Reduction in invasive meningococcal disease in Queensland: A success for immunisation

Vicki G Slinko, Amy Sweeny

Abstract

Since 2003, the Australian government has funded a conjugate serogroup C meningococcal vaccine for those aged over 1 year and born since 1 January 1984. This summary of the epidemiology of invasive meningococcal disease (IMD) in Queensland assesses the effect that the vaccination program has had on IMD notifications. In Queensland, IMD cases are notified to the Notifiable Conditions System by clinicians and laboratories. Additional surveillance data are collected by population health units from relatives of the case, the case and medical practitioners. In 2005, Queensland recorded its lowest number of cases and lowest incidence of IMD since statewide surveillance began. This remained low in 2006. The serogroup C rate in Queensland also declined to its lowest in 2006. The pattern of age-specific incidence remains similar, though rates are lower in all but those aged less than 12 months. However, Indigenous rates are still twice non-Indigenous rates. The case fatality rate for IMD (all serogroups) has declined, possibly due to the reduced incidence of serogroup C and septicaemia cases. The program appears to have mostly achieved its aims of: reducing illness and death in the population at highest risk; inducing immunity in those who are vaccinated; and reducing the incidence of disease. However, there is considerable natural fluctuation in the rates of IMD and continued surveillance will be needed to monitor trends. *Commun Dis Intell* 2007;31:227–232.

Keywords: invasive meningococcal disease, Queensland, serogroup C, vaccination program, surveillance, notification, coverage, incidence, case fatality rate

Introduction

Meningococcal disease is an uncommon but important public health problem in Australia. The invasive form of the disease is a serious illness with a variable case fatality rate in industrialised countries ranging between 7% for meningitis and 19% for septicaemia.[1] Those known to be at highest risk of the disease are children aged less than five years (particularly infants), followed by adolescents and young adults.

The bacterium *Neisseria meningitidis* is usually carried asymptomatically in the back of the throat and nose. However, only a small number of people develop invasive disease, which appears most often as meningitis and/or septicaemia. Other localised manifestations include arthritis, pneumonia and conjunctivitis.

The factors leading to development of invasive meningococcal disease (IMD) are poorly understood, but risk factors include smoking, exposure to tobacco smoke and living in crowded conditions.[2]

In early 2003, a federally funded conjugate serogroup C meningococcal vaccination became part of the immunisation schedule in Queensland. All children aged more than 12 months and born since 1 January 1984 were eligible for the single dose vaccine. The program was introduced to:[3]

- reduce the illness and death in the population at highest risk of meningococcal disease;
- induce long term immunity in those who are vaccinated; and
- reduce the population incidence of disease.

This summary of the epidemiology of IMD in Queensland is to assess the effect that the vaccination program has had on the epidemiology of IMD.

Methods

IMD is immediately notifiable to Queensland Health under legislation, by both laboratories and clinicians. The data are maintained on the Notifiable Conditions Systems database and have been collated since 1993. In 1999, enhanced surveillance for IMD was established. Enhanced surveillance is conducted by communicable diseases staff of the population health units who also coordinate public health responses.

The criteria for notification of IMD are contained in Queensland Health *Guidelines for the Control of Communicable Diseases in the Community.*[4] This definition is compatible with the national guidelines,[5] though in Queensland nucleic acid testing is classified as laboratory definitive evidence rather than suggestive evidence. The Queensland IMD criteria were updated on 6 August 2005. The change was to make the case definition clearer but is unlikely to have changed the case detection rate. Cases are classified to the calendar year in which the date of onset occurs.

Figures for vaccination coverage come from the Vaccination Information and Vaccination Administration System, a Queensland Health register which maintains information on Queensland immunisation providers and vaccination events, and provides details to Australian Childhood Immunisation Register.

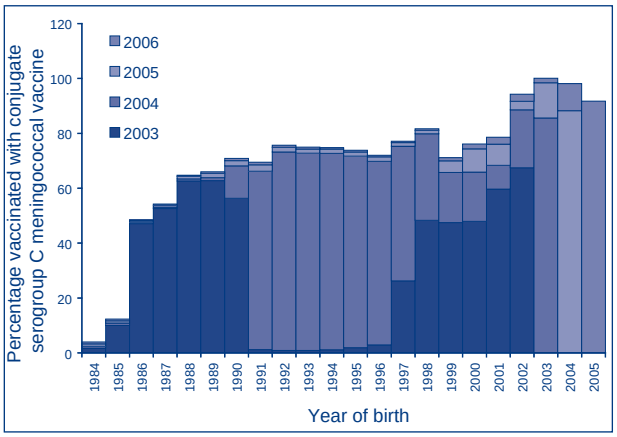
Denominators for notification rates each year use the Estimated Resident Population (ERP) from Australian Standard Geographical Classification.[6] The coverage percentages represent the number of persons in each annual birth cohort vaccinated divided by the 2006 ERP denominator for that birth cohort. The denominators for Indigenous calculations use high projections of Experimental Projections of Aboriginal and Torres Strait Islander Australians.[7]

Analysis was performed in Excel®[8] and Epi-Info version 3.3.2®.[9]

Results

High coverage against serogroup C IMD has been achieved for many at-risk populations in Queensland. Cohorts born since 2002, (children aged between 0–4 years in 2006), have coverage rates exceeding 90% (Figure 1). Persons born between 1988 and 2001 have achieved a coverage rate between 60% and 80% generally (Figure 1).

Figure 1. Per cent of coverage with conjugate serogroup C meningococcal vaccine, Queensland, date 2003 to 2006, by year of birth and vaccination



The notification rates for both serogroup C and non-serogroup C disease have declined since vaccine introduction (Figure 2). In 2005, the rate of IMD declined to its lowest (62 cases: 1.6/100,000 residents) since 1993. It remained low in 2006 (68 cases: 1.7/100,000). Only four cases of known serogroup C disease were reported in 2006.

The highest notification rate of IMD remains in those aged under 5 years (particularly infants) with a smaller peak of the disease in the teenage years (Table 1).

There has been little serogroup C disease in those aged < 1 year: 2 cases in 2003 and 1 in 2006. Since the vaccination program was introduced in 2003 there has been a gradual decline in the number of cases of serogroup C disease in those eligible for free vaccine: 2003 (14), 2004 (13), 2005 (4), 2006 (1). The

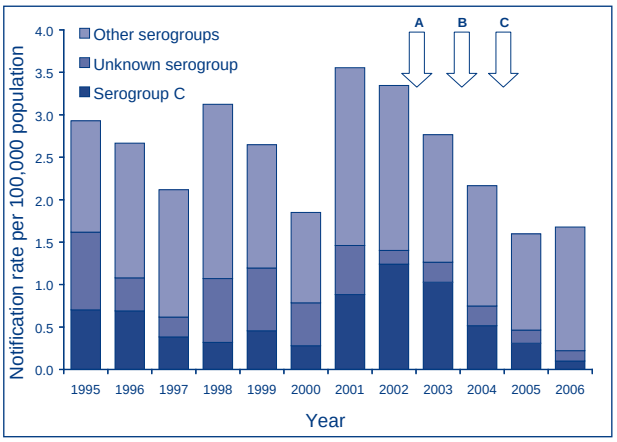
Table 1. Notification rate of invasive meningococcal disease, Queensland, 1995 to 2006, by age group

Age group	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
<1	28.6	24.2	24.2	33	24.2	14.8	28.2	33.5	29.5	18.9	18.4	31.8
1–4	11.8	10.3	13.4	12.9	10.8	7.2	12	8	5.5	6.9	6	6.3
5–9	1.7	4.6	0.4	3.3	4.6	1.6	6.1	4.2	2.6	1.5	1.9	0.7
10–19	5.0	4.8	4.1	5.6	4.0	3.7	5.5	6.2	5.2	5.6	2.6	3.5
20–29	2.8	2.4	1.4	2.6	2.8	1.9	4.9	3.1	4.2	2.2*	1.3*	1.4*
30–39	1.2	0.4	0.4	0.8	0.4	0.4	0.7	2.2	1.8	0.9	0.4	0.9
40+	0.9	0.7	0.4	1.2	1.1	0.6	1	1.3	0.8	0.5	0.8	0.2
Total	2.8	2.6	2.1	3.2	2.8	1.9	3.6	3.3	2.8	2.2	1.6	1.7

Notification rates in shaded areas are for those groups eligible for free vaccine since the vaccination program began.

* Some individuals in these age groups will have been vaccinated in the catch up program.

Figure 2. Notification rate of serogroup C and invasive meningococcal disease, Queensland, 1995 to 2006



A Grades 8–12 school vaccination program introduced, vaccination of 1–5-year-olds and others not covered by continuing school program through usual providers.

B Grades 1–8 school vaccination program introduced.

C Vaccination of any others born on or after 1 January 1984, by usual providers.

Figure 3. Invasive meningococcal disease notifications, Queensland, 2000 to 2006, by month and year of onset

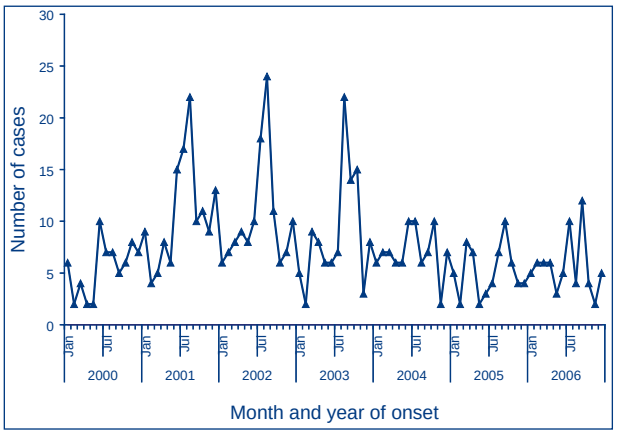
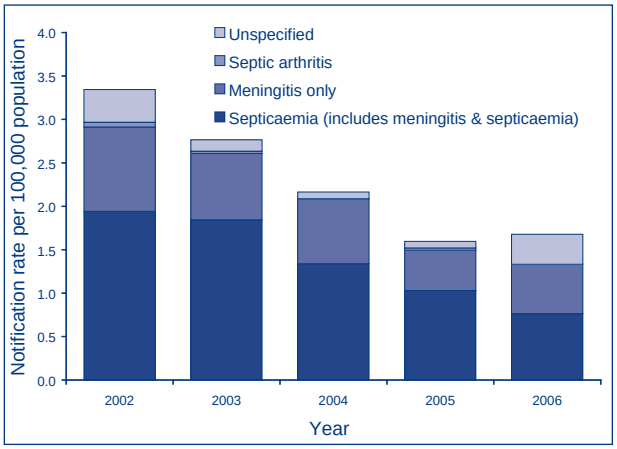


Figure 4. Notification rate of presentations of invasive meningococcal disease, Queensland, 2002 to 2006



vast majority of IMD in those eligible for free vaccine has been due to serogroup B disease (>90%). There have been no known vaccine failures.

The seasonality that was evident in previous years in IMD notifications (with a typical late-winter early-spring peak) is no longer obvious (Figure 3).

Types of clinical presentations since the vaccination program was introduced remain unchanged. The vast majority are meningitis and/or septicaemia. Since the introduction of the vaccination program, the number of presentations of septicaemia has been decreasing (Figure 4): 2002 (72), 2003 (70), 2004 (52), 2005 (40), 2006 (31).

The case fatality rate for IMD in Queensland is low (Table 2) and has fallen since the vaccination program. In Queensland, serogroup C disease is associated with nearly a fourfold greater risk of dying compared to serogroup B disease (Table 3, RR = 3.8; (95%CI 2.1, 7.2).

There continues to be a higher notification rate of IMD in Indigenous persons compared with non-Indigenous persons (Table 4). For the post-vaccination campaign period (2003–2006), Indigenous people were three times as likely to be notified with IMD compared to non-Indigenous (RR = 3.0; 95% CI 2.1, 4.3). There has not been a death of an Indigenous person from IMD since 2003.

Table 2. Invasive meningococcal disease case fatality, Queensland, 2000 to 2006

Year	Died	Total	Case fatality rate
2000	4	66	6.1
2001	11	129	8.5
2002	5	124	4.0
2003	9	105	8.6
2004	3	84	3.6
2005	3	62	4.8
2006	2	68	2.9
Total	37	638	5.8

Discussion

Case ascertainment may have improved due to advances in laboratory techniques. Nucleic acid testing/polymerase chain reaction has been used in Queensland since 1999 as laboratory definitive evidence of disease and the IgM test was introduced in 2000 (laboratory suggestive evidence). Improved case ascertainment would result in a higher rate of disease.

Table 3. Risk factors for dying of invasive meningococcal disease, Queensland, 2000 to 2006

Characteristic	Deaths (n=37)		All cases (n= 635)		Relative risk	95% confidence intervals
	n	%	n	%		
Sex						
M	21	57	346	54		
F	16	43	292	46	1.1	0.6, 2.1
Indigenous status						
Indigenous†	3	8	55	9		
Non-Indigenous†	33	92	536	91	0.9	0.3, 2.8
Serogroup						
C	21	57	163	26	3.8*	2.1, 7.2*
B	11	30	370	58	0.3*	0.2, 0.6*
Other/unknown	5	13	105	16	N/A	N/A

* Indicates statistical significance (α= 0.05).

† Indigenous status determined for 36 deaths, 591 cases.

Table 4. Risk of invasive meningococcal disease (all ages), Queensland, 2001 to 2006, by indigenous status

Vaccination program	Year	Indigenous cases	Non-Indigenous cases	Relative risk	95% confidence intervals
Before vaccination program	2001	7	118	1.5	0.7, 3.2
	2002	6	118	1.2	0.6, 2.8
During vaccination program	2003	13	92	3.4*	1.9, 6.0*
	2004	12	72	3.8*	2.1, 7.1*
	2005	6	56	2.4*	1.0, 5.5*
	2006	5	63	2.0	0.8, 5.1
	2003–2006	36	283	3.0*	2.1, 4.3*

* Indicates statistical significance (α= 0.05).

In 2005, the notification rate of IMD decreased to the lowest since Queensland-wide surveillance began and remained low in 2006. The notification rate of serogroup C disease is now at its lowest level recorded. Nonetheless, there has been considerable natural fluctuation in IMD.[10] The vaccination campaign and lower IMD notification rates follow a peak notification period in 2001–2002. Rates similar to those following the vaccination campaign were previously seen in 1997 and 2000. However, the steady declining trend since 2003 could be ascribed to the vaccination program.

One limitation to interpreting the change in serogroup-specific incidence is the change in the proportion of all IMD cases serogrouped over time. Before the vaccination campaign, up to 25% of IMD cases did not have serogroup information. This has improved since 2001.

The pattern of age-specific incidence of IMD remains unchanged. Those with the highest incidence (aged less than 12 months) are not eligible for free vaccine. The vast majority of the IMD in this age group is due to serogroup B. The small number of cases of serogroup C disease in those aged less than 1 year and in the whole population, may be due to reduced nasal carriage rates of *Neisseria meningitidis* serogroup C. There have been no recent studies of meningococcal nasal carriage in Australia to verify this hypothesis.

The rates of IMD in those eligible for free vaccine are currently some of the lowest recorded for Queensland. After the roll-out of the catch-up program from 2003, serogroup C disease has gradually been decreasing, with only 1 case recorded in those eligible for free vaccine in 2006. This was an overseas visitor working at an island resort, who may not have known about eligiblity or had access to vaccination. There is a continuing need to increase community awareness about the importance and benefits of vaccination for this disease.

The case fatality rate from IMD in Queensland has improved since the introduction of the vaccination program. The reduction in presentations with septicaemia and serogroup C disease (more likely to result in death) may account for this. The program appears to have achieved its aim of reducing illness and death in the population at highest risk of meningococcal disease.

Interestingly, the usual peak of notifications in winter[11] has not been evident after 2003. In 2000, before the vaccination program, there was no obvious winter peak of notifications and that year also had a low incidence of serogroup C disease.

Studies[12,13] suggest the meningococcal serogroup C vaccination program gives high short-term vaccine effectiveness and substantial herd immunity but the long term effectiveness remains unknown. There have been no known vaccine failures since the vaccination program was introduced in Queensland. Overall, the evidence suggests that the serogroup C meningococcal vaccination program has induced immunity for up to 4 years in those vaccinated.

The discrepancies between Indigenous and non-Indigenous health in Australia are well known. Though the relative risk of IMD in Indigenous persons has been decreasing recently, it remains at almost twice that of non-Indigenous persons. Obviously, further work needs to be done in this area, perhaps addressing risk factors for developing IMD.[2]

The meningococcal C vaccination program in Queensland has mostly been successful in achieving its aims. However, there needs to be continued vigilance with surveillance to evaluate longer term trends which can inform public health action and ensure sustained success.

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Author details

Vicki G Slinko,[1,2] Master of Applied Epidemiology Scholar

Amy Sweeny,[2] Principal Epidemiologist and Manager of Surveillance

1. National Centre for Epidemiology and Population Health, Australian National University, Acton, Australian Capital Territory
2. Communicable Diseases Branch, Queensland Health, Brisbane, Queensland

Corresponding author: Dr Vicki Slinko, Master of Applied Epidemiology Scholar, Communicable Diseases Branch Communicable Diseases Branch, Queensland Health, GPO Box 48, Brisbane QLD 4001. Telephone: +61 7 3234 0672. Facsimile: +61 7 3234 0057. Email: Vicki_Slinko@health.qld.gov.au

References

1. Apicella M. *Neisseria meningitidis*. In: *Mandell, Douglas and Bennett's Principles and Practice of Infectious Diseases*. Elsevier, Philadelphia: 2005.
2. McCall B, Neill A, Young M. Risk factors for invasive meningococcal disease in southern Queensland, 2000–2001. *Intern Med* J 2004;34: 464–468.
3. Queensland Health. National Meningococcal C Vaccination Program: 2003.
4. Queensland Health. Queensland Health *Guidelines for the Control of Communicable Diseases in the Community*. 3rd Edn. Queensland Health. Brisbane: 2005.
5. Australian Government Department of Health and Ageing. National Notifiable Diseases Surveillance System data, 2004. Available from: http://www.health.gov.au/internet/wcms/publishing.nsf/content/cda-surveil-nndss-casedefs-cd_mening.htm Accessed on 10 May 2007.
6. Australian Bureau of Statistics. Estimated Resident Populations by Statistical Local Area tables for relevant year.
7. Australian Bureaus of Statistics. Experimental Projections of Aboriginal and Torres Strait Islander Australians, ATSIC Regions, 2001–2009. Catalogue no. 3238.0.55.002.
8. Microsoft ®. Excel. 2002 (10.6501.6626) SP3. Microsoft Corporation.
9. Centers for Disease Control and Prevention. Epi Info. Version 3.3.2. Centers for Disease Control, Atlanta.
10. Patel M. Australia's century of meningococcal disease: development and the changing ecology of an accidental pathogen. *Med J Aust* 2007;186:136–141.
11. Australian Meningococcal Surveillance Programme. Annual report of the Australian Meningococcal Surveillance Programme, 2005. *Commun Dis Intell* 2006;30: 205–221.
12. Trotter CL, Andrews NJ, Kaczmarski EB, Miller E, Ramsay ME. Efffectiveness of meningococcal serogroup C conjugate vaccine 4 years after introduction. *Lancet* 2004;364:365–367.
13. Borrow R, Miller E. Long-term protection in children with meningococcal C conjugate vaccine: lessons learned. *Expert Rev Vaccines* 2006;5:851–857.