mumps, and rubella vaccine (p.2223) is usually used. For discussion of immunisation schedules, see under Vaccines, p.2202.

Preparations

Proprietary Preparations (details are given in Part 3)
Cz.: Mopavac; ***Ger.:*** M-M Vax†.

Measles and Rubella Vaccines

Vacunas del sarampión y la rubéola.
ATC — J07BD53.

Pharmacopoeias. Many pharmacopoeias, including *US*, have monographs.
USP 31 (Measles and Rubella Virus Vaccine Live). Bacterially sterile preparation of suitable live strains of measles virus and live rubella virus. It may contain suitable antimicrobial agents. Each labelled dose provides an immunising dose of each component. It should be stored at 2° to 8° and be protected from light.

Adverse Effects and Precautions

As for vaccines in general, p.2201.
See also under Measles Vaccines, p.2221, and Rubella Vaccines, p.2236.

Incidence of adverse effects. Eight million children aged between 5 and 16 years were immunised with a measles and rubella vaccine in 1994 in the UK. By October 1995 the UK CSM had received reports on 2735 suspected adverse reactions most of which were minor and self-limiting.[1] Serious suspected reactions were rare and generally the number of reported cases was consistent with the background frequency of the particular disorder.

1. Committee on Safety of Medicines/Medicines Control Agency. Adverse reactions to measles rubella vaccine. *Current Problems* 1995; **21:** 9–10. Also available at: http://www.mhra.gov.uk/home/idcplg?IdcService=GET_FILE&dDocName=CON2015633&RevisionSelectionMethod=LatestReleased (accessed 25/05/06)

Effects on hearing. Profound, irreversible sensorineural deafness was reported in a 27-year-old woman after administration of a measles and rubella vaccine.[1] Sensorineural deafness has also been reported after use of measles, mumps, and rubella vaccine (below), and monovalent measles vaccine (p.2221).

1. Hulbert TV, *et al.* Bilateral hearing loss after measles and rubella vaccination in an adult. *N Engl J Med* 1991; **325:** 134.

Effects on the nervous system. Optic neuritis was reported in 2 children given measles and rubella vaccine 2 to 3 weeks previously.[1]

1. Stevenson VL, *et al.* Optic neuritis following measles/rubella vaccination in two 13-year-old children. *Br J Ophthalmol* 1996; **80:** 1110–11.

Interactions

As for vaccines in general, p.2202.
See also under Measles Vaccines, p.2222.

Uses and Administration

Measles and rubella vaccines may be used for active immunisation although for primary immunisation a combined measles, mumps, and rubella vaccine (p.2223) is usually used. For discussion of immunisation schedules, see under Vaccines, p.2202.

Preparations

USP 31: Measles and Rubella Virus Vaccine Live.

Proprietary Preparations (details are given in Part 3)
Braz.: Rudi-Rouvax†; ***Chile:*** MoRu-Viraten; ***Ital.:*** MoRu-Viraten†; ***Mex.:*** Moruviraten; ***Thai.:*** Rudi-Rouvax†.

Measles, Mumps, and Rubella Vaccines

Vacunas del sarampión, la parotiditis y la rubéola.
ATC — J07BD52.

Pharmacopoeias. Many pharmacopoeias, including *Eur.* (see p.vii) and *US*, have monographs.
Ph. Eur. 6.2 (Measles, Mumps and Rubella Vaccine (Live); Vaccinum Morbillorum, Parotitidis et Rubellae Vivum). A freeze-dried preparation containing suitable live attenuated strains of measles virus, mumps virus (*Paramyxovirus parotitidis*), and rubella virus. The vaccine is prepared immediately before use by reconstitution from the dried vaccine. It contains in each dose not less than 3.0 log $CCID_{50}$ of infective measles virus, not less than 3.7 log $CCID_{50}$ of infective mumps virus, and not less than 3.0 log $CCID_{50}$ of infective rubella virus. The dried vaccine should be stored at 2° to 8° and be protected from light.
The BP 2008 states that MMR may be used on the label.
USP 31 (Measles, Mumps, and Rubella Virus Vaccine Live). A bacterially sterile preparation of suitable live strains of measles virus, mumps virus, and rubella virus. It may contain suitable antimicrobial agents. Each labelled dose provides an immunising dose of each component. It should be stored at 2° to 8° and be protected from light.

Adverse Effects and Precautions

As for vaccines in general, p.2201.
See also under Measles Vaccines, p.2221, Mumps Vaccines, p.2225, and Rubella Vaccines, p.2236.
Events due to the measles component usually occur 6 to 11 days after vaccination and those due to the mumps and rubella components after 2 to 3 weeks but may occur up to 6 weeks after vaccination.
Adverse effects tend to be less frequent after the second dose of vaccine than after the first dose.
Measles, mumps, and rubella vaccines should not be given to individuals with a confirmed anaphylactic reaction to any antibacterial such as neomycin or kanamycin, that may be used in the manufacturing process.
Recommendations on vaccination in persons with egg allergy are discussed under Hypersensitivity, below.

Incidence of adverse effects. A double-blind placebo-controlled crossover study[1] in 581 pairs of twins showed that the frequency of adverse effects from the use of measles, mumps and rubella (MMR) vaccine was between 0.5 and 4.0%, indicating that adverse reactions are much less common than was previously thought. A study in the USA[2] showed that children given the vaccine at age 4 to 6 years had fewer adverse effects than those given it at 10 to 12 years. A later study[3] based on family reported symptoms was unable to detect any vaccine-related adverse effects when the second dose of MMR vaccine was given at either 4 to 6 years or 10 to 12 years. Vaccine-related adverse effects after the first dose of MMR vaccine were reported in about 17% in those vaccinated between the age of 12 and 20 months.
A further study[4] that assessed the effect of almost 3 million doses of vaccines in 1.8 million individuals revealed that 173 potentially serious reactions were claimed to have been caused by vaccination. There were 77 neurologic, 73 allergic, and 22 miscellaneous reactions recorded, and 1 death reported. However, 45% of the reactions were probably caused by some other factor. It was therefore concluded that serious events caused by MMR vaccine are rare and are greatly outweighed by the risks of the natural diseases.

1. Peltola H, Heinonen OP. Frequency of true adverse reactions to measles-mumps-rubella vaccine: a double-blind placebo-controlled trial in twins. *Lancet* 1986; **i:** 939–42.
2. Davis RL, *et al.* MMR2 immunization at 4 to 5 years and 10 to 12 years of age: a comparison of adverse clinical events after immunization in the vaccine safety datalink project. *Pediatrics* 1997; **100:** 767–71.
3. LeBaron CW, *et al.* Evaluation of potentially common adverse events associated with the first and second doses of measles-mumps-rubella vaccine. *Pediatrics* 2006; **118:** 1422–30.
4. Patja A, *et al.* Serious adverse events after measles-mumps-rubella vaccination during a fourteen-year prospective follow-up. *Pediatr Infect Dis J* 2000; **19:** 1127–34.

Effects on the blood. Thrombocytopenia occurs rarely in children receiving measles, mumps, and rubella vaccine and usually resolves spontaneously. The rubella component is considered to be the most likely cause. An increased incidence of thrombocytopenia after the second dose of the vaccine has been reported in children who developed thrombocytopenia after the first dose.[1] A study[2] by the UK Public Health Laboratory Service has suggested a link between measles, mumps, and rubella vaccine and the occurrence of idiopathic thrombocytopenic purpura, with an absolute risk of 1 in 22 300 of occurrence within 6 weeks of the first dose of the vaccine, and 2 out of every 3 cases attributable to it. Children with idiopathic thrombocytopenic purpura before receiving measles, mumps, and rubella vaccine experienced no vaccine-associated recurrences. A further study[3] of children aged 13 to 24 months and diagnosed with idiopathic thrombocytopenic purpura for the first time between January 1988 and December 1999 similarly found the attributable risk of developing it within 6 weeks of receiving the vaccine to be about 1 in 25 000. As a consequence of these findings, the UK CSM has recommended[4] that children developing idiopathic thrombocytopenic purpura within 6 weeks of vaccination with measles, mumps, and rubella vaccine, or any of its components, should have serological testing before their second dose is due; if this suggests that full immunity is not established, then a second dose should be given.

1. Vlacha V, *et al.* Recurrent thrombocytopenic purpura after repeated measles-mumps-rubella vaccination. *Pediatrics* 1996; **97:** 738–9.
2. Miller E, *et al.* Idiopathic thrombocytopenic purpura and MMR vaccine. *Arch Dis Child* 2001; **84:** 227–9.
3. Black C, *et al.* MMR vaccine and idiopathic thrombocytopaenic purpura. *Br J Clin Pharmacol* 2003; **55:** 107–11.
4. Committee on Safety of Medicines/Medicines Control Agency. MMR vaccine and idiopathic thrombocytopenic purpura. *Current Problems* 2001; **27:** 15. Also available at: http://www.mhra.gov.uk/home/idcplg?IdcService=GET_FILE&dDocName=CON007456&RevisionSelectionMethod=LatestReleased (accessed 24/05/06)

Effects on the bones and joints. Arthralgia and arthritis occurring in patients given mumps, measles, and rubella vaccines have generally been attributed to the rubella component.[1] However, arthritis has been reported in an infant after vaccination with measles and mumps vaccine.[2]

1. Benjamin CM, *et al.* Joint and limb symptoms in children after immunisation with measles, mumps, and rubella vaccine. *BMJ* 1992; **304:** 1075–8.
2. Nussinovitch M, *et al.* Arthritis after mumps and measles vaccination. *Arch Dis Child* 1995; **72:** 348–9.

Effects on hearing. Nine cases of sensorineural hearing loss after measles, mumps, and rubella vaccine were reported to the UK CSM between 1988 and 1993.[1] Of these, 3 cases were judged not to have been associated with the vaccine. In the remaining 6, the mumps virus component was considered to be the most likely cause of deafness if the vaccine was to blame, but the risk was considered to be small compared with the risks of natural infection. However, sensorineural deafness has also been reported after measles and rubella vaccine (see above) and monovalent measles vaccine (see p.2221).

1. Stewart BJA, Prabhu PU. Reports of sensorineural deafness after measles, mumps, and rubella immunisation. *Arch Dis Child* 1993; **69:** 153–4.

Effects on the nervous system. Although there have been case reports[1] linking Guillain-Barré syndrome with measles, mumps, and rubella vaccine, a retrospective study[2] that involved 189 patients with the syndrome and about 630 000 recipients of the vaccine could not find a causal association.
Prolonged tonic-clonic seizures were associated with prolonged hemiparesis in a 16-month-old girl 6 days after measles, mumps, and rubella vaccination.[3] There was evidence of transient encephalopathy. However, a causal relationship between measles-containing vaccines and encephalitis is generally considered to be unlikely. Other reported neurological effects after vaccination include gait disturbances,[4,5] and transverse myelitis.[6] However, a retrospective study[7] found no evidence for a causal association between vaccination and acute ataxia and the development of gait disturbances and suggested the original reports represented chance occurrence.
For discussion of meningitis and encephalitis occurring after measles, mumps, and rubella vaccination, see under Adverse Effects of Mumps Vaccines, p.2225.

1. Morris K, Rylance G. Guillain-Barré syndrome after measles, mumps, and rubella vaccine. *Lancet* 1994; **343:** 60.
2. Patja A, *et al.* Risk of Guillain-Barré syndrome after measles-mumps-rubella vaccination. *J Pediatr* 2001; **138:** 250–4.
3. Sackey AH, Broadhead RL. Hemiplegia after measles, mumps, and rubella vaccination. *BMJ* 1993; **306:** 1169.
4. Plesner A-M. Gait disturbances after measles, mumps, and rubella vaccine. *Lancet* 1995; **345:** 316.
5. Plesner AM, *et al.* Gait disturbance interpreted as cerebellar ataxia after MMR vaccination at 15 months of age: a follow-up study. *Acta Paediatr* 2000; **89:** 58–63.
6. Joyce KA, Rees JE. Transverse myelitis after measles, mumps, and rubella vaccine. *BMJ* 1995; **311:** 422.
7. Miller E, *et al.* No evidence of an association between MMR vaccine and gait disturbance. *Arch Dis Child* 2005; **90:** 292–6.

Hypersensitivity. Since the measles and mumps components of measles, mumps, and rubella vaccines are grown in cell cultures of chick embryos the vaccine was formerly contra-indicated in individuals with a history of anaphylactic reactions to egg. In both the UK and USA, serious reactions to egg including anaphylaxis are no longer regarded as absolute contra-indications to vaccination although specialist advice should be obtained and vaccination performed only under controlled conditions. It is generally agreed that the vaccine can be given safely to children with less severe reactions to eggs.
A confirmed anaphylactic reaction to gelatin, kanamycin, or neomycin is a contra-indication to measles, mumps, and rubella vaccines.

Inflammatory bowel disease and autism. A controversial report[1] in 1998 linked measles, mumps, and rubella vaccination with the development of inflammatory bowel disease and behavioural abnormalities including autism. However, there is now overwhelming evidence from studies and analyses that the vaccine does not cause autism.[2-11] Similarly, the link between measles-containing vaccines and inflammatory bowel disease has not been substantiated (see under Precautions for Measles Vaccines, p.2222).

1. Wakefield AJ, *et al.* Ileal-lymphoid-nodular hyperplasia, non-specific colitis, and pervasive developmental disorder in children. *Lancet* 1998; **351:** 637–41.
2. Peltola H, *et al.* No evidence for measles, mumps, and rubella vaccine-associated inflammatory bowel disease or autism in a 14-year prospective study. *Lancet* 1998; **351:** 1327–8.
3. Roberts R. There is no causal link between MMR vaccine and autism. *BMJ* 1998; **316:** 1824.
4. Taylor B, *et al.* Autism and measles, mumps, and rubella vaccine: no epidemiological evidence for a causal association. *Lancet* 1999; **353:** 2026–9.
5. Kaye JA, *et al.* Mumps, measles, and rubella vaccine and the incidence of autism recorded by general practitioners: a time trend analysis. *BMJ* 2001; **322:** 460–3. Correction. *ibid.*; 720.
6. Dales L, *et al.* Time trends in autism and in MMR immunization coverage in California. *JAMA* 2001; **285:** 1183–5.
7. Halsey NA, *et al.* Measles-mumps-rubella vaccine and autistic spectrum disorder: report from the new challenges in childhood immunizations conference convened in Oak Brook, Illinois, June 12-13, 2000. Abstract: *Pediatrics* 2001; **107:** 1174. Full version: http://pediatrics.aappublications.org/cgi/content/full/107/5/e84 (accessed 14/12/04)
8. Smeeth L, *et al.* MMR vaccination and pervasive developmental disorders: a case-control study. *Lancet* 2004; **364:** 963–9.
9. Immunization Safety Review Committee. *Immunization safety review: vaccines and autism.* Washington DC: National Academy Press, 2004. Also available at: http://www.nap.edu/catalog/10997 (accessed 15/07/08)
10. Demicheli V, *et al.* Vaccines for measles, mumps and rubella in children. Available in The Cochrane Database of Systematic Reviews; Issue 4. Chichester: John Wiley; 2005 (accessed 02/05/06)
11. Department of Health. *Immunisation Against Infectious Disease* 2006: "The Green Book". Available at: http://www.dh.gov.uk/PolicyAndGuidance/HealthAndSocialCareTopics/GreenBook/GreenBookGeneralInformation/GreenBookGeneralArticle/fs/en?CONTENT_ID=4097254&chk=isTfGX (accessed 14/04/08)

Interactions

As for vaccines in general, p.2202.
See also under Measles Vaccines, p.2222.

Uses and Administration

Measles, mumps, and rubella vaccines are used for active immunisation against measles, mumps, and rubella. They are used for primary immunisation in children 12 months of age or older and to protect susceptible contacts during an outbreak of measles. For discussion of immunisation schedules, see under Vaccines, p.2202.

In the UK, it is recommended that all children receive two doses of 0.5 mL of a measles, mumps, and rubella vaccine by intramuscular injection (or subcutaneously if there is a bleeding disorder). These are usually given shortly after the first birthday and before school entry, but may be given at any age if routine vaccination has been omitted, allowing 3 months between doses. The combined vaccine may also be used for prophylaxis after exposure to measles provided it is given within 72 hours of contact. However, it is not considered to be effective for postexposure prophylaxis against either mumps or rubella. If the vaccine is given before 12 months of age, re-immunisation will be necessary starting at between 12 and 15 months with a further dose according to national schedules.

Similar schedules are used in the USA.

Preparations

Ph. Eur.: Measles, Mumps, and Rubella Vaccine (Live);
USP 31: Measles, Mumps, and Rubella Virus Vaccine Live.

Proprietary Preparations (details are given in Part 3)
Arg.: MMR II; Trimovax; Triviraten; ***Austral.:*** MMR II†; Priorix; ***Austria:*** Priorix; ***Belg.:*** MMR Vax; Priorix; ***Braz.:*** MMR II†; Priorix†; Trimovax†; Vacina Comb. Contra Sarampo, Caxumba e Rubeola; Vacina Contra Sarampo, Caxumba e Rubeola; Vacina de Virus Vivos de Sarampo, Caxumba e Rubeola; ***Canad.:*** MMR II; Priorix; ***Cz.:*** MMR II; MMRVaxPro; Priorix; Trimovax†; Trivivac; ***Denm.:*** MMR; ***Fin.:*** MMR II; Priorix; ***Fr.:*** MMRVaxPro; Priorix; R.O.R.; ***Ger.:*** MMR Triplovax; MMR Vax; Priorix; ***Gr.:*** MMR II; MMRVaxPro; Priorix; ***Hong Kong:*** MMR II; Priorix; Trimovax; Triviraten†; ***Hung.:*** MMR II; ***India:*** Tresivac; ***Indon.:*** MMR II; Trimovax; ***Irl.:*** MMR II; Priorix; ***Israel:*** MMR II; Priorix; ***Ital.:*** MMR II; Morupar†; Priorix; ***Malaysia:*** MMR II; Priorix; Triviraten†; ***Mex.:*** MMR II; Morupar†; Priorix; ***Neth.:*** Priorix; ***Norw.:*** MMR II; Priorix; ***NZ:*** Priorix; Triviraten; ***Philipp.:*** Morupar†; Priorix; Trimovax; Triviraten; ***Pol.:*** MMR II; Priorix; Trimovax†; ***Port.:*** Priorix; ***Rus.:*** MMR II (ММР II); Priorix (Приорикс); ***S.Afr.:*** Morupar†; Priorix; Trimovax; ***Singapore:*** MMR II; Priorix; ***Spain:*** Priorix; Triviraten†; Vacuna Triple MSD; ***Swed.:*** MMR II; Priorix; ***Switz.:*** MMR II; Priorix; Triviraten; ***Thai.:*** MMR II; Morupar†; Priorix; Trimovax; Triviraten†; ***Turk.:*** MMR II; Priorix; Trimovax; Triviraten; ***UK:*** MMR II; Priorix; ***USA:*** MMR II; ***Venez.:*** Priorix; Trimovax†.

Multi-ingredient: ***NZ:*** MMR II.

Measles, Mumps, Rubella, and Varicella-Zoster Vaccines

ATC — J07BD54.

Profile

Measles, mumps, rubella, and varicella-zoster vaccines are used for active immunisation against measles, mumps, rubella and varicella (chickenpox).

Preparations

Proprietary Preparations (details are given in Part 3)
Cz.: Priorix-Tetra; ProQuad; ***NZ:*** Priorix-Tetra; ***Port.:*** Priorix-Tetra; ProQuad; ***USA:*** ProQuad.

Meningococcal Vaccines

Vacunas de polisacáridos meningocócicos.

ATC — J07AH01; J07AH02; J07AH03; J07AH04; J07AH05; J07AH06; J07AH07.

Pharmacopoeias. Many pharmacopoeias, including *Eur.* (see p.vii), have monographs.

Ph. Eur. 6.2 (Meningococcal Polysaccharide Vaccine; Vaccinum Meningitidis Cerebrospinalis). It consists of one or more purified capsular polysaccharides obtained from one or more suitable strains of *Neisseria meningitidis* group A, group C, group Y, and group W135; it may contain a single type of polysaccharide or any mixture of the types. It is prepared immediately before use by reconstitution from the stabilised freeze-dried vaccine with a suitable sterile liquid. The freeze-dried vaccine should be stored at 2° to 8° and be protected from light.

The BP 2008 states that Men plus the relevant antigen may be used on the label (for example MenAC).

Ph. Eur. 6.2 (Meningococcal Group C Conjugate Vaccine; Vaccinum Meningococcale Classis C Coniugatum). A liquid or freeze-dried preparation of purified capsular polysaccharide derived from a suitable strain of *Neisseria meningitidis* group C covalently linked to a carrier protein. The vaccine may contain an adjuvant. The freeze-dried vaccine should be stored at 2° to 8° and be protected from light.

The BP 2008 states that MenC(conj) may be used on the label.

Adverse Effects and Precautions

As for vaccines in general, p.2201.

Immunity to the unconjugated serogroup C polysaccharide in meningococcal vaccines may be insufficient to confer adequate protection against infection in infants under about 2 years of age.

Effects on the nervous system. From June 2005 to September 2006, 17 cases of Guillain-Barré syndrome were reported to the Vaccine Adverse Event Reporting System (VAERS) after use of a tetravalent (A, C, W135, and Y) meningococcal conjugate vaccine (Menactra). Whether the cases were caused by the vaccine or were coincidental was unknown.[1,2] The CDC recommends that persons with a history of Guillain-Barré syndrome should not be vaccinated with the tetravalent meningococcal conjugate vaccine.[2]

1. CDC. Guillain-Barré syndrome among recipients of Menactra meningococcal conjugate vaccine - United States, June-July 2005. *MMWR* 2005; **54:** 1023–5.
2. CDC. Update: Guillain-Barré syndrome among recipients of Menactra meningococcal conjugate vaccine— United States, June 2005-September 2006. *MMWR* 2006; **55:** 1120–4. Correction. *ibid.*; 1177.

Pregnancy and the neonate. A study[1] in 157 Asian women given a tetravalent polysaccharide vaccine in the third trimester of pregnancy found that immunisation was safe for both mothers and infants. Infants were provided with significantly increased levels of IgG for 2 to 3 months and of oral IgA for 6 months from breast feeding.

1. Shahid NS, *et al.* Placental and breast transfer of antibodies after maternal immunization with polysaccharide meningococcal vaccine: a randomized, controlled evaluation. *Vaccine* 2002; **20:** 2404–9.

Interactions

As for vaccines in general, p.2202.

Uses and Administration

Meningococcal vaccines are used for active immunisation against *Neisseria meningitidis* infections, which include meningitis and septicaemia. They are preparations of purified polysaccharide antigens from *N. meningitidis* and may be monovalent, containing the antigen of only one serotype of *N. meningitidis* or polyvalent, containing antigens of two or more serotypes. Conjugation of the polysaccharide to a carrier such as diphtheria CRM_{197} protein or to tetanus toxoid protein increases the immunogenicity.

In the UK, primary immunisation is recommended during infancy whereas in the USA routine immunisation is recommended during adolescence or for those at increased risk for meningococcal disease from 2 to 10 years of age. In the UK, a conjugate meningococcal C vaccine is used and is generally given by intramuscular injection with the subcutaneous route reserved for patients with haemophilia or thrombocytopenia. Infants, starting at 2 months of age, are given 3 doses of 0.5 mL at monthly intervals. If primary immunisation is delayed until 5 months of age then 2 doses, one month apart, are sufficient; children over 1 year of age and adults should be given a single dose only. In the USA, routine immunisation with a single dose, given intramuscularly, of a conjugate tetravalent vaccine from groups A, C, Y, and W135 is performed at 11 to 18 years of age if not previously vaccinated. For discussion of immunisation schedules see under Vaccines, p.2202.

Asplenic persons or those who have terminal complement component deficiencies are at higher than normal risk of acquiring meningococcal infection and therefore they should be immunised. Either a conjugate meningococcal C vaccine or a tetravalent vaccine (A, C, Y, and W135, unconjugated or conjugated) may be used depending on availability.

Meningococcal vaccines are also indicated in persons travelling to countries where the risk of infection is high. They should receive a tetravalent meningococcal polysaccharide vaccine (either unconjugated or conjugated) rather than the group C conjugate vaccine, and should be immunised even if they have already received the latter. Vaccination is indicated particularly for visits of 1 month or more and for those backpacking or living or working with local residents. Vaccination is a visa requirement for Hajj pilgrims to Saudi Arabia.

Meningococcal vaccines may be given as an adjunct to chemoprophylaxis in contacts of persons with meningitis (see p.178).

A meningococcal group B vaccine has been developed in New Zealand and contains outer membrane vesicles from *N. meningitidis* group B strain NZ 98/254. It is given for primary immunisation against the New Zealand strain (P1.7-b,4* PorA protein) of group B meningococcal disease. Adults and children over 6 months old are given three doses of 0.5 mL at intervals of 6 weeks intramuscularly; infants less than 6 months old should be given 4 doses, at 6 weeks, 3 months, 5 months, and 10 months of age. Vaccines against other group B meningococci are under investigation (see below).

◊ Reviews.

1. Ruggeberg J, Heath PT. Safety and efficacy of meningococcal group C conjugate vaccines. *Expert Opin Drug Saf* 2003; **2:** 7–19.

Vaccine development. Despite the established use of vaccines against meningococcal groups A, C, W135, and Y, about 60 to 80% of meningococcal infections (p.179) in the UK and the USA are caused by *Neisseria meningitidis* of group B serotype. Unfortunately the purified group B polysaccharide is only poorly immunogenic, even after conjugation with proteins but several avenues of research are being followed in the development of an effective vaccine. These include vaccines based on other outer membrane proteins contained in outer membrane vesicles, in particular the most important outer membrane proteins, PorA, and on lipopolysaccharide derivatives. More recently, group B meningococcal vaccine based on PorA has been developed in New Zealand (see above) and is available for primary immunisation against the New Zealand strain specifically, and has resulted in a marked reduction in incidence in that country. Recombinant technology has been used in the Netherlands to develop both a monovalent PorA vaccine and a hexavalent vaccine containing 6 PorA proteins, including that of the New Zealand strain. Results obtained with the New Zealand PorA antigen in the hexavalent formulation have been poor, but it has been shown to stimulate a satisfactory immune response in infants or small children in the monovalent form. The successful sequencing of the meningococcal genome has allowed discovery of several new proteins and raised potential for the development of new candidate vaccines, including novel surface-located vaccine candidates which are currently in preclinical evaluation.

An intranasal meningococcal group B vaccine is also under development.

References.

1. Katial RK, *et al.* Immunogenicity and safety testing of a group B intranasal meningococcal native outer membrane vesicle vaccine. *Infect Immun* 2002; **70:** 702–7.
2. Jodar L, *et al.* Development of vaccines against meningococcal disease. *Lancet* 2002; **359:** 1499–1508.
3. Vermont CL, van den Dobbelsteen GP. Meningococcal serogroup B infections: a search for a broadly protective vaccine. *Expert Rev Vaccines* 2003; **2:** 673–81.
4. Broker M. Development of new vaccines against meningococcal disease. *Arzneimittelforschung* 2003; **53:** 805–13.
5. Zimmer SM, Stephens DS. Meningococcal conjugate vaccines. *Expert Opin Pharmacother* 2004; **5:** 855–63.
6. Zimmer SM, Stephens DS. Serogroup B meningococcal vaccines. *Curr Opin Investig Drugs* 2006; **7:** 733–9.
7. Holst J. Strategies for development of universal vaccines against meningococcal serogroup B disease: the most promising options and the challenges evaluating them. *Hum Vaccin* 2007; **3:** 290–4.
8. Kelly C, *et al.* A prospective study of the effectiveness of the New Zealand meningococcal B vaccine. *Am J Epidemiol* 2007; **166:** 817–23.
9. McNicholas A, *et al.* Surveillance of vaccine breakthrough cases following MeNZB vaccination. *N Z Med J* 2008; **121:** 38–46.
10. van Alphen L, van den Dobbelsteen G. Meningococcal B vaccine development and evaluation of efficacy. *Hum Vaccin* 2008; **4:** 158–61.
11. WHO: Initiative for Vaccine Research (IVR). Neisseria meningitidis. Information available at: http://www.who.int/vaccine_research/diseases/soa_bacterial/en/index2.html (accessed 13/04/06)

Preparations

Ph. Eur.: Meningococcal Group C Conjugate Vaccine; Meningococcal Polysaccharide Vaccine.

Proprietary Preparations (details are given in Part 3)
Arg.: Antimeningococica A+C; Meningitec†; Menjugate; NeisVac-C; Va-Mengoc-BC; ***Austral.:*** Mencevax ACWY; Meningitec; Menjugate; Menomune; NeisVac-C; ***Austria:*** Mencevax ACWY; Meningitec; Menomune; NeisVac-C; ***Belg.:*** Mencevax ACWY; Meningitec; Meningovax A+C†; Menjugate; NeisVac-C; ***Braz.:*** Va-Mengoc-BC†; Vacina Meningococica A+C; Vacina Meningococica Conjugada Grupo C; ***Canad.:*** Meningitec; Menjugate; Menomune; NeisVac-C; ***Chile:*** Meningo A+C; ***Cz.:*** Menjugate; Menpovax A+C†; NeisVac-C; ***Denm.:*** Meningovax A+C; NeisVac-C; ***Fin.:*** Mencevax ACWY; Meningovax A+C; NeisVac-C; ***Fr.:*** Meningitec; Meninvact; Menjugate; Menomune; NeisVac; ***Ger.:*** Mencevax ACWY; Meningitec; Meningokokken-Impfstoff A + C; Menjugate; NeisVac-C; ***Gr.:*** Meningitec; Meninvact; Menjugate; Menomune; NeisVac-C; Vaccin Meningococcique; ***Hong Kong:*** Mencevax ACWY; Meningococcal A+C†; ***Hung.:*** Mencevax ACWY; Meningitec; Menjugate; NeisVac-C; ***Indon.:*** Mencevax ACWY; ***Irl.:*** Mengivac (A+C)†; Meningitec; Menjugate; ***Israel:*** Mencevax AC†; Mencevax ACWY; ***Ital.:*** Mencevax ACWY; Meningitec; Meninvact; Menjugate; Menomune; NeisVac-C; ***Malaysia:*** Mencevax ACWY; Menomune†; ***Neth.:*** Meningovax A+C; Meninvact; Menjugate; NeisVac-C; ***Norw.:*** Mencevax AC; Meningitec; Meningovax A+C; NeisVac-C; ***NZ:*** Mencevax ACWY; Meningitec; Menomune; MeNZB; ***Philipp.:*** Euro A & C; ***Pol.:*** NeisVac-C; ***Port.:*** Meningitec; Menjugate; NeisVac-C; ***Rus.:*** Mencevax ACWY (Менцевакс АСWY); ***S.Afr.:*** Imovax Meningo A & C; Mencevax; ***Singapore:*** Mencevax ACWY; Menomune; ***Spain:*** Mencevax AC; Meningitec; Meninvact†; Menjugate; NeisVac-C; Vacuna Antimeningococica A+C; ***Swed.:*** Meningitec†; Meningovax A+C; NeisVac-C; ***Switz.:*** Mencevax ACWY; Meningitec; Menjugate; NeisVac-C; ***Thai.:*** Meningococcal A+C†; Menomune; ***Turk.:*** Imovax Meningo A+C; ***UK:*** ACWY Vax; Mengivac (A+C)†; Meningitec; Menjugate; NeisVac-C; ***USA:*** Menactra; Menomune; ***Venez.:*** Imovax Meningo A+C†; Mencevax ACWY†.