MEASLES CONTROL IN NSW DIVISIONS OF GENERAL PRACTICE

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Measles is among the leading causes of death worldwide, and is responsible for more deaths than road traffic accidents or lung cancer.[1] The World Health Organization Western Pacific Region has declared a goal of measles elimination. Australia conducted a National Measles Control Campaign (MCC) in 1998 as part of a long-term strategy to eliminate measles from Australia.[2] This campaign consisted of changing the scheduled age of the second dose from 12 years to four years, as well as a catch-up campaign for children aged 5–12 years.

Communicable disease control is usually monitored by trends in notifications,[3] but these data are retrospective and are often not timely enough to initiate preventive measures. Future epidemics and disease control targets can be predicted by the use of mathematical modelling, which uses vaccine coverage or sero-epidemiological data to model projected levels of susceptibility to communicable diseases in the population.

Central to mathematical modelling is the concept of the reproductive number, *R*, which is the number of secondary cases generated from one index case of a communicable disease. The basic reproductive number, R_0, is the number of secondary infections produced by a typical infective case in a totally susceptible population. Factors affecting R_0 include the infectivity of an organism, the duration of infectiousness, and population mixing patterns. The effective reproductive number, R_t, is the number of secondary cases produced by a typical case in a given population, taking into consideration the level of population immunity to that disease.

When *R* is greater than one, cases increase from one generation to the next, and an epidemic may ensue. When *R* is less than one, cases decrease from one generation to the next, and an epidemic is not possible. The epidemic threshold is defined at *R* equals one. Endemic disease transmission is eliminated if *R* is maintained below the epidemic threshold (that is, *R* is less than one) for sustained periods.[4,5] In this article we aimed to determine variations in measles control by divisions of general practice (DGP) in NSW.

METHODS

Vaccine coverage estimates

Vaccine coverage estimates were obtained from the Australian Childhood Immunisation Register (ACIR),[6] a national register which records the immunisation status of all children aged 0–7 years for scheduled vaccines. The ACIR was first established in 1996, so coverage data at four years of age are only available for the first birth cohort of children born in 1996. To predict measles control, we used the ACIR measles-mumps-rubella (MMR) coverage data recorded in 2001 for the doses given at 12 months and four years (and recorded by five years of age).

NSW postcode data were used to examine coverage by DGPs, which are geographically defined administrative areas. There are 123 DGPs in Australia (37 in NSW), and 90 per cent of general practitioners (GPs) belong to a DGP.

Modelling

The population was stratified into five age groups: 0–4, 5–9, 10–14, 15–19, and 20+ years. The proportions susceptible in each age group x_i before and after the MCC were estimated from the seroprevalence data.[7] Projections of the proportion susceptible in subsequent years were based on the post-campaign susceptibility in each cohort, on the assumption that no immunity would be acquired through natural infection. In new cohorts the proportion susceptible was estimated from the expected vaccine coverage and vaccine efficacy (assumed to be 90 per cent after one dose, and 99 per cent after two doses).

The potential for measles transmission was summarised by the effective reproduction number, *R*, the average number of secondary cases produced by a typical infectious case.[8] *R* depends on the transmission potential for measles in a totally susceptible population and on the proportion susceptible in each age group. R_{0ij} is the average number of secondary cases in the *i*th age group caused by an infectious individual in the *j*th age group if all individuals in the *i*th age group are susceptible to infection. Values for R_{0ij} from previous studies in the UK and Canada were used.[9]

$$(R_{0ij}) = \begin{pmatrix} 0.96 & 0.43 & 0.43 & 0.43 & 0.43 \\ 0.48 & 4.99 & 1.80 & 0.48 & 0.48 \\ 0.48 & 1.80 & 7.48 & 0.48 & 0.48 \\ 0.48 & 0.48 & 0.48 & 8.73 & 0.48 \\ 5.23 & 5.23 & 5.23 & 5.23 & 5.23 \end{pmatrix}$$

If only a proportion x_i of the *i*th age group are susceptible to infection then R_{ij}, the number of secondary infections in that group caused by an infectious individual in the *j*th age group is given simply by $R_{ij} = R_{0ij}\, x_i$. The overall *R* is calculated as the leading eigenvalue of the next generation matrix R_{ij}.[10]

RESULTS

The mean vaccination coverage for the 37 NSW DGPs for two doses of MMR at five years of age was 54 per cent, with a range of 24–67 per cent. At five years of age, 11 per cent of NSW children had not received any doses of MMR, and 35 per cent had received only a single dose. Thus, we estimated that 15 per cent of five year olds remained

susceptible to measles (comprising 11 per cent with no doses, 3.5 per cent with a single dose, and 0.5 per cent who had received two doses of vaccine). The proportion susceptible at age five years ranged from seven per cent in the best DGP to 31 per cent in the DGP with the worst coverage.

Figures 1–4 show the average, best, and worst *R* values over time for NSW DGPs, grouped by geographic regions, and shows the projected time when each will exceed the epidemic threshold if vaccination coverage remains at current levels. There is a wide variation in the level of measles control between DGPs, with the poorest measles control in inner-urban DGPs.

DISCUSSION

The benefits of a catch-up campaign (such as the MCC) are transient.[9] Long-term measles control requires high levels of coverage with the routine two-dose schedule.[9] It is important that the success of the MCC be consolidated by improving and maintaining high levels of coverage with both the first and second doses of MMR. Our data indicate that 73 per cent of those who are susceptible at age five are children who received no doses of vaccine, with the remainder being children who received one or two doses but did not seroconvert. It is more important to target the unvaccinated children with a first dose than to give second doses to children who have already had one. Improving second dose coverage from 54 per cent to 89 per cent would still leave nearly 12 per cent of 5-year-old children susceptible.

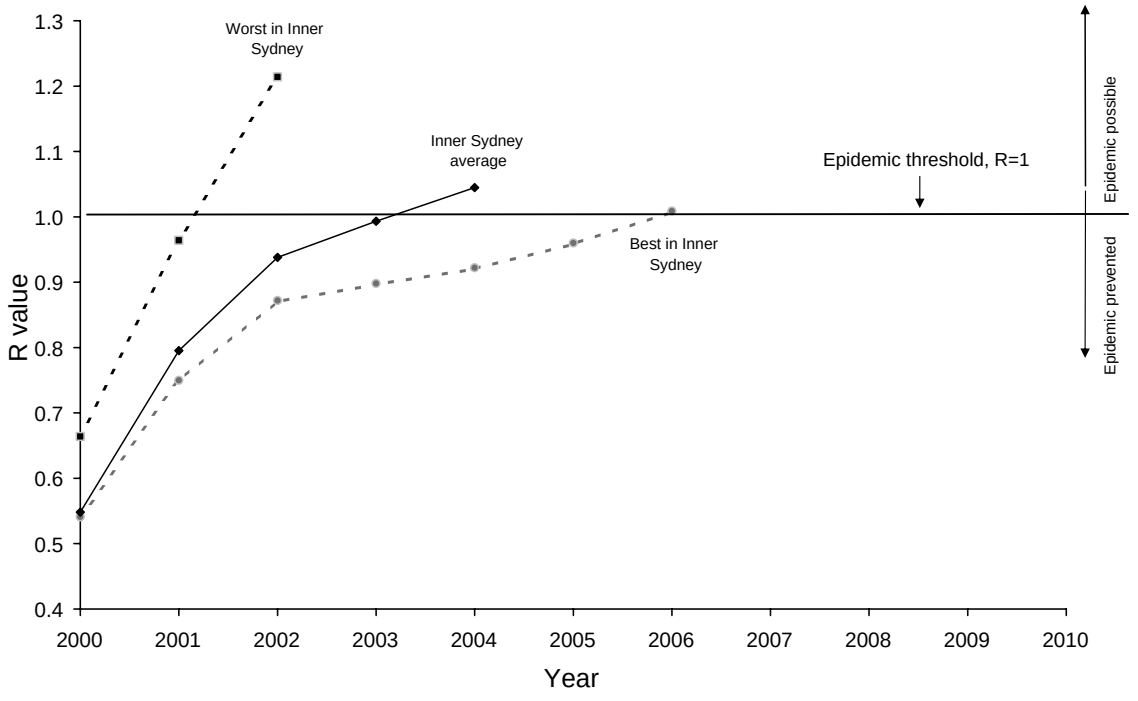
In the year 2000, the start of the study time period, all DGPs had a low value of *R*, reflecting the success of the 1998 MCC in reducing susceptibility to measles in the target age groups. However, modelling shows that *R* will gradually increase over time if coverage remains at current levels. The inner-urban DGPs appeared to have the worst measles control, with coverage levels as low as 24 per cent for two doses of MMR.

There is a wide variation in coverage of two doses of MMR in this cohort of children born in 1995, ranging from 24 per cent to 67 per cent, in NSW DGP. The modelling indicates that some DGPs may already be exceeding the epidemic threshold for measles. If wild measles virus is introduced into the community, these DGPs may be at risk of outbreaks. Some are known to have higher rates of conscientious objectors to vaccination, and may genuinely have lower coverage rates. However, differential levels of reporting of vaccine coverage by DGP may be a factor in this apparent variation. The extent to which under-reporting contributes to 'apparent' low coverage can only be determined by further ascertainment by DGPs.

In 1998, incentive payments for medical practitioners were introduced for scheduled vaccines at two, four, six, 12 and 18 months, but not for the four-year MMR dose.[6] Genuinely low coverage with two doses of MMR may be

FIGURE 1

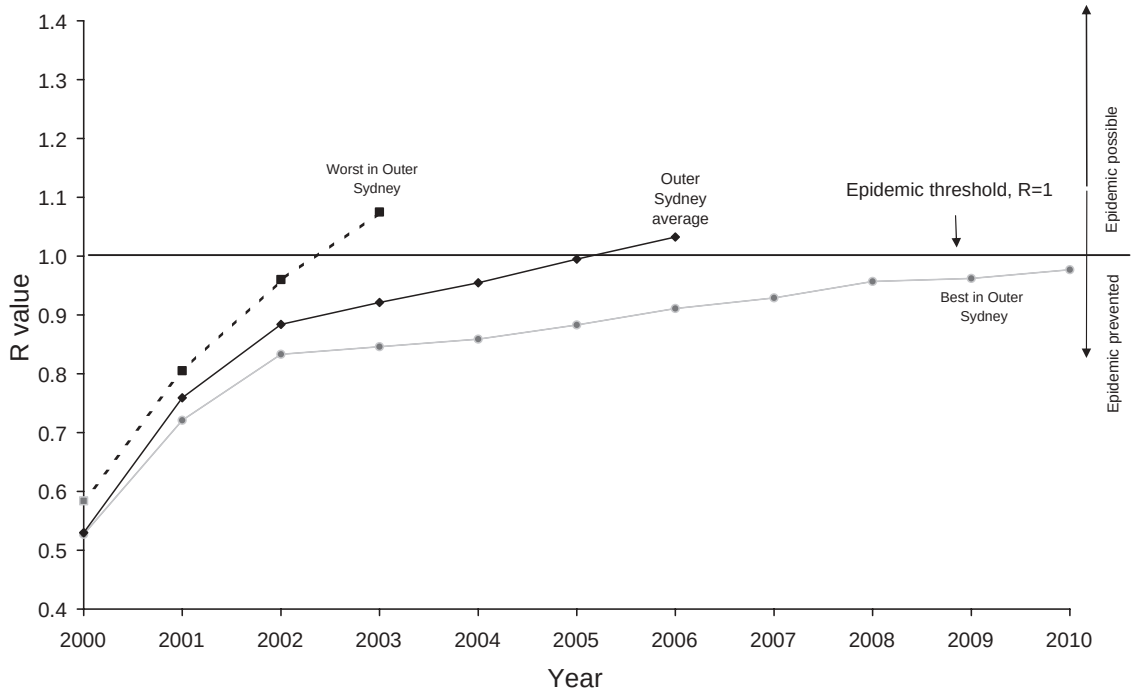
THE PROJECTED *R* VALUES OVER TIME FOR INNER SYDNEY DIVISIONS OF GENERAL PRACTICE



Source: The Australian Childhood Immunisation Register

FIGURE 2

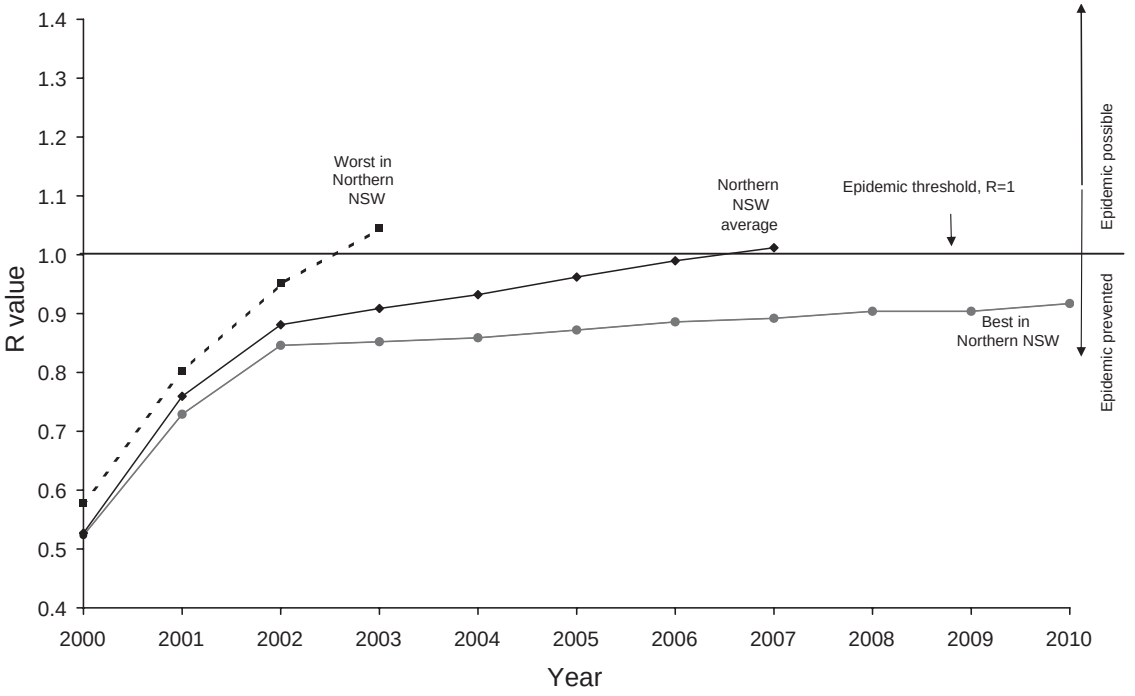
THE PROJECTED *R* VALUES OVER TIME FOR OUTER SYDNEY DIVISIONS OF GENERAL PRACTICE



Source: The Australian Childhood Immunisation Register

FIGURE 3

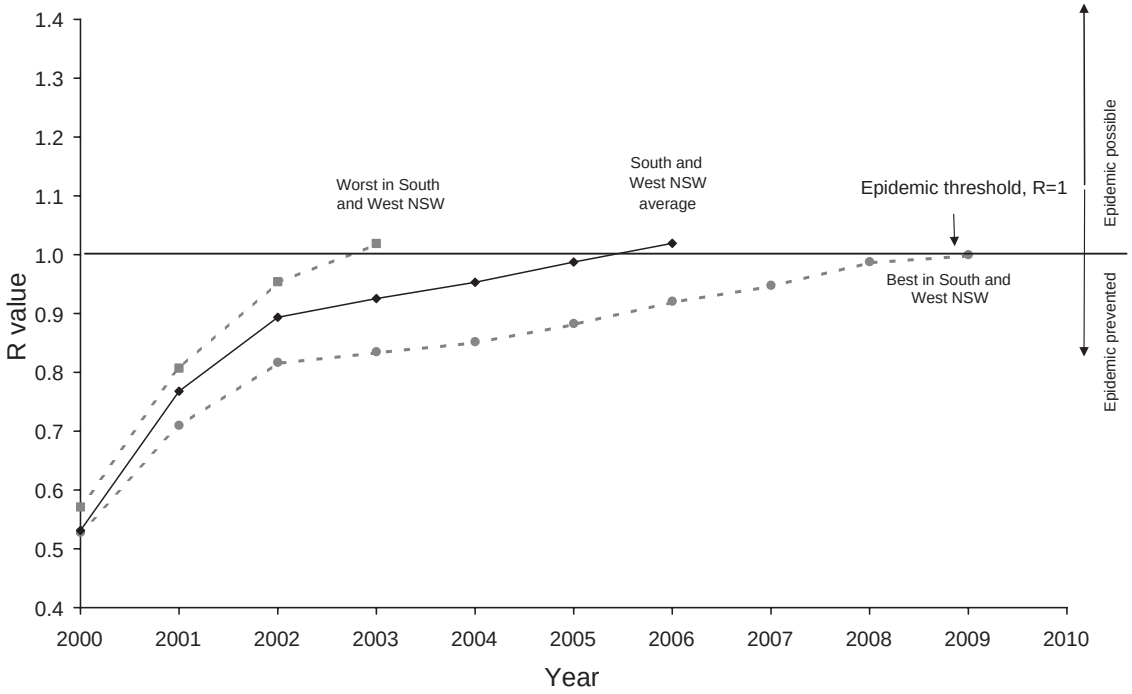
THE PROJECTED *R* VALUES OVER TIME FOR NORTHERN NSW DIVISIONS OF GENERAL PRACTICE



Source: The Australian Childhood Immunisation Register

FIGURE 4

THE PROJECTED *R* VALUES OVER TIME FOR SOUTHERN AND WESTERN NSW DIVISIONS OF GENERAL PRACTICE



Source: The Australian Childhood Immunisation Register

explained by the fact that the second dose of MMR is not subject to an incentive payment for medical practitioners. It has been shown that parental and provider factors play a role in uptake of the second dose of MMR. A UK study showed that MMR vaccination, particularly the second dose, is not perceived to be important for children's health.[11] Another UK survey of doctor attitudes to MMR vaccination showed that there was lack of consensus over the need for a second dose, with only 20 per cent of practitioners stating that they would unequivocally recommend the second dose to a wavering parent.[12] However, this study was performed in an environment where MMR was unfairly receiving considerable adverse publicity.

The limitation of using ACIR data for the calculation of vaccination coverage relates to the degree of under-reporting to the ACIR, leading to underestimation of coverage. A recent study showed that the ACIR under-estimates coverage by five per cent at two years of age.[13] In addition, the change of schedule for the second dose of MMR from 12 to four years in 1998 is not reflected in the personal immunisation record books of the study cohort. This may contribute to the study cohort having low coverage (because parents may not realise that the second dose is due) and may also result in underestimation of coverage (because the immunisation record book does not allow for a dose at four years to be recorded). These factors may reduce the absolute values of *R* slightly, but should not affect the differences between DGP or the trends we describe.

CONCLUSION

Mathematical modelling is useful in evaluating disease control as it can summarise susceptibility profiles by a single parameter, the reproduction number *R*, which quantifies the level of herd immunity in the population, and allows the prediction of epidemics.[8] This provides more information than disease notification data alone, and contributes to informed planning of vaccination programs.

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HEPATITIS B IMMUNISATION IN CHILDREN AGED 10–13 YEARS IN NEW SOUTH WALES, 2001

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Hepatitis B is a viral infection that is an important cause of morbidity and mortality globally. The World Health Organization estimates that about two billion people have been infected and 350 million are chronic carriers.[1] Between 1991 and 2001, just over 6,000 hepatitis B notifications per year were reported to the Australian health system, including an average of 250 per year which were identified as incident cases. Approximately half of all cases notified, and a quarter of incident cases, were resident in New South Wales (NSW).[2]

This article describes a survey of the parents or carers of children aged 10 to 13 years in NSW to assess hepatitis B immunisation coverage rates in pre-adolescent children. In Australia, hepatitis B vaccine has been available since the early 1980s and it has been recognised by the National Health and Medical Research Council (NHMRC) as safe and effective since 1983. NSW Health introduced a policy in 1983 which recommended hepatitis B immunisation of: household contacts and sexual partners of hepatitis B carriers; prisoners; residents of some institutions and hostels; health care workers; some patients; injecting drug users and men who have sex with men.[3,4] In 1986, the NHMRC recommended hepatitis B immunisation for children born into high-risk groups where at least 5 per cent of the population are hepatitis B surface antigen carriers. NSW Health implemented that recommendation in 1987.[5] NSW Health also recommended that pregnant women in NSW be screened for hepatitis B and that infants born to hepatitis B surface antigen positive mothers receive hepatitis B immunoglobulin and vaccine on the first day of life. Current data indicate that this program is very effective with over 99 per cent of women screened and 94 per cent of infants born to hepatitis B positive mothers receiving hepatitis B immunoglobulin within 12 hours of birth.[6]

In 1996, the NHMRC recommended hepatitis B immunisation for all adolescents aged 10–13 years and this was introduced in NSW in 1999.[7] This program has been mainly administered through general practitioners. From May 2000, the NHMRC recommended a birth dose of hepatitis B vaccine for all babies with a further three doses at two, four and six months of age.[8]

All childhood immunisations are reported to the Australian Childhood Immunisation Register for children aged less than seven years. Reliable estimates of hepatitis B immunisation in children aged 10–13 years are not available in NSW. To estimate the current uptake of hepatitis B immunisation among children aged between 10 and13 years in NSW, NSW Health interviewed a random sample of the parents and carers of adolescent children in this age group. The survey also sought to clarify reasons why parents did not seek free hepatitis B immunisation for their children.