

9 Measles

9.1 Introduction

The earliest written description of measles is classically attributed to the Persian born physician Abu Becr (Rhazes) in the 10th century. Rhazes was the first to differentiate measles from smallpox and considered the former to be more dreaded. Although he recognised both the cyclical and seasonal nature of the disease, it was not until the 17th century that Thomas Sydenham of London identified the infectious nature of measles. The studies of Peter Panum in the Faroe Islands in 1846 showed that the disease was acquired solely by direct transmission. Outbreaks of measles occurred for the first time in the South Pacific during the mid- and late 19th century, with devastating results among the Fijians and New Zealand Māori. In 1954 Enders and Peebles in the United States (US) reported the first successful isolation and propagation of the measles virus in human and monkey kidney cells. This led to the production of a live attenuated measles vaccine, which was first licensed for use in the US in 1963.

9.2 The illness

Measles is an acute, highly communicable viral illness, usually transmitted via exposure to infected respiratory secretions. There is a prodromal phase of two to four days with fever, conjunctivitis, coryza and Koplik spots on the buccal mucosa. The characteristic maculopapular rash appears on the third to seventh day, spreads over three to four days from the head over the trunk to the extremities, and lasts for up to one week. The patient is most unwell during the first day or two after the appearance of the rash.

The incubation period is usually 10 to 12 days, but may range up to 21 days, and is prolonged in the immune suppressed. Measles is highly infectious from the beginning of the prodromal phase until four days after the appearance of the rash. Complications are common in 10 percent of cases (see Table 9.1), and include otitis media, pneumonia, croup or diarrhoea. Encephalitis has been reported in 1 in every 1000 cases, of whom some 15 percent die and a further 25 to 35 percent are left with permanent neurological damage. Other complications of measles include bronchiolitis, sinusitis, myocarditis, corneal ulceration, mesenteric adenitis, hepatitis and thrombocytopenic purpura.

Subacute sclerosing panencephalitis (SSPE), a rare degenerative central nervous system disease resulting from persistent measles virus infection, is fatal. In the US, where there is widespread measles immunisation, this complication has virtually disappeared. The case fatality rate for reported cases of measles in the US is 1 in 1000. Measles is particularly severe in the malnourished and in patients with defective cell-mediated immunity, who may develop giant cell pneumonia or encephalitis without evidence of rash, and have a much higher case fatality rate.

Measles is also serious in healthy children: over half of all the children who died from measles in the United Kingdom (UK) between 1970 and 1983 were previously healthy.¹ No other conditions were reported as contributing to the death of seven people who died from measles in the 1991 New Zealand epidemic.

In general, vitamin A is not necessary for children with measles in industrialised countries. However, it is recommended for children under two years of age who are hospitalised with complications of measles, and other children with risk factors such as immune deficiency or malabsorption (see section 9.8).

9.3 Epidemiology

Measles is the most common vaccine preventable cause of death among children throughout the world. The Global Burden of Disease Study ranked measles eighth, both as a cause of death and as a cause of disability adjusted life years (DALYs) lost, in the global population (all ages combined) in 1990.² Among children aged between zero and four years in non-industrialised countries, measles ranked fourth as a cause of DALYs lost, and was the infectious agent with the highest burden of disease. In 1989 the World Health Organization (WHO) Expanded Programme on Immunization estimated that 1.5 million children died annually from measles or its complications. The disease is highly infectious in non-immune communities, with epidemics occurring approximately every second year. A 1951 outbreak of infection in southern Greenland, a country which had not previously experienced measles, resulted in an almost 100 percent infection rate of adults and children. Indigenous cases of measles, mumps and rubella have been eliminated from Finland over a 12-year period using a two-dose measles, mumps and rubella vaccine (MMR) schedule given between 14 and 16 months and at six years of age.³

The US reported⁴ that of the 251 cases of measles reported in the US from 2001 to 2004, 177 (71 percent) were in US residents, and of these 100 were preventable. Forty-three percent of these preventable cases were associated with international travel; the rest were acquired in the US. Preventable cases are those that would not occur had the person received the recommended immunisation schedule, including MMR vaccination at six to 11 months if the infant is travelling outside the US. The 77 non-preventable cases had received a measles containing vaccine, or were expected to be protected because of their age, and of these 16 percent were associated with travel. International travel is an important factor in reintroducing measles into a country.

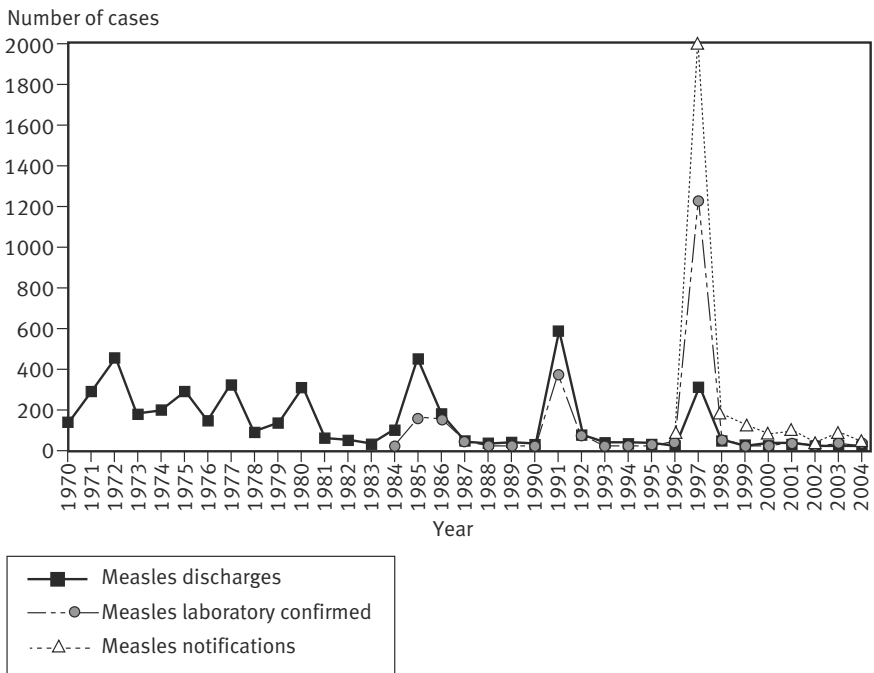
In October 2005 the Regional Health Assembly of the Western Pacific Region of WHO endorsed a target that by 2012 measles would be eliminated from the Western Pacific Region. To reach this target, all countries in the region will need to have ongoing high levels of measles immunisation coverage with two doses of vaccine, including at least one dose after the age of one year. All countries will also need to have surveillance systems for measles, and in order to monitor progress every

suspected case of measles will need laboratory confirmation at a national measles reference laboratory. Positive viral cultures will be sent to the regional laboratory in Melbourne, Australia, for detailed analysis of the virus. The New Zealand National Measles Laboratory, set up in 2005, is at Canterbury Health Laboratories. (See section 9.8.)

New Zealand epidemiology

Despite the introduction of the measles vaccine in 1969, measles occurred every year until 1980, with a pattern of ‘low’ years (an average of approximately 100 hospitalisations per year) alternating with ‘high’ or ‘epidemic’ years (an average of approximately 300 hospitalisations per year). Increased uptake of the measles vaccine, which is thought to have reached 70 percent or more by 1980, resulted in this epidemic cycle becoming more accentuated. Measles virtually disappeared between epidemic years, which occurred less frequently (1984/85, 1991 and 1997) but were of increased size, with 400 hospitalisations in 1984/85 (see Figure 9.1 for hospital discharges, notifications of measles, and laboratory confirmed cases). A shift in the age distribution of cases towards older ages was also noted. This effect was most evident in the 1991 epidemic, and was seen more in European than in Māori or Pacific children.

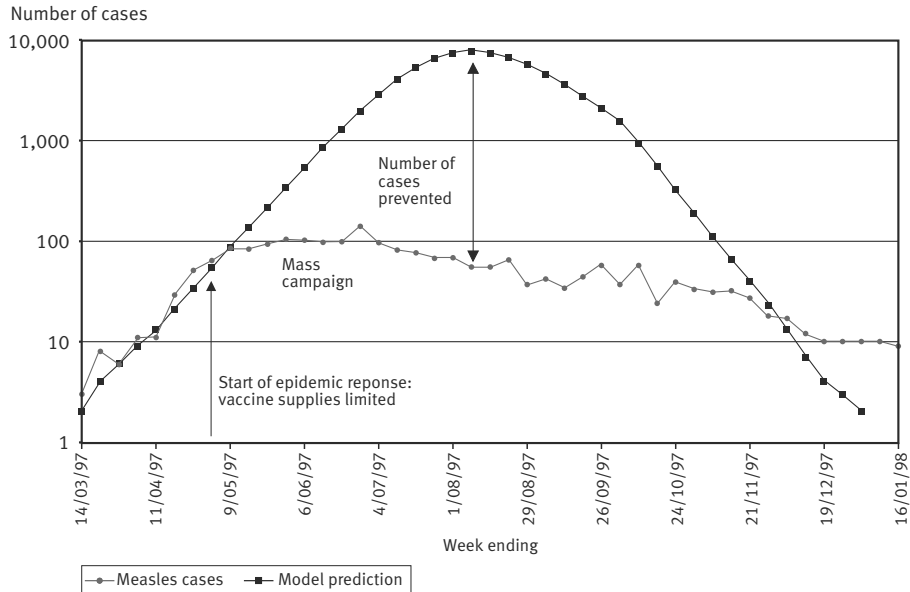
Figure 9.1: Hospital discharges from measles, 1970–2004, notifications, 1996–2004, and laboratory confirmed cases, 1984–2004.



The 1991 epidemic involved increased hospitalisations from May 1991 to January 1992. During this period a total of 629 people were hospitalised with a principal or secondary diagnosis of measles; for 568, measles was the primary diagnosis. During the epidemic the deaths of four unimmunised children were reported, but mortality records revealed a total of seven deaths during the epidemic. Excluding the cases that died, there were 10 hospitalised cases of measles encephalitis, 94 of pneumonia and 61 of otitis media. In the second half of the epidemic, reports of measles were requested and 10,000 were received; on this basis it was estimated that the epidemic involved 40,000 to 60,000 cases.

An epidemic was predicted in 1997,⁵ and an immunisation campaign was planned to prevent it. However, the epidemic began in April 1997, three months before the planned start of the campaign. The campaign was then brought forward so that 90–95 percent of cases were prevented⁶ (see Figure 9.2). There were 2169 cases identified via notification, laboratory and hospitalisation data, including 314 hospitalisations. There was one case of disease related measles encephalitis and no deaths. The total number of cases in this epidemic is unknown as under reporting was likely. Figure 9.2 shows the effect of the immunisation campaign in limiting the extent of the epidemic.

Figure 9.2: Actual number of notified cases of measles compared with predicted cases during the 1997 measles epidemic



Large scale measles epidemics occur when the number in the susceptible population increases and the immunisation coverage is low. It has been estimated that to prevent recurrent outbreaks of measles, 95 percent of the population must be immune. Since measles vaccine efficacy is 90–95 percent and not all children receive the first scheduled dose, the only way to achieve this level of immunity is by implementing a two dose immunisation strategy, as is now recommended.

In 2000 a mathematical model was developed to estimate the future timing of measles epidemics in New Zealand. The model included MMR immunisation coverage, the numbers of notified cases of measles, and the MMR coverage in the 1997 MMR campaign. The results suggested that if no changes were made to the MMR schedule of 15 months and 11 years, the next measles epidemic would be between 2002 and 2004.⁷ However, if the schedule was changed to give MMR at 15 months and at four years, before school entry, the length of time between epidemics would increase and eventually measles may be eradicated, if coverage was high. Therefore from January 2001 the National Immunisation Schedule was changed to give the first dose of MMR at 15 months and the second dose at four years of age, prior to school entry. During 2001 there was an MMR school catch-up programme throughout the country for all children between 5 and 10 years of age who would not receive MMR in year 7 (form 1) because of the 2001 schedule change.

During the 2001 MMR school catch-up programme it is estimated that 71 percent of all children received a first or second dose of MMR, or reported they had already received two doses of a measles containing vaccine. An additional 10 percent of children reported they would be going to their general practitioner for an MMR vaccine, so that an estimated total of about 81 percent of children were immunised.

There have been no further measles epidemics since 1997. Figure 9.1 shows the numbers of notified cases and those that are laboratory confirmed. Small numbers of cases of measles are notified each year: in 2003 there were 67 cases of measles notified, of which 11 were laboratory confirmed; and in 2004, 33 cases were notified, of which nine were laboratory confirmed. As the number of cases reported decreases it is important that all cases of suspected measles are laboratory investigated.

In 2005 the measles mathematical model was updated to calculate the effect of the measles catch-up in 2001 and to estimate the effect of changing the National Immunisation Schedule to give MMR at age 15 months and at age four years before school entry.⁸ Because there is no accurate immunisation coverage data until the National Immunisation Register (NIR) is fully operational, the model relies on estimates of coverage. The model shows that if the MMR immunisation coverage at 15 months is 85 percent, and at age four years is 80 percent, then New Zealand would not expect an epidemic of measles for another 10–20 years. If immunisation

coverage were higher, a longer time interval between epidemics would be likely. Although MMR coverage of 85 percent of both doses is likely to prevent further epidemics, because areas of low coverage may exist within any population, the model suggests that New Zealand needs to achieve a coverage level of 90 percent for both doses of MMR at 15 months and four years to eliminate epidemics. If MMR coverage of 90 percent or higher for both doses of MMR is achieved and maintained, the length of time between epidemics will increase and may lead to the eradication of measles.

As the incidence of measles decreases in New Zealand, it is important to continue high MMR immunisation coverage to lower the risk of imported measles causing outbreaks. Every suspected case of measles will need laboratory confirmation and characterisation to inform the local medical officer of health, so that public health control measures can be put in place.

History of the New Zealand Immunisation Schedule

The measles vaccine was introduced in 1969 for children between 10 months and five years of age who had not had measles, and for those under 10 years at special risk. In 1974 the recommended age for the measles vaccine was changed from 10 months to 12 months, and in 1981 was changed to 12–15 months of age. These changes attempted to find a balance between too early immunisation, where the vaccine is neutralised by maternally acquired antibody, and the requirement to protect the very young during an epidemic.

MMR vaccine was introduced in 1990 to be given at 12–15 months of age in place of the measles vaccine. The dose at age 11 years was introduced in 1992. In 1996 the timing of the first dose of MMR was changed to 15 months of age to be given at the same time as the booster dose of diphtheria, tetanus, whole cell pertussis and *Haemophilus influenzae* type b (DTwPH) vaccine.

At the start of the 1997 epidemic, the measles immunisation campaign, using MMR, targeted all children under 10 years of age. During the campaign the recommended time for the first dose was brought forward to 12 months of age, and in Auckland a dose was recommended for children six to 11 months of age repeated at 15 months of age.⁹ The national coverage achieved in the campaign is not known, but estimates for the school aged population range from 55 percent for Auckland to 85 percent for the Wellington region.

In 2001 the schedule was changed to give the first dose of MMR at 15 months of age and the second dose at four years. There was a school catch-up programme for the second MMR dose for children between five and 10 years of age. This schedule of two doses of MMR at the age of 15 months and four years continues.

9.4 Vaccines

The measles vaccine is only available as one of the constituents of MMR vaccine. (See below for administration in infants under 12 months of age.) The M-M-R® II (MSD) vaccine used and publicly funded is a freeze dried preparation containing live attenuated measles, mumps and rubella viruses. It must be stored in the dried state at +2°C to +8°C and protected from light. It must be reconstituted only with the diluent supplied by the manufacturer, refrigerated at +2°C to +8°C and used within eight hours or discarded.

The MMR vaccine viruses have been regarded as being non-transmissible from vaccinees. There are two poorly documented case reports of transmission: one of rubella and one of a mumps vaccine strain from a vaccine that is no longer in production.¹⁰ Following immunisation with both measles and rubella vaccines, live virus has been isolated rarely from pharyngeal secretions.^{11,12} There have been no confirmed cases of disease transmission from vaccine virus. The measles and mumps vaccines are grown in chick embryo cell cultures and rubella vaccine in human diploid cell culture.

MMR vaccines licensed in New Zealand are:

- M-M-R® II (MSD), which contains further attenuated Enders' Edmonston (Moraten) strain measles, RA 27/3 rubella, and Jeryl Lynn mumps
- PRIORIX™ (GSK), which is now available and contains Schwartz strain measles, RA 27/3 rubella, and RIT 4385 mumps strain derived from the Jeryl Lynn strain
- Triviraten Berna (Swiss Serum and Vaccine Institute), which contains the measles Edmonston-Zagreb strain, the mumps high titre Rubini strain and the rubella Wistar RA 27/3 strain. This vaccine is not recommended in New Zealand because it has been shown to be less effective against mumps compared with other MMR vaccines.¹³

Quadrivalent measles, mumps, rubella and varicella vaccine (MMRV)

Successful clinical trials of an MMRV vaccine have led to regulatory approval in the US.¹⁴ The antibody response rates in children aged 12 to 23 months given a dose of MMRV vaccine were comparable with children given MMR and varicella vaccines at different sites. Children given MMRV showed higher geometric mean titres to measles and mumps than children receiving MMR and varicella vaccine separately. A second dose of MMRV given 90 days later elicited a further rise in titres to MMR and a greater rise in response to varicella. The vaccine studied had a higher dose of varicella vaccine virus than the varicella vaccine alone, because previous studies with a lower dose of varicella had been unsuccessful.

An MMRV vaccine is expected to be available in New Zealand soon (in the next one to three years). (See section 17.4.)

Efficacy

'Primary vaccine failure' refers to the lack of protective immunity despite vaccination. It is due to failure of the vaccine to stimulate an immune response. This occurs in 5–10 percent of recipients after the first dose and is rare after a second dose.

Seroconversion to all three viruses of MMR vaccine occurs in 85–100 percent of recipients. Most studies show 90–95 percent efficacy against measles. Those who do not seroconvert after the initial MMR dose almost always seroconvert after the second.

Even though antibody levels decline over time, secondary vaccine failure (ie, vaccine failure due to waning of protective immunity) has only rarely been documented for any of the three components of the vaccine. A meta-analysis of the measles vaccine found no evidence of secondary vaccine failure in the US manufactured vaccine currently used in New Zealand.¹⁵

Dosage

The correct dose is all of the reconstituted vaccine (about 0.5 mL) given by subcutaneous injection in the deltoid area to all age groups. (See section 2.3 for needle sites and sizes.)

9.5 Recommended immunisation schedule

Children

Measles vaccine is recommended as MMR at 15 months and four years of age, before school entry. Two doses of measles vaccine are recommended because the 5–10 percent who fail to be protected by the first dose will nearly all be protected by the second. The second dose of measles vaccine can be given as soon as four weeks after the first dose. The MMR vaccine may be given to children of any age whose parents/caregivers request it and no opportunity should be missed to achieve immunity.

The MMR vaccine should be given irrespective of a history of measles, mumps or rubella infection or measles immunisation. A clinical history does not reliably indicate immunity unless confirmed by serology. Furthermore, there are no known ill effects from vaccinating children, even if they have had serologically confirmed measles.

After reimmunisation, reactions are expected to be clinically similar but much less frequent since most vaccine recipients are already immune. No unusual reactions have been associated with measles or MMR reimmunisation.¹⁶

Adolescents and young adults born in 1989 or earlier

Adolescents and young adults born in 1989 or earlier may have received the measles vaccine at 12 to 15 months of age, and MMR during the 1997 campaign. They will

have therefore received the recommended two doses of measles, but only one of mumps and rubella. While the main reason for a two-dose MMR schedule is to protect against measles, two doses of all three antigens is recommended. These individuals should receive a second dose of MMR (ie, a third dose of measles vaccine).

Adults

MMR should be given to any adult who is known to be susceptible to one or more of the three diseases.

Adults born before 1969 should be considered to be immune to measles.

Adults born after 1969, who do not have a documented history of two doses of measles / MMR immunisation – administer one dose of MMR to those who fulfil one of the following conditions:

- born after 1969
- a student in post-secondary education
- a health care worker with patient contact – all should be immune to measles, mumps and rubella, but if a health care worker does not have a documented history of two doses of a measles containing vaccine they should receive a single dose of MMR
- a susceptible international traveller visiting a country in which measles is endemic.

The reactions to reimmunisation are expected to be less frequent than with primary immunisation, as most vaccinees will be immune.

Administration

MMR vaccine can be given concurrently with other vaccines, as long as separate syringes are used and the injections are given at different sites. If not given concurrently, live vaccines should be given one month apart. MMR can be given to non-immune adults and should be considered for those in institutional care or whose occupation may expose them to a higher risk (eg, health professionals or those training as health professionals).

Immune suppression

MMR is contraindicated in children who are immune suppressed (eg, those suffering from leukaemia), but they may be partially protected from exposure to infection by ensuring that all contacts are fully immunised, including hospital staff and family members.

MMR vaccination is recommended for children with HIV (human immunodeficiency virus) infection at 12 months of age who are asymptomatic and children who are

not severely immune compromised. MMR is contraindicated in children with severe immune suppression from HIV because vaccine related pneumonitis (from the measles component) has been reported.¹⁷ Discuss vaccination of children with HIV infection with their specialist.

MMR vaccine under 12 months of age

MMR may be recommended to infants between 6 and 12 months of age during measles outbreaks if cases are occurring in the very young (see section 9.8). These children still require MMR at 15 months and four years of age because their chance of protection from measles is lower when the vaccine is given at less than 12 months of age. Any recommendations will be made by the medical officer of health and Ministry of Health based on the local epidemiology.

9.6 Expected responses and adverse events following immunisation (AEFI)

Expected responses

It is commonly reported that 5–15 percent of children experience a fever of 39.5°C or over and 5 percent a rash 6–12 days post-immunisation. A placebo controlled study has shown that fever and/or rash in most cases are unrelated to immunisation, and only rash in 1.6 percent and high fever in 1.4 percent of cases could be attributed to MMR; these fevers were most likely nine or 10 days after immunisation and the rash occurred in the second week.¹⁸ The mumps vaccine may produce parotid and/or submaxillary swelling in about 1 percent of vaccinees, most often 10–14 days after immunisation. The rubella vaccine can cause a mild rash, fever and lymphadenopathy between two and four weeks after immunisation. There were no persisting sequelae associated with the administration of three million doses of MMR to 1.5 million children in Finland.^{19,20}

Febrile convulsions occur in 1 in 3000 children, six to 12 days after immunisation. Parents/caregivers should be advised to give the child paracetamol 15 mg/kg four hourly (up to a maximum of four doses in 24 hours) if a fever develops. Children with a history of convulsions should be given MMR, but the parents/caregivers should be warned that there may be a febrile response.

Arthritis or arthralgia occurs after both the rubella disease and vaccine, especially in adults. About 15 percent of adult women and less than 1 percent of children get joint symptoms about two to four weeks after immunisation. There is no evidence to suggest that rubella vaccine leads to long term arthritis: two large controlled studies found no evidence,^{21,22} while another study did find a slight increase in arthritis risk from rubella vaccine, but this was of borderline statistical significance.²³ A review of the available evidence concluded that rubella vaccine does not cause chronic arthritis.²⁴

Adverse events following immunisation

Thrombocytopenia occurs in approximately 1 in 30,000 doses, 15 to 35 days after immunisation. The clinical course of these cases is usually transient and benign.²⁵ The risk may be increased in those with a previous diagnosis of immune thrombocytopenic purpura (ITP), especially if it occurred after an earlier dose of MMR vaccine. Therefore it is recommended that any child who develops ITP within six weeks of receiving the first dose of measles vaccine or MMR undergo serological evaluation before receiving a second dose. The second dose is recommended for children who are not fully immune against measles, mumps and rubella.²⁶

Central nervous system symptoms following measles vaccine are reported to occur in one in one million children. In most cases this seems to be a chance occurrence that is not caused by the vaccine. An analysis of claims for encephalitis following measles vaccine in the US found clustering of events at eight to nine days after immunisation.²⁷ This clustering supports, but does not prove, the claim that the vaccine causes encephalitis, albeit rarely and at a lower rate than the wild virus illness.

The MMR vaccine containing the Urabe strain of mumps was withdrawn in 1992 following a UK study that found a 1 in 11,000 risk of mumps vaccine meningitis. MMR containing the Urabe strain was used from 1991 until it was withdrawn in 1992 in New Zealand. Aseptic meningitis occurs in 1 in 800,000 doses following administration of the Jeryl Lynn strain of mumps vaccine,^{28,29} which is used in New Zealand.

Adverse outcomes not linked to MMR

There have been several epidemiological studies published from the UK,³⁰ Finland³¹ and elsewhere^{32,33} confirming there is no link between MMR vaccine and the development of autism in young children.

The concern arose because in 1995 a group of researchers from the Royal Free Hospital in London published a study comparing children who took part in the 1964 UK Medical Research Council measles vaccine trial and received the measles vaccine at 10 to 24 months of age, with a cohort of their unvaccinated partners and with a longitudinal birth cohort from the National Child Development study born in 1958. The researchers looked at the history of inflammatory bowel disease (IBD) – that is, Crohn’s disease and ulcerative colitis – in all three groups and found that the group receiving the measles vaccine had an increased risk of Crohn’s disease (with a relative risk [RR] of 3.01, and 95 percent confidence interval [CI] 1.45–6.23) and of ulcerative colitis (RR 2.53, 95 percent CI 1.15–5.58) compared with the birth cohort. The researchers suggested this indicated that the measles virus might play a part in the development of Crohn’s disease and ulcerative colitis.³⁴

In 1998³⁵ the researchers found that in a series of 12 children with chronic bowel disease and a regressive developmental disorder, parents thought the onset of

neurological symptoms was associated with MMR in eight of the 12 children, measles infection in one child and otitis media in one child. In nine of the children the neurological syndrome was classified as autism. All the children had intestinal abnormalities of chronic colitis and 11 children had lymphoid nodular hyperplasia. It was suggested by the researchers that there was an association between IBD, autism and the MMR vaccine.

The methodology used in this study was criticised³⁶ because of the small number of cases in the series, and selection bias. There was concern that the report was based on cases referred to a group known to be interested in the relationship between MMR vaccine and IBD rather than based on a population based study. There were no controls to compare events following immunisation, and there was no clear case definition for cases. There are no other reports suggesting an association between IBD and behavioural syndromes or autism following MMR or measles vaccine in the millions of doses of vaccine used worldwide since the 1960s.^{37,38,39,40}

Members of the original study group proposing the association have now withdrawn their claims.⁴¹

The hypothesis was also examined in studies by other researchers and in other countries. A study from Finland⁴² followed up those children who developed gastrointestinal disease after MMR. At the end of 1996 three million doses of MMR vaccine had been delivered with 31 children reported with gastrointestinal symptoms, none of whom developed either IBD or autism. A population based study from the UK, which examined the incidence of autism after the introduction of MMR,⁴³ also failed to find any association or increase in the incidence of autism. In this study a community child health system was used to identify children diagnosed with autism born since 1979. The records showed no increase in incidence following the introduction of MMR and no difference in the age at diagnosis of cases who had received MMR before or after 18 months, compared with those never vaccinated with MMR.

The Institute of Medicine in the US reviewed this issue⁴⁴ and concluded in their report that the evidence does not support, at the population level, a link between MMR vaccine and autistic spectrum disorder (ASD). The Immunisation Safety Review Committee did not exclude the possibility that MMR could contribute to ASD in a small number of children, because it is difficult to assess a rare occurrence and biological models have not been disproved. The Committee recommended no change or review of MMR licensure, or change in the US MMR programme.

Table 9.1 shows the complications associated with contracting measles, mumps and rubella, and from receiving the MMR vaccine.

Table 9.1: Risks from contracting measles, mumps and rubella, and from receiving the MMR vaccine

Measles complications	
Otitis media, pneumonia, diarrhoea	1/10–100
Encephalitis, probably resulting in brain damage	1/1000
Death	1/1000
Rubella complications	
Congenital rubella: cataracts, deafness, cardiac malformations, and brain damage. Some abnormality of the fetus will be detectable in 85 percent of women infected in the first eight weeks of pregnancy. (See Table 11.1.)	
Mumps complications	
Meningitis	1/7
Orchitis	1/5 post-pubertal males
Nerve deafness	1/15,000
Death	1.8/10,000
Vaccine complications	
Rashes, fever, local reactions, parotid swelling	1/7
Febrile convulsions	400/1,000,000
Transient joint symptoms – children	1/35
Thrombocytopenia	33.3/1,000,000
Encephalitis	1/1,000,000
Aseptic meningitis	< 1/100,000

Any severe or unexpected reactions should be reported to CARM, PO Box 913, Dunedin, using the prepaid postcard HP3442 (see section 2.4) or via online reporting at <http://carm.otago.ac.nz>. If the patient or parent/caregiver does not consent to being identified, the report should be made without personal identification.

9.7 Contraindications

The general contraindications that apply to all immunisations are relevant to the MMR and single antigen measles vaccines (eg, children with an acute febrile illness should have their immunisation deferred) (see section 1.9).

Anaphylaxis following a previous dose of measles vaccine or MMR is a contraindication to a further dose of MMR. Children who have anaphylaxis after MMR should be serologically tested, and referred to or discussed with a paediatrician if non-immune to rubella or measles.

Children who have a hypersensitivity reaction after MMR should be serologically tested for immunity, and if non-immune referred to a paediatrician for evaluation and consideration of skin testing before receiving a second dose of MMR.

Other specific contraindications include:

- individuals with proven anaphylaxis (but not contact dermatitis) to neomycin
- children with immune suppression (ie, children with significantly impaired cell mediated immunity, including those with untreated malignancy, altered immunity as a result of drug therapy – including high dose steroids – or receiving high dose radiotherapy) (see section 1.8)
- children who have received another live vaccine, including Bacillus Calmette-Guérin (BCG), within the previous month (See Chapter 12: Tuberculosis)
- pregnant women
- women of childbearing age, who should be advised to avoid pregnancy for the next 28 days after the MMR or measles vaccines
- individuals who have received immunoglobulin or a blood transfusion during the preceding 11 months (see Table 1.11 for the length of time to defer measles vaccine after specific blood products)
- children with HIV infection who are severely immune compromised.⁴⁵

Egg allergy

Egg allergy is no longer considered a contraindication to the measles or MMR vaccines. Various studies have confirmed these children can be vaccinated safely.^{46,47,48} Other components of the vaccine (eg, gelatin)⁴⁹ may be responsible for allergic reactions. It is, however, recommended that any child who has a history of anaphylaxis with cardiorespiratory symptoms for reasons other than a reaction to MMR (see above) should be vaccinated under close supervision, with adrenaline and age appropriate resuscitation equipment immediately available.

Vaccinators should be aware of the possibility that allergic reactions including anaphylaxis may occur. (See also section 1.8 for information on immunising a child on steroids.)

9.8 Control measures

Notify all cases of measles on suspicion to the local medical officer of health. A single case of measles should be considered an outbreak and result in a suitable outbreak response. Practitioners are reminded that a diagnostic measles serology test (IgM) should be done on every child when measles is suspected, to confirm the diagnosis.

There are other causes of rash, respiratory symptoms, conjunctivitis and fever in children, and a laboratory confirmed diagnosis is needed to guide control measures

and predict disease spread. When measles is suspected, do an IgM test on the patient for rapid diagnosis and send a sample for viral isolation.

The recommended laboratory test for measles diagnosis is measles specific IgM (see Table 1.5). Although measles virus may be isolated very early in the illness or prodrome, the virus is quite delicate and often may not be cultured. The diagnosis is usually made serologically, with a rise in serum immunoglobulin G (IgG) antibodies demonstrated on paired sera. A rapid diagnosis may be made if IgM can be demonstrated in the initial serum sample.

The sensitivity of the measles IgM assay varies, and may be diminished if the specimen is taken during the first 72 hours after rash onset. If the test is negative and the generalised rash persists, the IgM test should be repeated. Measles IgM is detectable for at least one month after rash onset.

Serological or virological diagnosis of the early cases is essential, and outbreak control planning and response should not be delayed. All children who could be infected during the outbreak and have not received two doses of measles vaccine should be offered MMR, ideally within three days of diagnosing the index case. The live measles vaccine, if given within 72 hours of measles exposure, will provide protection in some cases, so prompt immunisation may protect those susceptible.

If there is doubt about the state of immunity, the vaccine should be given because there are no ill effects from vaccinating an individual who is already immune. Particular attention should be paid to individuals born during 1969–75. At that time the measles vaccine was given at 10 months of age. There is now good evidence that the vaccine is less effective at that age because of residual maternally acquired passive immunity, and so these people are less likely to be protected.

In an outbreak affecting infants, the use of MMR vaccine for infants between six and 14 months of age should be considered. If the MMR vaccine is given before the first birthday, MMR should still be given at 15 months and four years of age because of the lower seroconversion rate for those receiving the vaccine under 12 months.

Immunoglobulin should be administered to protect measles exposed individuals in whom the vaccine is contraindicated (see section 9.7). Children with compromised immunity (eg, those with leukaemia) who come into contact with measles should be given normal human immunoglobulin (IG) (0.5 mL/kg to a maximum of 15 mL) as soon as possible after exposure. IG should also be considered for immune compromised adults who have no antibodies to measles. If immune competent individuals need IG prophylaxis, the dosage should be 0.25 mL/kg to a maximum of 15 mL. IG is most effective if given within 72 hours of exposure, but can be effective even if given within six days. If a large dose is needed, an intravenous preparation of IG (IVIG) may be used.

Parents/caregivers should be advised that cases should be excluded from early childhood services, school or community gatherings until at least four days after the appearance of the rash. Immunised contacts (ie, who have received two doses after their first birthday) need not be excluded from early childhood services, school or community gatherings. Non-immune contacts (those with no documentation of any immunisation or laboratory confirmed measles) should be excluded from school, early childhood services or community gatherings because of the risk of catching the disease themselves, and the risk of passing on the disease during the prodromal phase to other susceptible children.

The recommended period during which absence from an early childhood service or school is advised extends from diagnosis of the first case until 14 days after the appearance of the rash in the last case. Non-immune contacts may return to school immediately after receiving the measles vaccine, although there is a small risk that some may be incubating the disease.

Recommendations for vitamin A for infants and children with measles infection

In developing countries, the use of vitamin A has been associated with decreased morbidity and mortality. In Australasia, vitamin A supplementation is recommended for:⁵⁰

- infants hospitalised with measles and its complications, where there is pre-existing marginal nutrition or where community vitamin A deficiency is a recognised problem.
- older patients with acute measles, who are in a wider risk group including those with fat malabsorption (cystic fibrosis, short bowel syndrome and cholestasis), those with moderate to severe malnutrition (including adolescents with eating disorders), and those with immunodeficiency, including those on immunosuppressive therapy.

The recommended dosage is a single oral dose of 100,000 IU at the time of diagnosis, and for those cases who are malnourished or who have overt vitamin A deficiency a repeat dose on day 2 and day 28 following diagnosis.

The only form of vitamin A available in New Zealand is a tablet called Ro-A-Vit. Each Ro-A-Vit contains 50,000 IU of vitamin A. The replacement dose for a child who is vitamin A deficient is one tablet a day for two days for a child under one year of age, and two tablets a day for two days for a child aged one to two years. This tablet is dispersible in water. It is recommended that the family be advised to cut the tablet into four to eight pieces and dissolve them in milk. The tablet has a chocolate flavour.

For more details on control measures, refer to *Control of Communicable Diseases Manual*.⁵¹

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