients and fewer Health Care Card holders than the comparison group. These differences were accounted for in the weighting applied to the Hunter Valley region data used in the analysis. The lower rate of general check-ups for Hunter Valley region patients potentially reflects differences in health care utilisation. We are not aware of any other likely systematic differences between these groups.

The BEACH data used in this analysis necessarily rely on a sample of patient encounters from a sample of randomly

Table 6. Smoking status for sub-sample of adults (aged 18 years and over), Hunter Valley region and rural NSW patients, 1998–2010

Smoking status	Hunter Valley region[a] ($n = 743$) Percent (95% CI)	Rural NSW (excluding Hunter) ($n = 30\,717$) Percent (95% CI)	Hunter Valley region compared with rural NSW[b]
Never smoked	58.3 (52.5–64.1)	47.2 (46.4–48.1)	↑
Previous smoker	24 (19.6–28.5)	31 (30.2–31.7)	↓
Current smoker	17.7 (13.8–21.5)	21.8 (21.0–22.5)	–

[a]Weighted data
[b]↑ Significantly higher; ↓ Significantly lower; – No difference
Source: Bettering the Evaluation and Care of Health program.

Table 7. Rate of respiratory chapter problems managed by time period, Hunter Valley and rural NSW patients, 1998–2010

Location	April 1998–March 2004 Rate per 100 encounters (95% CI)	April 2004–June 2010 Rate per 100 encounters (95% CI)	Change over time[b]
Hunter Valley region[a]	15.9 (12.2–19.5)	20.9 (16.1–25.8)	–
Rural NSW (excluding Hunter)	20.2 (19.4–21.1)	18.1 (17.3–18.9)	↓

[a]Weighted data
[b]↓Significantly lower; – No difference
Source: Bettering the Evaluation and Care of Health program.

selected GPs. However, the inclusion of data from 18 GPs representing seven practices suggests the Hunter Valley region data should not be unduly influenced by different diagnostic and prescribing practices of individual participating GPs.

Conclusion

There was no evidence of a significant difference in problems managed or medications prescribed by GPs for residents of communities potentially affected by heavy industrial activity (coal mining and power generation) in the Hunter Valley region of NSW compared with residents in the remainder of rural NSW during the period 1998–2010. The diverging trend for respiratory problem management over time is worthy of further exploration.

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References

1. Castledon WM, Shearman D, Crisp G, Finch P. The mining and burning of coal: effects on health and environment. *MJA* 2011; 195: 333–5.
2. Higginbotham N, Freeman S, Connor L, Albrecht G. Environmental injustice and air pollution in coal affected communities, Hunter Valley, Australia. *Health Place* 2010; 16(2): 259–66. doi:10.1016/j.healthplace.2009.10.007
3. NSW Department of Health. Respiratory and cardiovascular diseases and cancer among residents in the Hunter New England Area Health Service. Available at: http://www.health.nsw.gov.au/pubs/2010/hne_respi_cardio.html (Cited 5 September 2012).
4. Britt H, Miller GC, Charles J, Henderson J, Bayram C, Pan Y et al. General practice activity in Australia 2009–10. General practice series no 27. Cat. No. GEP 27. Canberra: Australian Institute of Health and Welfare; 2010.
5. Classification Committee of the World Organisation of Family Doctors. ICPC-2. International Classification of Primary Care. 2nd ed. Oxford: Oxford University Press; 1998.
6. Australian Bureau of Statistics. Census Paper 03/01. ASGC Remoteness Classification: Purpose and Use. Available at: http://www.abs.gov.au/websitedbs/d3110122.nsf/0/f9c96fb635cce780ca256d420005dc02/$FILE/Remoteness_Paper_text_final.pdf (Cited 5 September 2012).
7. Centre for Inland Health. Particulate matter and air pollution in a NSW regional centre: A review of the literature and opportunities for action. Wagga Wagga: Charles Sturt University; 2011.

Are pregnancy outcomes associated with risk factor reporting in routinely collected perinatal data?

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Abstract: Aim: To assess reporting characteristics of commonly dichotomised pregnancy outcomes (e.g. preterm/term birth); and to investigate whether behaviours (e.g. smoking), medical conditions (e.g. diabetes) or interventions (e.g. induction) were reported differently by pregnancy outcomes. **Methods:** Further analysis of a previous validation study was undertaken, in which 1680 perinatal records were compared with data extracted from medical records. Continuous and polytomous variables were dichotomised, and risk factor reporting was assessed within the dichotomised outcome groups. Agreement, kappa, sensitivity and positive predictive value calculations were undertaken. **Results:** Gestational age, birthweight, Apgar scores, perineal trauma, regional analgesia and baby discharge status (live birth/stillbirth) were reported with high accuracy and reliability when dichotomised (kappa values 0.95–1.00, sensitivities 94.7–100.0%). Although not statistically significant, there were trends for hypertension, infant resuscitation and instrumental birth to be more accurately reported among births with adverse outcomes. In contrast, smoking ascertainment tended to be poorer among preterm births and when babies were <2500 g. **Conclusion:** Dichotomising variables collected as continuous or polytomous variables in birth data results in accurate and well ascertained data items. There is no evidence of systematic differential reporting of risk factors.

Population level data are well suited to studies evaluating health care. With the risk of sampling bias removed, estimation of incidence and prevalence rates can be made, allowing for description of the total burden of a particular disease or outcome, analysis of risk factors and trends, as well as identification of health inequalities and estimation of health costs.[1,2] Accurate conclusions from such analyses rely on high quality data that truly represent the population experience. Assessment of data quality (completeness and accuracy) is typically undertaken by a validation study, in which data from a sample of records from the population dataset are compared to a highly reliable and accurate source of data ('the gold standard') for the corresponding records. The accuracy and reliability of individual data items are typically reported.[3,4]

The variables in perinatal population data can be continuous (e.g. gestational age), nominal (e.g. mode of delivery) and ordinal (e.g. first, second, third or fourth degree perineal tears), with validation of such variables typically reporting percent agreement and kappa statistics. These types of variables are frequently dichotomised in analyses (e.g. preterm birth, caesarean section, or third–fourth degree tears),[5,6] but little assessment has been undertaken into the accuracy and reliability of their dichotomised form.

Differential reporting in population health data occurs when a variable is reported with different accuracy and reliability amongst different strata of another variable. This can introduce systematic bias, leading to under or over-estimation of risk factor effects.[7] For example, if smoking is more likely to be reported when an infant is growth restricted, this could result in the effect of smoking on growth restriction being over-estimated. Different accuracy and reliability statistics have been demonstrated for reporting of both pregnancy hypertension and induction depending on the mode of delivery,[2,8] and for hypertension depending on the gestation.[9] However, we are only aware of one other study that has investigated whether the occurrence of adverse infant or maternal outcomes might result in increased reporting of established risk factors for these outcomes.[9]

With little published research reporting on the dichotomised form of population data, the aims of our study were therefore twofold: a) to assess reporting characteristics of commonly dichotomised pregnancy outcomes; and b) to

investigate whether behaviours (e.g. smoking), medical conditions (e.g. diabetes) or interventions (e.g. induction) were reported differently by outcomes.

Methods

This study involved further analysis of data from a previous validation study of the 1998 New South Wales (NSW) Perinatal Data Collection (PDC). The PDC (formerly known as the NSW Midwives Data Collection) is a population-based statutory surveillance system and serves as a primary source of information about pregnancy and birth outcomes in NSW for all births ≥20 weeks gestation or ≥400 g birthweight. The original study is described in detail elsewhere.[3] Briefly, randomly selected records from the PDC (referred to as the 'PDC sample') were compared with 'gold standard' data extracted from the corresponding patient's medical records (referred to as the 'validation data'). The PDC sample comprised 1680 records representing 2% of the state's births from 98 hospitals around NSW. Information from the medical records of the selected sample of women was extracted by experienced health managers without reference to information contained in the PDC sample. The data item with highest frequency of missing values was Apgar5, which was missing from six records in the PDC sample (0.36%), and from nine records in the validation data (0.54%).

We first assessed the accuracy and reliability of continuous and polytomous data items when examined as dichotomous outcomes. We chose data items that are commonly dichotomised including: gestational age (<37 weeks gestation, ≥37 weeks gestation); birthweight (<2500 g, ≥2500 g; <4000 g, ≥4000 g); Apgar score at 1 minute (Apgar1 <4, Apgar1 ≥4) and Apgar score at 5 minutes (Apgar5 <7, Apgar5 ≥7); epidural, caudal, pudendal or spinal analgesia (regional analgesia yes/no); second, third or fourth degree tears and/or episiotomy (perineal trauma yes/no); and baby discharge status (stillbirth/live birth).

Next we examined potential differential reporting of risk factors by determining the accuracy and reliability of risk factor reporting in the PDC sample for different pregnancy outcomes. Specifically, we hypothesised that the following established risk factors may be more likely to be reported in the presence of an associated outcome:

- smoking when infants were small or preterm[10]
- maternal hypertension among preterm births[11]
- maternal diabetes when infants were large[12]
- instrumental birth (forceps or vacuum) among women who experienced perineal trauma[13]
- induction among women who required regional analgesia[14]
- infant resuscitation (intermittent positive pressure respiration, bag and mask or intubation, or external cardiac massage and ventilation) when Apgar5 <7.

Analysis

Using the validation data as the 'gold standard', the reliability and accuracy of PDC reporting was determined by calculating the sensitivity, specificity, positive predictive value (PPV), negative predictive value, percent agreement and Cohen's kappa statistic. These reporting characteristics were determined first for the commonly dichotomised variables and then for risk factors in the hypothesised outcome strata. When a record was missing a data item, it was excluded from the relevant analysis. We assessed the homogeneity of risk factor reporting across the dichotomised outcome strata by the Breslow-Day test, with Zelan adjustment where cell counts were less than five.

All analyses included the associated 95% exact binomial confidence intervals. These are not presented in the tables, but are available from the authors on request. All analyses were undertaken using SAS (version 9.2, SAS Institute, Cary, NC, USA).

Results

Of the 1680 records in the original validation study, 1678 were available for analysis. Characteristics of the PDC sample were representative of all births in NSW (Table 1).

Commonly dichotomised pregnancy outcomes (preterm birth, low and high birthweight, Apgar scores, perineal trauma, regional analgesia and stillbirth) as reported in the PDC had excellent levels of agreement, and high levels of ascertainment (sensitivities >94%) and accuracy (PPVs >96%) (Table 2).

The results of the investigation into differential reporting are presented in Table 3. PPVs were high, with 11 of 14 individual analyses ≥90%, but with inconsistencies in direction among outcome groups for each risk factor. There was more variability in the sensitivities, ranging from 66% for reporting of infant resuscitation amongst the group whose Apgar5 was ≥7, to 99% for reporting of inductions with no regional analgesia. In total, six out of the 14 sensitivity measures were ≥90%. There was no overall pattern suggestive of better reporting in the presence of an adverse outcome. Although there was a trend to higher ascertainment of infant resuscitation among infants with low Apgar5 (sensitivities of 86% vs 66%), of instrumental birth among women with perineal trauma (97% vs 88%), and of hypertension among preterm birth (77% vs 67%), the reverse was true for ascertainment of smoking both among preterm birth (82% vs 90%) and among small infants <2500 g (83% vs 90%). There were no statistically significant differences in reporting across strata, with Breslow-Day p values all >0.05.

Discussion

This study demonstrated that dichotomising perinatal outcome data into categories that are typically reported

Table 1. Comparison of Perinatal Data Collection (PDC) sample with all NSW births, 1998

Characteristics	Sample of PDC data[a] *n* (%)	NSW births[b,c] *n* (%)
Labour onset		
Spontaneous	1067 (63.6)	56 283 (65.2)
Induced	446 (26.6)	20 898 (24.2)
No labour	164 (9.8)	9103 (10.6)
Mode of delivery		
Normal vaginal delivery	1174 (70.0)	59 398 (68.8)
Forceps	91 (5.4)	4545 (5.3)
Vacuum	81 (4.8)	4526 (5.2)
Vaginal breech	18 (1.1)	1050 (1.2)
Caesarean section – planned (no labour)	164 (9.8)	9103 (10.6)
Caesarean section – intra-partum	149 (8.9)	7654 (8.9)
Any smoking during pregnancy	333 (19.9)	17 066 (19.8)
Maternal medical conditions		
Gestational diabetes or diabetes mellitus	67 (4.0)	3451 (4.0)
Any hypertension	119 (7.1)	6202 (7.2)
Gestational age <37 completed weeks	102 (6.1)	5953 (6.9)
Infants with Apgar1 <4	55 (3.3)	2878 (3.3)
Infants with Apgar5 <7	37 (2.2)	2191 (2.6)
Infant birthweight <2500 g	90 (5.4)	5299 (6.1)
≥4000 g	201 (12.0)	10 404 (12.1)
Perineal status		
Intact	732 (43.6)	38 581 (44.7)
1st degree tear or graze	335 (20.0)	16 300 (18.9)
2nd degree tear	294 (17.5)	14 926 (17.3)
3rd degree tear	10 (0.6)	608 (0.7)
4th degree tear	1 (<0.1)	48 (<0.1)
Episiotomy	247 (14.7)	12 633 (14.6)
Both tear and episiotomy	24 (1.4)	1249 (1.5)
Regional analgesia	554 (33.0)	27 623 (32.0)
Induction	446 (26.6)	20 898 (24.2)
Infant resuscitation	127 (7.6)	6565 (7.6)
Baby discharge status		
Discharged	1558 (92.3)	80 517 (93.3)
Stillbirth	11 (0.7)	595 (0.7)
Neonatal death	2 (0.1)	200 (0.2)
Transferred	106 (6.3)	4859 (5.6)
Transferred and died	0 (0.0)	16 (<0.1)

[a]Sample size = 1678.
[b]Sample size = 86 305.
[c]Source: 1998 Perinatal Data Collection.

in population health research[5,6] resulted in high levels of ascertainment and accuracy. With all sensitivities ≥94.7% and all PPVs ≥96.1%, reassurance is provided for the use of these data items in their dichotomised form where necessary for comparison to other findings or due to sample size constraints. There was no evidence of overall systematic bias in risk factor reporting across one strata of outcome (the adverse group) compared to the other. This study adds new information on dichotomised reporting characteristics and differential reporting. Strengths of this study include the highly representative nature of the PDC sample, the use of six measures of accuracy and reliability, and the small percentage of missing data. Limitations included small numbers in some outcome strata. Lack of statistical significance may thus have been a result of under-powering for some categories.

Most risk factors were fairly well ascertained regardless of outcome strata, with the exception of hypertension and infant resuscitation among the groups that did not have an adverse outcome. Reliability, as measured by PPV, was lowest amongst diabetes reporting for the adverse group, but numbers were small. There was a non-significant trend towards higher ascertainment of hypertension, instrumental birth and infant resuscitation in the adverse groups. It is recognised that these trends could become significant with larger sample sizes, and may introduce biases in research.

The non-significant trends in differential reporting were not always in the hypothesised direction. Ascertainment for behaviour (smoking) was lower amongst the adverse outcome group, while ascertainment for some interventions (instrumental birth and infant resuscitation) and for hypertension was higher in the adverse outcome groups. This latter finding is consistent with another study that identified a trend towards increased ascertainment of hypertension among women who delivered prematurely or suffered a morbidity.[9] While it might be expected that some risk factors which may be reported earlier in pregnancy (e.g. smoking, hypertension) may not have the same impact on reporting as risks occurring closer to delivery (e.g. induction, infant resuscitation), there were no differences in ascertainment or accuracy for these factors. Overall our findings demonstrate the randomness of reporting errors and no evidence of systematic bias due to differential reporting by outcome.

This study used data collected in 1998 as this was the last time the PDC was validated against medical records. Some changes to the recording of information are likely to have occurred with the advent of electronic systems, but the majority of PDC recording still occurs at the time of the birth admission, and hence accuracy of variables once dichotomised and of maternal or infant outcome risk factor reporting are unlikely to have been affected.

Table 2. Agreement, ascertainment and accuracy of dichotomised pregnancy outcome variables reported in the Perinatal Data Collection (PDC) compared with validated data, NSW, 1998

Outcome	Cases in PDC sample	Cases in validation data	Agreement %	Kappa	Sensitivity %	Specificity %	PPV %
<37 weeks gestation	102	103	99.5	0.95	95.1	99.7	96.1
<2500 g birthweight	90	90	99.9	0.99	98.9	99.9	98.9
≥4000 g birthweight	201	202	99.9	0.99	99.5	100.0	100.0
Apgar1 <4	55	54	99.9	0.99	100.0	99.9	98.2
Apgar5 <7	37	38	99.8	0.96	94.7	99.9	97.3
Perineal trauma	576	575	97.8	0.95	96.9	98.3	96.7
Regional analgesia	554	561	98.2	0.96	96.6	98.9	97.8
Stillbirth	11	11	100.0	1.00	100.0	100.0	100.0

Records with missing data were excluded.
PPV: positive predictive value.

Table 3. Agreement, ascertainment and accuracy of dichotomised pregnancy risk factors reported in the Perinatal Data Collection (PDC) and grouped by pregnancy outcomes compared with validated data, NSW, 1998

Risk	Outcome *n* = number in outcome identified by PDC sample	Risk identified by PDC sample	Risk identified by validation data	Agreement %	Kappa	Sensitivity %	PPV %
Smoking	<37 weeks gestation ($n = 100$)[a]	27	33	94.0	0.86	81.8	100.0
	≥37 weeks gestation ($n = 1542$)	304	322	97.1	0.91	90.4	95.7
	<2500 g ($n = 87$)[a]	29	35	93.1	0.85	82.9	100.0
	≥2500 g ($n = 1555$)	302	320	97.2	0.91	90.3	95.7
Hypertension	<37 weeks gestation ($n = 102$)[a]	20	26	94.1	0.83	76.9	100.0
	≥37 weeks gestation ($n = 1576$)	99	132	96.5	0.74	66.7	88.9
Diabetes	≥4000 g ($n = 201$)[a]	11	10	98.5	0.85	90.0	81.8
	<4000 g ($n = 1473$)	56	59	99.1	0.88	86.4	91.1
Instrumental birth	Perineal trauma ($n = 575$)[a]	144	146	98.6	0.96	96.6	97.9
	No perineal trauma ($n = 1011$)	28	32	99.6	0.93	87.5	100.0
Induction	Regional analgesia ($n = 553$)[a]	170	173	97.3	0.94	94.8	96.5
	No regional analgesia ($n = 1123$)	275	267	98.6	0.96	98.5	95.6
Infant resuscitation	Apgar5 <7 ($n = 37$)[a]	20	21	86.5	0.73	85.7	90.0
	Apgar5 = 7–10 ($n = 1628$)	106	139	96.3	0.73	66.2	86.8

Records with missing data were excluded.
PPV: positive predictive value.
[a]Outcome known to be associated with risk factor (adverse outcome).

Conclusion

Our findings demonstrate that dichotomised perinatal variables have high levels of accuracy and reliability when compared with medical records. In addition, ascertainment of risk factors show some non-significant differences within different pregnancy outcome groups; however reporting errors are random in their direction, revealing that there is no evidence of systematic bias.

References

1. Benchimol EI, Manuel DG, To T, Griffiths AM, Rabeneck L, Guttmann A. Development and use of reporting guidelines for assessing the quality of validation studies of health administrative data. *J Clin Epidemiol* 2011; 64(8): 821–9. doi:10.1016/j.jclinepi.2010.10.006
2. 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
3. Taylor L, Pym M, Bajuk B, Sutton L, Travis S, Banks C. Validation study: NSW Midwives Data Collection 1998. *N S W Public Health Bull Supplementary Series* 2000; 9(1): 97–9. doi:10.1071/NB00045
4. 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
5. 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
6. Roberts CL, Algert CS, Morris JM, Ford JB, Henderson-Smart DJ. Hypertensive disorders in pregnancy: A population-based study. *Med J Aust* 2005; 182(7): 332–5.
7. 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
8. Roberts C, Lain S, Hadfield R. Quality of population health data reporting by mode of delivery. *Birth* 2007; 34(3): 274–5. doi:10.1111/j.1523-536X.2007.00184_2.x
9. Roberts CL, Bell JC, Ford JB, Hadfield RM, Algert CS, Morris JM. The accuracy of reporting of the hypertensive disorders of pregnancy in population health data. *Hypertens Pregnancy* 2008; 27(3): 285–97. doi:10.1080/10641950701826695
10. Cnattingius S. The epidemiology of smoking during pregnancy: smoking prevalence, maternal characteristics, and pregnancy outcomes. *Nicotine Tob Res* 2004; 6(Suppl 2): S125–40. doi:10.1080/14622200410001669187
11. Rosenberg TJ, Garbers S, Lipkind H, Chiasson MA. Maternal obesity and diabetes as risk factors for adverse pregnancy outcomes: differences among 4 racial/ethnic groups. *Am J Public Health* 2005; 95(9): 1545–51. doi:10.2105/AJPH.2005.065680
12. Makgoba M, Savvidou MD, Steer PJ. The effect of maternal characteristics and gestational diabetes on birthweight. *BJOG* 2012; 119(9): 1091–7. doi:10.1111/j.1471-0528.2012.03388.x
13. Mikolajczyk RT, Zhang J, Troendle J, Chan L. Risk factors for birth canal lacerations in primiparous women. *Am J Perinatol* 2008; 25(5): 259–64. doi:10.1055/s-2008-1075040
14. Maslow AS, Sweeny AL. Elective induction of labor as a risk factor for cesarean delivery among low-risk women at term. *Obstet Gynecol* 2000; 95(6 Pt I): 917–22. doi:10.1016/S0029-7844(00)00794-8

How does tele-learning compare with other forms of education delivery? A systematic review of tele-learning educational outcomes for health professionals

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Abstract: Telecommuniciation technologies, including audio and videoconferencing facilities, afford geographically dispersed health professionals the opportunity to connect and collaborate with others. Recognised for enabling tele-consultations and tele-collaborations between teams of health care professionals and their patients, these technologies are also well suited to the delivery of distance learning programs, known as tele-learning. **Aim:** To determine whether tele-learning delivery methods achieve equivalent learning outcomes when compared with traditional face-to-face education delivery methods. **Methods:** A systematic literature review was commissioned by the NSW Ministry of Health to identify results relevant to programs applying tele-learning delivery methods in the provision of education to health professionals. **Results:** The review found few studies that rigorously compared tele-learning with traditional formats. There was some evidence, however, to support the premise that tele-learning models achieve comparable learning outcomes and that participants are generally satisfied with and accepting of this delivery method. **Conclusion:** The review illustrated that tele-learning technologies not only enable distance learning opportunities, but achieve comparable learning outcomes to traditional face-to-face models. More rigorous evidence is required to strengthen these findings and should be the focus of future tele-learning research.

Telecommunications are increasingly being used by the health professions to deliver health care services and to exchange health information across distances. Telehealth, tele-collaborations and tele-consultations are contributing to improvements in the quality, availability and efficiency of health care services to distance locations.[1] Telehealth, for example, enables existing forms of interactions between health care providers and recipients to occur at a distance, through the use of telecommunications.[2] Similarly, distance learning methods utilising telecommunication technologies are helping to overcome the challenges of engaging in traditional forms of education across distances. Referred to as 'tele-learning', it involves making connections among people and resources, and transferring images and voice data via communication technologies, for learning-related purposes.[3,4]

Like telehealth, tele-learning utilises telecommunications to connect participants, helping to alleviate barriers to accessing learning opportunities and enriching distance learning experiences. The relative ease of use and availability of telecommunication technologies means that audioconferencing (teleconferencing) and videoconferencing are well established and frequently used communication mechanisms for staff in the health sector.[5] For the purpose of this review, the term 'tele-learning' describes the use of video and/or audio-based technologies for distance learning purposes.

Enabling collaborations between geographically distributed health workers makes the use of telecommunications especially relevant to professionals working in rural and remote areas.[6] NSW Health has made substantial investments in telecommunication infrastructure, making

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tele-learning more readily accessible within education and clinical facilities,[7] although it should be noted that the financial implications of tele-learning were outside the scope of this review.

This review sought to establish whether education using tele-learning methods results in equivalent learning outcomes when compared to traditional face-to-face methods. The review was commissioned by NSW Health to ascertain whether there was an evidence base to support the use of videoconferencing to develop and deliver educational programs to health professionals (videoconferencing being one way of enabling clinicians working in rural and remote areas to have access to continual professional development and educational programs).

Methods

A systematic review was conducted to identify literature relevant to the use of tele-learning technologies in delivering education and training materials/programs to health professionals. A review of abstracts refined the results to literature reporting on learning outcomes achieved from tele-learning interventions. Researchers and review stakeholders from the public health sector collaborated in the formulation and refinement of the specific review questions and search parameters.

Review questions translated into the following search terms; videoconference/ing, tele-learning, tele-education, telehealth, telemedicine, teleconference/ing, audio conference/ing, videostreaming, education, learning outcomes, multidiscipline/ary, face-to-face, professional development, continuing medical education, distance education, distance learning, podcast/ing and vodcast/ing.

Information sources

The following medical and educational databases were the basis for the search: MEDLINE, Cochrane Database of Systematic Reviews, American College of Physicians Journal Club, Database of Abstracts of Reviews of Effects (DARE), Cochrane Central Register of Controlled Trials (CENTRAL), Embase, Cumulative Index to Nursing and Allied Health Literature (CINAHL), PubMed, University of Sydney catalogue search (Summon search), PsycINFO, Educational Resources Information Center (ERIC), British Education Index (BEI), and Google Scholar.

Reference lists from original articles were utilised to identify relevant literature and two frequently cited journals were searched by hand: *Journal of Telemedicine and Telecare* and *Telemedicine and e-Health*. An internet search for relevant literature, including grey literature sources, was conducted using the Google search engine and other government and education databases.

Inclusion and exclusion criteria

The search focused primarily on the education of health professionals, but also included tertiary students.

The review included both synchronous (content delivered simultaneously to face-to-face and tele-learning cohorts) and asynchronous delivery models (content delivered to the cohorts at different times). Studies utilising desktop computers and the internet were included where the technologies were used for televised conferencing, including synchronous and asynchronous streamed lectures. The review excluded facilitated e-learning and online education models such as the use of social networking, blogs, wikis and Blackboard™ learning management system software.

Results published prior to 2000 were excluded from the review as it was considered they would not incorporate the technologies currently available. Other exclusions included: papers discussing education and training interventions at lower than bachelor levels; health care delivery via telemedicine; and papers primarily focused on the technical specifications/IT equipment requirements for videoconferencing. Due to the relatively low number of randomised controlled trials and other rigorous methodological studies, searches were not limited, in the first instance, by study type. The search included qualitative, comparative, observational and evaluation studies, randomised controlled trials and systematic reviews.

Results

The search retrieved 47 records. Of these, four randomised controlled studies[8–11] and nine comparative studies[12–20] were identified as measuring learning outcomes of tele-learning versus traditional face-to-face education. The remaining 34 papers were either descriptive observational studies or did not measure tele-learning versus face-to-face education and so were excluded from the review. While the 13 included studies (summarised in Table 1) reported comparable learning outcomes achieved by the delivery methods, the scientific rigour of these studies was not strong; this needs to be considered when drawing conclusions from the literature. Many of these studies noted a failure to control for variables such as participant prior knowledge and ability, instructor experience and methods, and instructor and participant familiarity with technology. Limitations also included small sample sizes and non-random selection of participants. As mentioned, studies focused on health professionals and tertiary students.

Two of the randomised controlled studies[8,9] compared traditional didactic institution-based lectures with interactive synchronous videoconference lectures. Both studies found no significant difference in knowledge acquisition or learning outcomes. In addition to the synchronous delivery of a lecture via videoconference, one of these

Table 1. Randomised controlled trials (RCT) and comparative studies of learning outcomes – tele-learning vs face-to-face education, 2000–2012

Study	Study design	Intervention (sample size)	Study population	Outcome measure	Controlled for potential confounders	Results
Stain et al.[8]	RCT	Videoconference plus PowerPoint materials delivered via the internet ($n = 12$) Face-to-face lecture ($n = 98$)	Medical students	Mean exam results (mark out of 100) taken from 4 exams administered weekly across 4 weeks	Yes (participants' prior knowledge and ability)	**Mean scores** Videoconference = 70.5% Face-to-face = 71.4% No significant difference ($p = 0.65$)
van Boxel et al.[9]	RCT	15 participants randomly allocated to attend 4 alternating workshops (2 via video-conference and 2 face-to-face)	Nurses	Qualitative evaluation and learning effectiveness (pre- and post-test)	No	**Mean percentage increase in learning effectiveness** Videoconference = 17% Face-to-face = 18% No significant difference ($p > 0.5$)
Spickard et al.[10]	RCT	Online lecture ($n = 48$) Face-to-face lecture ($n = 47$)	Medical students	Knowledge (mark out of 16), time, and student satisfaction	Yes (pre-test knowledge)	**Summary post-test knowledge scores** Online = 10.8 Face-to-face = 10.7 No significant difference ($p = 0.91$)
Solomon et al.[11]	RCT	*Two courses delivered across two platforms* Digital lecture ($n = 17$) Face-to-face lecture ($n = 12$)	Medical students	Exam (5–6 questions) for each course	No	**Mean exam results** *Course 1* Digital = 4.88 Face-to-face = 4.42 No significant difference ($p = 0.22$) *Course 2* Digital = 9.00 Face-to-face = 9.25 No significant difference ($p = 0.41$)
Latour et al.[12]	Comparative	*Undergraduate course* Videoconference ($n = 145$) Face-to-face ($n = 24$) *Graduate course* Videoconference ($n = 5$) Face-to-face ($n = 17$)	Animal science students	Exam results (out of a possible 100)	No	**Mean results** *Undergraduate course* Videoconference = 78.9 Face-to-face = 81.0 *Graduate course* Videoconference = 86.1 Face-to-face = 83.6
Loewen et al.[13]	Comparative	Videoconference ($n = 26$) Face-to-face ($n = 30$)	Health care professionals	Post-test (mark out of 62)	No	**Mean post-test scores** Videoconference = 57.0 Face-to-face = 54.7 Significant increase in knowledge for both groups ($p < 0.001$)
Markova et al.[14]	Comparative	Up to 36 participants split between videoconference and face-to-face on 17 occasions	Resident physicians	Pre- and post-test marks in percentages	No	**Percentage difference between pre-test and post-test** Videoconference = 14.9% Face-to-face = 15.2% No significant difference ($p = 0.922$)
Kidd et al.[15]	Comparative	Videoconference ($n = 75$) Face-to-face ($n = 38$)	Undergraduate pharmacy students	Course grade (out of 100)	No	**Mean course grade** Videoconference = 87.8% Face-to-face = 90.7% Significant difference ($p = 0.024$)

Bertsch et al.[16]	Comparative	52 participants attended 6 series of 8 lectures in 2-month blocks: 4 face-to-face and 4 via videoconference	Third year medical students	Exam at end of each 2-month block (out of 100)	No	**Mean score across 12 months** Videoconference = 78% Face-to-face = 76% No significant difference (p = 0.66)
Kerns et al.[17]	Comparative	Combination of face-to-face and video-conference (*n* = 10) Face-to-face (*n* = 26)	Nurse anaesthesia students	Exam (out of 600)	No	**Mean scores** Combination = 401 Face-to-face = 392 No significant difference (p = 0.52)
Chen et al.[18]	Comparative	59 participants took part in up to 4 different modalities of 2 courses: live, videocast, audiocast, and prerecorded computer-based format	Health professionals	Pre- and post-test knowledge tests (identical) for each modality in each course	No	**Mean score gains** *Course 1* Live = 1.44 Video = 1.00 Audio = 0.64 Computer = 0.20 Significant increases in live (p = 0.050) and video (p = 0.046) modes *Course 2* Live = 0.67 Video = 1.43 Audio = 1.60 Computer = 1.17 Significant increases in video (p = 0.000), audio (p = 0.000) and computer (p = 0.003) modes
Haythornthwaite[19]	Comparative	32 participants undertook training program delivered via videoconference with 20 completing assessment Face-to-face (*n* = 11)	Rural youth workers	Comparison of videoconference participants' pre- and post-scores on 2 knowledge modules (both out of 10) and satisfaction levels with outcomes previously achieved by face-to-face participants of same program. Only those results with significant differences were reported	No	**Mean improvement between pre- and post-scores** *Module 1 knowledge* Videoconference = 1.05 Face-to-face = 0.50 Significant improvement in videoconference group (p < 0.02)
Umble et al.[20]	Comparative	Videoconference (*n* = 116) Face-to-face (*n* = 196)	Health professionals	Comparison of 5 outcome indicators including knowledge (5 multiple choice questions with maximum score of 5) administered pre, immediately post, and at 3-month follow up	No	**Mean knowledge results** Face-to-face = 3.82, 4.48, 4.52 Videoconference = 2.68, 4.19, 4.24 Significant increases across all results (p < 0.001)

studies[8] delivered PowerPoint materials to remote participants via the internet. The first study[8] involved 110 surgical clerkship students, however only 12 of these students participated in the videoconferencing intervention. The second study[9] involved 15 community nurses, with the low sample sizes attributed to recruitment and facility capacity limitations.

One study compared the learning outcomes of 95 medical students allocated to either attend live lectures or use the internet to access and view the streamed lecture on a desktop computer.[10] The streamed lecture consisted of a PowerPoint presentation with optional audio accompaniment. The delivery mode was asynchronous, meaning that students could view the material at any time and there was no interaction between the lecturer and student. Summary post-test scores were almost identical (10.8 vs 10.7 out of a possible 16 for online and face-to-face modes, respectively); no statistically significant difference was found between the two modes of delivery.

The fourth controlled trial[11] compared face-to-face lectures with a digital lecture format, similar to streaming (but using the previous year's lectures sent to students in CD-ROM format), to compare performances of 29 third year medical students across two courses. Again, mean exam results for both courses were very similar between those who attended the face-to-face lectures (achieving 4.42 and 9.25 respectively) and those who utilised the distance learning format of the lectures (achieving 4.88 and 9.0 respectively).

The nine comparative studies[12–20] further reinforced comparable learning outcomes for face-to-face and tele-learning delivery formats. Of note, videoconferencing was the prominent tele-learning method utilised by the majority of the comparative studies. Studies involving participants from multidisciplinary neonatal care teams,[13] pharmacology,[15] medicine,[14,16] and nursing[17] all demonstrated that there was little or no difference in learning outcomes when comparing traditional classroom instruction with distance learning via interactive videoconference. While a study on mental health training for workers[19] based in rural centres found significant improvement in knowledge for the videoconference participants, similar learning outcomes were achieved across both groups.

One comparative study[18] assessed multiple tele-learning methods, including simultaneous videocast of the live lecture, simultaneous audiocast of the live lecture, and a pre-recorded computer-based format, with the live lecture format. Significant increases in knowledge gain were demonstrated across multiple delivery modes with evaluation of user feedback showing similar levels of interest and acceptability.

Another comparative study[20] of a large national immunisation continuing education course for the public health workforce in the United States demonstrated comparable outcomes for classroom and distance (satellite broadcasted) trained participants. The study concluded that classroom and distance delivery methods have comparable outcomes in continuing education and can foster the implementation of practice guidelines and recommendations.

Most of the included studies reported qualitative participant satisfaction results. In terms of satisfaction with tele-learning versus traditional face-to-face education models, participants routinely reported a high level of acceptability and satisfaction with tele-learning delivery models[11,13–15] but a preference for traditional face-to-face models.[10,12]

Discussion

The literature indicates that tele-learning can provide an effective means of delivering educational outcomes for health professionals.

The majority of the available literature on tele-learning is descriptive or observational. This review focused on randomised controlled trials and comparative studies. Caution must be taken when interpreting the results of these studies as they often lacked an established evaluation framework, and failed to control for independent variables such as participants' prior knowledge and ability, instructor experience and methods, and instructor and participant familiarity with technology. Limitations also included small sample sizes and non-random selection of participants.

Despite limited rigorous evidence, the available literature supports the notion that tele-learning methods achieve comparable learning outcomes when compared with traditional face-to-face learning methods.

Two studies indicated participant preference for more traditional face-to-face education delivery methods over tele-learning methods. However, the literature also indicated a high level of participant satisfaction with tele-learning methods, with many participants indicating that they would partake in future tele-learning opportunities or recommend these opportunities to others. Two studies reported a perception that tele-learning should only be used when face-to-face is not feasible and should complement rather than replace traditional teaching.[5,21] Therefore, like Birden and Page,[22] we could surmise that tele-learning is a useful adjunct to traditional learning methods.

Conclusion

The literature supports tele-learning as an effective means of delivering education that can achieve learning outcomes that are comparable to traditional face-to-face learning methods. The utility of tele-learning infrastructure for enabling distance learning opportunities should be considered. However, the limited availability of rigorous evidence highlights the need for further research to reinforce the equivalency of tele-learning delivery methods.

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References

1. Maeder A. Telehealth Standards Directions Supporting Better Patient Care. HIC 2008 Conference: Australia's Health Informatics Conference. Melbourne, Vic. Health Informatics Society of Australia.
2. Currell R, Urquhart C, Wainwright P, Lewis R. Telemedicine versus face to face patient care: effects on professional practice and health care outcomes. *Cochrane Database Syst Rev* 2000; (2): CD002098.
3. Moonen J. The efficiency of telelearning. *J Asynchronous Learn Netw* 1997; 1(2): 68–77.
4. Taylor JC. Distance education technologies: The fourth generation. *Australian Journal of Education Technology* 1995; 11(2): 1–7.
5. Naylor C, Madden DL, Neville L, Oong DJ. Pilot study of using a web and teleconference for the delivery of an Epi Info training session to public health units in NSW, 2005. *N S W Public Health Bull Supplementary Series* 2009; 20(2): 22–37.
6. Newman C, Martin E, McGarry DE, Cashin A. Survey of a videoconference community of professional development for rural and urban nurses. *Rural Remote Health* 2009; 9(2): 1134.
7. Sackett KM, Campbell-Heider N, Blyth JB. The evolution and evaluation of videoconferencing technology for graduate nursing education. *Comput Inform Nurs* 2004; 22: 101–6. doi:10.1097/00024665-200403000-00012
8. Stain SC, Mitchell M, Belue R, Mosely V, Wherry S, Adams CZ et al. Objective assessment of videoconferenced lectures in a surgical clerkship. *Am J Surg* 2005; 189(1): 81–4. doi:10.1016/j.amjsurg.2004.04.012
9. van Boxel P, Anderson K, Regnard C. The effectiveness of palliative care education delivered by videoconferencing compared with face-to-face delivery. *Palliat Med* 2003; 17(4): 344–58. doi:10.1191/0269216303pm753oa
10. Spickard A, Alrajeh N, Cordray D, Gigante J. Learning about screening using an online or live lecture: does it matter? *J Gen Intern Med* 2002; 17(7): 540–5. doi:10.1046/j.1525-1497.2002.10731.x
11. Solomon DJ, Ferenchick GS, Laird-Fick HS, Kavanagh K. A randomised trial comparing digital and live lecture formats. *BMC Med Educ* 2004; 4: 27. doi:10.1186/1472-6920-4-27
12. Latour MA, Collodi P. Evaluating the performance and acceptance of teleconference instruction versus traditional teaching methods for undergraduate and graduate students. *Poult Sci* 2003; 82: 36–9.
13. Loewen L, Seshia MM, Fraser Askin D, Cronin C, Roberts S. Effective delivery of neonatal stabilization education using videoconferencing in Manitoba. *J Telemed Telecare* 2003; 9(6): 334–8. doi:10.1258/135763303771005234
14. Markova T, Roth LM, Monsur J. Synchronous distance learning as an effective and feasible method for delivering residency didactics. *Fam Med* 2005; 37(8): 570–5.
15. Kidd RS, Stamatakis MK. Comparison of students' performance in and satisfaction with a clinical pharmacokinetics course delivered live and by interactive videoconferencing. *Am J Pharm Educ* 2006; 70(1): 10. doi:10.5688/aj700110
16. Bertsch TF, Callas PW, Rubin A, Caputo MP, Ricci MA. Effectiveness of lectures attended via interactive video conferencing versus in-person in preparing third-year internal medicine clerkship students for Clinical Practice Examinations (CPX). *Teach Learn Med* 2007; 19(1): 4–8.
17. Kerns AS, McDonough JP, Groom JA, Kalynych NM, Hogan GT. Televideo conferencing: is it as effective as "in person" lectures for nurse anesthesia education. *AANA J* 2006; 74(1): 19–21.
18. Chen T, Buenconsejo-Lum L, Braun KL, Higa C, Maskarinec GG. A Pilot Evaluation of Distance Education Modalities for Health Workers in the US – Affiliated Pacific Islands. *Developing Human Resources in the Pacific* 2007; 14(1): 20–8.
19. Haythornthwaite S. Videoconferencing training for those working with at-risk young people in rural areas of Western Australia. *J Telemed Telecare* 2002; 8: 29–33. doi:10.1258/13576330260440772
20. Umble KE, Cervero RM, Yang B, Atkinson WL. Effects of traditional classroom and distance continuing education: a theory-driven evaluation of a vaccine-preventable diseases course. *Am J Public Health* 2000; 90(8): 1218–24. doi:10.2105/AJPH.90.8.1218
21. Strehle EM, Earle G, Bateman B, Dickson K. Teaching medical students pediatric cardiovascular examination by telemedicine. *Telemed J E Health* 2009; 15(4): 342–6. doi:10.1089/tmj.2008.0120
22. Birden H, Page S. Teaching by videoconference: a commentary on best practice for rural education in health professions. *Rural Remote Health* 2005; 5(2): 356–63.

Environmentally sustainable health care: using an educational intervention to engage the public health medical workforce in Australia

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Abstract: Awareness of the benefits of environmentally sustainable health care is growing. In the United Kingdom in 2010, an educational intervention on sustainable health care was successfully delivered to public health registrars. We conducted a feasibility study to test the intervention in Australia. **Methods:** The intervention consisted of a 1-day workshop delivered face-to-face covering climate change, sustainability and health. The workshop was modified, piloted and then delivered to 33 health professionals. Modifications included using Australian resources, introducing active learning exercises and including guest speakers. Delivery by videoconference was trialled. Outcomes were assessed in three areas – awareness, advocacy and action – using questionnaires and follow-up telephone interviews. **Results:** There were improvements in participants' mean *awareness* and *advocacy* scores. All participants rated sustainability as 'important' for health professionals and many looked to their professional organisation to take a lead advocacy role on this issue. **Discussion:** This study demonstrated that the workshop is feasible for use in Australia; the modifications and delivery by videoconference were well received.

Provision of health care services is an energy intensive activity and the health sector is a major consumer of water, food, transport, pharmaceuticals, and other resources.[1,2] In aggregate, these resources and related waste products are the 'ecological footprint' of health care services. Health professionals need to understand the importance of planetary health for the future health and wellbeing of people[3,4] and work to ensure the delivery of sustainable forms of health care.

The health care sector would derive multiple benefits – health, financial, reputational and environmental – from taking a lead on sustainability. Environmentally sustainable health care requires the transformation of the health care sector – a shift from expensive and carbon-intensive delivery (e.g. excessive use of pharmaceuticals and single-use items) – towards more efficient use of resources and innovative models of care. Health professionals are central to both the design and delivery of health services and must advocate for, lead and help manage this transformation. Education about climate change and sustainability is slowly being incorporated into undergraduate health curricula,[5] and strategies such as the recent NSW Health Environmental Sustainability Strategy[6] should improve staff awareness of this issue. However, most health professionals have not been taught about sustainability and how they can both adapt their practice and support the health system to change.

In the United Kingdom (UK), the National Health Service (NHS) Sustainable Development Unit (www.sdu.nhs.uk) is tasked with assisting the NHS to become a leading low-carbon and sustainable health service. The Unit developed an educational intervention on sustainable health care and in 2010 delivered this to more than 200 UK Faculty of Public Health registrars, from both medical and non-medical backgrounds, through 15 workshops.[7] The intervention consisted of a 4-hour workshop and, using a train-the-trainer approach, provided participants with resources and encouragement to run further workshops themselves. At the end of the workshop, the participants were asked to pledge to take action and a sample were followed up to determine what action they had taken and why.

The current study sought to determine whether a modified version of this intervention was suitable for an Australian

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public health medicine audience, including specialist postgraduate trainees and established practitioners.

Methods

Permission was sought from the NHS Sustainable Development Unit to use the intervention and the supporting resources. They agreed to provide free access on the condition that it remained free access and that adaptation and further implementation was evaluated.

Literature review updated

A literature review conducted in late 2009 exploring the education and training of health professionals in sustainable health care informed the original development of the intervention. This was updated in 2011[8] through a search in PubMed using the terms 'climate change medical education', 'environmental sustainability medical education', 'climate change health education', 'climate change health professional development' and 'climate change health training'. As it was an update, the search was limited to the past 3 years and to English language papers ($n = 106$). Few papers of direct relevance were identified, and most of these were debate and discussion papers rather than presentations of original research. A number of the relevant papers were written by Australian authors, however these focused on the education of medical students as opposed to postgraduate training or the professional development of practitioners. Two papers called for doctors and health professionals to raise awareness and advocate on this issue.[9,10]

An additional search strategy used personal communication with colleagues engaged in the Sustainable Healthcare Education network (http://greenerhealthcare.org/sustainable-healthcare-education).

Updating the resources and adapting delivery

The intervention materials, in particular the major resource of a PowerPoint slide bank of approximately 130 slides, were updated and tailored for Australian participants. For example, local publications and research findings describing the health consequences of climate change for the Australian population were included. The train-the-trainer format of the workshops was retained. To encourage active learning and reflection by participants, a verbal self-rating exercise was introduced at the beginning and repeated at the end of the workshop (Box 1). Situational interest was enhanced through invited guest speakers describing the action they have taken to create sustainability initiatives within their local health system.[11] The workshop was piloted with 10 Fellows and Trainees of the Royal Australasian College of Physicians (RACP) working group on climate change and further refined on the basis of their feedback.

The final model consisted of a 4–5 hour workshop on climate change, sustainability and health. It was delivered face-to-face in three workshops held at the RACP Education Centre in Sydney in June 2011. For the final workshop, in addition to the face-to-face audience, a remote audience at seven sites around Australia was linked by videoconference.

Box 1. Self-ranking exercise

Participants were asked to rank themselves on how confident they felt to advocate on the issue of climate change, sustainability and health using a scale of 0 to 10, where 0 is not at all confident and 10 is extremely confident. Participants stood and positioned themselves along an imaginary line in the room and reflected with the group on how they ranked themselves.

This exercise was undertaken at the beginning of the workshop and then repeated again at the end, just before participants completed their evaluation forms.

Evaluation

To allow comparison of the results of the workshops held in the UK and Australia, the learning objectives were maintained and only minor changes made to the evaluation method[7] (e.g. feedback was sought on the modifications made to the workshop's format and delivery).

As in the original study, outcomes in the areas of awareness, advocacy and action were assessed, and these acted as surrogate measures of knowledge, attitudes and practices. Levels of *awareness* and *advocacy* were measured using a questionnaire administered on arrival at the workshop (baseline) and again at the end of the workshop (post-intervention). The respondents self-rated their levels of awareness (10 statements) in relation to statements about climate change (basic science and health effects), sustainability, the carbon footprint of the NHS (the carbon footprint of the Australian health system has not been measured, however it is likely to be comparable to that of the UK), and the roles and responsibilities of health professionals using a four-point modified Likert scale (from 'not at all aware' to 'strongly aware'). They also rated their ability to advocate (10 statements) using a four-point Likert scale (from 'strongly disagree' to 'strongly agree'). The participants' baseline and post-intervention questionnaire scores were compared as pairs of matched questionnaires.

This study included, at the end of the questionnaire, two closed questions that explored the participants' perception of the importance of this issue to health professionals; one open-ended question that asked what role they would like their professional body to take on this issue; and three open-ended questions that sought their general feedback on the workshop.

The *action* objective was evaluated by conducting telephone interviews 3 months after the intervention with a random sample of five participants (covering all three workshops). The interview consisted of 10 semi-structured questions and lasted approximately 30 minutes. Interviewees were asked whether and to what extent they had achieved their pledged actions; they were encouraged to speak freely about their experiences and their opinions on this issue. The responses were collated and a framework analysis conducted to identify the emerging themes. Both the interviews and analysis were conducted by the first author.

Results

Awareness and advocacy

Across the three workshops there were 33 participants; the majority were Fellows and Trainees of the Australasian Faculty of Public Health Medicine (AFPHM), the target audience, but there were also general practitioners and other medical specialists present. There were 23 completed, matched questionnaires (response rate: 70%). Several people arrived late or left the workshop early and so did not complete both questionnaires, and some videoconference participants did not return their questionnaires.

The mean improvement in participants' self-reported levels of *awareness* was 11.1 points, and in *advocacy* was 9.1 points. Given that there were 10 awareness questions, with four possible Likert-scale responses, these results indicate that, on average, participants moved up one whole 'point' on the awareness scale on every question, as a result of the workshop. For example, in response to the question 'I could explain the basic science of climate change' the participant may have moved from 'disagree' to 'agree'. There were also 10 advocacy questions, and so the results for those were similar. Interestingly, these results are very similar to those documented in the UK in 2010.[7]

As part of the advocacy objective, one of the aims of the project was for participants to subsequently facilitate a similar session themselves. Of the five participants followed up by telephone at 3 months, two had facilitated a session.

The workshop: how to engage and challenge participants

Nearly all (97%) participants rated the workshop as either 'extremely useful' or 'useful', with an even split between the two rankings. Participants cited the 'train-the-trainer' approach and the expectation of adopting an advocacy role and acting on this issue as being "empowering", for example: "[it is] our responsibility" to "take concrete action". The discussion topics that caught their attention were: the focus on sustainability rather than climate change; the per capita carbon footprints of countries (Australia's is amongst the highest in the world); and the realisation that climate change is an issue of social justice and health inequity. Framing the issue positively and focusing on the co-benefits for health were valued.

Professional and public perceptions of sustainability

When asked their opinion about sustainability, 82% of participants rated it as 'extremely important' for health professionals (with the remaining 18% rating it as 'important'). In response to an open-ended question about what role participants would like their professional body (the RACP or AFPHM) to take on this issue almost every participant (93%) answered and the majority (85%) stated that they would like the College/Faculty to take a professional lead and/or adopt a public advocacy role on this issue.

Reflection on pledged actions

In reply to the question, 'To what extent have you achieved your actions?' three of the five people interviewed responded, 'somewhat'. The most common reasons for not achieving actions were lack of time, and being a newcomer and relatively junior at their workplace. These results were comparable with those from the UK study.

A clear difference with the UK responses was the comments regarding the public perception of climate change. Three of the five Australian interviewees commented upon the "poor level of discussion" in Australia about the carbon tax and climate change in general; one person noted that people advocating action on climate change are often regarded as "radical". To tackle this, interviewees suggested: focusing on sustainability (rather than climate change) and on the health co-benefits, and for support, forming an action group rather than acting as individuals.

Videoconferencing the intervention

Videoconferencing delivery was logistically and technically successful, and remote participants engaged well throughout the session. Remote participants were asked to scan and email their questionnaires to the facilitator however the response rate for this group was low. The feedback received, however, was positive.

Discussion

This study was limited by its small size, and in particular the small number of telephone interviews conducted. However, its objective was modest: to assess the feasibility of adapting a proven educational intervention to an Australian public health audience. The improvements in participants' awareness and advocacy scores, the fact that the workshops were well received, and participants' support for action on this issue, suggest that this is a feasible model for Australia.

The modifications to the workshop helped to build an environment for active learning and reflection (self-ranking exercise and the use of at least one local guest speaker as part of each workshop). These provided a source of situational interest to stimulate learning and motivate participants.[11,12]

The workshop is relevant to rural, remote and metropolitan health practitioners. To enable accessibility of the workshop for these health practitioners in Australia, the acceptability of videoconferencing as a mode of delivery is relevant.[13]

Many of the themes that emerged from the open-ended evaluation questions were similar to those in the UK study.[7] Many of the differences appear to stem from a frustration among Australian participants about the lack of national political leadership for systematic change on this issue. There are different political and legislative contexts for action on climate change in the UK and Australia. In the UK, there is continuing bipartisan support for action, and the current Conservative-led Government pledged to be "the greenest government ever".[14] The UK *Climate Change Act* (2008)[15] provided the impetus for the NHS carbon reduction targets and the health sector is required to report regularly to Parliament, along with all other sectors, on the success of carbon reduction strategies. The first of these reports was tabled this year.[16] Meanwhile the NHS, the Department of Health (England), many of the medical colleges including the Royal College of Physicians and the Royal College of General Practitioners, the Faculty of Public Health, and leading medical journals such as the *British Medical Journal* and *The Lancet*, are championing this issue.

A supportive environment is developing in New South Wales. The State Government Sustainability Policy sets targets and strategies that include sustainability measures to reduce greenhouse gas emissions.[17] Nationally, the work of the Climate Commission[18] has supported evidence-informed action, while the formation of the Climate and Health Alliance (http://caha.org.au/) creates a collective voice for health and public health organisations. The workshops described in this paper and supported by the AFPHM and the RACP contribute to both raising the awareness of public health professionals and encouraging them to advocate for change within their own workplaces. In order to affect widespread change in the health care system, other health professionals, including practicing clinicians, will need to become informed and active on this critical health issue.

Conclusion

Sustainability is a 'good news' story for health; it encompasses a focus on preventive care, healthier lifestyles, more efficient resource use and less waste, futures planning and innovative models of care and service delivery, including greater use of information communication technology. It represents an opportunity for health professionals to help to transform health care and the systems through which it is delivered. The workshops described in this paper have the potential to engage the public health workforce in Australia with the challenge of achieving environmentally sustainable health care.

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References

1. Healthy Hospitals, Healthy Planet, Healthy People. Addressing climate change in health care settings [Discussion Draft]. World Health Organization & Health Care Without Harm. Available at: http://www.who.int/globalchange/publications/climatefootprint_report.pdf (Cited 5 August 2013).
2. Pencheon D, Rissel CE, Hadfield G, Madden DL. Health sector leadership in mitigating climate change: experience from the UK and NSW. *N S W Public Health Bull* 2009; 20(11–12): 173–6.
3. Boyden S. The Biology of Civilisation: Understanding Human Culture as a Force in Nature. Sydney: UNSW Press; 2004.
4. Rockström J, Steffen W, Noone K, Persson A, Chapin FS 3rd, Lambin EF et al. A safe operating space for humanity. *Nature* 2009; 461: 472–5. doi:10.1038/461472a
5. Barna S. Teaching Sustainable Healthcare in English Medical Schools Survey 2010 – Summary of Results. Sustainable Healthcare Education Network. Available at: http://greenerhealthcare.org/sustainable-healthcare-education/resources/2012/02/teaching-sustainable-healthcare-english-medical-s (Cited 5 August 2013).
6. Health Environmental Sustainability Strategy NSW. 2012 to 2015. Available at: http://www0.health.nsw.gov.au/pubs/2012/pdf/env_sus_strat201215.pdf (Cited 29 August 2013).
7. Charlesworth KE, Ray S, Head F, Pencheon D. Developing an environmentally sustainable NHS: outcomes of implementing an educational intervention on sustainable health care with UK public health registrars. *N S W Public Health Bull* 2012; 23(1–2): 27–30. doi:10.1071/NB11018
8. Charlesworth K, Madden L, Capon A, Englehard S. Climate Change, Sustainability and Health – Workshops for Medical Professionals: Evaluation Report. July 2011, Australasian Faculty of Public Health Medicine. Available at: http://www.racp.edu.au/page/racp-faculties/australasian-faculty-of-public-health-medicine/news-and-events/reports/ (Cited 5 August 2013).

9. Green EI, Blashki G, Berry HL, Harley D, Horton G, Hall G. Preparing Australian medical students for climate change. *Aust Fam Physician* 2009; 38(9): 726–9.

10. Sarfaty M, Abouzaid S. The physician's response to climate change. *Fam Med* 2009; 41(5): 358–63.

11. Rotgans JI, Schmidt HG. Situational interest and academic achievement in the active-learning classroom. *Learn Instr* 2011; 21: 58–67. doi:10.1016/j.learninstruc.2009.11.001

12. Schraw G, Lehman S. Situational interest: a review of the literature and directions for future research. *Educ Psychol Rev* 2001; 13(1): 23–52. doi:10.1023/A:1009004801455

13. Tomlinson J, Munro A, Johnson R, Madden DL, Phillips R, McGregor D et al. How does tele-learning compare with other forms of education delivery? A systematic review of tele-learning educational outcomes for health professionals. *N S W Public Health Bull* 2013; 24(2): 70–5.

14. British Prime Minister David Cameron pledges that his government will be, "the greenest government ever" when speaking to civil servants at the Department of Energy and Climate Change, London, May 2010. Available at: http://www.guardian.co.uk/environment/2010/may/14/cameron-wants-greenest-government-ever (Cited 5 August 2013).

15. Climate Change Act 2008 (c.27), House of Lords Hansard Vol.705 Col.1477, House of Commons Hansard Vol.485 Col.855. London: HMSO (26 November 2008).

16. UK Climate Change Risk Assessment. Government Report. Department for Environment, Food and Rural Affairs (United Kingdom). London: The Stationery Office; January 2012. Available at: http://www.defra.gov.uk/publications/2012/01/26/pb13698-climatechange-riskassessment/ (Cited 5 August 2013).

17. NSW Government Sustainability Policy. Department of Environment & Climate Change NSW, 2008. Available at: http://www.environment.nsw.gov.au/government/policy.htm (Cited 5 August 2013).

18. Hughes L, McMichael T. The Critical Decade: Climate Change and Health. Commonwealth of Australia (Department of Climate Change and Energy Efficiency), 2011. Available at: http://climatecommission.gov.au/wp-content/uploads/111129_FINAL-FOR-WEB.pdf (Cited 5 August 2013).

Knowledge and beliefs about alcohol consumption, longer-term health risks, and the link with cancer in a sample of Australian adults

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Abstract: Aim: This study explores knowledge and beliefs about longer-term health risks related to alcohol consumption among Australian adults. **Methods:** Data were drawn from the 2009 Cancer Institute NSW Lifestyle and Cancer Survey, a telephone survey of adults in NSW. Participants ($n = 1255$) were asked about their alcohol consumption, knowledge of the Australian guidelines (revised in 2009), and personal perceptions and beliefs about longer-term health risks from alcohol consumption. **Results:** Seventy-eight percent of the sample drank alcohol either occasionally or weekly, with 37% of drinkers drinking above the current Australian guidelines (two standard drinks on any day). Two-thirds (67%) correctly nominated the maximum number of standard drinks per day that met the current Australian guidelines, and a similar proportion (64%) agreed that regular moderate alcohol consumption can have serious health consequences in the longer term. Knowledge of the guidelines and longer-term health consequences was lower for drinkers, especially those drinking above the guidelines. Less than half (48%) of the participants were aware that drinking alcohol could cause cancer and 51% were aware that limiting alcohol intake helps prevent cancer. **Conclusion:** The current Australian guidelines, the longer-term health risks and the link with cancer are not well understood, especially by those who drink frequently and above the guidelines.

Alcohol has a range of chronic effects on health, including cardiovascular disease, cirrhosis of the liver, diabetes and cancer.[1–5] It is estimated that 5% of all cancers diagnosed each year in Australia are attributable to long-term chronic use of alcohol.[6] Australian per capita consumption of alcohol is high by world standards.[7,8] Current Australian guidelines for the consumption of alcohol (revised in 2009) state that there is no level of alcohol consumption that can be guaranteed as safe or risk-free and that in order to minimise the risk of alcohol-related harm (i.e. injury, disease and death), healthy men and women should not drink more than two standard drinks on any day.[9] This represents a downward revision for men (from four to two drinks a day) from the previous guidelines.[10] Furthermore, the guidelines state that drinking less frequently over a lifetime (e.g. drinking weekly rather than daily) considerably reduces the risk of alcohol-related harm and disease.

A UK study conducted in 2009 found that only 14% of adults recognised alcohol consumption as a cancer risk factor[11] but, to date, there has been very little published Australian research investigating public knowledge of the link between alcohol and longer-term health risks.[12] This study aimed to assess the public's: (a) understanding regarding 'safe' levels of alcohol consumption in relation to minimising the risks of longer-term alcohol-related harm; (b) knowledge and beliefs about the longer-term risks of alcohol consumption; and (c) recognition of personal longer-term health risks from alcohol consumption.

Methods

Data were drawn from the 2009 Cancer Institute New South Wales (NSW) Lifestyle and Cancer Survey, a telephone survey of NSW adults (aged 18 years and over) conducted to monitor beliefs, attitudes and behaviours relating to cancer preventive lifestyle factors. Households were recruited through list-assisted random digit dialling (of landline telephone numbers only) and a random selection procedure was used for selecting a participant within the household. An overall response rate of 15% was achieved (American Association for Public Opinion Research response rate #4).[13] This survey contained multiple modules on lifestyle behaviours and cancer with a total sample size of 1508; analyses for this paper were limited to the participants who responded to questions from the module on alcohol ($n = 1255$). Sample

demographics are shown in Table 1. Data were weighted for the probability of selection, based on the age and gender distribution of the NSW population.[14]

Measures

Alcohol consumption

All participants were asked how often they drank alcohol (at least once a week, less than once a week, I don't drink alcohol) and, if they drank at all, how many standard drinks they would usually consume during a typical drinking occasion. A standard drink was defined for participants as one middy (285 mls) of full-strength beer, one schooner (425 mls) of light beer, one small glass (or standard serve) of wine (100 mls), or one pub-sized nip (30 mls) of spirits. Those who drank at least once a week (hereafter 'weekly drinkers') were also asked on how many days they would drink during a typical week. To facilitate analysis, weekly drinkers were grouped into four categories based on the current Australian guidelines according to their frequency and level of consumption (Table 2).

Table 1. Sample characteristics, participants for alcohol module, Cancer Institute NSW Lifestyle and Cancer Survey, 2009, unweighted

	Total sample ($n = 1255$) *n* (%)[a]
Gender	
Male	604 (48.2)
Female	650 (51.8)
Age (years)	
18–29	262 (21.2)
30–44	341 (27.5)
45–64	401 (32.3)
65+	235 (19.0)
Income	
<$40 000	347 (32.0)
$40 000–$80 000	295 (27.2)
>$80 000	443 (40.8)
Education	
<High school	273 (21.9)
High school	528 (42.3)
Tertiary	447 (35.8)
Household includes children	
No	760 (60.7)
Yes	493 (39.3)

[a]Proportion of those who responded to the question.

Knowledge relating to 'safe' levels of alcohol consumption

Participants were asked the maximum number of standard drinks an adult male/female could have on any day without significantly increasing their risk of health problems in the longer term.

Knowledge and beliefs about health effects of alcohol consumption

All participants were asked whether they thought cancer, heart disease, diabetes, high cholesterol, liver problems, digestive problems, and overweight/obesity could result from drinking too much alcohol. They were also asked whether they agreed that "Regular moderate alcohol consumption can have serious health consequences in the long term" (1 = disagree strongly to 5 = agree strongly; dichotomised into agree strongly/somewhat vs other) and "Limiting your alcohol intake helps prevent cancer" (agree strongly/somewhat vs other).

Perceptions of personal risk from alcohol consumption

Participants were asked if they agreed with the following statements: "I should be drinking less alcohol than I currently drink" (agree strongly/somewhat vs other), and "What do you think is the likelihood of becoming seriously ill from your drinking if you continue to drink alcohol at your current level?" (definitely/probably will vs other).

Covariates

Covariates of interest were gender, age, household income, education, and whether there were any children aged 17 years and under living in the household.

Statistical analyses

Chi-squared analyses were conducted to examine socio-demographic differences between weekly drinkers and

Table 2. Categories of participants who drank at least once a week ('weekly drinkers') according to frequency and level of alcohol consumption, Cancer Institute NSW Lifestyle and Cancer Survey, 2009

		Frequency of alcohol consumption	
		Drinks 1–3 days/week	Drinks 4–7 days/week
Typical level of alcohol consumption	Drinks within recommended guidelines (<=2 standard drinks a day)	Category A	Category B
	Drinks above guidelines (>2 standard drinks a day)	Category C	Category D

non-drinkers, and between weekly drinker categories. Multiple logistic regression analyses were used to determine associations between the levels of drinking and the following outcomes: (a) knowledge of the current guidelines for alcohol consumption; (b) knowledge about the long-term health risks of moderate alcohol consumption; (c) recognition that alcohol can cause cancer; (d) belief that limiting alcohol intake helps prevent cancer; (e) belief that they should be drinking less than current consumption; and (f) belief that they could become seriously ill from current drinking. For each of these outcomes, two analyses including all covariates were conducted. The first included the full sample while the second used only the sample of weekly drinkers. The analyses were generated using SAS (version 9.2, SAS Institute, Cary, NC).

Results

Alcohol consumption

Almost half of all participants drank alcohol at least once per week while 22% reported that they did not drink alcohol at all (Table 3). Over half the men were weekly drinkers, compared to 40% of women. Those participants aged 45–64 years, tertiary educated, high income, or with no children in their household were more likely to be weekly drinkers.

The proportion of all drinkers who were drinking above the current guidelines was 37%. Of the weekly drinkers, 43% were drinking above the guidelines (Categories C and D). Over half of the men who drank at least weekly were drinking above the guidelines, as were over three-quarters of those aged 18–29 years. The greatest proportion of tertiary educated participants were in Category A (i.e. drinking within the recommended guidelines), while around half of participants with lower levels of education were drinking above the guidelines (Categories C or D).

Correct knowledge of Australian guidelines

Sixty-seven percent of participants correctly nominated the maximum number of standard drinks per day that met the current Australian guidelines; that is, between zero and two. Drinkers were less likely to know the correct amount that meets the guidelines than non-drinkers (Table 4). In addition, those drinking above the guidelines (Category C and D) were less likely to know the guidelines than those in Category A (Table 5).

Long-term harms of alcohol consumption

Approximately two-thirds (64%) of participants agreed that regular moderate alcohol consumption can have

Table 3. Current alcohol consumption by socio-demographic indicators, Cancer Institute NSW Lifestyle and Cancer Survey, 2009

	Total sample (n = 1255)				Weekly drinkers (n = 646)				
	Never (%)	Less than weekly (%)	Weekly (%)	p-value	Category A (%)	Category B (%)	Category C (%)	Category D (%)	p-value
Total	22.0	29.6	48.4	–	33.2	24.1	24.1	18.6	–
Gender									
Male	14.8	28.1	57.2		24.7	21.4	32.9	21.1	
Female	28.6	31.0	40.4	<0.01	40.7	22.0	25.7	11.6	<0.01
Age (years)									
18–29	26.2	34.4	39.4		15.9	8.6	65.5	10.0	
30–44	19.0	35.8	45.2		36.5	13.1	35.7	14.7	
45–64	18.8	24.4	56.9		33.5	22.1	22.9	21.5	
65+	28.2	23.3	48.5	<0.01	30.5	45.3	7.0	17.2	<0.01
Income									
<$40 000	32.4	30.5	37.1		29.9	23.9	31.5	14.8	
$40 000–$80 000	22.1	31.2	46.7		33.4	21.7	27.9	17.1	
>$80 000	12.7	26.5	60.9	<0.01	30.2	19.2	33.8	16.8	0.85
Education									
<High school	31.9	26.8	41.4		26.9	26.6	22.4	24.1	
High school	19.5	32.3	48.2		24.7	19.1	39.2	17.0	
Tertiary	18.4	28.3	53.3	<0.01	40.6	21.8	23.6	13.9	<0.01
Household includes children									
No	22.8	26.7	50.5		30.1	26.9	24.7	18.3	
Yes	20.6	34.0	45.4	0.02	33.7	12.8	38.7	14.8	<0.01

NB: Percentages may not add to 100 due to rounding; p-values are from chi-square tests.

Table 4. Correct knowledge of the alcohol guidelines, attitudes towards the long-term harms of alcohol consumption and perceived personal risk, by alcohol consumption (all participants), Cancer Institute NSW Lifestyle and Cancer Survey, 2009

	Total sample ($n = 1255$)	Never ($n = 224$)			Less than weekly ($n = 295$)			Weekly ($n = 564$)		
	%	%	OR	CI	%	OR	CI	%	OR	CI
Correct knowledge of recommendations (0–2 standard drinks/day)	67	84	1	–	73	0.51**	0.32–0.83	57	0.25**	0.16–0.39
Regular moderate alcohol consumption can have serious health consequences in the long term (agree)	64	83	1	–	69	0.44**	0.29–0.68	59	0.35**	0.23–0.52
Alcohol can cause cancer (agree)	48	53	1	–	49	1.10	0.78–1.57	52	1.01	0.73–1.41
Limiting your alcohol intake helps prevent cancer (agree)	51	54	1	–	56	0.92	0.64–1.31	49	0.69*	0.50–0.97
I should be drinking less than I currently drink (agree) – *all drinkers only* ($n = 857$)	36	n/a	n/a	n/a	21	1	–	47	4.00**	2.85–5.61
I am likely to become seriously ill from my current drinking (definitely/probably will) – *all drinkers only* ($n = 859$)	14	n/a	n/a	n/a	9	1	–	17	2.56**	1.61–4.07

NB: Controlled for gender, age, income, education, children in household.
OR = odds ratio; CI = confidence interval.
*p < .05, ** p < .01.

Table 5. Correct knowledge of the alcohol guidelines, attitudes towards the long-term harms of alcohol consumption and perceived personal risk, by alcohol consumption (weekly drinkers only), Cancer Institute NSW Lifestyle and Cancer Survey, 2009

	Weekly drinkers ($n = 564$)											
	Category A			Category B			Category C			Category D		
	%	OR	CI	%	OR	CI	%	OR	CI	%	OR	CI
Correct knowledge of recommendations (0–2 standard drinks/day)	71	1	–	57	0.63	0.37–1.06	54	0.56*	0.34–0.92	36	0.27**	0.15–0.49
Regular moderate alcohol consumption can have serious health consequences in the long term (agree)	61	1	–	51	0.72	0.44–1.18	73	1.53	0.94–2.49	41	0.46**	0.27–0.79
Alcohol can cause cancer (agree)	53	1	–	56	1.04	0.64–1.70	44	1.34	0.84–2.12	60	0.85	0.50–1.46
Limiting your alcohol intake helps prevent cancer (agree)	48	1	–	44	1.07	0.65–1.78	54	1.00	0.63–1.59	46	1.04	0.60–1.78
I should be drinking less than I currently drink (agree)	28	1	–	52	4.18**	2.44–7.19	49	2.23**	1.36–3.63	73	9.42**	5.09–17.45
I am likely to become seriously ill from my current drinking (definitely/probably will)	11	1	–	12	1.28	0.59–2.74	19	1.38	0.70–2.72	32	4.25**	2.10–8.60

NB: Controlled for gender, age, income, education, children in household.
OR = odds ratio; CI = confidence interval.
*p < .05, ** p < .01.

serious health consequences in the longer term. Drinkers were less likely to agree than non-drinkers. Similarly, Category D drinkers were less likely to agree than Category A drinkers.

Only 48% of participants were aware that drinking too much alcohol could cause cancer. Participants' awareness varied in relation to the effect of alcohol on heart disease (79%), diabetes (70%), high cholesterol (54%), liver problems (98%), digestive problems (76%), and being overweight or obese (89%). There were no significant differences between drinkers and non-drinkers, or between any of the weekly drinker categories, in relation to knowledge of the causal link between alcohol and cancer.

Further, half of the participants agreed that limiting alcohol intake helps prevent cancer (51%). Weekly drinkers were less likely than non-drinkers to agree.

Perceived personal risk

Just over one-third of drinkers agreed that they should be drinking less than they currently drink (36%). Weekly drinkers were four times more likely than occasional drinkers to agree that they should be drinking less. Category B, C and D drinkers were similarly more likely to agree than Category A drinkers.

Weekly drinkers were over two times more likely to believe they would become seriously ill from their current drinking than occasional drinkers. Category D drinkers were more likely to agree with this statement than those in Category A.

Discussion

These results suggest a substantial knowledge deficit among many adults in relation to the current recommendations for alcohol consumption, as well as the link between longer-term health risks and moderate alcohol consumption. There is a clear need to address alcohol consumption, particularly among those aged 18–44 years, those with lower levels of education, and men.

There is evidence that, while many national health organisations have guidelines for moderate alcohol consumption, people in these countries either do not know or are confused by these guidelines.[12,15,16] Despite the fact that approximately two-thirds of the sample correctly nominated the amount that met the recommended guidelines for alcohol consumption, drinkers were generally less likely to correctly identify the recommendations, as were those weekly drinkers who drank above the guidelines. While it is important to note that these findings may have been influenced by the introduction of current guidelines in the same year as the survey, they still suggest a need to increase awareness of the current guidelines for alcohol consumption.

Of concern was that, despite mounting evidence, about one-third of the sample did not agree that regular moderate alcohol consumption can have serious health consequences in the long term. Furthermore, there was an association between alcohol consumption and recognition of the longer-term impact of drinking, suggesting either a knowledge deficit in drinkers, especially heavier drinkers, or self-exempting beliefs, in that drinkers are less likely to want to recognise that their behaviour is putting them at risk. The implication from either of these scenarios would be that increasing the awareness and belief of these drinkers of the long-term health consequences of their drinking would be an important component in a strategy to reduce consumption.

In our study, participants' definition of 'moderate drinking' was not assessed. Other research has identified some confusion over what constitutes 'moderate' drinking[16] and that heavier drinkers have been found to have an inflated definition of moderate drinking.[17] In our study, while the heaviest drinkers were the most likely to recognise that they should drink less than they currently drink, it may be that even if these heavier drinkers reduced consumption to what they perceive as 'moderate', it may not be to a level sufficient to significantly reduce their risk of long-term harm. Future research should investigate the public's understanding of 'moderate drinking'.

Our findings also suggest that recognition of cancer as a possible long-term consequence of alcohol is also an issue to address and add weight to existing evidence that understanding of cancer risk from alcohol consumption is poor.[18] It is possible that public knowledge of long-term harms of alcohol consumption may be confounded by some evidence suggesting beneficial effects of alcohol.[16] This is despite the fact that the clinical consensus is that people do not need to take up or maintain drinking for health benefits since alternative means of preventing heart and vascular disease are available.[7] There is therefore scope for further research exploring cancer as a motivator to reduce or abstain from alcohol consumption.

A major limitation of the study is the low response rate. This was impacted by a short fieldwork period (3 weeks) prior to the launch of a campaign and therefore an inability in many cases to contact the randomly selected adult in the household. Additionally, the length of the survey (approx. 26 mins) may have acted as a deterrent for some potential respondents. Despite our sample having more tertiary educated people than would be expected compared to the NSW population,[19] the levels of alcohol consumption in this sample correspond closely to the levels reported in more representative studies.[20] Secondly, this study relied on self-reported alcohol consumption, which may be subject to recall bias, especially as most alcoholic beverages are not served as the equivalent of one standard drink. This means that participants may have significantly underreported their actual consumption if they simply reported how many *drinks* they usually consume, rather than calculating the number of *standard drinks*. Participants' understanding of the term 'standard drink' was not assessed in this survey but there is some evidence from other studies showing that understanding of a standard drink is often poor and that, as a result, drinks are commonly over-poured and consumption underreported.[21,22]

Conclusion

Our results validate the need for continued efforts to reduce alcohol consumption among adults. New initiatives should target those aged 18–44 years, men, and those with lower levels of education. Implementation of well-resourced

public education initiatives would be expected to contribute to a reduction in the burden of cancer and other alcohol-related disease.

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References

1. World Health Organization. Global status report on alcohol and health. WHO; Geneva: 2011.
2. Danaei G, Vander Hoorn S, Lopez AD, Murray CJ, Ezzati M; Comparative Risk Assessment collaborating group. (Cancers). Causes of cancer in the world: comparative risk assessment of nine behavioural and environmental risk factors. *Lancet* 2005; 366(9499): 1784–93. doi:10.1016/S0140-6736(05)67725-2
3. Lewis S, Campbell S, Proudfoot E, Weston A, Cotter T, Bishop JF. Alcohol consumption and cancer risk. Cancer Institute NSW: Sydney; 2007.
4. World Cancer Research Fund/American Institute for Cancer-Research. Food, Nutrition, Physical Activity, and the Prevention of Cancer: a Global Perspective. AICR: Washington DC; 2007.
5. International Agency for Research on Cancer. Working Group on the Evaluation of Carcinogenic Risks to Humans. Alcohol drinking. In: IARC monographs on the evaluation of carcinogenic risks to humans. International Agency for Research on Cancer: Lyon. 1988; p. 1–378.
6. Winstanley MH, Pratt IS, Chapman K, Griffin HJ, Croager EJ, Olver IN et al. Alcohol and cancer: a position statement from Cancer Council Australia. *Med J Aust* 2011; 194(9): 479–82.
7. National Preventative Health Taskforce. Australia: the healthiest country by 2020. Technical Report No 3: Preventing alcohol-related harm in Australia: a window of opportunity. Commonwealth of Australia: Canberra; 2009.
8. Organisation for Economic Co-operation and Development (OECD). OECD health data: statistics and indicators for 30 countries. OECD: Paris; 2009.
9. National Health and Medical Research Council. Australian guidelines to reduce health risks from drinking alcohol. NHMRC: Canberra; 2009.
10. National Health and Medical Research Council. Australian Alcohol Guidelines: Health Risks and Benefits. NHMRC: Canberra; 2001.
11. Sanderson SC, Waller J, Jarvis MJ, Humphries SE, Wardle J. Awareness of lifestyle risk factors for cancer and heart disease among adults in the UK. *Patient Educ Couns* 2009; 74(2): 221–7. doi:10.1016/j.pec.2008.08.003
12. Australian Institute of Health & Welfare. 2004 National Drug Strategy Household Survey: detailed findings. AIHW: Canberra; 2005.
13. American Association for Public Opinion Research (AAPOR). Standard definitions: final dispositions of case codes and outcome rates for surveys. AAPOR: Lenexa, Kansas; 2011.
14. Australian Bureau of Statistics. Population by age and sex, Australian states and territories, June 2006. ABS: Canberra; 2007.
15. Lader D, Goddard E. Drinking: adults' behaviour and knowledge in 2006. Office for National Statistics: London; 2006.
16. Green CA, Polen MR, Janoff SL, Castleton DK, Perrin NA. "Not getting tanked": definitions of moderate drinking and their health implications. *Drug Alcohol Depend* 2007; 86(2–3): 265–73. doi:10.1016/j.drugalcdep.2006.07.002
17. Ogborne AC, Smart RG. Public opinion on the health benefits of moderate drinking: results from a Canadian National Population Health Survey. *Addiction* 2001; 96(4): 641–9. doi:10.1046/j.1360-0443.2001.96464113.x
18. Miles A, Redeker C, Pouli N. Beliefs about the level of smoking, alcohol intake and body mass index required to increase cancer risk. *Prev Med* 2010; 51(3–4): 340–1. doi:10.1016/j.ypmed.2010.06.014
19. Australian Bureau of Statistics. 2011 Census. Available at: http://www.censusdata.abs.gov.au/census_services/getproduct/census/2011/quickstat/1?opendocument&navpos=220 (Cited 4 September 2013).
20. Australian Institute of Health & Welfare. 2007 National Drug Strategy Household Survey: detailed findings. AIHW: Canberra; 2008.
21. Carruthers SJ, Binns CW. The standard drink and alcohol consumption. *Drug Alcohol Rev* 1992; 11(4): 363–70. doi:10.1080/09595239200185491
22. White AM, Kraus CL, Flom JD, Kestenbaum LA, Mitchell JR, Shah K et al. College students lack knowledge of standard drink volumes: implications for definitions of risky drinking based on survey data. *Alcohol Clin Exp Res* 2005; 29(4): 631–8. doi:10.1097/01.ALC.0000158836.77407.E6

Typhoid fever, NSW, 2005–2011

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Abstract: Aim: To examine trends in the incidence of typhoid fever in NSW to inform the development of prevention strategies. **Methods:** Typhoid fever case notification data for the period 2005–2011 were extracted from the NSW Notifiable Conditions Information Management System. Population incidence rates were calculated and analysed by demographic variables. **Results:** There were 250 case notifications of typhoid fever in NSW from 2005 to 2011, of which 240 are likely to have been acquired overseas. Case notifications remained relatively stable over the review period with the highest rates in Western Sydney Local Health District (10.9 per 100 000 population). Two-thirds (66.4%) of all case notifications are likely to have been acquired in South Asia, and about half of overseas-acquired case notifications were most likely to have been associated with travel to visit friends and relatives. Hospitalisation was required for 79.6% of cases where hospitalisation status was known. Prior typhoid vaccination was reported in 7% of cases in 2010 and 2011 where vaccination status was known. **Conclusion:** While typhoid fever rates remain low in NSW, case notifications of this preventable infection continue to be reported, particularly in travellers visiting friends and relatives in South Asia. Further research to better understand barriers to the use of preventive measures may be useful in targeting typhoid fever prevention messages in high-risk groups, particularly South Asian communities in NSW.

Typhoid fever is a systemic bacterial infection caused by the *Salmonella enterica* subsp. enterica serovar Typhi (commonly *S.* Typhi) and is primarily spread by the faecal-oral-route.[1] Typhoid fever typically presents as sustained fever, abdominal pain and headaches, with complications such as gastrointestinal bleeding occurring in 10–20% of untreated patients. The case fatality rate is less than 1% with appropriate antibiotic treatment.[2] Up to 10% of untreated patients continue to excrete *S.* Typhi for 3 months after symptoms resolve, and 1–4% of untreated patients continue to excrete *S.* Typhi for over 12 months and become chronic carriers.[1] Ongoing *S.* Typhi excretion is an important public health issue, particularly if the person works in an occupation associated with higher risk of transmission, such as food preparation.

S. Typhi causes a considerable burden of disease worldwide, particularly in low and middle income countries. The global annual incidence of typhoid fever in 2004 was estimated at 22 million cases, with 220 000 deaths.[3] The incidence of typhoid fever in developed countries has steadily declined over the past 50 years due to improved water quality and sanitation, with annual incidence rates of typhoid fever ranging from 0.13 to 1.2 cases per 100 000 population and almost all case notifications associated with international travel.[4] In Australia in 2011 there were 135 typhoid fever case notifications reported, equivalent to 0.6 per 100 000 population.[5]

People who travel to typhoid-endemic countries – such as India, Sri Lanka, Pakistan, Bangladesh and Nepal – to visit friends and relatives (VFR) have been shown to be at particular risk of acquiring typhoid fever infection.[6–8] These travellers are more likely to travel to rural areas that have poor sanitation, to stay for longer periods of time, and are less likely to adopt safe food and water practices.[4] A UK study considering both typhoid and paratyphoid fever found 88% of travel-associated case notifications involved VFR travel, and of these 89% were travellers of Indian, Pakistani or Bangladeshi ethnicity.[9]

Food and water precautions (such as not eating uncooked foods and only drinking boiled and bottled water) and personal hygiene (such as hand washing) are essential to prevent typhoid fever.[2,10] The Australian Technical Advisory Group on Immunisation also recommends vaccination for all people aged over 2 years who are travelling to an endemic region.[11]

International travel by New South Wales (NSW) residents is increasing. In 2011, there were 2.7 million short-term departures, an increase of 50% since 2005. VFR travel was the reason for almost one-quarter (23.5%) of these departures.[12] In this context, the present study examined trends in the incidence of typhoid fever in NSW from 2005 to

2011, and the importance of country of birth, place of travel, and vaccination status, in order to develop appropriately targeted prevention strategies.

Methods

Under the NSW *Public Health Act 2010*, hospitals and laboratories must notify cases of typhoid fever to NSW Health. Public Health Units investigate all case notifications of typhoid to: collect relevant risk information, identify the likely source of infection, and instigate control measures if necessary. Laboratory confirmation through isolation of *S.* Typhi in blood, urine, faeces or other clinical specimens is required before a case notification can be classified as typhoid.[13] Confirmed case notifications are entered onto the NSW Notifiable Conditions Information Management System (NCIMS). Data describing typhoid fever cases were extracted from NCIMS for the period 1 January 2005–31 December 2011, and cleaned and analysed using Microsoft Excel 2007. Missing data fields were reviewed, and fields related to travel and likely country of disease acquisition were completed by cross-referencing with free text information recorded in the 'Notes' field where available. Where travel to more than one country was recorded, country of likely disease acquisition was the typhoid-endemic country in which the case spent the most time.

A case was classified as overseas acquired where recent travel was reported prior to onset of illness, noting the incubation period for typhoid fever can be longer than 60 days.[13] These case notifications were assigned to one of six categories:

1. 'Confirmed VFR travel': the record clearly indicated the case travelled to the country of likely disease acquisition to visit friends and relatives.
2. 'Probable VFR travel': the case's country of birth was the same as the country of likely disease acquisition.
3. 'Possible VFR travel': the case's name had plausible associations to the country of likely disease acquisition, though the country of birth was different or unknown.
4. 'Non-VFR travel': the record clearly indicated the case travelled to the country of likely disease acquisition for a purpose other than visiting friends and relatives.
5. 'Immigrant': the record clearly indicated the case recently immigrated to Australia from the country of likely disease acquisition.
6. 'Unknown': the reason for recent travel was unknown.

Data describing 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] Annual notification rates by age group and Local Health District (LHD) were calculated using the year-end estimated population for LHDs and NSW as a whole, obtained from the 2006 Australian Census of Population and Housing and downloaded from the NSW Health Outcomes Information Statistical Toolkit (HOIST).

Descriptive analyses were performed for demographic variables (age, sex, country of birth), recent travel, country of likely disease acquisition, vaccination status and reasons for not being vaccinated, and hospitalisation status. Vaccination data were only available for 2010 and 2011, as vaccination status was not systematically recorded in the database before this.

Results

Annual case notifications and rates per 100 000 population by LHD are presented in Table 1. In NSW, there were 250 notifications of typhoid fever from 2005 to 2011. Annual rates remained stable, ranging from 0.4 per 100 000 population to 0.6 per 100 000 population. The highest numbers and rates of notifications were found in metropolitan Sydney, particularly in Western Sydney LHD.

The age distribution of cases is presented in Table 2. The average age of cases remained relatively stable over the period, ranging from 24 years in 2007 to 30 years in 2009. Three age groups (0–4 years, 20–24 years and 25–29 years) accounted for almost half (47.2%) of the total number of cases. Males accounted for 53.6% of notifications overall.

Two hundred and forty cases had recently travelled; all of these people were assumed to have acquired their infection overseas. Ten cases were locally acquired; six of these were contacts of another known or possible case, three were chronic carriers, and one worked in a laboratory and could have been exposed to the *S.* Typhi isolate at work. For the six cases who were contacts, it was not clear from their record if their contact was with a case who acquired the disease overseas or not.

Information describing country of birth was available for 221 (88.4%) typhoid fever cases (Table 3). Overall, 45.6% of cases were born in South Asia; this figure increases to 47.1% when locally-acquired case notifications are excluded. The country of likely disease acquisition was available for 230 of the 240 overseas-acquired case notifications (Table 3). Two-thirds (66.4%) of all typhoid fever case notifications were believed to have been acquired in South Asia: India (47.5%), Bangladesh (12.9%), and Pakistan (6.3%). Travel to Samoa was reported by 5.0% of cases.

Reason for travel could be classified for 204 (85.0%) overseas-acquired case notifications. Only one case (0.4%) was confirmed VFR travel, 116 (48.3%) were probable VFR travel, 68 (28.3%) were possible VFR travel and 11 (4.6%) were recent immigrants from typhoid-endemic countries. The other eight cases (3.3%) were non-VFR travel. Almost all cases in the 0–4-year age

Table 1. Number of case notifications and annual rate per 100 000 population of typhoid fever by Local Health District NSW, 2005–2011

Local Health District	2005	2006	2007	2008	2009	2010	2011	Total	Rate
Sydney	7	2	4	8	4	3	8	36	1.1
South Western Sydney	4	6	4	10	8	6	5	43	0.9
South Eastern Sydney	4	7	4	5	4	7	7	38	0.8
Illawarra Shoalhaven	1				1		1	3	0.1
Western Sydney	3	11	17	16	14	8	15	84	1.8
Nepean Blue Mountains	1	1	0	0	1	1	1	5	0.3
Northern Sydney	3	5	2	2	7	3	3	25	0.5
Central Coast	2	0	0	0	0	0	0	2	0.1
Hunter New England	0	0	0	0	2	0	2	4	0.1
Northern NSW	0	1	0	2	1	0	0	4	0.2
Mid North Coast	1	0	0	0	0	0	0	1	0.1
Murrumbidgee	0	0	1	0	1	0	0	2	0.1
Western NSW	0	0	0	0	1	0	0	1	0.1
Albury	0	0	0	0	1	0	0	1	0.3
Total	**26**	**33**	**32**	**43**	**45**	**29**	**42**	**250**	
Annual rate per 100 000	0.4	0.5	0.5	0.6	0.6	0.4	0.6	–	0.6

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

Table 2. Number of case notifications of typhoid fever by age, NSW, 2005–2011

Age group (years)	2005	2006	2007	2008	2009	2010	2011	Total	%
0–4	0	5	6	8	6	4	3	32	12.8
5–9	1	3	3	4	0	1	4	16	6.4
10–14	1	2	6	3	3	0	4	19	7.6
15–19	9	2	1	2	4	2	2	22	8.8
20–24	8	3	3	7	3	7	6	37	14.8
25–29	3	7	2	5	10	7	15	49	19.6
30–34	0	4	3	6	5	2	1	21	8.4
35–39	0	2	3	5	3	3	2	18	7.2
40–44	1	3	2	0	2	0	3	11	4.4
45–49	1	0	0	0	1	3	0	5	2.0
50–54	2	1	0	2	2	0	0	7	2.8
55–59	0	0	1	0	2	0	1	4	1.6
60–64	0	0	1	1	3	0	1	6	2.4
65+	0	1	1	0	1	0	0	3	1.2
Total	**26**	**33**	**32**	**43**	**45**	**29**	**42**	**250**	**100.0**

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

group could be classified as probable ($n = 7$, 24.1%) or possible ($n = 19$, 65.5%) VFR travel.

Hospitalisation status was recorded for 90.4% ($n = 226$) of all typhoid fever cases, with 79.6% ($n = 199$) of all cases requiring hospitalisation. No deaths were recorded. Vaccination status was reported for 55 (77.5%) of the 71 cases in 2010 and 2011. For five cases (7.0%), either the patient or their general practitioner reported that the patient had been vaccinated for typhoid; 50 cases (70.4%) reported they had not been vaccinated. Reasons for not being vaccinated were recorded for 30 (60%) of the 50 unvaccinated cases. The most common reasons cited were: choosing not to ($n = 10$), not considering ($n = 9$) or not knowing about vaccination ($n = 5$), and not believing there would be a risk staying with friends and family ($n = 2$).

Discussion

Consistent with estimates in other high income countries,[4,10] the incidence rate of typhoid fever in NSW is low and remained stable from 2005 to 2011 despite

Table 3. Typhoid fever cases by global region of birth and region of likely disease acquisition, NSW, 2005–2011

Global region	Region of birth		Region of likely acquisition	
	n	%	*n*	%
Australia and New Zealand	56	22.4	10	4.0
East and South East Asia	25	10.0	34	13.6
Europe and Central Asia	9	3.6	7	2.8
Latin America and the Caribbean	1	0.4	1	0.4
Middle East and North Africa	1	0.4	2	0.8
Pacific	11	4.4	17	6.8
South Asia	114	45.6	166	66.4
Sub-Saharan Africa	4	1.6	3	1.2
Missing	29	11.6	10	4.0
Total	**250**	**100.0**	**250**	**100.0**

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

increased international travel during this period. Typhoid fever has serious implications, as evidenced by the high rates of hospitalisation amongst cases. Despite moderate vaccine efficacy,[15] some of these case notifications could have been prevented through vaccination, as only 7% of typhoid cases in 2010 and 2011 reported receiving vaccination prior to travel.

Also similar to previous studies,[9,10] this review shows typhoid cases in NSW are strongly associated with travel to the South Asia region. In about half of cases, the most likely reason for travel is visiting friends and relatives. This group has been shown to face particular barriers in accessing pre-travel advice and taking precautions, including being unaware of the potential risks to their health in returning to their country of origin, language constraints, and financial considerations in accessing health care in Australia.[16] In particular, the associated out of pocket costs and short duration of immunity (3 years) may be disincentives to typhoid vaccination among at-risk groups.[11] Estimates of typhoid vaccine uptake amongst Australian travellers are not available, but studies from other developed countries also suggest uptake rates are low, especially among VFR travellers.[17]

The highest rates of typhoid fever were found in metropolitan Sydney LHDs, particularly Western Sydney LHD. Typhoid fever cases in this LHD have been analysed in greater depth in a separate review.[18] The higher rates in metropolitan LHDs most likely reflect the proportion of the population in these areas with links to typhoid-endemic countries. Targeted approaches to promoting typhoid fever prevention could be trialled and evaluated with these communities. Measures could include health professionals providing advice during routine health checks and working with multicultural health services to develop culturally and linguistically appropriate resources. Recent research indicates that community-based initiatives which use multicultural media and events can be an effective way to provide health education messages.[19]

Young adults appear to be at particular risk, which may reflect higher rates of international travel among this group.[20] The relatively large number of cases in children aged under 5 years – most of whom have VFR as a probable or possible reason for travel – underscores the need to promote typhoid fever prevention to parents.

Limitations to this study include the amount of missing data on variables such as country of birth and vaccination status, reliance on self or general practitioner reporting of vaccination status, and lack of definitive information on the reason for travel. Classification as a 'possible' VFR case based on last name was particularly subjective. Severe cases are more likely to be identified and investigated, which may have resulted in an overestimation of the hospitalisation rate in this group.

Conclusion

This study confirms that typhoid fever is an important public health problem, particularly for people of South Asian ethnicity who may be returning to the region to visit friends and relatives. Further research, including surveys of high-risk communities to better understand barriers to seeking pre-travel advice, and in the use of preventive measures, may be useful to inform targeted prevention strategies and further reduce the incidence of typhoid fever in NSW. Increasing adherence to food and water precautions and personal hygiene measures would have the added benefit of reducing the risk of other predominantly travel-related enteric infections such as paratyphoid fever, hepatitis A, hepatitis E, and shigellosis.

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References

1. Heymann DL, ed. Control of Communicable Diseases Manual. 19th ed. Washington: American Public Health Association; 2008.
2. Mandell G, Bennett J, Dolin R, eds. Mandell, Douglas and Bennett's Principles and Practice of Infectious Diseases. 7th ed. London: Churchill Livingstone; 2010.
3. Crump JA, Luby SP, Mintz ED. The global burden of typhoid fever. *Bull World Health Organ* 2004; 82(5): 346–53.
4. Connor BA, Schwartz E. Typhoid and paratyphoid fever in travellers. *Lancet Infect Dis* 2005; 5: 623–8. doi:10.1016/S1473-3099(05)70239-5
5. Australian Government Department of Health and Ageing. National Notifiable Diseases Surveillance System. Typhoid Notifications. Available at: http://www9.health.gov.au/cda/Source/CDA-index.cfm (Cited 3 May 2012).
6. Kidenya V, Ferson M. Typhoid and paratyphoid fever in south-eastern Sydney, 1992–1997. *Commun Dis Intell* 2000; 24: 233–6.
7. Wilson ME, Weld LH, Boogild A, Keystone JS, Kain KC, von Sonnenburg F et al. Fever in returned travellers: results from the GeoSentinel Surveillance Network. *Clin Infect Dis* 2007; 44(12): 1560–8. doi:10.1086/518173
8. Basnyat B, Maskey AP, Zimmerman MD, Murdoch DR. Enteric (typhoid) fever in travelers. *Clin Infect Dis* 2005; 41(10): 1467–72. doi:10.1086/497136
9. UK Health Protection Agency. Foreign travel-associated illness – a focus on those visiting friends and relatives. 2008 report. Available at: http://www.hpa.org.uk/Publications/InfectiousDiseases/TravelHealth/0812Foreigntravelassociatedillness/ (Cited 3 May 2012).
10. Crump JA, Mintz ED. Global trends in typhoid and paratyphoid fever. *Clin Infect Dis* 2010; 50(2): 241–6. doi:10.1086/649541
11. Australian Government Department of Health and Ageing and National Health and Medical Research Council. The Australian Immunisation Handbook. 9th edition. Available at: http://www.health.gov.au/internet/immunise/publishing.nsf/Content/Handbook-home (Cited 3 May 2012).
12. Australian Bureau of Statistics. Overseas Arrivals and Departures – Customised Data Report. 12 March 2012.
13. NSW Health. Typhoid response protocol for NSW Public Health Units. Sydney; 2004.
14. World Bank Country and Lending Groups. Available at: http://data.worldbank.org/about/country-classifications/country-and-lending-groups (Cited 3 May 2012).
15. Whitaker JA, Franco-Paredes C, del Rio C, Edupuganti S. Rethinking typhoid fever vaccines: implications for travelers and people living in highly endemic areas. *J Travel Med* 2009; 16(1): 46–52. doi:10.1111/j.1708-8305.2008.00273.x
16. Leder K, Tong S, Weld L, Kain KC, Wilder-Smith A, von Sonneburg 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
17. Angell SY, Cetron MS. Health disparities among travelers visiting friends and relatives abroad. *Ann Intern Med* 2005; 142(1): 67–72. doi:10.7326/0003-4819-142-1-200501040-00013
18. Blackstock SJ, Sheppeard VK, Paterson JM, Ralph AP. Typhoid and paratyphoid fever in Western Sydney Local Health District, NSW, January–June 2011. *N S W Public Health Bull* 2012; 23(7–8): 148–52. doi:10.1071/NB11041
19. Leder K, Lau S, Leggat P. Innovative community-based initiatives to engage VFR travelers. *Travel Med Infect Dis* 2011; 9(5): 258–61. doi:10.1016/j.tmaid.2011.09.002
20. Australian Bureau of Statistics. Overseas Arrivals and Departures, Australia, Dec 2011. Cat No 3401.0.

Challenges in the use of tests to diagnose tuberculosis infection

The Editors
NSW Public Health Bulletin

Dear Editors

Congratulations on the publication of the "Tuberculosis in NSW" edition (2013; 24(1)). It makes excellent reading on a disease that continues to smoulder in this country. However, there is one topic on which some authors appear unclear: the limitations of immunological tests for both tuberculosis (TB) disease and infection. I refer to the tuberculin skin test (TST) and interferon-gamma release assays (IGRAs), in particular the QuantiFERON-Gold In Tube® (QFT-Gold IT). Certainly Britton et al are correct in stating the unreliability of such tests in infants under the age of 2. Indeed, these tests have little application in diagnosing disease, but are the only diagnostic agents we have for infection. It is not good enough for authors to tell us that the TST is negative or positive since this means nothing in an investigation where we have to balance sensitivity against specificity. A TST threshold of 10 mm induration might be said to achieve this balance, but the QFT-Gold IT shows that it does not. Across the world, tuberculins are produced that are of different potency, are recommended to be given in different doses (not always 10 units), and a "positive induration" may be less than 10 mm. Therefore authors should be encouraged to tell us what dose of which tuberculin has achieved what degree of induration. Although IGRAs are reported as positive and negative, this is dependant on an arbitrary cut-off point. The criterion we use for a "positive" TST in Australia may be sensitive, but has poor specificity and for QFT-Gold IT, mediocre sensitivity, if good specificity. I am surprised that none of the articles dealing with TB infection mention the use of both tests being used together (except in the BCG-vaccinated), a strategy that we in Australia can surely afford.

John E. Thompson

Editor, *The Australian Tuberculosis Review*

The Editors
NSW Public Health Bulletin

Dear Editors

Thompson agrees that both the tuberculin skin test (TST) and interferon-gamma release assays (IGRAs) have little application in diagnosing tuberculosis (TB) disease, although they provide important information about likely *Mycobacterium tuberculosis* infection, as does a careful TB exposure history.[1,2] We acknowledge that choosing a TST induration cut-off represents a sensitivity and specificity trade-off. The use of variable cut-offs (5, 10 or 15 mm) depending on the likelihood of TB exposure (using lower values when the likelihood of *M. tuberculosis* infection is higher) has been advocated by the American Thoracic Society.[3] However, this rationale does not apply to TB-endemic areas where TB exposure risk is near universal. The World Health Organization (WHO) promotes a single cut-off of ≥10 mm (≥5 mm in immunocompromised individuals), using 5 tuberculin units (TU) of purified protein derivative (PPD) or equivalent, such as 2TU RT-23® (Statens Serum Institute, Denmark).[4] New South Wales uses 5TU (0.1 ml Tubersol®; Sanofi Pasteur, Toronto, Canada) with WHO aligned cut-offs.

Since PPD includes multiple peptides that are also found in BCG vaccine and non-tuberculous mycobacteria, TST specificity is compromised. The QuantiFERON-Gold In Tube® test (QFT-Gold IT) has improved specificity, especially in BCG-vaccinated individuals, but not all discordant results can be ascribed to poor TST specificity. Suboptimal QFT-Gold IT sensitivity is a concern, particularly in young children, while indeterminate results and blood sampling (which requires 3 ml of whole blood) pose additional challenges.[5,6] In the United Kingdom, National Institute for Health and Clinical Excellence (NICE) guidelines previously recommended a two-step process using TST for screening and QFT-Gold IT for confirmation, but revised guidelines encourage clinicians to consider preventive therapy in high-risk individuals who test TST positive and QFT negative.[7] Since the risk of disease progression, including disseminated forms of disease such as TB meningitis and miliary TB, is highest in young children (<2–3 years of age),[8] combined testing should be considered, with either positive test indicating likely *M. tuberculosis* infection. False-positive TST readings in BCG-vaccinated children remain problematic in this context. Research into better immunodiagnostic tests is a key research priority.

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References

1. Britton P, Perez-Velez CM, Marais BJ. Diagnosis, treatment and prevention of tuberculosis in children. *N S W Public Health Bull* 2013; 24(1): 15–21. doi:10.1071/NB12100

 10.1071/NB13012

2. National TB Advisory Committee. Position statement on interferon-gamma release assays in the detection of latent tuberculosis infection. *Commun Dis Intell* 2012; 36: 125–31.

3. American Thoracic Society. Targeted tuberculin testing and treatment of latent infection. *Am J Respir Crit Care Med* 2000; 161: S221–47. doi:10.1164/ajrccm.161.supplement_3.ats600

4. World Health Organization. Guidance for national tuberculosis programmes on the management of tuberculosis in children. Available at: http://whqlibdoc.who.int/hq/2006/WHO_HTM_TB_2006.371_eng.pdf (Cited 1 October 2013).

5. Mandalakas AM, Detjen AK, Hesseling AC, Benedetti A, Menzies D. Interferon-gamma release assays and childhood tuberculosis: systematic review and meta-analysis. *Int J Tuberc Lung Dis* 2011; 15(8): 1018–32. doi:10.5588/ijtld.10.0631

6. Connell TG, Zar HJ, Nicol MP. Advances in the diagnosis of pulmonary tuberculosis in HIV-infected and HIV-uninfected children. *J Infect Dis* 2011; 204(Suppl 4): S1151–8. doi:10.1093/infdis/jir413

7. National Institute for Health and Clinical Excellence (NICE). Tuberculosis: Clinical diagnosis and management of tuberculosis, and measures for its prevention and control (CG117). London: Royal College of Physicians; 2011. Available at: http://guidance.nice.org.uk/CG117 (Cited 1 October 2013).

8. Perez-Velez CM, Marais BJ. Tuberculosis in children. *N Engl J Med* 2012; 367: 348–61. doi:10.1056/NEJMra1008049

The Editors

NSW Public Health Bulletin

Dear Editors

I would like to thank Dr Thompson for his comments regarding limitations of diagnostic tests for latent tuberculosis infection (LTBI). It is true that a universal cut-off level of 10 mm induration to define a positive or negative tuberculin skin test (TST) (and thus the presence or absence of LTBI), as used in the NSW tuberculosis (TB) contact study,[1] does not account for individual variations. To establish whether infection is truly present the pre-test probability of a person having LTBI has to be taken into account together with the result of a screening test for LTBI: TST or interferon-gamma release assays (IGRAs). The pre-test probability is based on the exposure to TB depending on the incidence of TB in the country of residence (and in the country of origin, if different) as well as on the TB contact status (no contact, casual or close contact). In interpreting the actual test, the size of the TST reaction and whether a TST conversion occurred will influence the likelihood that true LTBI is present. Potential reasons for a false-positive TST or a false TST conversion, such as recent or multiple BCG vaccination(s), exposure to non-tuberculous mycobacteria and immunological boosting due to a previous TST in a BCG-vaccinated individual, have to be considered. Likewise, potential reasons for a false-negative TST or IGRA, such as conditions associated with anergy and a short time interval since exposure occurred, have to be taken into account when trying to establish whether true LTBI is present. While all those factors warrant consideration in clinical practice, such a highly individualised approach of determining whether true LTBI is present is not feasible when presenting data from a retrospective cohort study with more than 14 000 TB contacts. A TST result of 10 mm has a sensitivity of 90% and specificity of >95%, and is the recommended cut-off point for most clinical situations.[2] It is thus reasonable to use this cut-off to define LTBI in a study setting. In the NSW TB contact study all TB contacts were tested with the same tuberculin (5 tuberculin units, 0.1 ml Tubersol®; Sanofi Pasteur).

IGRAs were not routinely used in the examined cohort of TB contacts, but I agree with Thompson that a combination of TST and IGRA can be used not only to confirm a positive TST in a BCG-vaccinated low-risk person, but also to enhance the overall sensitivity in people with a high risk of infection and/or progression to disease. In this context, the tests could be used sequentially (in any order) after an initial test was negative or indeterminate/borderline.

IGRAs are not recommended if repeat testing is planned, for example in health care workers with potentially ongoing TB exposure, as studies on serial IGRA testing have shown high rates of conversions and reversion, independent of exposure or treatment.[3,4] Routine dual testing with both TST and IGRA is thus not indicated.

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References

1. Dobler CC. What do we know about the outcomes of tuberculosis contact investigations in NSW? *N S W Public Health Bull* 2013; 24(1): 34–7. doi:10.1071/NB12099

2. Menzies RI. Tuberculin skin testing. In: Reichman LB, Hershfield ES, eds. Tuberculosis: A Comprehensive International Approach. New York: Marcel Dekker; 2000. p. 279–322.

3. Metcalfe JZ, Cattamanchi A, McCulloch CE, Lew JD, Ha NP, Graviss EA. Test variability of the QuantiFERON-TB gold in-tube assay in clinical practice. *Am J Respir Crit Care Med* 2013; 187(2): 206–11. doi:10.1164/rccm.201203-0430OC

4. Slater ML, Welland G, Pai M, Parsonnet J, Banaei N. Challenges with QuantiFERON-TB Gold Assay for Large-Scale, Routine Screening of US Healthcare Workers. *Am J Respir Crit Care Med* 2013; 188(8): 1005–10. doi:10.1164/rccm.201305-0831OC

Hepatitis B

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Hepatitis B virus (HBV) infection remains a major public health issue with approximately 2 billion infected and an estimated 350 million chronically infected. South East and North East Asia are high prevalence areas in our region. While Australia is considered a low prevalence country for chronic hepatitis B (CHB), in 2000 up to 162 000 persons were estimated to have CHB.[1] Particular populations have high rates of infection, including people born in high endemicity countries, Indigenous Australians, men who have sex with men, and people who inject drugs (PWID).

HBV is a bloodborne and sexually transmitted viral infection spread either through punctured skin or mucosal exposure to contaminated blood or body fluids. The likelihood of developing chronic infection depends on the age at which a person is infected. The majority of infants (~90%) who become infected develop CHB, while only a minority of people exposed as adolescents or adults progress to chronic infection.

Chronic HBV infection is associated with significant morbidity and mortality, including cirrhosis and liver cancer.[2] About 25% of adults who were chronically infected during childhood die from HBV-related liver cancer or cirrhosis. This has particular relevance in Australia considering the large numbers of Asian-born Australians who were infected through perinatal exposure in their countries of birth. While therapy can control the infection and reduce sequelae, there is currently no cure for CHB.

Surveillance

Acute and chronic hepatitis B cases are routinely notified in all states and territories. Ascertainment of demographic data such as country of birth and Indigenous status, particularly for cases likely to be chronic, is incomplete and hinders a comprehensive description of the burden of HBV infection.

Prevention

Immunisation is the main prevention strategy to minimise HBV transmission. In Australia, the HBV vaccination program commenced in 1988, initially targeting neonates at high risk of infection and later expanding to universal infant vaccination and adolescent catch-up programs. Vaccination uptake and completion remain significant issues in PWID and other high-risk groups.

The recently-completed Hepatitis Acceptability and Vaccination Incentives Trial (HAVIT) was the first randomised controlled trial to assess the efficacy of incentives in increasing HBV vaccine completion in PWID. Participants allocated to the incentive condition were more than three times more likely to complete the vaccine series (87% vs. 66%, $p = .004$). Results indicate that the provision of modest financial incentives improved completion of the hepatitis B schedule among PWID.[3] Contingency management approaches, including conditional cash transfers, should underlie more widespread efforts to prevent vaccine-preventable infections in this population.

Public health response

Australia's public health response to HBV has, until recently, concentrated on universal infant HBV vaccination. However, the development of the National Hepatitis B Strategy 2010–2013 demonstrates a broader commitment to controlling the infection and its sequelae. The National Strategy aims to reduce the transmission of, and morbidity and mortality caused by, HBV and to minimise the personal and social impact of infection.[4] Priority populations include people from culturally and linguistically diverse (CALD) backgrounds, Aboriginal and Torres Strait Islander peoples, children born to mothers with CHB, and high risk unvaccinated adults. In addition the National HBV Testing Policy sets out a framework for providing quality testing and removing barriers to testing for health professionals.

NSW-specific activities include the development of a Hepatitis B Strategy, clinical guidelines relating to reactivation of CHB from immunosuppressive therapy, resources targeting people from CALD backgrounds, and education of health professionals and the community.

Health policy at national and state level, in combination with improved surveillance systems and monitoring the impact of HBV-related interventions, will help progress an appropriate public health response to this condition.

References

1. O'Sullivan BG, Gidding HF, Law M, Kaldor JM, Gilbert GL, Dore GJ. Estimates of chronic hepatitis B virus infection in Australia, 2000. *Aust N Z J Public Health* 2004; 28(3): 212–6. doi:10.1111/j.1467-842X.2004.tb00697.x
2. Dienstag JL. Hepatitis B virus infection. *N Engl J Med* 2008; 359(14): 1486–500. doi:10.1056/NEJMra0801644
3. Deacon RM, Topp L, Wand H, Day CA, Rodgers C, Haber PS et al. Correlates of susceptibility to hepatitis B among people who inject drugs in Sydney, Australia. *J Urban Health* 2012; 89(5): 769–78.
4. Australian Government Department of Health and Ageing. National Hepatitis B Strategy 2010–2013. Commonwealth of Australia; 2010. Available at: http://www.health.gov.au/internet/main/publishing.nsf/Content/ohp-national-strategies-2010-hepb/$File/hepb.pdf (Cited July 2012).

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Infectious disease management for Aboriginal children of Far West NSW

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Far West Local Health District New South Wales (NSW) covers an area of 194 000 km^2 and has approximately 30 000 residents. Ten percent of the population identifies as Aboriginal, but this proportion can be much higher in small communities surrounding Broken Hill. Aboriginal people in the Far West may identify with a range of different groups including: Barkindji, Maliangapa, Nyampa, Dieri and Wiljakali. Some of these groups have lived in the area for over 45 000 years.

For the most part, European colonisation of the Far West started about 180 years ago. The processes of colonisation have included removing Aboriginal people from family and traditional lands, disrupting traditional practices and interfering with existing public health and infection control strategies. Overall, there has been a rapid period of adaptation to new social and natural environments, with exposure to new pathogens and foreign, often enforced, methods for their management.[1]

Today, there is a higher prevalence of many infectious diseases in Aboriginal children in Far West NSW compared with NSW overall. Surveillance data show higher rates of pertussis, methicillin-resistant *Stapylococcus Aureus*, and gastrointestinal and skin infections in Aboriginal children of the region. Many of these infectious agents are of low pathogenicity and low virulence, thriving best where the environment and host are under stress.[2]

Adaptation to colonisation has resulted in a range of strategies to address host and environmental stressors. This includes strategies currently undertaken by the local Aboriginal Medical Service providing care to the Far West Aboriginal population. Maari Ma Health Aboriginal Corporation has taken a horizontal public health approach to infectious disease which includes strengthening child and community wellbeing. This approach reduces host susceptibility to infection through immunisation, better nutrition, breastfeeding, early literacy and maternal education.[3] Maari Ma also has an important role in developing an Aboriginal health workforce which helps ensure that infection control measures and education on treating and reducing the spread of disease are implemented and delivered appropriately.

Other horizontal approaches include addressing environmental stressors such as poor housing quality. In all settings, but even more so in rural and remote locations, house maintenance is an ongoing issue. In NSW, Aboriginal community groups and Land Councils are working with NSW Health, using the Housing for Health program, to upgrade existing housing to improve safety and health outcomes. All housing upgrade works are prioritised around life-threatening safety issues and nine healthy living practices.

The health priorities, or healthy living practices, include the provision of facilities for washing people – particularly children – once a day; the ability to wash clothes and bedding; the safe removal of waste water from the house and the surrounding living environment; improving nutrition by ensuring the ability to store, prepare and cook a meal; reducing the negative impacts of crowding; reducing the negative impacts of animals, vermin and insects; reducing the impact of dust; controlling the temperature of the living environment; and reducing hazards that cause minor trauma or injury.

NSW Health has assembled evidence from over 10 years of the Housing for Health program in NSW showing a 40% reduction in hospitalisations for infectious diseases in houses where the program had been conducted compared to houses not improved by the program.[4]

Since colonisation, the profile of infectious diseases in Far West Aboriginal children has changed, yet the underlying causes of these diseases are still being addressed. Aboriginal people are responding to this challenge through self-determination of medical services, health education, and through working in collaboration with government to strengthen the general wellbeing of communities.

References

1. Heritage Office and Department of Urban Affairs and Planning. Regional Histories of New South Wales. In: NSW Heritage Manual. Heritage Office and Department of Urban Affairs and Planning; 1996.
2. Friis R. Epidemiology for Public Health Practice. Maryland: Aspen Publishers; 1996.
3. Alperstein G, Burke H, Kennedy C on behalf of the Far West Aboriginal Child Development and Well-Being Management Group. Strategic Framework Document to improve child development and well-being for Aboriginal children in the Far West. Broken Hill: Maari Ma Health Aboriginal Corporation; 2009.
4. NSW Department of Health. 10 years of Housing for Health in NSW. An evaluation of a healthy housing intervention. In: Closing the Gap. Sydney: NSW Department of Health; 2010.

10.1071/NB12120

Communicable Diseases Report, NSW, January–March 2013

Communicable Diseases Branch
Health Protection NSW

For updated information, including data and facts on specific diseases, visit www.health.nsw.gov.au and click on **Public Health** and then **Infectious Diseases**. The communicable diseases site is available at: http://www.health.nsw.gov.au/publichealth/infectious/index.asp.

Figure 1 and Table 2 show notifications of communicable diseases with onset from January to March 2013 in New South Wales (NSW).

Enteric infections

Outbreaks of suspected foodborne disease

There were 12 outbreaks of foodborne or suspected foodborne disease reported by members of the public or identified through routine surveillance of *Salmonella* data in the first quarter of 2013. Five outbreaks were due to *Salmonella* Typhimurium, one each was due to norovirus, *Salmonella* Birkenhead, and *Salmonella* Cerro, and the others were due to unknown pathogens.

Only two investigations were able to provide sufficient evidence to identify the source of the infection. In one of these a Public Health Unit investigated three groups of people that ate at a restaurant in February 2013 and subsequently became ill with gastrointestinal illness. Seven out of a total 10 people consumed fried ice cream and all of these developed illness. All cases had stool samples that tested positive for *Salmonella* Typhimurium (MLVA 3-9-7-14-523 or 3-9-8-14-523). The NSW Food Authority (NSWFA) inspected the restaurant and took samples of frozen and cooked fried ice cream; these samples also tested positive for *Salmonella* Typhimurium (MLVA 3-9-7-14-523 or 3-9-8-14-523). The restaurant proprietor was warned about the risks of preparing fried ice cream with raw eggs and was fined for the sale of unsafe food. The NSWFA also inspected the egg farm that supplied the restaurant and found *Salmonella* with the same MLVA pattern on an egg rinse sample. In the other outbreak a cluster of *Salmonella* Typhimurium (MLVA 3-17-9-12-523) cases were notified by a hospital from a family of four. They were admitted to a hospital with salmonellosis in March 2013. The only common risk food consumed prior to this was banana smoothies made with milk and raw eggs; they had been eating these smoothies daily. The eggs came from a small boutique free-range egg farm. The family were provided with information about salmonellosis and the risks involved with eating raw eggs, and have since discontinued this practice.

Viral gastrointestinal disease

There were 136 reported outbreaks of (suspected) viral gastrointestinal disease in institutions in the first quarter of 2013. Of these, 49 (36%) occurred in aged-care facilities, 71 (52%) occurred in child-care centres, 14 (10%) in hospitals, and one each in a school and a military institution. The outbreaks affected a total of 1925 people.

In 45% ($n = 61$) of all outbreaks, one or more stool specimens were laboratory tested to identify a possible cause of the outbreak. Norovirus was identified in 34% ($n = 21$) of these outbreaks. In seven outbreaks, another pathogen was detected alongside norovirus (rotavirus in one outbreak, *Clostridium difficile* in three outbreaks, giardia in one outbreak and *Salmonella* in two outbreaks). Of the 61 outbreaks where one or more stool specimens were tested, 61% ($n = 37$) of all results were negative for any pathogens.

Respiratory infections

Influenza

Influenza continued to circulate at low levels in the first quarter of 2013, with evidence of co-circulation of influenza A(H1N1)2009, influenza A(H3N2), and influenza B strains. The number of influenza cases in January and February was slightly higher than the historical average for this time of year.

Influenza activity was also measured by the number of people who presented to 59 selected NSW emergency departments with influenza-like-illness (ILI). Presentations for ILI were also at low levels but slightly above seasonal averages in January and February.

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

10.1071/NB13011

Legionellosis

There were 13 cases of legionellosis due to *Legionella pneumophila* strains notified in the first quarter of 2013, a marked decrease from the 25 notified for the same period in 2012. There were also six notifications of legionellosis due to *L. longbeachae* strains, similar to the previous year (seven cases).

Vaccine-preventable diseases

Meningococcal disease

Eight cases of meningococcal disease were notified in NSW in the first quarter of 2013 (four in January and four in March), an increase from six notified for the same period in 2012. The age of the cases ranged from 10 months to 67 years, with five cases aged less than 5 years. Of the eight notifications, six (75%) were due to serogroup B (for which there is no vaccine), and two (25%) were due to serogroup C. The two cases of meningococcal disease caused by serogroup C were reported in adult women, one of whom (a woman aged in her fifties) died.

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

One case of measles was notified in NSW in the first quarter of 2013 (February). The case was an infant from South Western Sydney Local Health District, who acquired her infection in Pakistan. Public health measures were implemented and no further transmission was identified in association with this case.

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.

Pertussis

There were 637 pertussis cases notified in NSW during the first quarter of 2013 (293 in January, 202 in February and 142 in March). This is approximately one-third of the 2064 notifications for the same period in 2012, and represents the lowest number of notifications for a first quarter since 2007. Most cases were in the 0–4-year age group ($n = 155$), followed by the 5–9 ($n = 133$) and 10–14-year age groups ($n = 56$).

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 5338 cases of chlamydia notified in NSW during the first quarter of 2013. This number is slightly above the 5-year average of 5000 notifications for this quarter in previous years.

Gonorrhoea

There were 1097 cases of gonorrhoea notified in NSW during the first quarter of 2013, a 12% increase compared with the same period in 2012 ($n = 979$). Over the past 5 years the majority of notifications (80%) have been reported in males, with the highest number ($n = 935$) in the 25–29-year age group accounting for 22% of all notifications.

Syphilis

There were 239 cases of syphilis reported in NSW in the first quarter of 2013, an increase of 24% compared with the same period in 2012. Of the syphilis cases for the first quarter, 152 (64%) were classified as infectious syphilis.

Lymphogranuloma venereum

There were nine cases of lymphogranuloma venereum notified during the first quarter of 2013 compared to three notified during the first quarter of 2012. All cases have occurred in males, ranging in age from 18 to 75 years.

HIV

There were 78 cases of newly diagnosed HIV infection notified in NSW residents during the first quarter of 2013, a decrease from 112 notifications in same period in 2012 and from the first quarter 4-year average of 93. Similar to previous years, 77% of infections were reported to be homosexually acquired and 13% were heterosexually acquired (in people not from high HIV prevalence countries). The highest number of notifications was amongst people aged 20–29 years.

More than one-third (36%) of the notifications were reported as recent HIV infection at time of diagnosis (defined as either a negative or indeterminate HIV antibody test or seroconversion illness in the previous 12 months), while 15% were advanced infections (AIDS and/or CD4 <200 cells/μL). Of the 78 people notified, 42% had commenced treatment soon after diagnosis.

A summary of 2012 notification data for HIV is available at: www.health.nsw.gov.au/Infectious/hiv/Documents/2012-hiv-summary.pdf.

Arboviral infections

A total of 339 cases of arboviral infection were notified in NSW residents during the first quarter of 2013, a reminder of the importance of taking measures to avoid mosquito bites both in Australia and whilst travelling overseas. There were no cases of Murray Valley encephalitis or Kunjin virus infection reported in NSW residents during this period.

Ross River virus

There were 116 cases of Ross River virus infection notified in the first quarter of 2013. This was a substantial decrease from previous years, with 208 cases and 263 cases reported for the same period in 2012 and 2011 respectively. Notifications of Ross River virus infection were generally highest in coastal regions and lower in inland parts of the state during this period, likely reflecting rainfall patterns and mosquito activity.

Barmah Forest virus

There were 134 cases of Barmah Forest virus infection notified in NSW during this period, an increase over the same period for 2012 in which 105 cases were reported. The figure for 2013 should be interpreted with caution however as Health Protection NSW is investigating concerns of false positive results in this period.

Chikungunya virus

Four cases of Chikungunya virus infection were notified in NSW in the first quarter of 2013. All cases were acquired overseas in countries where Chikungunya is known to be endemic.

Dengue virus

There were 54 cases of dengue virus infection notified in NSW during this period, a decrease from 96 cases reported in the same period in 2012. All cases in the first quarter of 2013 were overseas-acquired infections, excluding one case in which country of acquisition was not recorded. Thailand and Indonesia accounted for almost half of infections, with 23% of notified cases being acquired in each. Thirteen percent of cases were acquired in the Philippines and 11% in India.

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 notification may be due to increased testing.

In 2012, NSW Health commenced the NSW Denominator Data Project 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 were requested from 14 public and private laboratories in NSW. The data were collated to give monthly aggregated data per condition. No demographic information was provided.

The positivity rate for all conditions from January 2012 to March 2013 ranged from 0.1% (shigellosis) to 5.7% (chlamydia infection) (Table 1). Notifications for chlamydia and gonorrhoea were correlated with testing, while the incidence of enteric conditions suggests that seasonal factors rather than testing patterns influence notification rates.

Table 1. Number and positivity (%) of tests performed for denominator data collected between January 2012 and March 2013

Condition	Tests	Number of tests	Positivity (%)
Chlamydia	*C.* trachomatis nucleic acid test (NAT)	468 356	5.7
Gonorrhoea	N gonorrhoeae NAT, culture	698 907	0.7
HIV	Serology	495 661	Not reported
Ross River virus infection	Serology	22 558	3.2
Barmah Forest virus infection	Serology	17 270	2.8
Pertussis	NAT, serology, culture	166 593	3.9
Salmonellosis	NAT, culture	234 056	1.7
Shigellosis			0.1
Cryptosporidiosis	Antigen, microscopy	202 065	0.6
Giardiasis			1.3

An investigation of *Salmonella* Typhimurium linked to contaminated eggs on the Central Coast of NSW, 2008

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Salmonella is a common cause of foodborne illness in Australia with an estimated 48 763 people (257 per 100 000 population) infected per year.[1] It is the most frequently notified enteric disease in New South Wales (NSW), with *S.* Typhimurium the most commonly identified serovar in outbreaks.[2]

In NSW, all *Salmonella* isolates from public and private laboratories are routinely sent to the NSW Enteric Reference Laboratory, Institute for Clinical Pathology and Medical Research (ICPMR), Westmead Hospital, for serotyping. *S.* Typhimurium isolates are then further subtyped using multilocus variable number tandem repeat analysis (MLVA).[3] For *S.* Typhimurium, five loci on the gene are used for tandem repeat analysis; the isolates with the same MLVA patterns are considered to be indistinguishable.[4] ICPMR reports notifiable enteric disease data to the Communicable Diseases Branch of Health Protection NSW daily, where the data are monitored as part of routine surveillance.

In February 2008, epidemiologists from the then NSW Department of Health identified nine *S.* Typhimurium cases with identical MLVA patterns geographically clustered around a town on the Central Coast of NSW. This paper describes the investigation of this point-source outbreak, using MLVA typing, and the public health response.

Methods

Epidemiological investigation

Upon detection of the outbreak a case-series analysis was conducted. A case was defined as a resident of NSW with gastroenteritis and *S.* Typhimurium MLVA 3-17-16-13-523 (or a related strain) identified from a stool specimen collected from 14 January 2008 to 4 May 2008. MLVA profiles that varied by one or two repeats at loci 2, 3 or 4 were viewed as a 'related strain'.[4]

Active case finding was undertaken through the local hospital and private laboratories, alerting them to the outbreak and ensuring priority transportation of all *Salmonella* isolates to ICPMR for further characterisation.

Identified cases were interviewed by telephone using a standard hypothesis-generating questionnaire. The questionnaire collected demographic information, details of symptoms experienced, as well as food and other potential exposures in the 7 days prior to illness onset. The information collected from these questionnaires was used to develop a targeted questionnaire that was subsequently used in case interviews.

Data were collated and analysed using Microsoft Excel.

Environmental investigation

The NSW Food Authority (NSWFA) inspected sites (including a local egg farm), which, as a result of the epidemiological investigation, were suspected of being potential sources of the outbreak. At the farm in question the NSWFA collected eggs and environmental samples from laying sheds for microbial analysis. Environmental samples were tested for *Salmonella* by ICPMR and were typed using the MLVA method.

The NSWFA traced the farm's supplier of hatchlings and chicken feed, as well as the farm's regular egg deliveries to commercial kitchens in the local area.

Results

Epidemiological investigation

Forty-four cases of *S.* Typhimurium MLVA 3-17-16-13-523 (later phage typed as *S.* Typhimurium phage type 126 or *S.* Typhimurium phage type 126 var 1 at the Microbiological Diagnostic Unit – Public Health Laboratory, University of Melbourne) were identified. Of these, 21 (48%) were interviewed. The 23 cases not interviewed were either not contactable or notification of their infections occurred after the source of the outbreak had been identified, control measures put in place and the investigation closed. Of the 44 confirmed cases, the majority (62%) were female. Cases were aged from 3 to 91 years (median 34 years). Ninety-five percent of cases lived in the Central Coast region of NSW.

The index case was notified to NSW Health through routine laboratory-based surveillance on 22 February 2008. The index case's specimen was collected on 14 January 2008; when interviewed, the case reported an illness onset date of 13 January 2008. The peak in collection of outbreak strain-positive specimens was in the week beginning 11 February 2008. The last specimen that tested positive for the outbreak strain was collected in the week beginning 5 May 2008, after the investigation was officially closed (Figure 1).

All of the 21 cases interviewed reported experiencing diarrhoea; one-third reported experiencing bloody

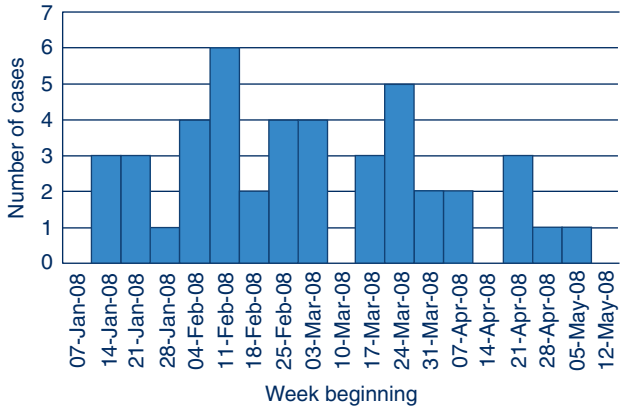

Figure 1. Cases of *Salmonella* Typhimurium MLVA 3-17-16-13-523 notified to NSW Health, January–May 2008 (by specimen collection date).

diarrhoea. Fifty-two percent of cases interviewed reported nausea, 43% reported vomiting, and 29% reported fever. Six cases (29%) required hospitalisation for their illness. The duration of illness ranged from 4 to 15 days.

Of the 21 cases interviewed, four (19%) reported purchasing eggs directly from the farm and consuming them prior to onset of illness. A further eight (38%) ate dishes purchased at local restaurants that, after investigation, were identified as containing eggs sourced from the farm. All other cases reported consuming eggs prior to their illness but could not recall where they purchased them. No other common food sources were identified.

Environmental investigation

The NSWFA conducted three site visits to the farm over the course of the investigation: on 4 March 2008, 17 March 2008, and 15 April 2008. The farm sold both eggs and chicken manure (for gardening) from a small roadside retail shop and distributed approximately 1800 eggs to local restaurants per week. A list of commercial kitchens to which the farm distributed eggs was obtained, resulting in the identification of six previously unlinked cases (two of which were outside the local area).

Results for the chicken faecal samples collected from two of the five cage lines and from a cloacal swab taken from a dead chicken (in a different cage line from the two where faecal samples were taken) were positive for *S.* Typhimurium MLVA 3-17-16-13-523.

The investigation of the farm's supplier of hatchlings and chicken feed identified that hatchlings were sourced from a major supplier with national distribution and feed was sourced from a large NSW regional supplier. Water used by the farm was sourced from a treated municipal supply. This information was collected as a routine part of the environmental investigation and used to test the hypothesis that the infectious agent may have been introduced to the chicken farm with supplied hatchlings, feed or water. As no cases of salmonellosis with the outbreak strain were identified elsewhere in NSW in the same period the hypothesis was rejected.

Public health intervention

The local Public Health Unit distributed public information through the media about risk factors for contracting salmonellosis, including reinforcing good food hygiene practices.

The farm was advised to cease 'wet wiping' of faecal matter from the surface of heavily soiled eggs as it is possible this practice increases the spread of *Salmonella* between eggs.

Discussion

This paper describes the investigation of a localised, protracted point-source outbreak of *S.* Typhimurium identified through routine surveillance.

Eggs are a known source of *Salmonella* infections. In 2012, eggs were identified as the cause of 93% (13/14) of foodborne *S.* Typhimurium outbreaks where investigators were able to identify a food vehicle (personal communication, J Musto). The environmental investigation identified *Salmonella* in three of the five cage lines. This investigation reinforces the need to strengthen *Salmonella* control measures at the point of production (on-farm control), during retail and wholesale (storage and packaging of eggs and food handling/food safety in food outlets), and at consumer level (food handling and food safety measures).

Washing of eggs is recognised as a risky process that can assist the transfer of *Salmonella* from the shell of contaminated eggs to the shell of uncontaminated eggs via contaminated washing water or washcloths.[5] The practice of 'wet wiping' of soiled eggs needs to be addressed through targeted education and tighter regulation.

The use of MLVA typing facilitated the early detection and rapid confirmation of cases, resulting in a faster and more effective public health response, and potentially averting many more cases of illness.

This investigation's limitations include poor food consumption recall by cases interviewed due, in part, to lag-time between sample collection, testing, and interview. Also, 'trace-back' of eggs is difficult as eggs are a commonly-consumed food, often purchased well before they are eaten; as such, recall of place of purchase and brand of eggs is often poor. Tracing the source of eggs sold by retailers or used in restaurants was also problematic, as supply records were often not kept.

Conclusion

MVLA typing is a useful tool for the identification of point-source outbreaks of *S*. Typhimurium. The outbreak described in this paper reinforces the need for strengthening *Salmonella* control at the point of production, retail and consumer preparation to reduce the burden of egg-related salmonellosis in Australia.

Acknowledgments

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References

1. Hall G, Raupach J, Yohannes K. An estimate of under-reporting of foodborne notifiable diseases: *Salmonella, Campylobacter* and Shiga Toxin producing *E*. coli (STEC). Working paper no. 52. Canberra: National Centre for Epidemiology and Population Health, Australian National University; 2006.
2. NSW 2011 OzFoodNet Annual Report. Available at: http://www.health.nsw.gov.au/Infectious/diseases/Documents/ofn_annual_report_2011.pdf (Cited 18 September 2013).
3. Gilbert GL. Using MLVA to type strains of *Salmonella* Typhimurium in New South Wales. *N S W Public Health Bull* 2008; 19(1–2): 29–31. doi:10.1071/NB07116
4. 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(2): 163–72. doi:10.1016/j.mimet.2004.06.014
5. Caudill AB, Curtis PA, Anderson KE, Kerth LK, Oyarazabal O, Jones DR et al. The effects of commercial cool water washing of shell eggs on Haugh unit, vitelline membrane strength, aerobic microorganisms, and fungi. *Poult Sci* 2010; 89(1): 160–8. doi:10.3382/ps.2009-00316

Figure 1. Reports of selected communicable diseases, NSW, Jan 2005 to Mar 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%

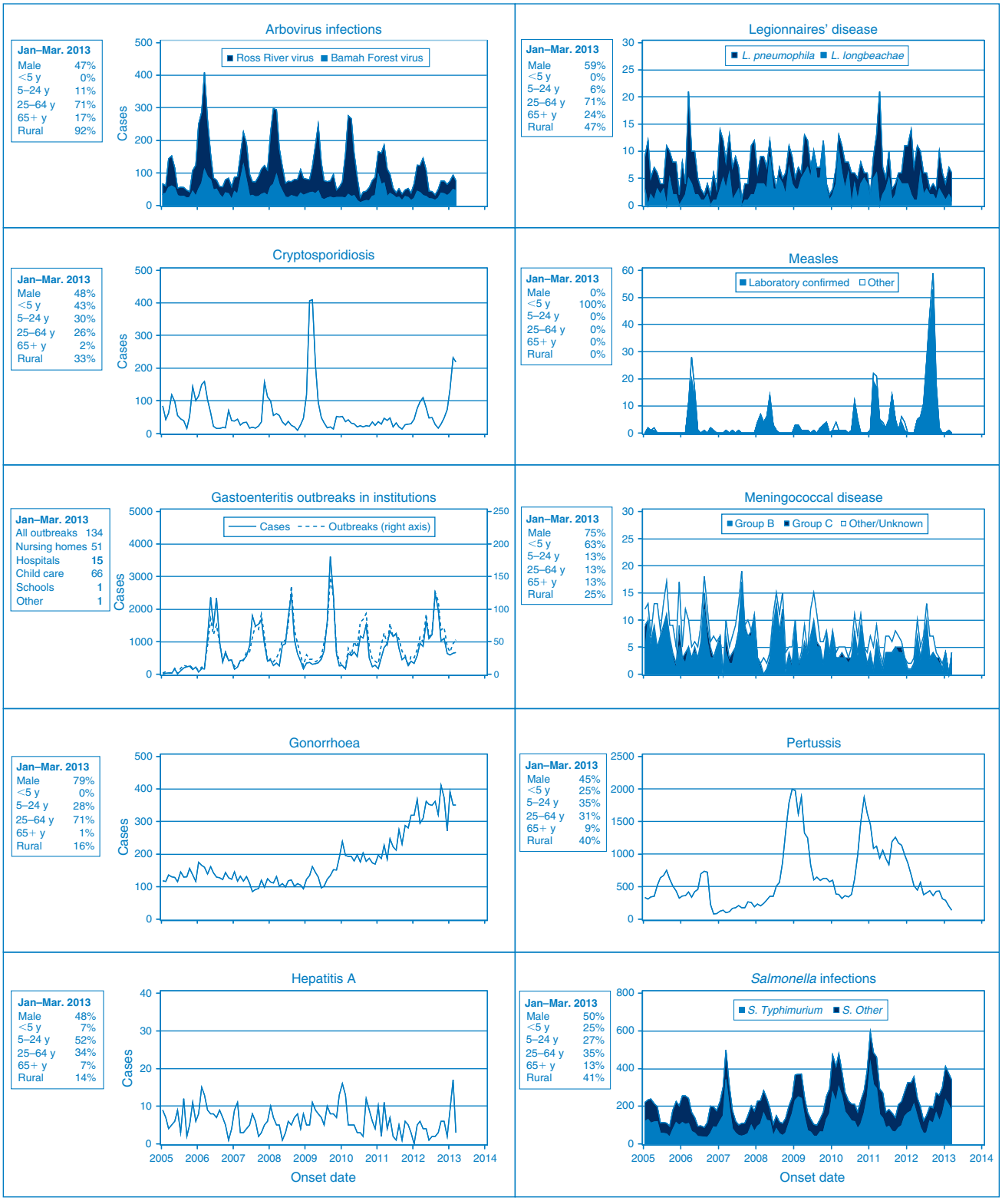

Table 2. Notifications of scheduled medical conditions with an onset date from January to March 2013 by Local Health District, NSW

Condition	Local Health District																Total 2013		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	Jan-Mar[b]	Year to date[b]	Jan-Mar[b]	Year to date[b]
Bloodborne and sexually transmissible																				
Chlamydia (genital)[a]	194	117	223	25	848	208	93	228	455	756	330	537	534	524	220	34	5338	5338	5894	5894
Gonorrhoea[a]	5	5	16	2	43	37	2	25	101	319	39	265	106	104	21	3	1097	1097	979	979
Hepatitis B – acute viral[a]	1	–	–	–	2	1	1	1	1	2	–	1	–	–	1	–	11	11	8	8
Hepatitis B – other[a]	12	6	9	–	17	2	4	11	83	78	9	101	114	108	9	2	565	565	599	599
Hepatitis C – acute viral[a]	1	–	2	–	3	2	–	–	–	2	1	–	–	–	–	–	11	11	13	13
Hepatitis C – other[a]	35	18	58	9	88	44	17	39	39	66	45	83	101	69	31	66	809	809	888	888
Hepatitis D – unspecified[a]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	2
Lymphogranuloma venereum	–	–	–	–	–	–	–	–	1	3	–	4	–	–	1	–	9	9	3	3
Syphilis	1	3	4	–	13	7	4	1	18	70	4	68	17	18	11	–	239	239	193	193
Vectorborne																				
Barmah Forest virus[a]	7	3	2	–	25	55	28	4	3	–	2	–	1	2	2	–	134	134	105	105
Ross River virus[a]	15	3	10	1	26	25	17	4	1	4	–	2	–	1	7	–	116	116	208	208
Arboviral infection (other)[a]	–	1	1	–	7	5	1	–	9	17	8	4	2	9	–	–	64	64	100	100
Malaria[a]	–	–	1	–	3	1	–	–	1	2	1	3	1	7	5	–	25	25	13	13
Zoonoses																				
Brucellosis[a]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1
Leptospirosis[a]	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–	–	2	2	9	9
Psittacosis[a]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1	1	7	7
Q fever[a]	–	4	1	1	8	7	3	–	1	–	2	–	–	1	–	–	28	28	39	39
Respiratory and other																				
Blood lead level[a]	11	3	36	28	5	3	1	6	3	1	11	4	11	6	9	–	138	138	135	135
Influenza[a]	6	6	4	1	23	35	7	3	74	78	10	33	44	61	9	–	394	394	232	232
Invasive pneumococcal infection[a]	3	1	4	–	9	5	1	2	5	3	3	5	6	10	7	–	64	64	57	57
Legionella longbeachae infection[a]	–	1	1	–	–	1	–	–	1	–	1	–	–	–	1	–	6	6	7	7
Legionella pneumophila infection[a]	1	–	–	–	2	–	–	–	3	–	2	–	1	2	2	–	13	13	25	25
Legionnaires' disease (other)[a]	–	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	2	2	2	2
Leprosy	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1	1	–	–
Meningococcal infection (invasive)[a]	–	–	–	–	2	–	–	–	2	–	–	–	2	1	1	–	8	8	6	6
Tuberculosis	1	2	–	–	2	1	1	1	12	13	–	18	21	20	2	1	95	95	114	114
Vaccine-preventable																				
Adverse event following immunisation[c]	20	23	12	1	29	16	10	7	38	26	10	11	7	29	14	–	253	253	83	83
H. influenzae b infection (invasive)[a]	1	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	2	2	–	–
Measles	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1	1	–	–
Mumps[a]	–	–	–	–	1	7	–	–	1	5	–	4	5	–	1	–	24	24	16	16
Pertussis	47	30	20	–	64	26	18	17	90	82	36	32	55	77	43	–	637	637	2064	2064
Rubella[a]	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1	1	4	4
Tetanus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1	1	–	–
Enteric																				
Cryptosporidiosis[a]	19	11	31	–	74	29	3	10	150	79	19	62	38	38	29	–	592	592	215	215
Giardiasis[a]	23	25	35	1	92	6	10	31	117	112	44	64	33	58	32	–	683	683	658	658
Haemolytic uraemic syndrome	–	–	–	–	–	1	–	–	–	–	1	–	1	–	–	–	3	3	3	3
Hepatitis A[a]	–	–	–	–	–	4	–	–	5	3	–	2	9	6	–	–	29	29	11	11
Hepatitis E[a]	–	–	–	–	–	–	–	–	1	1	–	–	–	5	–	–	7	7	1	1
Listeriosis[a]	–	–	–	–	1	1	–	–	3	2	–	2	1	1	–	–	11	11	10	10
Rotavirus[a]	11	–	2	2	24	11	1	2	11	8	4	3	11	8	3	–	101	101	190	190
Salmonellosis[a]	47	19	37	3	129	90	44	44	165	140	52	78	124	109	44	1	1126	1126	1004	1004
Shigellosis[a]	1	1	1	–	1	5	–	–	10	5	–	4	3	6	1	–	38	38	41	41
Typhoid[a]	–	–	–	–	1	–	1	–	4	2	–	1	2	11	1	–	23	23	16	16
Verotoxin-producing *E. coli*[a]	–	1	–	–	2	2	–	–	–	–	–	1	3	–	–	–	10	10	3	3
Miscellaneous																				
Creutzfeldt–Jakob disease	–	–	–	–	–	–	–	–	–	–	1	–	–	1	1	–	3	3	1	1

[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 are 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.

Contents

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