

# The Australian Measles Control Campaign, 1998<sup>\*</sup>

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**Abstract** The 1998 Australian Measles Control Campaign had as its aim improved immunization coverage among children aged 1–12 years and, in the longer term, prevention of measles epidemics. The campaign included mass school-based measles–mumps–rubella vaccination of children aged 5–12 years and a catch-up programme for preschool children. More than 1.33 million children aged 5–12 years were vaccinated at school: serological monitoring showed that 94% of such children were protected after the campaign, whereas only 84% had been protected previously. Among preschool children aged 1–3.5 years the corresponding levels of protection were 89% and 82%. During the six months following the campaign there was a marked reduction in the number of measles cases among children in targeted age groups.

**Keywords** Measles/prevention and control; Immunization programs/organization and administration; Measles–mumps–rubella vaccine/administration and dosage/adverse effects; School health services; Child; Child, Preschool; Evaluation studies; Australia (*source: MeSH*).

**Mots clés** Rougeole/prévention et contrôle; Programmes de vaccination/organisation et administration; Vaccin antimorbillieux-antiourlien-antirubéoleux/administration et posologie/effets indésirables; Service hygiène scolaire; Enfant; Enfant âge pré-scolaire; Etude évaluation; Australie (*source: INSERM*).

**Palabras clave** Sarampión/prevención y control; Programas de inmunización/organización e administración; Vacuna contra el sarampión-parotiditis-rubéola/administración y dosificación/efectos adversos; Servicios de salud escolar; Niño; Infante; Estudios de evaluación, Australia (*fuente: BIREME*).

*Bulletin of the World Health Organization*, 2001, **79**: 882–888.

Voir page 888 le résumé en français. En la página 888 figura un resumen en español.

## Introduction

Live attenuated measles vaccine was first licensed in Australia in 1968. Low coverage and outbreaks in the early 1980s prompted a national campaign against measles in 1987, but a survey in 1989 indicated that coverage of young children was only 85% (1). A measles epidemic occurred in 1993 and 1994, when nearly 10 000 cases and 4 deaths were notified (Fig. 1). This led to the introduction in 1994 of a second dose of

measles vaccine, in measles–mumps–rubella (MMR) vaccine, for all children aged 10–16 years, and the simultaneous ending of a rubella vaccination programme for schoolgirls. Between 1994 and 1995 the measles notification rate fell from 27 per 100 000 to 7 per 100 000, and by 1998 it had fallen to 2 per 100 000, the lowest recorded rate since national surveillance began in 1991 (2). In 1997, however, it emerged that only 83% of under-2-year-olds had received MMR vaccine (3). Moreover, the gap of ten years between the first and second doses of vaccine had allowed the pool of susceptible individuals to reach the annual birth cohort of 250 000, at which point epidemics were likely to occur (4). Consequently, unless measles vaccination coverage could be rapidly improved, repeated measles outbreaks were to be expected.

Since 1994 a number of WHO regions have targeted measles for either elimination or accelerated control (5). As part of the Western Pacific Region, Australia has focused on control, and in 1997 its Measles Control Campaign (MCC) was announced. This campaign, which began in June 1998, was designed as the first stage in a longer-term strategy to eliminate measles from the country. This paper describes the campaign and its evaluation, including the impact on vaccination coverage, measles immunity and disease incidence.

\* A detailed report of the 1998 Australian Measles Control Campaign can be obtained from the National Centre for Disease Control website (<http://immunise.health.gov.au>).

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Ref. No. 00–0640

## Components of the campaign

The MCC involved the following elements:

- changing the age range for the second dose of MMR from 10–16 years to 4–5 years;
- conducting a national media and education programme to encourage participation;
- mass school-based vaccination of children aged 5–12 years, regardless of their history of measles or immunization;
- sending letters to parents of preschool children aged 1–3.5 years whose first dose of MMR was due or overdue according to the Australian Childhood Immunisation Register (ACIR)<sup>a</sup>, encouraging them to update their children's vaccination status;
- sending letters to parents of all high-school children aged 12–18 years, encouraging them to ensure that their children had received two doses of MMR vaccine;
- initiating two other programmes to improve immunization uptake: a scheme linking immunization to the Childcare Assistance and the Childcare Rebate Scheme (CRS), introduced in April, and the General Practitioners Immunization Incentives Scheme (GPII), introduced in July (6).

## Evaluation

The evaluation of the campaign was designed and conducted by the National Centre for Immunisation Research and Surveillance of Vaccine Preventable Diseases. Vaccination coverage, adverse events associated with MMR vaccination, immunity before and after the campaign, and the impact on the incidence of disease in the six months following the campaign were investigated.

## Coverage

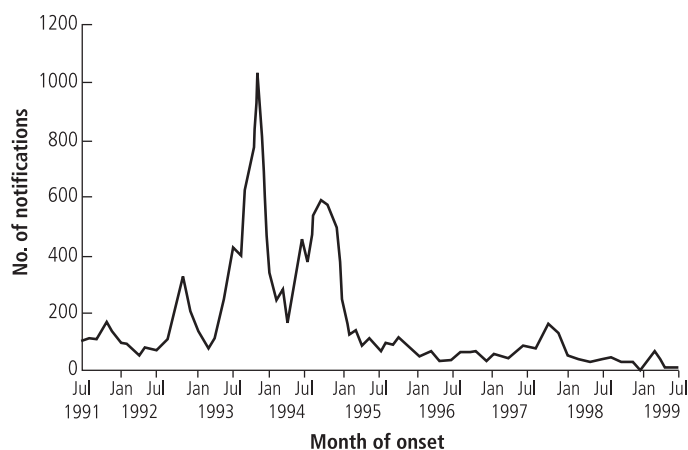
### Methods

*Preschool children.* ACIR (7) was used to identify children aged 1–3.5 years whose first dose of MMR vaccine was due or overdue. This age group was chosen because its first dose of vaccine became due after ACIR was established in January 1996 and should therefore have been recorded on the register.

A reminder letter based on the health belief model (8) was sent to parents of children whose immunization was overdue. The effect of the letter was determined by a) using ACIR to follow the

<sup>a</sup> ACIR was the major tool used in the estimation of coverage of preschool children. This national immunization register, established in January 1996, aims to record the immunization status of all children under the age of 7 years. It is operated by the Health Insurance Commission, which also administers the national Medicare System. Children on the register are identified from the Medicare database with which nearly 98% of children are registered by the age of 12 months. Notifications of immunization are received from providers either electronically or by post and the data are updated on a daily basis. The Health Insurance Commission uses the register to provide regular coverage reports and to administer a recall-reminder system. ACIR also provides national data for programme management and targeted immunization efforts, e.g. MCC.

Fig. 1. Measles notifications in Australia, July 1991 to July 1999



Source: National Notifiable Diseases Surveillance System

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vaccination status of all such children and b) conducting telephone interviews with a random sample of parents of such children. The register was also used to examine overall MMR coverage of children aged under 7 years.

The relationship between demographic factors and immunization status according to the parental survey was examined by means of univariate analysis. Pearson's  $\chi^2$  test, Student's *t* test and Wilcoxon's test were used, where appropriate, to determine differences.

*Primary-school children.* Standardized data collection forms were completed during school visits. Coverage was calculated as the number of students vaccinated divided by the total number of students enrolled. The data were analysed by means of SAS (9) and Excel software (10). Pearson's  $\chi^2$  test was used to compare proportions; *P*-values < 0.05 were considered statistically significant.

A multistage cluster sampling method (11) was used to select 30 schools from each state or territory of Australia and the parents of primary-school children for participation in surveys after the campaign. School coordinators completed a short written questionnaire. The effect of school characteristics on vaccination coverage was determined by univariate analysis. Mean coverage levels for each characteristic were compared by means of ANOVA. In each of the 240 study schools, 20 students were randomly selected; the parents who consented to being interviewed by telephone were asked whether their children had been vaccinated during the campaign as well as their attitudes to it. Univariate analysis was performed to examine the relationship between the children's vaccination status and the demographic characteristics of parents and schools.

## Results

*Preschool children.* Reminder letters were sent to parents of 162 143 children whose vaccination was due or overdue; by the cut-off date of 31 March 1999, ACIR showed that 60 028 (37%) had been vaccinated and

that 102 115 (63%) remained unaccounted for. Of the vaccinated children, some 40 000 (67%) had been vaccinated previously, and 20 128 were vaccinated after the reminder letter was sent. Of the overdue cohort who were vaccinated, 72% received their vaccination during the first two months of the campaign. Older children accounted for a greater proportion of the vaccinations given after the letter was sent, indicating that the letter had an important impact on those children for whom MMR vaccination was most delayed.

Of the 1601 children selected for parental interview, 910 (57%) were successfully contacted. The remaining 43% could not be contacted because of problems in the electronic matching of common names with telephone numbers. Interviews were held with 886 parents (55%). There were no significant differences between respondents and non-respondents with respect to children's ages ( $P=0.06$ ), sex ( $P=0.3$ ), or state or territory of residence ( $P=0.6$ ). However, a larger proportion of non-respondents (70%) than of respondents (64%,  $P=0.001$ ) were from metropolitan areas. Of the 886 surveyed children, 797 had received an MMR vaccine and 700 (79%) had been vaccinated before the letter was received. Those vaccinated after receipt of the letter tended to live in households with only one or two children and to have parents in paid employment. They also tended to be younger than the children who remained unvaccinated after receipt of the letter and to have parents who had attained higher levels of education than those who remained unvaccinated.

According to ACIR, overall coverage of children aged under 7 years for both MMR and the third dose of diphtheria–tetanus–pertussis vaccine (DTP3) remained identical and stable at around 20 000 vaccinations per month between January 1996 and August 1998, when the number of MMR vaccinations rose sharply to about 100 000 (Fig. 2). Since this rise coincided with both the start of the MCC and with two other initiatives (CRS and GPII (6)), the contribution of individual initiatives was difficult to determine.

*Primary-school children.* A total of 8783 schools in the eight states and territories participated in the campaign. Their combined population of eligible children aged 5–12 years was 1.78 million. According to data collected at the time of vaccination, 1.33 million primary-school children (75%) received MMR vaccine within the school-based programme between July and December 1998 (Table 1).

A questionnaire was completed by 192 (80%) of the 240 selected schools. Information from 187 of these schools showed that comparatively high vaccination coverage was associated with rural schools ( $P < 0.001$ ), schools with fewer than 10% of students who spoke a language other than English at home ( $P=0.004$ ), and schools that used verbal reminders to encourage parents to return consent forms ( $P=0.01$ ).

Of the 3840 parents who were invited to participate in the survey, 2225 (58%) returned the

consent form, 1860 (84%) agreed to be interviewed, and all but 16 were contacted. No demographic information was available for those parents who did not participate. It was reported by 1772 parents (96%) that their children had been vaccinated during the campaign, 80% within the school-based programme and 16% elsewhere, the majority by their local general practitioner (Table 2). Vaccination outside the school-based programme was more likely for children attending a large school ( $P < 0.001$ ) or a metropolitan school ( $P=0.007$ ), but was not associated with the type of school (government or non-government), parental characteristics (marital status, level of education, employment of respondent or respondent's partner) or the number of children in the household. Satisfaction with the school-based programme was expressed by 89% of parents; 87% said they would have their children vaccinated at school in the future.

## Adverse events

### Methods

Adverse events following immunization (AEFIs) with MMR vaccine during the period of the campaign were notified to one of the three national surveillance systems: the Adverse Drug Reactions Advisory Committee (ADRAC)<sup>b</sup> (12), the Serious Adverse Events Following Vaccination Surveillance Scheme (SAEFVSS)<sup>b</sup> (12), and the campaign coordinators for each state and territory.

AEFIs were included for analysis if they commenced within 30 days of MMR vaccination, were notified by 1 September 1999, and involved children aged 5–12 years. Minor syncopal events and anxiety reactions were excluded from the analysis. All reported AEFIs were reviewed by a panel of six experts, including three paediatricians, and were classified according to definitions recommended by the Pan American Health Organization (13). A causality rating was assigned to each AEFI in accordance with a classification scheme developed by ADRAC in 1997.

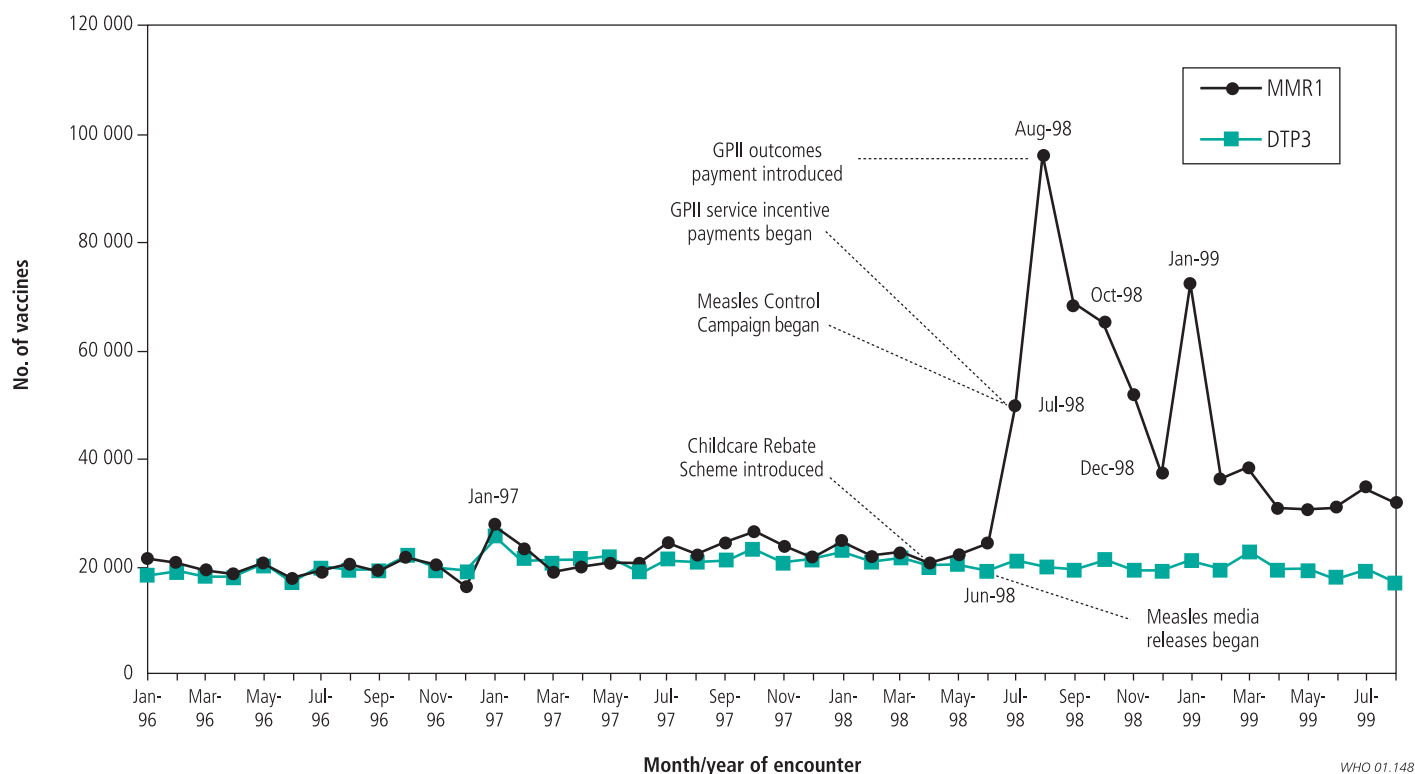
### Results

There were 89 AEFIs following an estimated 1.7 million doses of MMR vaccine administered during the campaign (12), a rate of 5 per 100 000 doses. All children who were reported to have experienced an AEFI and who were followed up recovered without sequelae; nine could not be followed up through the ADRAC system because of confidentiality constraints.

The most common reactions were syncopal fits (21/89, 24%), allergic reactions not including anaphylaxis (11/89, 12%) and other reactions including illnesses resembling mumps and measles (10/89, 11%). There was one report of anaphylaxis, (i.e. less than one case per million doses delivered)

<sup>b</sup> ADRAC is responsible for the post-marketing surveillance of all drugs, including vaccines, and receives reports from providers, manufacturers and the community. SAEFVSS collects data on defined serious adverse events reported by public health units. Both ADRAC and SAEFVSS are passive surveillance schemes.

Fig. 2. Trends in vaccine use for measles–mumps–rubella, 1st dose (MMR 1) and diphtheria–tetanus–pertussis, 3rd dose (DTP 3), according to the Australian Childhood Immunisation Register (ACIR), January 1996 to August 1999



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and there were six reports of anaphylactoid reactions (one case per 280 000). Also, there were six reports of neurological reactions, including one case of encephalopathy: in all six cases it was considered possible that the neurological reaction was causally related to MMR vaccination. Uncommon reactions included arthralgia (2/89), arthritis (1/89), and parotitis (4/89). Recovery occurred without sequelae in the 90% of children who were followed up.

### Immunity

#### Methods

Diagnostic laboratories throughout Australia contributed nearly 6000 residual specimens of sera, which were tested for measles IgG as a marker of seroprotection. Of these specimens, 2936 were collected before and 2918 after the campaign. The samples were stratified by age from 1 to 18 years and the sample sizes were proportional to the state and territory populations. Sera were not included from subjects who were immunocompromised, had received multiple transfusions in the previous 3 months, or whose sera were collected specifically for the diagnosis of measles. Age, sex and state or territory of residence were recorded for each specimen. Samples were centrally tested by means of a standardized enzyme-linked immunoassay (EIA). Measles IgG levels < 150 mIU/ml were considered negative, those in the range 150–343 mIU/ml as equivocal, and those > 343 mIU/ml as positive. Equivocal sera were retested by plaque reduction neutralization (PRN)

Table 1. Proportions of primary-school children vaccinated at school in the Australian Measles Control Campaign according to real-time data, July–December 1998

	No. of students	% of enrolled students
Students enrolled	1 781 864	100
Parental consent given	1 415 596	79.4
Students vaccinated	1 333 980	74.9

assay. Individuals with a measles antibody level greater than 343 mIU/ml as determined by EIA or with a PRN titre >900 were defined as immune, i.e. protected against infection (14).

#### Results

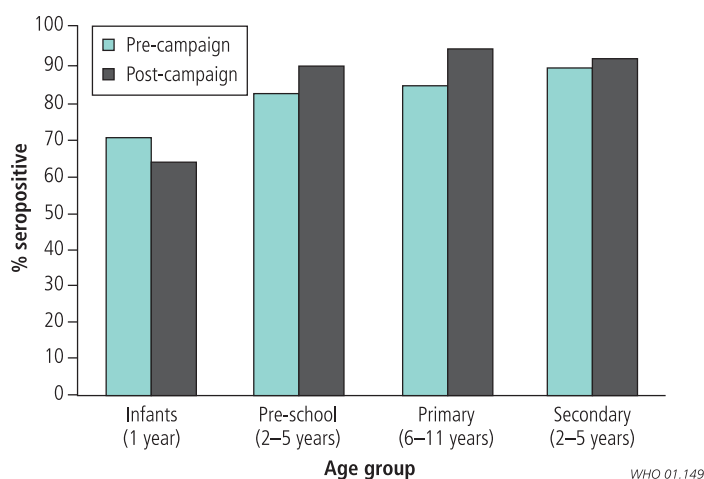
There were highly significant differences ( $P < 0.001$ ) between results obtained before and after the campaign for preschool and primary-school children (Fig. 3). Seropositivity rose from 82% to 89% among children aged 2–5 years and from 84% to 94% among those aged 6–11 years. There was no significant difference between the proportions of infants aged 1 year who were seropositive before (70%) and after (63%) the campaign ( $P = 0.2$ ). These low values suggested that many infants failed to receive their first dose of MMR at the scheduled age of 12 months. The levels of seropositivity in people aged 12–18 years before and after the campaign were not significantly different at 89% and 91% respectively ( $P = 0.2$ ).



Table 2. Measles–mumps–rubella vaccination status of schoolchildren surveyed after the Australian Measles Control Campaign ( $n = 1844$ )

Vaccination status	No. of children	% of surveyed children
Vaccinated at school	1483	80.4
Vaccinated elsewhere	211	11.4
Vaccinated before campaign	68	3.7
Vaccinated after campaign	10	0.5
<b>Total vaccinated</b>	<b>1772</b>	<b>96</b>
Medical reason for not vaccinating	14	0.8
Opposed to vaccination	11	0.6
Intention to have child vaccinated	42	2.3
Ineligible/other	5	0.3
<b>Total not vaccinated</b>	<b>72</b>	<b>4</b>

Fig. 3. Proportion of children seropositive for measles IgG pre- and post-measles control campaign



## Impact on disease

### Methods

Notification data received by the National Notifiable Diseases Surveillance System (NNDSS) were examined to identify any impact of the campaign on disease incidence. Notifications covering the six months immediately after the campaign (January–June 1999) were compared with those for the same period of 1998 and with the average number of notifications for the period January–June in 1996, 1997, and 1998.

### Results

Of the 166 cases reported between January and June 1998, 68 involved children aged 1–4 years (41%), and 30 children aged 5–12 years (18%). While there was no significant reduction in the overall number of cases (151) in the 6 months immediately following the campaign, there was a marked reduc-

tion in the number of cases in the age groups that were targeted by it (Table 3). Except for the age group 19–29 years, there were fewer notifications after the campaign than in the 3 years preceding it.

## Discussion

The MCC was one of the largest initiatives in the area of immunization delivery in Australia's history. Each of the studies in this evaluation confirmed that the campaign was highly successful, particularly among preschool and primary-school children. However, 12–18-year-olds, who were not specifically the subject of media programmes, exhibited no change in immunity status.

The primary-school parental survey indicated that the campaign achieved 96% coverage of children aged 5–12 years, and that 80% of them were vaccinated at school. This demonstrated the effectiveness and acceptability of the school-based programme. The serological survey suggested that this was likely to be an accurate estimate of coverage, since seropositivity for the age group increased from 84% before the campaign to 94% ( $P < 0.001$ ) subsequently.

The telephone interviews with parents of preschool children indicated that about 90% of the children aged 1–3.5 years whose vaccinations were overdue were vaccinated. Of these children, 79% had been vaccinated before receipt of the reminder letter, indicating the low sensitivity of ACIR, at the time, as a means of identifying children whose first dose of MMR vaccination was overdue. Despite these limitations, this estimate is supported by the results of the serological evaluation, showing that 89% of children aged 1–4 years were protected after the campaign.

The outcomes of the MCC in Australia compare favourably with those of countries that have conducted similar mass vaccination campaigns in an attempt to prevent measles outbreaks or improve measles control. For example, in 1994, as part of a national campaign in the United Kingdom, 92% of the 7.1 million children aged 5–16 years in England received measles–rubella vaccination (15). Serological surveillance showed that this programme produced a significant fall (from 15.7% to 6.6%) in the proportion of children aged 5–16 years with low levels of measles antibody (15). In New Zealand, a nationwide campaign in 1997 aimed to give all children aged 2–10 years a second dose of MMR vaccine in order to prevent a predicted outbreak (16). However, the outbreak commenced a month before the start of the campaign. Although the school-based programme was estimated to have achieved a lower coverage (56%) than that obtained by the programmes in the United Kingdom and Australia, the outbreak was controlled (17).

The rate of adverse events associated with MMR vaccination during the campaign in Australia was low (5 per 100 000) compared with the rates

Table 3. Comparison of measles notifications, by age group, before and after the Australian Measles Control Campaign

Age group (years)	No. notified					
	After campaign (January–June 1999)		Before campaign (January–June 1998)		Before campaign (January–June 1996–98)	
<1	23	(15) <sup>a</sup>	45	(27)	82	(21)
1–4	21	(14)	68	(41)	127	(33)
5–12	11	(7.3)	30	(18)	66	(17)
13–18	8	(5.3)	3	(1.8)	19	(4.9)
19–29	77	(51)	18	(11)	70	(18)
≥30	11	(7.3)	2	(1.2)	23	(5.9)
<b>Total</b>	<b>151</b>	<b>(100)</b>	<b>166</b>	<b>(100)</b>	<b>387</b>	<b>(100)</b>

<sup>a</sup> Figures in parentheses are % of notifications in each age group.

reported from the United Kingdom (14.9 per 100 000) for measles–rubella vaccine (18) and from New Zealand (40 per 100 000) for MMR vaccine (O. Mansoor, personal communication, 2000). These differences may be attributable to the use of different vaccine formulations, definitions, and reporting systems. Underreporting is known to be a feature of adverse event surveillance systems, but acute and serious reactions are usually reported. It is likely that the early recognition and management of severe allergic reactions by trained nursing staff reduced the incidence of true anaphylaxis during the MCC.

The importance of the MCC can already be measured in terms of its impact on disease incidence in the targeted age groups. Comparison of national notification data showed a decrease in both the numbers and proportions of cases in the targeted age groups after the campaign. In contrast, persons aged 19–29 years accounted for an increased proportion of notifications, from 11% before the campaign to 51% subsequently. For this reason, during 2001 it is intended to target persons aged 18–30 years for MMR immunization.

Accurate surveillance data are essential for tracking the impact of the MCC and for planning appropriate interventions aimed at elimination. The serological surveys provided an objective appraisal of the campaign. Such surveys can be used to track community levels of immunity on a regular basis and provide a basis for planning and evaluating future campaigns. Surveillance and laboratory confirmation of measles cases can also be expected to play an increasingly important role as disease incidence declines (19, 20).

At least in the short term, the incidence of measles in all age groups in Australia will probably remain low. It is now important to maintain the momentum generated by the campaign, to identify and manage at-risk groups, and to improve surveillance methods so that the ultimate goal of measles elimination can be reached. ■

### Acknowledgements

We acknowledge the assistance of the Commonwealth Department of Health and Aged Care, in particular Ms Sue Campbell-Lloyd; the Health Insurance Commission; the State and Territory authorities and the campaign coordinators; the Departments of Education of New South Wales and Victoria; and the Hunter Valley Research Foundation.

The national serosurvey would not have been possible without generous cooperation from directors and staff of the collaborating laboratories in all states and territories.

We also thank staff associated with the National Centre for Immunisation Research and Surveillance of Vaccine Preventable Diseases, in particular Dr Tim Heath, who helped to develop the protocol for the evaluation; and Sue Botham, Barbara Clifton-Smith, Anne-Marie Egan, Gerri Smith, Jill Forrest, Marysia Carr, Kate Wyllie, Janaki Amin, Siranda Torvaldsen and Andrew Tucker.

The evaluation studies were approved by the Departmental Ethics Committee of the Commonwealth Department of Health and Family Services (Ethics Register No. 98/0135).

**Conflicts of interest:** none declared.

## Résumé

### La campagne australienne de lutte contre la rougeole, 1998

La campagne australienne de lutte contre la rougeole réalisée en 1998 avait pour but l'amélioration de la couverture vaccinale des enfants de 1 à 12 ans et, à long terme, la prévention des épidémies de rougeole. Elle comportait la vaccination de masse en milieu scolaire des enfants de 5 à 12 ans par le vaccin antirougeoleux-antiourlien-antirubéoleux, ainsi qu'un programme de rattrapage destiné aux enfants d'âge préscolaire. Plus de 1,33 million d'enfants de 5 à 12 ans ont été vaccinés à

l'école : le contrôle sérologique montre que 94 % de ces enfants ont été protégés après la campagne, alors que 84 % seulement avaient été protégés antérieurement. La protection des enfants d'âge préscolaire de 1 à 3,5 ans était respectivement de 89 % et 82 %. Pendant les six mois qui ont suivi la campagne, le nombre de cas de rougeole chez les enfants des groupes cibles était considérablement réduit.

## Resumen

### La campaña de lucha contra el sarampión en Australia en 1998

La campaña de lucha contra el sarampión llevada a cabo en Australia en 1998 tenía como objetivo mejorar la cobertura inmunitaria entre los niños de 1 a 12 años y, a largo plazo, prevenir las epidemias de sarampión. La campaña incluía la vacunación masiva en las escuelas de los niños de 5 a 12 años contra el sarampión-parotiditisrubéola y un programa de vacunación de seguimiento destinado a niños en edad preescolar. Más de 1,33 millones de niños de 5 a 12 años fueron

vacunados en la escuela: la vigilancia serológica mostró que el 94% de esos niños quedaron protegidos después de la campaña, mientras que sólo un 84% había gozado de protección anteriormente. Entre los niños en edad preescolar, 1-3,5 años, los niveles correspondientes de protección fueron del 89% y el 82%. Durante los seis meses que siguieron a la campaña se observó una marcada reducción de los casos de sarampión entre los niños de los grupos de edad en cuestión.

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