Measles immunity among young adults in Victoria

Heath A Kelly,[1] Michaela A Riddell,[1,2] Stephen B Lambert,[3] Jennie A Leydon,[1] Mike G Catton[1]

Abstract

Measles outbreaks in Victoria in 1999 and 2001 have suggested that a substantial proportion of young Victorian adults may be susceptible to measles infection. We performed a serosurvey of 300 18-30-year-old healthy blood donors and 312 sera retrieved after diagnostic testing for a non-rash illness in patients of the same age group, with the aim of estimating the proportion of young adults in Victoria immune to measles. We also aimed to define more precisely the birth cohorts at risk of measles infection, with cohorts reflecting the measles immunisation policies of previous years. There was no significant difference in measles immunity between the 300 blood donors (79.0%, 95% confidence interval 73.9-83.5) and the 312 patients whose sera had been stored (84.0%, 95% CI 79.4-87.9, p=0.11). There was, however, a significant difference in immunity by birth cohort. In the combined results from both samples, the proportion of people born between 1968 and 1974 who were immune to measles was 88.4 per cent (95% CI 84.1-91.6) while the proportion of those born between 1975 and 1981 was 74.1 per cent (95% CI 68.7-79.1). This study confirms that a substantial proportion of young Victorian adults are susceptible to measles, but also demonstrates that those born between 1975 and 1981 are more likely to be non-immune than those born before 1975. A review of published Australian data supports this conclusion and confirms the need for a measles control program aimed at young adults. *Commun Dis Intell* 2001;25:129-132.

Keywords: measles, immunity, cohort analysis, immunisation, young adults

Introduction

In some countries where universal measles vaccination has been introduced over an extended period of time, young adults are emerging as the group most at risk of measles infection.[1,2] The first measles outbreak in Australia involving predominantly young adults occurred in Victoria, with spread to South Australia, between February and May 1999. Approximately 85 per cent of the 75 notified cases confirmed with measles in this outbreak were born between 1968 and 1981 (aged between 18 and 30 years).[3] These young adults were most likely to be susceptible to infection because of the timing of changes to measles vaccination practices in Australia. Measles vaccine was first licensed in Australia in 1968, recommended for children aged 15 months in 1971, and included for 12-month-old infants in the first national childhood immunisation schedule in 1975.[4] Prior to the introduction of vaccine, most people acquired immunity through infection with wild measles virus in childhood. Despite suggestions of an initially poor uptake,[5] the availability of measles vaccine in Australia from 1968 lead to a reduction in circulating wild measles virus. This was reflected in decreased measles and measles encephalitis admissions to Fairfield Hospital.[6]

The reduction in circulating wild measles virus and low vaccine coverage has left a cohort of young Australian adults with varying susceptibility to infection. In response to this, the Federal Minister for Health has announced funding to improve measles vaccination coverage in all Australians aged 18 to 30 years.[7] To more clearly define the specific birth cohorts at risk of infection; to estimate this risk; and to promote improved efficiency of this vaccination program, we studied measles immunity in 2 groups of young adults resident in Victoria.

Methods

We anticipated that susceptibility to measles among young adults might be as high as 20 per cent. To estimate this proportion with 5 per cent precision at the 95 per cent confidence level (CI), a sample size of 246 was needed. People aged 18 to 30 years are scattered throughout the community and would have been difficult to sample randomly. Instead we studied 300 healthy blood donors from Melbourne (median age 21 years, range 18-30; 44% male) and 312 patients (median age 24 years, range 18-30; 49% male) whose serum had been stored at the Victorian Infectious Diseases Reference Laboratory (VIDRL) following diagnostic testing for a non-rash illness. Age was defined at the date blood was collected. Ethics approval for this study was obtained from the Australian Red Cross Blood Service, Victoria, and the Research and Ethics Committee of the Royal Melbourne Hospital Research Foundation.

Measles specific immunoglobulin G (IgG) was determined at VIDRL using a standard commercial enzyme immunoassay (Dade Behring Enzygnost, Marburg, Germany) in accordance with the manufacturer's instructions. Sera initially defined as equivocal were re-tested. People were considered measles immune if their measles IgG was reported as positive, corresponding to a measles specific IgG concentration of approximately 320 mIU/mL.

1. Victorian Infectious Diseases Reference Laboratory, North Melbourne, Victoria.
2. Department of Paediatrics, University of Melbourne, Parkville, Victoria.
3. Clinical Epidemiology and Biostatistics Unit, Royal Children's Hospital, Parkville, Victoria.

Corresponding author: Dr Heath Kelly, Head of Epidemiology Division, Victorian Infectious Diseases Reference Laboratory, Locked Bag 815, Carlton South 3053. Telephone: +61 3 9342 2608. Facsimile: +61 3 9342 2665. E-mail: heath.kelly@mh.org.au

Sera from healthy blood donors were collected in March 1999 and sera collected and stored at VIDRL between January and September 1999 were retrieved for testing.

Immunity was analysed by birth cohorts, based on the immunisation practice at the time. People born between 1968 and 1970 inclusive, the period when the measles vaccine was first licensed in Australia, and prior to the recommendation of measles vaccine for children aged 15 months, were analysed as one cohort. There was no change in measles vaccine policy in the next 4 years and people born between 1971 and 1974 inclusive were analysed as a second cohort. In 1975 measles vaccine was included in the childhood immunisation schedule. People born in 1975 or later were therefore analysed as a third cohort. Exact 95 per cent confidence intervals (95% CI) for proportions were calculated using the binomial distribution. Tests for association were performed using Fisher's exact test or the chi-squared distribution.

Results

Estimates of measles immunity for the samples of healthy blood donors and stored serum samples are shown by birth cohort and sex in the Table. The overall measles immunity amongst the 300 blood donors was 79.0 per cent (95% CI 73.9-83.5) and amongst the 312 patients whose sera had been stored was 84.0 per cent (95% CI 79.4-87.9). There was no significant difference between the 2 samples in the estimation of the proportion of young adults immune to measles (p=0.11). Within each sample, males were more susceptible than females but the differences did not reach statistical significance.

There was no significant difference in immunity by exact year of birth within each of the defined birth cohorts. There was however, a significant difference in immunity by birth cohort, with both samples demonstrating significantly lower immunity amongst people born in or after 1975 compared with the 2 earlier birth cohorts.

In the sample of healthy blood donors, 87.1 per cent of young adults born before 1975 were immune to measles compared with 70.3 per cent born in or after 1975 (p=0.0004). In the sample from VIDRL, 89.6 per cent of young adults born before 1975 were immune to measles compared with 77.8 per cent born in or after 1975 (p=0.005). There was no significant difference in the proportion of people immune in either sample when comparing those born in 1968-70 with those born in 1971-74. Neither was there a significant difference from the 2 samples when comparing the proportion of people immune born in or after 1975. In combining the results from both samples, we estimated that the proportion of people born between 1968 and 1974 who were immune to measles was 88.4 per cent (95% CI, 84.1-91.6) while the proportion of those born between 1975 and 1981 was 74.1 per cent (95% CI, `68.7-79.1).

Discussion

The results of 2 serosurveys of convenience samples (healthy blood donors and stored sera from diagnostic testing for a non-rash illness) support the concept of a young adult cohort susceptible to measles infection in Victoria. We have shown that younger people, born in or after 1975, are relatively less likely to be immune to measles compared with those born before 1975. This is consistent with continuing

Table. Proportion of young Victorian adults immune to measles by birth cohort, sex, and institutional source of sample

	Australian Red Cross Blood Service, Victoria[2]								
	Male			Female			All		
Birth cohort[1]	N	% imm[4]	95% CI[5]	N	% imm[4]	95% CI[5]	N	% imm[4]	95% CI[5]
1968-1970	28	85.7	68.3-96.0	29	89.6	72.6-97.8	57	87.7	76.3-94.9
1971-1974	42	88.1	74.3-96.0	56	85.7	78.3-92.7	98	86.7	78.3-92.7
1975-1981	64	67.2	54.3-78.4	81	72.8	62.2-77.6	145	70.3	62.2-77.6

Table. (continued) Proportion of young Victorian adults immune to measles by birth cohort, sex, and institutional source of sample

	Victorian Infectious Diseases Reference Laboratory[3]								
	Male			Female			All		
Birth cohort[1]	N	% imm[4]	95% CI[5]	N	% imm[4]	95% CI[5]	N	% imm[4]	95% CI[5]
1968-1970	34	91.2	76.3-98.1	35	88.6	73.2-96.8	69	89.9	80.2-95.8
1971-1974	48	85.4	72.2-93.9	46	93.5	82.1-98.6	94	89.4	81.3-94.8
1975-1981	73	71.2	59.4-81.2	76	84.2	74.0-91.6	149	77.9	70.3-84.2

1. For description of birth cohorts, see text.
2. Healthy blood donors aged 18-30 years in 1999.
3. Sera stored post diagnostic testing for a non-rash illness from patients aged 18-30 years in 1999.
4. % imm= Percentage of subjects immune to measles.
5. 95% CI= Exact 95 per cent binomial confidence interval.

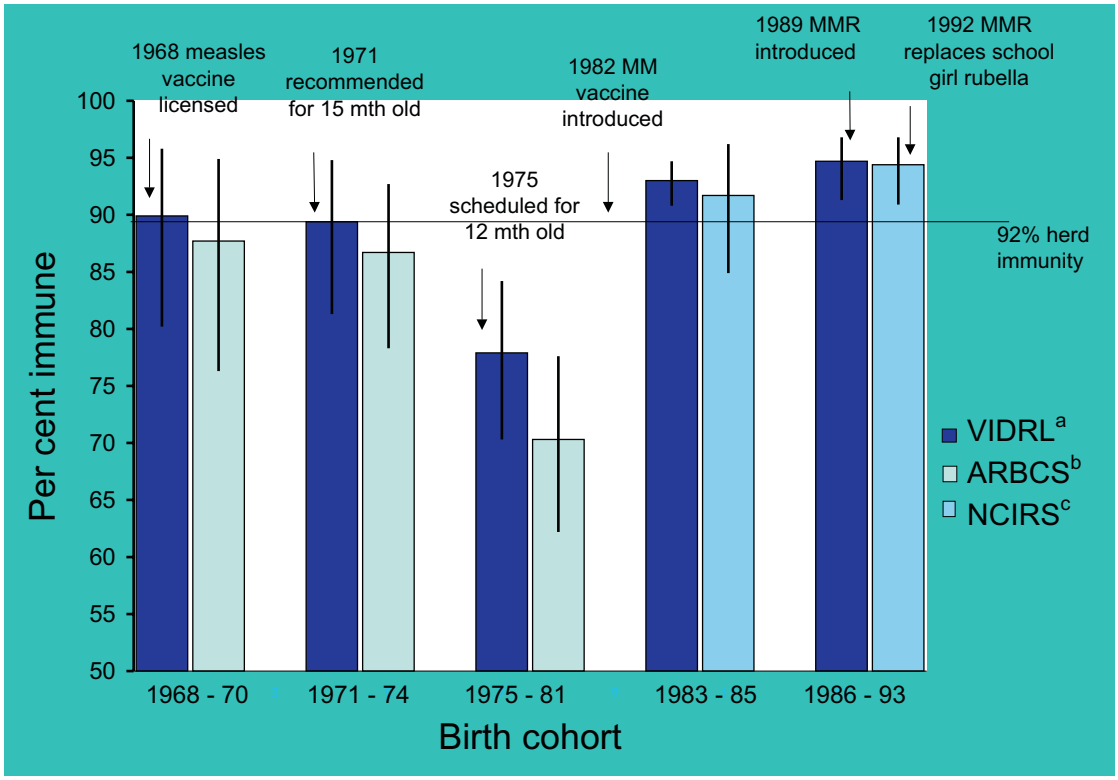
circulation of wild virus (and subsequent natural immunity) until 1975, when the first national immunisation schedule, which included measles vaccine for 12 month olds, was implemented. Partial population immunity after 1975 can be attributed to a decrease in circulating wild measles virus in conjunction with incomplete vaccine coverage.

The 2 convenience samples may not represent the general community, but it is difficult to assess the direction and magnitude of any biases. While it is acknowledged that blood donors are healthier than the general community, it is not clear what implications this has for measles immunity in a sample of blood donors. Neither is it clear whether people who have had serum drawn for a diagnostic test of an illness not involving a rash will be more or less likely to be immune to measles than the general population. Generalisation of statistical inferences from the convenience samples should be made cautiously, as neither sample faithfully represents the population of young adults in Victoria. Estimates of immunity by birth cohort from the 2 samples however, were consistent and there are no published random samples of measles immunity amongst young Australian adults.

We estimated that approximately 12 per cent of young Victorian adults born between 1968 and 1974 were susceptible to measles, increasing to one in four of those born between 1975 and 1981. Herd immunity for measles is estimated to occur at a population immunity in the range of 92-95 per cent.[8] This level of immunity has been demonstrated amongst Australian primary school aged children following the 1998 Measles Control Campaign[9] but has not been demonstrated for young adults in Australia. This is illustrated in the Figure using data from the current study and a study evaluating the Measles Control Campaign in Victoria.[10] The figure also includes comparative Victorian data from the national evaluation of the Measles Control Campaign.[9] Immunity in these birth cohorts is comparable, since collection of all sera from Victoria was done in 1999, the year in which the outbreak of measles among young adults occurred.

There are 2 other reports of measles immunity amongst young people living in Victoria. Of 83 residents at the Melbourne Juvenile Justice Centre, aged 14 to 17 years (included in the 1975-81 birth cohorts), 20 per cent were susceptible to measles.[11] In a sample of 540 Australian born university health care students tested in 1997 and 1998, 96 per cent of whom were aged less than 23 years, 9 per cent were found to be susceptible to measles.[12] Neither of these samples is probably representative of the general population, and awareness of the importance of vaccine preventable diseases in the student sample may explain the lower estimate of measles susceptibility. The estimate of susceptibility among the residents of the Juvenile Justice Centre is consistent with the current study.

Figure. Proportion of Victorians immune to measles (95% CI) by birth cohort and changes in vaccination policy by year



a. VIDRL Victorian Infectious Diseases Reference Laboratory
1968-1981 birth cohorts: 312 sera collected in 1999 and stored post diagnostic testing for a non-rash illness from patients aged 18-30 years;
1983-1993 birth cohorts: 1118 sera collected in 1999 by 3-stage random cluster survey of Victorian school students.

b ARCBS Australian Red Cross Blood Service – Victoria.
1968-1981 birth cohorts: sera from 300 healthy blood donors aged 18-30 years collected in 1999.

c NCIRS National Centre for Immunisation Research and Surveillance
1983-1993 birth cohorts: Data from 376 sera collected in 1999 and submitted to NCIRS from Victorian laboratories as part of the National Evaluation of the Measles Control Campaign

Available data from other Australian States also support the findings of the current study, but suggest some geographic variation in at-risk birth cohorts. A recent measles outbreak in South Australia consisted of 7 cases with a median case age of 32 years.[13] Unpublished data from a serosurvey conducted in 1997 referred to in this report, indicate that only 3 per cent of persons in South Australia born before 1975 were susceptible to measles. Data from the stored sera of 1300 patients in New South Wales show that in 1997, 14 per cent of persons aged 14 to 19 years (born 1979-83) were susceptible to measles compared with an estimated 5 per cent population susceptibility amongst people aged 20 to 25 years.[14] A recent Queensland serosurvey involving 3367 people aged 16 to 25 years (born 1972-83) whose sera had been collected in 1999, showed that approximately 16 per cent were susceptible to measles.[15]

The susceptibility of young adults to measles infection, in Victoria at least, will continue to be a problem as highlighted by the 1999 outbreak, and confirmed by this study. Indeed, a second outbreak of measles, affecting mainly young adults, has occurred in Victoria in the early months of 2001.[16] Given the success of the Measles Control Campaign and the routine 2-dose measles-mumps-rubella vaccination schedule, improving the control of measles in the general community will increasingly rely on the development of vaccination programs for young adults.[3] In addition to opportunistic vaccination of those from the at-risk birth cohorts, it may be prudent to ensure specific groups of young adults have documented evidence of 2 doses of a measles containing vaccine. These include health care workers, tertiary students, travellers, and armed forces recruits. Young adults born between 1975 and 1981 are more at risk, but probably more accessible, than the older cohort. We should make every effort to vaccinate this group before they too become harder to reach.

Acknowledgements

Irene Gooi facilitated the collection of serum samples from the Australian Red Cross Blood Service, Victoria.

References

1. Duclos P, Redd SC, Varughese P, Hersh BS. Measles in adults in Canada and the United States: implications for measles elimination and eradication. *Int J Epidemiol* 1999; 28:141-146.
2. Miller M, Williams WW, Redd SC. Measles among adults, United States, 1985-1995. *Am J Prev Med* 1999; 17:114-119.
3. Lambert SB, Morgan ML, Riddell MA, Andrews RM, Kelly HA, Leydon JA et al. Measles outbreak in young adults in Victoria, 1999. *Med J Aust* 2000; 173:467-471.
4. Gidding HF, Burgess MA, Kempe AE. A short history of vaccination in Australia. *Med J Aust* 2001:174:37-40.
5. Christopher PJ. Measles immunization in Sydney. *Med J Aust* 1972;2:414-415.
6. Tobin S, Kelly H. Measles encephalitis in Victoria, 1962-96: down but not out (letter). *Aust N Z J Pub Health* 1999;23:443.
7. Campbell M. Young adult measles vaccination (editorial). *Commun Dis Intell* 2000;24:241-242.
8. Anderson RM, May RM. Immunisation and herd immunity. Modern vaccines. London: Edward Arnold, 1990:24-33.
9. Anon. Let's work together to beat measles: a report on Australia's Measles Control Campaign. Canberra: Commonwealth Department of Health and Aged Care, 2000.
10. Riddell M, Leydon J, Ugoni A, Kelly H. A seroevaluation of the school based measles 'catch-up' immunisation campaign in Victorian school aged children (*Aust N Z J Pub Health.* In press).
11. Thompson SC, Ogilvie E, Veit F, Crofts N. Serostatus for vaccine-preventable diseases in residents at Melbourne Juvenile Justice Centre. *Aust N Z J Pub Health* 1998:22: 573-577.
12. Veitch M, Tallent D, De Petra V, Hogg G. Susceptibility of university health care students to measles and rubella. Immunisation beyond 2000: 6th National Public Health Association Immunisation Conference, Melbourne, Australia, 1998. Public Health Association of Australia.
13. Holland R, Hall R. A cluster of measles. *Commun Dis Intell* 2000;24:142-143.
14. Gilbert GL, Chan SW, Escott R, Dickeson D, Heath T, Amin J, Burgess MA. Seroepidemiology of measles in New South Wales, 1997. Report to the National Centre for Disease Control, Commonwealth Department of Health and Aged Care, 1998 (available from the Department).
15. Crome M, Selvey L, Faoagali J, Firman D, Witt M, Bowtell R. A seroprevalence study of measles susceptibility in Queenslanders aged 16 to 25 years. *Australasian Epidemiologis*t 2000;7:4.
16. Andrews R, for the Surveillance and Response Team. Measles outbreak among young adults in Victoria. *Commun Dis Intell* 2001;25:12.