

MMR/MR vaccines

Journal/MMWR articles of vaccine failure

Measles [Mumps](#) [Rubella](#)

MEASLES

[Roberts RJ, et al.](#) Reasons for non-uptake of measles, mumps, and rubella catch up immunisation in a measles epidemic and side effects of the vaccine. *BMJ*. 1995 Jun 24;310(6995):1629-32. PMID: 7795447; UI: 95315783.

Many of the objections raised by parents could be overcome by emphasizing that primary immunisation does not necessarily confer immunity and that diagnosis of measles is unreliable.

The Lancet, vol. 353, January 9, 1999, pp. 98-102---"Effect of subclinical infection on maintaining immunity against measles in vaccinated children in West Africa" : Subclinical measles occurred in 45 percent of vaccinated children exposed to natural measles. "new epidemics, albeit milder in form, may occur in vaccinated areas[, a fact] which should be recognised in campaigns to eradicate measles." [Note: if sustained as chronic infections, subclinical measles infections can result in numerous other diseases.]

Rev. Soc. Bras. Med. Trop., vol. 28, no. 4, Oct-Dec 1995, pp. 339-43 "Clinical and epidemiological findings during a measles outbreak occurring in a population with a high vaccination coverage" : "The history of previous vaccination [in very early childhood] did not diminish the number of complications of the cases studied. The results of this work show changes in age distribution of measles leading to sizeable outbreaks among teenagers and young adults."

Clin. Invest. Med., vol. 11, no. 4, August 1988, pp. 304-9: "Measles serodiagnosis during an outbreak in a vaccinated community" (from a group of 30 measles-sufferers displaying IgM antibodies during the acute phase of illness, 17 had been vaccinated for measles. All 17 experienced measles again, showing IgM antibodies indicating acute infection. "A history of prior vaccination is not always associated with immunity nor with the presence of specific antibodies."

Aaby P, et al. (1990) Measles incidence, vaccine efficacy, and mortality in two urban African areas with high vaccination coverage. J Infect Dis. 1990 Nov;162(5):1043-8. PMID: 2230232; UI: 91037153.

Measles incidence, vaccine efficacy, and mortality were examined prospectively in two districts in Bissau where vaccine coverage for children aged 12-23 months was 81% (Bandim 1) and 61% (Bandim 2). There was little

difference in cumulative measles incidence before 9 months of age (6.1% and 7.6%, respectively). Between 9 months and 2 years of age, however, 6.1% contracted measles in Bandim 1 and 13.7% in Bandim 2. Even adjusting for vaccination status, incidence was significantly higher in Bandim 2 (relative risk 1.6, $P = .04$). Even though 95% of the children had measles antibodies after vaccination, vaccine efficacy was not more than 68% (95% confidence interval [CI] 39%-84%) and was unrelated to age at vaccination. Unvaccinated children had a mortality hazard ratio of 3.0 compared with vaccinated children ($P = .002$), indicating a protective efficacy against death of 66% (CI 32%-83%) of measles vaccination. These data suggest that it will be necessary to vaccinate before age 9 months to control measles in hyperendemic urban African areas. <http://www.ncbi.nlm.nih.gov/htbin-post/Entrez/query?uid=2230232&form=6&db=m&Dopt=b>

Boulianne N, et al.(1991) [Major measles epidemic in the region of Quebec despite a 99% vaccine coverage]. Can J Public Health. 1991 May-Jun;82(3):189-90. French. PMID: 1884314; UI: 91356447.

The 1989 measles outbreak in the province of Quebec has been largely attributed to an incomplete vaccination coverage. In the Quebec City area (pop. 600,000) 1,363 confirmed cases of measles did occur. A case-control study conducted to evaluate risk factors for measles allowed us to estimate vaccination coverage. It was measured in classes where cases did occur during the outbreak. This population included 8,931 students aged 5 to 19 years old. The 563 cases and a random sample of two controls per case selected in the case's class were kept for analysis. The vaccination coverage among cases was at least 84.5%. Vaccination coverage for the total population was 99.0%. Incomplete vaccination coverage is not a valid explanation for the Quebec City measles outbreak. <http://www.ncbi.nlm.nih.gov/htbin-post/Entrez/query?uid=1884314&form=6&db=m&Dopt=b>

Ceyhan M, et al. (1992) The evaluation of vaccination against measles at nine months of age (report of an epidemic). Turk J Pediatr. 1992 Jul-Sep;34(3):127-33. PMID: 1485379; UI: 93134677.

Sixteen measles cases were studied during an epidemic that broke out in Etimesgut district of Ankara. Eight of these children had never been vaccinated against measles while the remainder had been vaccinated at nine months of age. In the sera obtained during the course of the illness, anti-measles antibody was not detectable in six vaccinated children and in four unvaccinated children. Upon observing the siblings of the subjects, it was determined that one out of three who had not been vaccinated against measles and three out of seven who had been vaccinated at nine months of age contracted the disease within a month. However none of the siblings who had been vaccinated against measles at 15 months contracted the disease. In our cases, although vaccination at nine months of age could not prevent measles, it resulted in a milder form of the disease. It seems that measles vaccine administered to infants at around nine months of age does not prevent the occurrence of the disease in many children. <http://www.ncbi.nlm.nih.gov/htbin-post/Entrez/query?uid=1485379&form=6&db=m&Dopt=b>

Cherry JD, (1973) Feigin RD, Shackelford PG, Hinthorn DR, Schmidt RR. A clinical and serologic study of 103 children with measles vaccine failure. J Pediatr 1973 May;82(5):802-8

Cherry et al. (1972) described an epidemic in St Louis City and County during 1970 & 1971, during which 130 children were hospitalised and 6 died. The attack rate was much higher in vaccinated than unvaccinated children.

"In the measles epidemic of 1984-1985 in Auckland, New Zealand (Hardy et al. 1986) 35% of all measles cases were vaccinated, 9% were unsure and 67% were unvaccinated. However the largest number of cases were in children one year old or less, below the age at which they would be vaccinated."--Scheibner.

Coetzee N, et al. (1994) The 1992 measles epidemic in Cape Town--a changing epidemiological pattern. S Afr Med J. 1994 Mar;84(3):145-9. PMID: 7740350; UI: 95258851

Over the last 6 years there has been a decline in the incidence of measles in Cape Town. However, during August 1992 an outbreak occurred, with cases reported at many schools in children presumably immunised. The objectives of this study were to characterise the epidemic in Cape Town and to determine possible reasons for the outbreak. The investigation consisted of two components--a description of the epidemic and an investigation of an outbreak at one primary school. Results indicate that during the last 4 months of the year, 757 cases were notified in Cape Town, compared with 144 in the first 8 months. The epidemic affected mainly white and coloured children over 5 years of age ($P < 0.001$). In contrast, during the period before the epidemic most cases occurred in black children and in those aged less than 1 year ($P < 0.001$). There was no significant increase in hospitalised cases. Investigation of the outbreak at one school revealed that the attack rate was 7.6% (25/329 children). Immunisation coverage (at least one dose of any measles vaccine) was 91% and vaccine efficacy was estimated to be 79% (95% CI 55-90); it was highest for monovalent measles (100%) and lowest for measles-mumps-rubella (74%). The epidemiology of measles in Cape Town has thus changed as evinced in this epidemic, with an increase in the number of cases occurring in older, previously vaccinated children. The possible reasons for this include both primary and secondary vaccine failure. <http://www.ncbi.nlm.nih.gov/htbin-post/Entrez/query?uid=7740350&form=6&db=m&Dopt=b>

Currier RW 2d, et al. (1972) Measles in previously vaccinated children. Evaluation of an outbreak. Am J Dis Child. 1972 Dec;124(6):854-7. No abstract available. PMID: 4639221; UI: 73055262.

Davis RM, et al.(1987) A persistent outbreak of measles despite appropriate prevention and control measures. Am J Epidemiol. 1987 Sep;126(3):438-49. PMID: 3618578; UI: 87295970.

From January 4 to May 13, 1985, an outbreak of 137 cases of measles occurred in Montana and persisted for 12 generations of spread. A total of 114 cases occurred on the Blackfeet Indian reservation in northwest Montana. Of the 137 cases, 82 (59.9%) were in school-aged children (aged 5-19 years). Of the 114 cases on the reservation, 108 (94.7%) were classified as programmatically nonpreventable. A total of 64 (82.1%) of the 78 patients on the reservation who were born after 1956 and were above the recommended age at vaccination had a history of adequate measles vaccination. Additionally, an audit of immunization records at the schools in Browning, Montana, where most of the cases occurred, showed that 98.7% of students were appropriately vaccinated. A retrospective cohort study in the Browning schools failed to identify age at vaccination or time since vaccination as significant risk factors for vaccine failure. Overall vaccine efficacy was 96.9% (95% confidence interval =89.5-98.2%). None of 80 Browning students who were vaccinated at less than 12 months of age and revaccinated at 15 months of age or older became infected. A case-control study showed a significant association between attendance at Browning basketball games and infection early in the outbreak. This outbreak suggests that measles transmission may persist in some settings despite appropriate implementation of the current measles elimination strategy. <http://www.ncbi.nlm.nih.gov/htbin-post/Entrez/query?uid=3618578&form=6&db=m&Dopt=b>

Edmonson MB, et al.(1990) Mild measles and secondary vaccine failure during a sustained outbreak in a highly vaccinated population. JAMA. 1990 May 9;263(18):2467-71. PMID: 2278542; UI: 90230400.

A prolonged school-based outbreak of measles provided an opportunity to study "vaccine-modified" mild measles and secondary vaccine failure. Thirty-six (97%) of 37 unvaccinated patients had rash illnesses that met the Centers for Disease Control clinical case definition of measles, but 29 (15%) of 198 vaccinated patients did not, primarily because of low-grade or absent fever. Of 122 patients with seroconfirmed measles, 10 patients (all previously

vaccinated) had no detectable measles-specific IgM and significantly milder illness than either vaccinated or unvaccinated patients with IgM-positive serum. Of 108 vaccinated patients with seroconfirmed measles, 17 patients (16%) had IgM-negative serology or rash illnesses that failed to meet the clinical case definition; their mean age (13 years), age at the time of vaccination, and time since vaccination did not differ from those of other vaccinated patients. The occurrence of secondary vaccine failure and vaccine-modified measles does not appear to be a major impediment to measles control in the United States but may lead to underreporting of measles cases and result in overestimation of vaccine efficacy in highly vaccinated populations. <http://www.ncbi.nlm.nih.gov/htbin-post/Entrez/query?uid=2278542&form=6&db=m&Dopt=b>

Gustafson TL, (1987) Lievens AW, Brunell PA, Moellenberg RG, Buttery CM, Schulster LM. Measles outbreak in a fully immunized secondary-school population. N Engl J Med 1987 Mar 26;316(13):771-4

An outbreak of measles occurred among adolescents in Corpus Christi, Texas, in the spring of 1985, even though vaccination requirements for school attendance had been thoroughly enforced. Serum samples from 1806 students at two secondary schools were obtained eight days after the onset of the first case. Only 4.1 percent of these students (74 of 1806) lacked detectable antibody to measles according to enzyme-linked immunosorbent assay, and more than 99 percent had records of vaccination with live measles vaccine. Stratified analysis showed that the number of doses of vaccine received was the most important predictor of antibody response. Ninety-five percent confidence intervals of seronegative rates were 0 to 3.3 percent for students who had received two prior doses of vaccine, as compared with 3.6 to 6.8 percent for students who had received only a single dose. After the survey, none of the 1732 seropositive students contracted measles. Fourteen of 74 seronegative students, all of whom had been vaccinated, contracted measles. In addition, three seronegative students seroconverted without experiencing any symptoms. We conclude that outbreaks of measles can occur in secondary schools, even when more than 99 percent of the students have been vaccinated and more than 95 percent are immune.

Rauth and Schmidt (1965). The authors followed 386 children who had received 3 doses of killed measles virus vaccine in 1961. Of these 386, 125 had been exposed to measles and 54 of them developed the disease.

Barratta et al. (1970) investigated an outbreak of measles in Florida from Dec 1968-1969 and found there was little difference in the incidence of measles in vaccinated and unvaccinated children.

[Herceg A, et al.](#) An outbreak of measles in a highly immunised population: immunisation status and vaccine efficacy. Aust J Public Health. 1994 Sep;18(3):249-52. PMID: 7841251; UI: 95143332.

All of the immunised cases had received measles-mumps vaccine. There was no increased risk of measles infection in those who had been immunised at under 15 months of age compared with those immunised at 15 months or older, or in those who could not provide a date of immunisation compared with those who could. None of the children who had received two doses of vaccine caught measles.

Hersh BS, et al. (1991) A measles outbreak at a college with a prematriculation immunization requirement. Am J Public Health. 1991 Mar;81(3):360-4. PMID: 1994745; UI: 91135797.

BACKGROUND. In early 1988 an outbreak of 84 measles cases occurred at a college in Colorado in which over 98 percent of students had documentation of adequate measles immunity (physician diagnosed measles, receipt of live measles vaccine on or after the first birthday, or serologic evidence of immunity) due to an immunization requirement in effect since 1986. METHODS. To examine potential risk factors for measles vaccine failure, we

conducted a retrospective cohort study among students living in campus dormitories using student health service vaccination records. **RESULTS.** Overall, 70 (83 percent) cases had been vaccinated at greater than or equal to 12 months of age. Students living in campus dormitories were at increased risk for measles compared to students living off-campus (RR = 3.0, 95% CI = 2.0, 4.7). Students vaccinated at 12-14 months of age were at increased risk compared to those vaccinated at greater than or equal to 15 months (RR = 3.1, 95% CI = 1.7, 5.7). Time since vaccination was not a risk factor for vaccine failure. Measles vaccine effectiveness was calculated to be 94% (95% CI = 86, 98) for vaccination at greater than or equal to 15 months. **CONCLUSIONS.** As in secondary schools, measles outbreaks can occur among highly vaccinated college populations. Implementation of recent recommendations to require two doses of measles vaccine for college entrants should help reduce measles outbreaks in college populations. <http://www.ncbi.nlm.nih.gov/htbin-post/Entrez/query?uid=1994745&form=6&db=m&Dopt=b>

Hull HF, et al. (1985) Risk factors for measles vaccine failure among immunized students. *Pediatrics*. 1985 Oct;76(4):518-23. PMID: 4047794; UI: 86015842.

An outbreak of measles occurred in a municipal school system which had reported 98% of students immunized against measles. A case-control study was conducted to determine reasons for vaccine failure. Vaccine failure was associated with immunizations that could not be documented in the provider's records. Among children with provider-documented immunization, vaccine failure was associated with vaccination at 12 to 14 months of age with an odds ratio of 4.73. Among children vaccinated at 15 months or older, vaccine failure was not associated with time elapsed since vaccination. Studies should be conducted to determine whether unreliable immunization records are a more widespread problem. Further consideration should be given to routine revaccination of children previously vaccinated at 12 to 14 months of age. <http://www.ncbi.nlm.nih.gov/htbin-post/Entrez/query?uid=4047794&form=6&db=m&Dopt=b>

Judelsohn RG, et al. (1980) School-based measles outbreaks: correlation of age at immunization with risk of disease. *Am J Public Health*. 1980 Nov;70(11):1162-5. PMID: 7425187; UI: 81037187.

During the Spring of 1978, students with a history of previous measles vaccination accounted for over three-fourths of 203 cases of measles in a metropolitan county. Seventy cases occurred in two schools where 99% of the students were vaccinated. We analyzed countywide data to determine past patterns of measles vaccination, including outbreak control and vaccination update clinics. We also examined records of children from the two schools to assess the relationship between disease incidence and age at vaccination. When susceptibility was determined by trained health workers rather than by parents, fewer doses of measles vaccine were estimated to be needed. The majority of cases occurred among children 5 to 9 years old. Attack rates were higher for children vaccinated at 12 months of age or younger than for those vaccinated at 13 months of age or older. There were no significant differences in attack rates among children vaccinated at 13 months of age or older. These findings support recommendations for delaying routine measles vaccination until after 12 months of age and suggest that, during outbreaks, all children vaccinated prior to 13 months of age be revaccinated. <http://www.ncbi.nlm.nih.gov/htbin-post/Entrez/query?uid=7425187&form=6&db=m&Dopt=b>

Kawamoto A, et al. (1995) Two independent outbreaks of measles in partially vaccinated junior high schools in Tottori, Japan. *Arch Virol*. 1995;140(2):349-54. PMID: 7710360; UI: 95225752.

We analyzed retrospectively a relative risk of measles attacks in vaccinated vs. unvaccinated students using two independent outbreaks in Japan. The first involved 33/328 (10%) students where 64% students and 30% measles cases had been vaccinated. The second involved 27/241 (11%) students where 81% students and 48% measles cases

had been vaccinated. The attack rates of vaccinated vs. unvaccinated students were significantly low ($p < 0.001$), but they accounted 25% in both episodes. The statistically significant clinical features among vaccinated and unvaccinated cases included the average duration of fever, 5.16 +/- 1.71 vs. 6.67 +/- 2.19 days ($p = 0.01$) and the incidence of complications, 0 vs. 25%, respectively. These results suggested that the measles in vaccinated cases were mostly due to secondary failures. <http://www.ncbi.nlm.nih.gov/htbin-post/Entrez/query?uid=7710360&form=6&db=m&Dopt=b>

Krause PJ, et al (1979) . Epidemic measles in young adults. Clinical, epidemiologic, and serologic studies. Ann Intern Med. 1979 Jun;90(6):873-6. PMID: 443682; UI: 79185850.

An outbreak of measles at the University of California at Los Angeles provided the opportunity to study clinical, epidemiologic, and serologic characteristics of the disease in young adults in the present vaccine era. Of the 34 cases studied, 18 occurred in persons who thought they were immune. Fifteen of 19 seronegative students vaccinated during the epidemic responded with a secondary (IgG) antibody response. Antibody prevalence studies indicated that 91% of the student population had measles antibody at the onset of the outbreak, and history relating to measles correlated poorly with antibody prevalence. Of 212 adults vaccinated, 58% complained of one or more symptoms. Seventeen percent were confined to bed, and in three women vaccine-associated illness was notably severe. That measles will continue to be a problem in adults with our present national approach to immunization is predicted. <http://www.ncbi.nlm.nih.gov/htbin-post/Entrez/query?uid=443682&form=6&db=m&Dopt=b>

Landrigan PJ (1973) , Griesbach PH. IMJ Ill Med J 1973 Apr;141(4):367-72. Measles in previously vaccinated children in Illinois. PMID: 4148345, UI: 74041503

Leeb A. Measles vaccination failure--cause for concern? Aust Fam Physician. 1992 Mar;21(3):297-301, 304. PMID: 1605769; UI: 92296993.

The author describes a propagated epidemic of measles virus infection on the north-west coast of Tasmania. Almost 20 per cent of children between the ages of 1 year and 15 years contracted the illness, 45 per cent of whom were previously vaccinated. A retrospective cross-sectional study was conducted to assess the incidence of infection and the vaccination status of the community and to investigate the apparent measles vaccine failure. <http://www.ncbi.nlm.nih.gov/htbin-post/Entrez/query?uid=1605769&form=6&db=m&Dopt=b>

[Markvart K, et al.](#) [Explosive occurrence of measles in a vaccinated population]. Cesk Epidemiol Mikrobiol Imunol. 1977 Jan;26(1):15-24. Czech. No abstract available. PMID: 140009; UI: 77160099. [\[See Related Articles\]](#)

Maulitz RM, et al. (1997) A measles outbreak in a New England community. Perspectives. Am J Dis Child. 1977 Jan;131(1):57-9. PMID: 835522; UI: 77108959.

Between May 30 and June 29, 1974, 28 cases of measles occurred in schoolchildren in a residential New England community. The index patient probably contracted the disease on a school field trip 11 days before the onset of her illness. Of the other 27 cases, 15 had received live measles vaccine before age 1, and ten had no history of vaccination or disease. Four documented vaccine failures did occur in children vaccinated after age 1, but this was not an unusual number compared with the total number of vaccinees evaluated during the investigation. Control

measures for susceptible persons including vaccination or modifying doses of immune serum globulin for exposure occurring more than 24 hours earlier. No additional cases of measles were reported for one month after the epidemic. <http://www.ncbi.nlm.nih.gov/htbin-post/Entrez/query?uid=835522&form=6&db=m&Dopt=b>

Nkowane BM, et al (1987) . Measles outbreak in a vaccinated school population: epidemiology, chains of transmission and the role of vaccine failures. Am J Public Health. 1987 Apr;77(4):434-8. PMID: 3826461; UI: 87154064.

An outbreak of measles occurred in a high school with a documented vaccination level of 98 per cent. Nineteen (70 per cent) of the cases were students who had histories of measles vaccination at 12 months of age or older and are therefore considered vaccine failures. Persons who were unimmunized or immunized at less than 12 months of age had substantially higher attack rates compared to those immunized on or after 12 months of age. Vaccine failures among apparently adequately vaccinated individuals were sources of infection for at least 48 per cent of the cases in the outbreak. There was no evidence to suggest that waning immunity was a contributing factor among the vaccine failures. Close contact with cases of measles in the high school, source or provider of vaccine, sharing common activities or classes with cases, and verification of the vaccination history were not significant risk factors in the outbreak. The outbreak subsided spontaneously after four generations of illness in the school and demonstrates that when measles is introduced in a highly vaccinated population, vaccine failures may play some role in transmission but that such transmission is not usually sustained. <http://www.ncbi.nlm.nih.gov/htbin-post/Entrez/query?uid=3826461&form=6&db=m&Dopt=b>

Oguz F, et al. (1995) Analysis of measles cases in a university pediatric hospital during 1988 and 1993 outbreaks. Turk J Pediatr. 1995 Apr-Jun;37(2):83-92. PMID: 7597773; UI: 95320940.

In Turkey, a mass measles immunization campaign was initiated in 1985, and the decision was made to administer the first of the measles vaccinations at nine months of age instead of 12-15 months. Following the campaign there was a decrease in the number of measles cases seen in the Outpatient Department of Istanbul University Children's Hospital in 1986 and 1987; however, after 1987 an increase was observed in measles cases, which continued until 1993. In order to investigate the current measles epidemics, we reevaluated the measles cases seen in our Outpatient Department from 1986 to 1993. We also investigated the vaccination status and the hospitalization and mortality rates of measles cases in the epidemics of 1988 and 1993. Since 1988 (except 1989) a significant increase (412-1375 percent) has been observed in measles cases, and between 1986 and 1993 more than half of all measles cases were in children older than four years of age. In 1988 and 1993 we found that most vaccinated measles cases were also in this age group, but the rate of complications and hospitalization among the vaccinated cases was lower compared to those who were not vaccinated. <http://www.ncbi.nlm.nih.gov/htbin-post/Entrez/query?uid=7597773&form=6&db=m&Dopt=b>

Paunio M (1998) , Peltola H, Valle M, Davidkin I, Virtanen M, Heinonen OP. Am J Epidemiol 1998 Dec 1;148(11):1103-10 Explosive school-based measles outbreak: intense exposure may have resulted in high risk, even among revaccines. Department of Public Health, University of Helsinki, Finland.

Even high levels of measles vaccination coverage have not always prevented outbreaks of measles spread by airborne transmission. It has been suggested that a large inoculum might increase vaccine failure risk. Airborne transmission might occasionally entail a large measles inoculum. The epidemiologic relevance of measles among properly vaccinated persons (i.e., those vaccinated after 15 months of age and with live attenuated virus) is increased when they become contagious. The authors studied inoculum intensities as measured by proxy variables and the contagiousness of properly vaccinated persons who contracted measles among 51 measles patients infected in one school, at home, or elsewhere, utilizing preexisting records of measles cases and 214 healthy controls from an explosive school outbreak that occurred in a rural Finnish municipality in 1989. One "super-spreader" infected 22

others in one day, including eight once-vaccinated students and one twice-vaccinated student, probably during an assembly of 144 students in a poorly ventilated hallway with no sunlight. Those infected later at home had high measles risk, even if they were revaccinees. When siblings shared a bedroom with a measles case, a 78 percent risk (seven out of nine children) was observed among vaccinees. Vaccinees had approximately 2 days' shorter incubation time than unvaccinated persons. Vaccinated and unvaccinated students were equally able to infect their siblings. Total protection against measles might not be achievable, even among revaccinees, when children are confronted with intense exposure to measles virus.

Rawls WE, et al. (1975) Analysis of a measles epidemic; possible role of vaccine failures. Can Med Assoc J. 1975 Nov 22;113(10):941-4. PMID: 1192310; UI: 76063956.

A measles epidemic occurred in the Greensville (Ont.) Unit schools during January and February 1975. There were 47 cases of measles in 403 students: 26 (55%) of the children had a history of being vaccinated and 18 (38%) had not been vaccinated. Among children known to have been vaccinated at less than 1 year of age 7 of 13 contracted measles, while among the 48 children who had not been vaccinated 18 contracted measles. The attack rate among vaccinees increased with increasing time since vaccination. The observations of this study as well as those of similar studies suggest that vaccine failures contributed to the genesis of the epidemic. It is recommended that all children initially vaccinated at less than 1 year of age should be revaccinated with live attenuated measles virus vaccine. <http://www.ncbi.nlm.nih.gov/htbin-post/Entrez/query?uid=1192310&form=6&db=m&Dopt=b>

Shasby DM, et al. (1977) Epidemic measles in a highly vaccinated population. N Engl J Med. 1977 Mar 17;296(11):585-9. PMID: 65732; UI: 77123672.

During November, 1975, to May, 1976, measles occurred at a rate of 20.3 cases per 1000 in a purported immunized population, of whom historical and serologic survey revealed that 9 per cent had no history of either measles illness or vaccination and 18 per cent did not have detectable measles antibody. Antibody was detectable in 92 per cent of those vaccinated at greater than or equal to 13 months, 80 per cent at 12 months and 67 per cent of those vaccinated when less than one year old (P less than 0.001), but no significant differences existed with increasing years since vaccination (P greater than 0.1). A second vaccination increased detectable antibody prevalence only in those originally vaccinated when less than nine months old (42 to 80 per cent, P less than 0.02). During a measles outbreak, more cases occurred in those receiving vaccine when less than 12 months old than in those vaccinated at greater than or equal to 12 months (37 per cent vs. 9 per cent, P less than 0.001). A second vaccination protected those originally vaccinated at less than 12 months (35 per cent ill without a second vaccination vs. 2 per cent with, P less than 0.001). Thus, a single measles vaccination of children less than 12 months old does not protect; a second vaccination will protect this group. <http://www.ncbi.nlm.nih.gov/htbin-post/Entrez/query?uid=65732&form=6&db=m&Dopt=b>

Sutcliffe PA, et al. (1996) Outbreak of measles in a highly vaccinated secondary school population. CMAJ. 1996 Nov 15;155(10):1407-13. PMID: 8943928; UI: 97099351.

OBJECTIVE: To examine the factors associated with measles vaccine effectiveness and the effect of two doses of vaccine on measles susceptibility during an outbreak. **DESIGN:** Retrospective cohort study. **SETTING:** A secondary school in the City of Toronto. **SUBJECTS:** The entire school population (1135 students 14 to 21 years of age). **MAIN OUTCOME MEASURES:** Risk of measles during an outbreak associated with age at first measles vaccination, length of time since vaccination, vaccination before 1980 and whether date of vaccination was estimated; vaccine efficacy of one dose versus two doses. **RESULTS:** Eighty-seven laboratory-confirmed or clinically confirmed cases of measles were identified (for an attack rate of 7.7%). The measles vaccination rate was

94.2%, and 10% of the students had received two doses of measles vaccine before the outbreak. Among those who had received only one dose of vaccine, vaccination at less than 15 months of age was associated with vaccine failure (relative risk 3.62, 95% confidence interval 2.32 to 5.66). There was no increased risk of vaccine failure associated with length of time since vaccination once the relative risk was adjusted for age at vaccination in a stratified analysis. Vaccination before 1980 and an estimated date of vaccination were not associated with increased risk of vaccine failure. Administration of a second dose of vaccine during the outbreak was not protective. Two doses of vaccine given before the outbreak conferred significant protection, and the relative risk of failure after one dose versus two doses was 5.0 (95% confidence interval 1.25 to 20.15). Of the 87 cases, 76 (87%) could have been prevented had all the students received two doses of measles vaccine before the outbreak, with the first at 12 months of age or later. CONCLUSIONS: Delayed primary measles vaccination (at 15 months of age or later) significantly reduced measles risk at later ages. However, revising the timing of the current 12-month dose would leave children vulnerable during a period in which there is increased risk of complications. The findings support a population-based two-dose measles vaccination strategy for optimal measles control and eventual disease elimination. <http://www.ncbi.nlm.nih.gov/htbin-post/Entrez/query?uid=8943928&form=6&db=m&Dopt=b>

Slater PE, et al. (1992-3) The 1991 measles epidemic in Israel. Public Health Rev. 1992-93;20(1-2):41-51. PMID: 1305976; UI: 93303282.

INTRODUCTION AND METHODS. Prior to the institution of universal childhood vaccination against measles in Israel in 1967, large outbreaks occurred in epidemic cycles at intervals of 2-4 years. The mean annual incidence in the pre-vaccination period, 1950-66, was 470/100,000 per year. With the institution of routine measles vaccination, incidence rates fell, and since 1970 measles incidence has averaged less than one-tenth the pre-vaccination incidence rate, although epidemics occurred in 1975, 1982, 1984-85, and 1991. In this report, based upon cases of measles reported to and investigated by the Ministry of Health, we present an analysis of the 1991 measles epidemic, the measures taken to contain it, and an overview of the prospects for measles control in Israel in the future. RESULTS AND CONCLUSIONS. The 1991 measles epidemic, 1036 reported cases (incidence: 20.0/100,000), began in the south of the country among underimmunized Beduin children and spread to the Jewish population in the south and then to the rest of the country. The highest incidence was in children aged 12-23 months, followed by children less than 12 months of age and children aged 2-4 years. In the main, cases occurred in persons never immunized in the past, but in 37% of cases vaccine failure seems to have occurred. Control measures included mass vaccination of children in the south and lowering the age for routine measles vaccination nationwide to 12 months. Despite very substantial gains towards measles control in Israel, elimination of the disease is not a realistic goal, mainly because the transmission potential of the disease is too high and vaccine coverage and efficacy are not high enough. Trends in measles incidence over the last four decades allow a cautious optimism that measles containment can be achieved. <http://www.ncbi.nlm.nih.gov/htbin-post/Entrez/query?uid=1305976&form=6&db=m&Dopt=b>

Srirajalingam M, et al (1998). Estimation of measles vaccination coverage and longer-term vaccine efficacy in a Queensland State High School during the 1993-94 measles epidemic. Aust N Z J Public Health. 1998 Dec;22(7):792-5. PMID: 9889445; UI: 99106119.

The parents of 470 students randomly selected from 1321 students attending a state high school were surveyed during the 1993-94 measles epidemic, by means of a take-home questionnaire. The response rate was 87%. Thirty stated that their child had measles during this epidemic; nine of these 30 gave a history of previous vaccination. Overall, 312 of the 470 (76%) stated that their child had been vaccinated, but only 34% indicated that they had vaccination records. There were no measles cases during this epidemic in the group with records. Those not vaccinated were at 10 times increased risk of contracting measles compared to those who had been vaccinated with or without records. Vaccine efficacy estimated in general a decade after vaccination based on parental recall of vaccination status regardless of whether they had vaccination records or not was 91% (95% CI 80%-96%). This

calculation excluded 123 who claimed to have had measles prior to 1993 and 30 uncertain of their vaccination status. <http://www.ncbi.nlm.nih.gov/htbin-post/Entrez/query?uid=9889445&form=6&db=m&Dopt=b>

Shelton JD, et al. (1978) Measles vaccine efficacy: influence of age at vaccination vs. duration of time since vaccination. *Pediatrics*. 1978 Dec;62(6):961-4. PMID: 733424; UI: 79095275.

To evaluate the recent decision of the Advisory Committee on Immunization Practice to increase the recommended age for initial measles vaccination from 12 to 15 months, we carried out a case control study of vaccine failure in a recent measles epidemic. Compared to children vaccinated at ages 15 months or older, we found an increased risk of vaccine failure among those vaccinated at 12 to 14 months (relative risk = 19.2, 95% confidence interval = 4.6 to 80.1). In order to sort out the influence of age at vaccination from elapsed time since vaccination, we subjected the data to discriminant analysis. Age at vaccination subsumed all of the effect of duration of time since vaccination. Thus, we find no evidence of waning immunity over time. <http://www.ncbi.nlm.nih.gov/htbin-post/Entrez/query?uid=733424&form=6&db=m&Dopt=b>

Sekla L, et al. (1988) An evaluation of measles serodiagnosis during an outbreak in a vaccinated community. *Clin Invest Med*. 1988 Aug;11(4):304-9. PMID: 3168353; UI: 89003844.

During an epidemic of measles in a vaccinated community, five serodiagnostic tests were performed on 67 persons on whom clinical and epidemiological data were available. The test found most suitable for a rapid diagnosis of measles infection was an Enzyme Linked Immuno Sorbent Assay for the detection of specific IgM antibodies. Only one false negative IgM was recorded. In a group of 45 persons who fulfilled the clinical definition of measles, specific IgM antibodies were detected in the acute phase serum of only 30 (66.6%), of whom 17 were vaccinated. When the convalescent sera were tested, specific IgM antibodies were detected in 25 of the 28 (89.2%) vaccinated, and in 17 of the 17 (100%) non vaccinated clinical cases. A convalescent blood should be tested in persons with a rash illness and no IgM antibodies in the acute phase serum. There were individual variations in the time of appearance of IgM. On the day of onset of rash, IgM antibodies were detected in 7 of the 12 (58.3%). A history of prior vaccination is not always associated with immunity nor with the presence of specific antibodies. <http://www.ncbi.nlm.nih.gov/htbin-post/Entrez/query?uid=3168353&form=6&db=m&Dopt=b>

Sanchez Y, et al. (1977) [What is wrong with the measles vaccine in Mexico? Study of an epidemic outbreak of measles]. *Bol Med Hosp Infant Mex*. 1977 Mar-Apr;34(2):291-7. Spanish. PMID: 843401; UI: 77134326.

The study included 205 children with measles seen after an epidemic outbreak in Distrito Federal during the first six months of 1976. 65.8% of the cases had not been given specific immunization and out of the 70 vaccinated cases (34.2%), one half of them were under one year old and were not given re-enforcement afterwards. The clinical picture suffered no changes in vaccinated children, 40% of infants showed initial exanthema on chest and abdomen with centrifugal distribution and in 41.5% of them, diarrhea appeared during the prodromal period. The most outstanding elements of this epidemic outbreak were the high number of sensible cases and the high percentage of children vaccinated before the age of one year and who were not later given re-vaccination. Inadequate handling of the vaccine or combination of vaccine with gammaglobulin used in 1969 and 1970, are also mentioned as a possibility to explain failures of the vaccine in this group of well vaccinated children. <http://www.ncbi.nlm.nih.gov/htbin-post/Entrez/query?uid=843401&form=6&db=m&Dopt=b>

Serra I, et al. (1990) [Measles in Chile]. Rev Med Chil. 1990 Feb;118(2):214-24. Spanish. PMID: 2152725; UI: 93303425.

Outbreaks of measles have occurred in Chile in 1979, 1985 and 1988. A greater proportion of cases affected babies under 1 year of age and patients above age 14. However, the increase in mortality was small. Low quality of the vaccine and deficiencies in the vaccination programs may be implicated in these epidemics. Use of high quality vaccines, vaccination programs based on serological information and better epidemiologic surveillance are proposed to prevent new outbreaks of the disease <http://www.ncbi.nlm.nih.gov/htbin-post/Entrez/query?uid=2152725&form=6&db=m&Dopt=b>

Tayil SE, et al. (1998) Sero-epidemiological study of measles after 15 years of compulsory vaccination in Alexandria, Egypt. East Mediterr Health J. 1998 Dec;4(3):437-47. [MEDLINE record in process] PMID: 10415952; UI: 99344441.

Cases of measles among 165 vaccinated and unvaccinated children were studied and the level of measles antibody in 230 previously vaccinated children was determined. Associations between demographic factors and immunological response to vaccination were also investigated. Approximately 80% of the children with measles had been vaccinated; their cases had significantly lower rates of complication. Rural areas accounted for significantly higher numbers of unvaccinated cases. Vaccination status did not correspond to place of exposure, duration of prodrome or accuracy of preliminary diagnosis. The seropositivity rate among vaccinated children was 86.1% with no significant variation with age. We recommend a second dose of measles vaccine and maintaining high vaccine coverage. <http://www.ncbi.nlm.nih.gov/htbin-post/Entrez/query?uid=10415952&form=6&db=m&Dopt=b>

Tohani VK, et al. (1992) Vaccine efficacy in a measles immunisation programme. Bur. 1992 Apr 24;2(5):R59-60. PMID: 1285105; UI: 94035478.

During a measles outbreak in Northern Ireland (between October 1988 and March 1989) it was noted that a proportion of cases had occurred in children who had previously been vaccinated against measles. A study was, therefore, set up to provide a rapid estimate of vaccine efficacy. Vaccine efficacy was calculated to be 94% (95% confidence limits, 91% to 96%). Investigation of the computerised records at 31 December 1991 revealed that 94% of children in the study cohort had received measles vaccine. As vaccination coverage increases, a higher proportion of cases of measles will, inevitably, have a history of vaccination. <http://www.ncbi.nlm.nih.gov/htbin-post/Entrez/query?uid=1285105&form=6&db=m&Dopt=b>

Trier H, et al. [Duration of immunity and occurrence of secondary vaccine failure following vaccination against measles, mumps and rubella]. Ugeskr Laeger. 1992 Jul 13;154(29):2008-13. Review. Danish. PMID: 1509566; UI: 92376936.

van Eijndhoven MJ, et al. (1994) [A measles epidemic in an adequately vaccinated middle school population]. Ned Tijdschr Geneesk. 1994 Nov 26;138(48):2396-400. Dutch. PMID: 7990987; UI: 95082975.

OBJECTIVE. To assess the extent of a measles epidemic in a secondary school. DESIGN. Retrospective and questionnaire investigation. SETTING. Secondary school, Bilthoven. METHOD. Questionnaire followed by laboratory testing for measles and other infectious diseases with exanthema. RESULTS. The response rate was 99% (935/949 pupils, aged 12-21 years, vaccination rate 92%). Seventy-seven students underwent laboratory investigations. Measles virus was isolated in 2 suspected patients. Thirty-three of 37 patients with clinical or

laboratory criteria of measles had been vaccinated. Complications of measles were not detected. Infection was also detected in patients with relatively few or atypical symptoms. The protective efficacy of measles vaccine could be determined because the attack rate of the school population was less than 5%. CONCLUSION. Primary failure of the measles vaccine might be the cause of the minor epidemic but the results do not cast doubt on the efficacy of the current measles vaccination programme. <http://www.ncbi.nlm.nih.gov/htbin-post/Entrez/query?uid=7990987&form=6&db=m&Dopt=b>

MMWR

MMWR Measles -- Hawaii Vol 33, No 50;702 12/21/1984

Of the 106 cases, 48 (45%) were considered preventable. Thirty-two of these patients had no record of measles vaccination or prior physician-diagnosed natural disease, and 16 had been vaccinated at under 12 months of age. Thirty-six of the 58 nonpreventable cases (62%) occurred among children 15 months of age or younger, most of whom were too young for routine vaccination. Eighteen (31%) of the nonpreventable cases had been immunized appropriately. The remaining four measles patients were 28 years of age or older--too old for routine vaccination. Of the 45 school-aged patients, 16 (35%) were vaccinated at 12 months of age or under; 12 (27%) were unvaccinated. Thus, non-immune schoolchildren accounted for 58% (28/48) of all preventable measles cases. <http://www.cdc.gov/epo/mmwr/preview/mmwrhtml/00000455.htm>

MMWR Measles in an Immunized School-Aged Population -- New Mexico Vol 34, No 04;052 02/01/1985.

The school system reported that 98% of students were vaccinated against measles before the outbreak began.. <http://www.cdc.gov/epo/mmwr/preview/mmwrhtml/00000476.htm>

MMWR Measles Outbreak among Vaccinated High School Students -- Illinois Vol 33, No 24;349 06/22/1984

The outbreak involved 16 high school students, all of whom had histories of measles vaccination after 15 months of age documented in their school health records <http://www.cdc.gov/epo/mmwr/preview/mmwrhtml/00000359.htm>

Mumps:

Hess U. [Mumps vaccines: vaccination failures from an immunological viewpoint]. *Soz Praventivmed.* 1995;40(2):110-5. German. PMID: 7747520; UI: 95266359.

Ströhle A; (1997) Eggenberger K; Steiner CA; Matter L; Germann D. Mumps epidemic in vaccinated children in West Switzerland. *Schweiz Med Wochenschr,* 1997 Jun, 127:26, 1124-33

Since 1991, 6 years after the recommendation of universal childhood vaccination against measles, mumps, and rubella (MMR triple vaccine), Switzerland is confronted with a large number of mumps cases affecting both vaccinated and unvaccinated children. Up to 80% of the children suffering from mumps between 1991 and 1995 had previously been vaccinated, the majority with the Rubini vaccine strain.

K T Goh. Lancet Volume 354, Number 9187 16 October 1999. Resurgence of mumps in Singapore caused by the Rubini mumps virus vaccine strain

The measles, mumps, and rubella vaccine containing the highly attenuated Rubini mumps virus strain conferred no protection against acute parotitis in vaccinated children in Singapore. Its introduction into the national childhood immunisation programme has resulted in a reduction in the seroprevalence of mumps to prevaccination levels.

Vaccination of 12-month-old children against mumps with the trivalent measles, mumps, and rubella (MMR) vaccine was introduced into the national childhood immunisation programme in Singapore in January, 1990. The vaccination coverage for children younger than 2 years ranged from 84.4% in 1990 to 92% in 1998. A "catch-up" measles vaccination programme for children aged 12-18 years used the MMR vaccine from July to November, 1997, to curb the resurgence of measles, and a second dose of MMR vaccine was routinely given to all primary school leavers (11 years) from January, 1998. Since January, 1990, three mumps-virus vaccine strains have been used in the MMR vaccine. These are the Urabe strain, the Jeryl-Lynn strain, and the Rubini strain. The Urabe strain was withdrawn in 1992 after an association with increased risk of aseptic meningitis was reported in other countries.¹ The Urabe strain was substituted by the Rubini strain during 1993-95.

Disease surveillance showed that although the incidence of measles and rubella has declined, that of mumps has increased, from 674 cases in 1997 to 1183 cases in 1998, and to 2586 cases for the first 7 months of 1999. At the current rate of increase, the incidence is likely to reach 200 per 100 000 population by the end of the year. The increase in the incidence of mumps was mainly seen in children younger than 15 years, which constituted 61% of the cases. Of 592 cases investigated for vaccination history during the last 4 months of 1998, 258 (43.6%) had documented evidence of immunisation with the MMR vaccine. All the vaccinated cases received one dose--the majority (85.3%) at government polyclinics. Of 195 cases who were known to have received mumps-virus vaccine strains, 144 (73.8%) were vaccinated with the Rubini strain, 42 (21.5%) with the Jeryl-Lynn strain, and nine (4.6%) with the Urabe strain. About three-quarters of the cases received their MMR vaccine 1-4 years before onset of illness.

Epidemiological investigations pointed to primary vaccine failure as the most likely cause for the resurgence of mumps. The short interval between vaccination and onset of illness indicated that secondary vaccine failure due to waning immunity is unlikely. Misdiagnosis by physicians could not have contributed to the sharp increase, since the clinical signs and symptoms of mumps are quite typical, and acute parotitis caused by other infections is uncommon. To calculate the vaccine efficacy of the Rubini strain vaccine, epidemiological investigations were carried out in five child-care centres in which mumps outbreaks had occurred. Of 2418 children, 2107 had documented evidence of mumps vaccination, and 197 had no documented evidence. The vaccination status of 114 children was unknown. There were 184 cases of mumps in these five child-care centres; 166 in the vaccinated group and 24 in the unvaccinated group. The attack rate was 166 of 2107 (7.9%) in the vaccinated group, and 18 of 197 (9.1%) in the unvaccinated group. Of those with documented evidence of vaccination, 140 of 1546 children vaccinated with the Rubini strain vaccine developed mumps, giving an attack rate of 9.1%. Thus the Rubini strain vaccine conferred no protection.

Further confirmation of the low efficacy of the Rubini strain was obtained from the results of periodic national seroepidemiological surveys on vaccine-preventable diseases. Serum samples were tested by ELISA for mumps virus IgG antibody with a commercial test kit (Mumps ELISA II, BioWhittaker, USA) at the Department of Pathology, Singapore General Hospital. The seroprevalence of mumps in children less than 5 years of age was 22% in 1989, before the introduction of the MMR vaccine. It increased to 72.4% in 1993 after mumps vaccination (with the Urabe strain and Jeryl-Lynn strain) was introduced. In 1998, the seroprevalence of mumps again fell to 25.6%. In view of the low protection conferred by the Rubini strain vaccine, the Ministry of Health deregistered the MMR vaccine containing this particular strain in May 1999. The low clinical protection provided by the highly attenuated Rubini strain was first noted in Switzerland, Italy, and Portugal.²⁻⁴ Sharp increases in mumps incidence in the 1990s prompted the Swiss Federal Office for Public Health to recommend the use of MMR vaccines containing other mumps virus strains.² Countries currently using the Rubini strain should monitor the incidence of mumps closely. If the incidence has not declined despite high immunisation coverage, the possibility of primary vaccine failure should be investigated.

1 Furesz J, Contreras G. Vaccine-related mumps meningitis--Canada. Can Dis Wkly Rep 1990; 16: 253-54.

2 Galazka AM, Robertson SE, Kraigher A. Mumps and mumps vaccine: a global review. Bull World Health Organ 1999; 77: 3-14.

3 Toscani L, Batou M, Bouvier P, Schlanepfer A. Comparison of the efficacy of various strains of mumps vaccine: a school survey. Soz Praventivmed 1996; 41: 341-47.

4 Germann D, Strohle A, Eggenberger K, Steiner CA, Matter I. An outbreak of mumps in a population partially vaccinated with the Rubini strain. Scand J Infect Dis 1996; 28: 235-38.

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Rubella

"The incidence of rubella virus infections in Switzerland after the introduction of the MMR mass vaccination programme" (European Journal of Epidemiology, vol. 11, no. 3, June 1995, pp. 305-10): In evaluating the impact of the MMR mass vaccination program begun in Switzerland in 1985, "we conclude that MMR mass vaccination has not interrupted the circulation of rubella virus in Switzerland, and that improvements in the implementation and surveillance of the MMR vaccination campaign are necessary in order to avoid [the] untoward effects of it."

[[Vaccination](#)]