Vaccinations for the Pediatric Traveler

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The care of the traveling child has become more complex and specialized as vaccine developments and recommendations have evolved. Differences in the pediatric immune response and the rationale for vaccine use or omission at certain ages must be considered. Protecting children from travel-related disease involves updating routine childhood immunizations and appropriately administering itinerary-specific travel vaccines. Routine childhood vaccinations may need to be accelerated for young infants traveling before the standard primary vaccine series can be completed. Hepatitis A, hepatitis B, Japanese encephalitis, yellow fever, varicella, and tickborne encephalitis vaccinations have pediatric indications, side effects, and uses. This review will address vaccine considerations and current US recommendations particular to traveling children.

INTRODUCTION

Caring for pediatric travelers presents unique challenges to travel medicine providers. Each aspect of travel medicine has caveats relating to the developmental stage, size, and maturity level of the infant, child, or adolescent traveler [1]. Protection against vaccine-preventable childhood diseases is particularly important for children who visit developing countries. Vaccinating children for travel requires consideration of the development of the pediatric immune response and the rationale for vaccine use or omission at certain ages [2].

Vaccine response. The development of human immune response begins in utero. Vaccine response in infants and children is characterized by several factors. The infant immune system is characterized by impaired T cell function. There is decreased collaboration between B and T cells, and the immunoglobulin repertoire is restricted. The antibody response to a given antigen is of low affinity [3]. Immunoglobulins are transferred via the placenta during the third trimester and form the beginnings of antigen response recognition. The nature and dose of antigen, the number of vaccine doses, the age at immunization, and the level of maternal antibody at the time of immunization affect the vaccine response [4].

Polysaccharide vaccines. Polysaccharide antigens are T cell independent and poorly immunogenic in young children and infants. T cell–independent antigens initiate B cell proliferation without the help of T cells. The antibody response elicited is protective in certain age groups, but it is not long-lasting. Children aged <2 years are unable to make IgG2 subclass antibody, the main response elicited by the polysaccharide vaccines; therefore, they do not respond to these vaccines. The quadrivalent meningococcal meningitis (A/C/Y/W-135) vaccine, Vi typhoid vaccine, and early versions of the Haemophilus influenzae B vaccines use polysaccharide vaccine technology [5]. Age limitations for these vaccines are therefore based on an ineffective response for persons under the licensed age, which is generally 2 years old.

Maternal antibody. Placental transfer of maternal antibody influences the outcome of certain vaccinations [4]. Maternal antibody to pertussis, mumps, and polio has been detected in infants. The antibodies are present for a variable period of time and are generally gone within the first 4–6 months of life. Little or no protection is conferred against hepatitis A, typhoid fever, polio, Japanese encephalitis (JE), yellow fever, pertussis, mumps, rubella, and measles, despite the presence of antibodies. Maternal antibody presence can interfere with the infant’s ability to develop antibodies. The recommended lower age limit of certain vaccines (measles, mumps, and rubella [MMR] and hepatitis A vaccines) reflects this finding.

Premature infants lack the benefit of maternal antibodies delivered at the end of a normal gestation, yet they respond to
vaccine antigens at an acceptable rate. Schedules for vaccinating former premature infants are identical to those for full-term infants.

Conjugate vaccines. Developments in vaccinology have led to improved ways of stimulating the immune response in both infants and adults. Oligosaccharide-protein conjugate vaccines produce a T cell–dependent response instead of a T cell–independent response [5]. This allows children aged <2 years to respond to important antigens. These vaccines also induce immunologic memory for robust booster responses to future doses. The newer H. influenzae B vaccines, 7-valent pneumococcal vaccine, and meningococcal A and C conjugate vaccines are capable of stimulating the infant immune system and provide good booster responses.

ROUTINE PEDIATRIC VACCINES

The current recommendations for routine childhood vaccination in the United States are shown in detail in figure 1. Most industrialized countries follow similar schedules with some variations. Detailed information on routine childhood schedules by country can be found at http://www-nt.who.int/vaccines/GlobalSummary/Immunization/CountryProfileSelect.cfm.

Intercurrent illness and vaccination. Minor febrile illnesses are not a contraindication to routine or travel vaccines and should not lead to postponement of indicated doses. Simultaneous administration of vaccines is acceptable and does not diminish antibody response. As with adults, live viral vaccines should be given together or separated by ≥30 days.

Accelerating routine vaccines. Routine pediatric vaccinations may need to be accelerated for young children. The recommended minimum amount of time between doses is listed in table 1. These recommendations reflect interfering maternal antibodies, lack of effective immune response, or lack of data. The minimum interval is required to produce an immunologic response. Longer intervals are preferable [6].

Diphtheria-tetanus–acellular pertussis (DTaP) vaccine. The combination of diphtheria, tetanus, and pertussis is rec-

<table>
<thead>
<tr>
<th>Vaccine</th>
<th>Earliest age for first dose</th>
<th>Minimum interval between doses, weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diphtheria-tetanus–acellular pertussis</td>
<td>6 weeks</td>
<td>4</td>
</tr>
<tr>
<td>Intravenous polio vaccine</td>
<td>6 weeks</td>
<td>4</td>
</tr>
<tr>
<td>Oral polio vaccine</td>
<td>Birth</td>
<td>4</td>
</tr>
<tr>
<td>Haemophilus influenzae B</td>
<td>6 weeks</td>
<td>4</td>
</tr>
<tr>
<td>Hepatitis B</td>
<td>Birth</td>
<td>4</td>
</tr>
<tr>
<td>PCV7a</td>
<td>6 weeks</td>
<td>4</td>
</tr>
<tr>
<td>Measles (single antigen)</td>
<td>6–11 monthsb</td>
<td>...</td>
</tr>
</tbody>
</table>

NOTE. From [6].

a Seven-valent conjugate pneumococcal vaccine (Prevnar; Wyeth)
b Followed by measles, mumps, and rubella vaccine at 12 months of age.
ommended for all children, as shown in figure 1. The side effect profile has improved with the development of the acellular pertussis component. The acellular pertussis component is minimally reactogenic, compared with the whole-cell pertussis vaccine, and it is the preferred product. There is ongoing investigation on the use of an additional dose of pertussis vaccine in adolescents and adults, but, currently, the use of vaccine containing pertussis should be limited to children aged <7 years.

The diphtheria toxoid content in dT vaccine is lower than in DTaP, DTP, or DT vaccines, to decrease the likelihood of local side effects at the site of injection. Children aged ≥7 years should receive dT for primary doses, if not previously immunized, or for booster doses.

**MMR vaccine.** Measles remains the leading cause of vaccine-preventable death among children worldwide. Outbreaks occur in both developed and developing countries (figure 2).

Administration of the first dose of MMR vaccine is recommended at 12–15 months of age in most industrialized countries. The presence of maternal measles antibody in infants aged <12 months may result in a suboptimal response to measles vaccine administered before this age. The first dose of the MMR vaccine gives protective immunity in ~95% of recipients. The second dose is not a booster dose, but it induces immunity in the remainder of those who may not have responded. The second dose can be given as soon as 1 month after the first dose. In the routine pediatric vaccine schedule in many countries, it is given when the child is 4–5 years old at kindergarten entry.

Infants aged 6–12 months traveling to the developing world should be vaccinated with the monovalent measles vaccine or, if unavailable, MMR vaccine [7]. This will provide immediate protection for several months but not a durable immune response. A second dose should be given no sooner than 4 weeks after the first dose. Any doses given before the age of 12 months are not considered countable, and the child still requires 2 MMR vaccinations after the age of 12 months. Any older child traveling to areas where measles is endemic should receive a second dose of MMR vaccine before departure. This second dose is a countable dose in their series, provided it is given 4 weeks after the first dose and the child is older than 12 months of age.

The MMR vaccine is well tolerated. Ten to 14 days after vaccination, 1 in 15 recipients will develop a red maculopapular rash, a fever, and a flulike syndrome resulting from the vaccination. These persons are not contagious for measles. Minor side effects include local discomfort at the site of injection, headache, and malaise. Side effects are less frequent after the second dose than after the first dose.

Contraindications to the MMR vaccine include a serious allergic reaction to a previous dose. A history of anaphylaxis

![Reported measles incidence rates per 100,000 population, 2001](http://www.who.int/vaccines-surveillance/graphics/htmls/meainc.htm)

to neomycin or gelatin allergy warrants consultation with and allergist or immunologist before MMR vaccine is administered. Allergy to eggs or egg protein is not a contraindication to receiving the vaccine. Recent concerns regarding the association between the MMR vaccine and the development of autism have been investigated [8] and refuted.

**Hepatitis B vaccine.** Hepatitis B vaccination is routine for children in the United States and in many countries. The 3-dose series can be started immediately at birth and be given at 0 months, 1 month, and 6 months. Alternatively, the doses can be given at 2, 4, and 6 months of age, with dose 2 being administered ≥1 month after dose 1 and dose 3 being administered ≥4 months after dose 1. Preterm infants should be immunized before hospital discharge, if they weigh ≥2 kg, or at 2 months of age. The vaccine should be given intramuscularly, preferably in the anterior thigh, for best response. A 2-dose schedule (with the doses being given 4–6 months apart) is an option for adolescents 11–15 years old [9]. Postimmunization serologic testing is not recommended for the routine pediatric population. Infants born to hepatitis B surface antigen–positive mothers, however, should have undergone serologic testing 1–2 months after the third dose of vaccine. Side effects of the hepatitis B vaccine include local pain at the injection site, and 1%–6% of vaccine recipients experience fever. Allergic reactions are rare.

**Polio vaccine.** Traveling infants can begin the inactivated polio vaccine (IPV) series at 6 weeks of age [10]. Maternal antibody presence limits its effectiveness at earlier ages [3]. The second dose of IPV can be given 4 weeks after the first dose. Additional doses should be given 4 weeks apart. The oral polio vaccine (OPV) containing live attenuated poliovirus vaccine strains is no longer recommended for primary immunization and is no longer available in the United States.

Data to not exist to indicate the exact waning of polio immunity. However, a single lifetime booster dose of IPV is recommended for adult travelers to regions where polio is endemic who have completed the primary series [11].

**Varicella vaccine.** Child and adult travelers from tropical countries to temperate climates may be at risk of acquiring varicella infection. There is no data to date on the incidence of varicella infection in travelers. It is known, however, that varicella infection is a disease of adolescents and adults in tropical, nonindustrialized countries, as opposed to a disease of childhood in temperate climates [12]. Testing for immunity, if there is no definitive history of the disease, and vaccinating susceptible individuals is recommended.

Varicella vaccination was licensed in the United States in March 1995 and is recommended for susceptible children and adolescents >12 months of age. A single dose is recommended for 1–12-year old persons [13]. Children aged >12 years should receive 2 doses spaced by 4–8 weeks. It is also recommended for international travelers, as well as nonpregnant adults who live in households with children, who work in day care settings, or who are exposed to settings of high transmission risk (e.g., colleges and military or correctional institutions). Susceptible adolescents are strongly encouraged to undergo vaccination, because they are more likely to experience complications of the disease. Varicella vaccine should not be used by most immunocompromised people.

Varicella vaccine efficacy data indicate that the vaccine is highly effective. Initial data indicated that it provides 97%–99% protection against varicella when dosing recommendations are followed. Recent studies [14] have reported a lower efficacy rate. However, there is no current recommendation for boosting the initial dose. This vaccine is well tolerated, and no major side effects have been demonstrated to date: 7%–8% of vaccinated persons develop a mild, vaccine-associated rash consisting of 2–5 varicella-like lesions.

The manufacturer recommends that salicylates not be administered for 6 weeks after varicella vaccine administration, because there is an association between varicella virus (not vaccine), salicylates, and Reye syndrome. Reye syndrome has not been reported in association with the vaccine.

**Influenza vaccine.** The influenza season is year-round in the tropics, December through April in Northern Hemisphere temperate zones, and April to October in Southern Hemisphere temperate zones. Influenza vaccination should be considered for all children older than 6 months of age traveling during the influenza season. Infants younger than 6 months do not respond well to the current vaccine. Infants and children <12 years of age should receive the split-virus preparation, which is less reactogenic than the whole-virus product. Children older than 12 years of age can receive the whole-cell vaccine. Any child receiving the influenza vaccine for the first time should receive 2 doses of the vaccine given 1 month apart. Influenza vaccine is an inactivated virus vaccine. The American Academy of Pediatrics and the American Committee on Immunization Practices recommend that all children aged 6–23 months, regardless of travel plans, be considered for influenza vaccination because of a higher incidence of complications and hospitalizations associated with influenza infection [15]. An intranasal influenza vaccine has been licensed in the United States for use in children aged >5 years and adults.

**PEDIATRIC TRAVEL VACCINATIONS**

**Required Vaccinations: Yellow Fever Vaccine**

Yellow fever is endemic in central South American and sub-Saharan Africa. The yellow fever vaccine is required for entry to these areas, and it may be required if the traveler has transited through regions where yellow fever is endemic and is entering countries where it is not. Initial experience with the vaccine
revealed an increased incidence of yellow fever encephalitis in young infants. Twenty-one cases of vaccine strain encephalitis have been reported since 1952. Fifteen of these cases were in the 1950s, and 13 were in infants aged <4 months. The incidence of vaccine-associated encephalitis in young infants has been estimated to be 0.5–4 cases per 1000 infants [16].

The vaccine-associated encephalitis (neurotropic) syndrome typically occurs 7–21 days after immunization and is characterized by a reversion to wild-type virus. Neurologic signs and CSF pleocytosis (WBC count, 100–500 cells/μL) with increased protein levels were noted clinically. A brief clinical course with complete recovery was typical. The basis for this increased risk in infants is unknown. Theories include the immature blood-brain barrier, a possible prolonged or higher virus load, and effects combined with a delayed clearance of vaccine-related infection [16]. There have been recent case reports of vaccine-associated vicerotropic disease with multiorgan system failure. Although this is very rare, there appears to be increased risk among vaccinees aged >70 years [17].

In 1960, an age restriction of 9 months of age was placed on the use of the vaccine and is generally followed internationally. Current advice for infants aged <9 months is to avoid travel to very high-risk areas or to those where there are ongoing epidemics or current cases. If travel is unavoidable, vaccine can be given when the child is >6 months of age, but an expert in the current epidemiology of transmission should be consulted to assess the real risk at the particular destination (table 2) [18]. It is recommended that children receive booster doses every 10 years, as for adults.

**Recommended Vaccinations**

**Hepatitis A vaccine.** Hepatitis A in young children is usually a mild disease. Children can serve as reservoirs and transmit the infection to adults and caregivers while they asymptptomatically shed the virus in their stools. Vaccination of persons in this age group is indicated to control the disease in both the child traveler and contacts. Hepatitis A vaccination is recommended for children traveling to developing countries, as it is for adults. In addition, routine vaccination with hepatitis A vaccine is recommended in certain high-risk regions of the United States [19]; these currently include 11 western states (California, Oregon, Washington, Nevada, Arizona, New Mexico, Oklahoma, South Dakota, Utah, Alaska, and Idaho).

Data exist to show that infants as young as 6 months of age will respond to hepatitis A vaccination if interfering maternal antibody is not present [20, 21]. Maternal antibody can interfere with seroconversion response. Seropositive infants respond well at 1 year of age or older, once the maternal antibody levels decrease. Specific pediatric formulations of hepatitis A vaccines exist and are currently licensed in the United States for children aged 2–18 years old. In most other countries, the vaccine is licensed for use in infants at 1 year of age, and the World Health Organization recommends its use in children aged >1 year.

For children unable or unwilling (in the case of off-label use) to receive the vaccine, immunoglobulin (Ig) can be given as passive hepatitis A prophylaxis [22]. The dose of Ig for preexposure prophylaxis against hepatitis A infection is found in table 3.

**Hepatitis A–hepatitis B combination vaccine.** A hepatitis A–hepatitis B combination vaccine, Twinrix (GlaxoSmithKline), is now available for adults. The adult formulation is licensed for use in persons aged ≥18 years in the United States and ≥16 years in Europe and Canada. For children aged 1–15 years, Twinrix-Junior (GlaxoSmithKline) is available and licensed for use in Europe and Canada [25]. It is also administered in a 3-dose series, with doses administered at 0, 1, and 6 months.

**Meningococcal meningitis vaccine.** Children traveling to the meningitis-prone areas in equatorial Africa during the dry season of December through June or to the Hajj in Saudi Arabia should receive the quadrivalent A/C/Y/W-135 meningococcal meningitis vaccine. This polysaccharide vaccine confers little immunity to children aged <2 years. Infants are unable to make significant antibody response to serogroup C. Infants as young as 3 months old will, however, respond to vaccine with serogroup A (the most common serogroup in epidemics) to a limited extent when 2 doses are given [26]. Children <2 years of age making a single trip to a high-risk area should be vaccinated, because there will be some short-term benefit of vaccination. Children vaccinated before the age of 4 years should be revaccinated at least once per year if they remain at risk, because the vaccine is less immunogenic in persons of this age than in older children.

In the United States, the quadrivalent meningococcal vaccine has been recommended for college freshman living in dormitories. Serogroups C and Y have emerged as significant causes of meningococcal meningitis in the United States. The incidence of meningococcal disease among US college freshman residing in dormitories is modestly high, at 4.6 cases per 100,000 persons, compared with 1.4 cases per 100,000 persons for all

**Table 2. Age limitations to the use of yellow fever vaccine.**

<table>
<thead>
<tr>
<th>Age of child, months</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;6</td>
<td>Never vaccinate children of this age</td>
</tr>
<tr>
<td>6–9</td>
<td>Vaccinate after consultation with the Centers for Disease Control and Prevention (Atlanta)</td>
</tr>
<tr>
<td>&gt;9</td>
<td>Vaccinate before travel to areas where yellow fever is endemic or there is a high rate of infection</td>
</tr>
</tbody>
</table>

NOTE. From [18].
Table 3. Summary of travel vaccinations for children.

<table>
<thead>
<tr>
<th>Vaccine</th>
<th>Age at vaccination</th>
<th>Primary series</th>
<th>Booster interval/comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cholera, oral (CVD103-HgR)*</td>
<td>&gt;2 years</td>
<td>1 dose given orally in buffered solution</td>
<td>Optimal interval not established; manufacturer recommends 6 months. Not available in the United States.</td>
</tr>
<tr>
<td>Hepatitis A</td>
<td>&gt;2 years</td>
<td>Havrix (GSK): 2 doses (0.5 mL im) at 0 and 6–18 months; Vaqta (Merck): 2 doses (0.5 mL im) at 0 and 6 months</td>
<td>See text</td>
</tr>
<tr>
<td>Immunoglobulin</td>
<td>Birth</td>
<td>0.02 mL/kg im</td>
<td>See text</td>
</tr>
<tr>
<td>Japanese B encephalitis</td>
<td>&gt;1 year</td>
<td>For children aged 1–3 years: 3 doses (0.5 mL sc) given at 0, 7, 14, or 30 days; for children aged &gt;3 years: 3 doses (1.0 mL sc) given at 0, 7, 14, or 30 days</td>
<td>Every 3 years</td>
</tr>
<tr>
<td>Meningococcal meningitis (ACYW-135)</td>
<td>&gt;2 years</td>
<td>1 dose (0.5 mL sc)</td>
<td>Boost annually if first dose was given before the child was 4 years old; see text for data on children aged &lt;2 years</td>
</tr>
<tr>
<td>Rabies</td>
<td>Birth</td>
<td>3 doses (1 mL given im in the deltoid/anterolateral thigh for infants, or 0.1 mL intradermally) at 0, 7, 21, or 28 days</td>
<td>Only HDCV approved for intradermal use</td>
</tr>
<tr>
<td>Tickborne encephalitis*</td>
<td>1–11 years</td>
<td>EncepurKinder (Chiron Behring): 3 doses (0.25 mL im) at 0, 1–3, and 9–12 months; FSME-Immun Junior (Baxter): 3 doses (0.25 mL im) at 0, 1–3, and 9–12 months</td>
<td>Booster dose recommended 3 years after the primary series for the standard dosing regimen of either vaccine; see text for accelerated schedules. Not available in the United States.</td>
</tr>
<tr>
<td>Typhoid</td>
<td>Oral (Ty21a)</td>
<td>4 doses (1 capsule given orally every other day)</td>
<td>Every 5 years</td>
</tr>
<tr>
<td>Vi, parenteral</td>
<td>&gt;2 years</td>
<td>1 dose (0.5 mL im)</td>
<td>Boost after 2 years for continued risk of exposure</td>
</tr>
<tr>
<td>Yellow fever</td>
<td>&gt;9 months</td>
<td>1 dose (0.5 mL sc)</td>
<td>Boost every 10 years; see text for children aged &lt;9 months</td>
</tr>
</tbody>
</table>

NOTE. See text for specific vaccine details. From [1]. HDCV, human diploid cell vaccine (Aventis).
* See manufacturer’s package inserts [23, 24] for recommendations on dosage.

18–23-year-old persons in the United States. Vaccination will decrease but not eliminate the disease in this group [27].

Although group B meningococcal meningitis remains a serious cause of disease, a vaccine for this serogroup has been difficult to develop as a result of the resemblance of the capsular antigens to human neural tissue. There is no currently commercially available vaccine against group B meningococcal meningitis in the United States.

Meningococcal meningitis conjugate vaccines. Protein conjugate vaccines for meningococcal serogroups A and C and an A/C combination are available in several countries. The conjugate vaccine produces a T cell–dependent response; thus, it is immunogenic in infants [28]. Meningococcal group C conjugate vaccine (e.g., Menjugate [Chiron] or NeisVac-C [Baxter]) has been licensed for use in infants aged <2 years in Canada, the United Kingdom, and several other European countries. It is routinely recommended in these countries at a schedule of 2, 4, and 6 months of age (in 3 doses given ≥4 weeks apart). A single dose is recommended for children aged 1–4 years. College students in the United Kingdom, as well as foreign students attending college there, receive the meningococcal A/C conjugate vaccine because the incidence of predominantly serogroup C disease among them (2 cases 100,000 persons) is twice the national average [29].

Typhoid fever vaccine. Both live, attenuated, oral Ty21a Salmonella enterica serotype Typhi and injectable, killed Vi polysaccharide vaccines are available for pediatric use. The capsule form of Ty21a (Vivotif; Berna) is licensed in the United States for use in children aged ≥6 years. The encapsulated suspension of live bacteria needs to pass undisturbed through the acid environment of the stomach; thus, it must be swallowed whole. In many countries, a lyophilized preparation, reconstituted in a buffered solution, is available in a 3-dose regimen for children aged ≥3 years. It is not available in the United States.

The Vi polysaccharide vaccine (Typhim Vi; Aventis) is poorly immunogenic in children aged <2 years [30]. It can be given as a single injection to children older than 2 years of age and confers protection for 2–3 years. Boosters are recommended if exposure or further travel warrants.

Children aged <2 years currently have no available vaccine for protection. Therefore, recommending meticulous food and water precautions is prudent. Efforts are underway to convert the Vi antigen into a T cell–dependent antigen, to produce an immunogenic vaccine for infants.
Rabies vaccine. Rabies is highly endemic in many countries. Given its potentially long latency and uniformly fatal outcome, advice on avoiding animal contact is essential for pretravel counseling. The initial treatment of animal bites, scratches, or saliva contact with soap and water first-aid measures must be emphasized, along with the importance of obtaining postexposure rabies prophylaxis as soon as possible. Children may be more likely to contact animals and may not report encounters [31]. Therefore, the preexposure rabies vaccination series should be considered for ambulatory children who will travel extensively to or live in rural villages in countries where rabies is endemic.

Other factors to consider in preexposure vaccination counseling include the worldwide shortage of human rabies Ig (RIG) and the variability in available types of rabies vaccine in developing countries. RIG is not necessary in the postexposure situation when the vaccine has been administered appropriately in the recommended 3-dose preexposure series. In addition, RIG is usually unavailable in developing countries. Purified equine rabies Ig is available in many developing countries and recommended if no RIG is available in postexposure situations.

Infants and children respond well to the vaccine, and no age limitations exist for its administration. Tissue culture vaccines (human diploid cell, rabies vaccine adsorbed, and chick embryo cell), which are used in industrialized countries, are the recommended products for prevention and exposure. The high cost of rabies preexposure immunization is a limitation for many travelers.

JE vaccine. JE is a mosquito-borne illness transmitted by the Culex mosquito in defined areas of Asia. Pigs are the reservoir for the virus. Amplification of the mosquito carrying the JE virus occurs in rural areas, particularly where there are flooded rice farms. JE is a subclinical infection in the majority of cases, but it causes residual neurologic morbidity in approximately one-half of those who have clinical disease. The case-fatality rate is ~25% [32]. It is rarely a disease involving travelers. Precise risk is difficult to define [33], but expatriates or travelers living for prolonged periods in places where JE is endemic or epidemic are considered to be at highest risk (figure 3). JE vaccine is primarily indicated for long-stay travel in rural areas of risk. Worldwide JE primary vaccination occurs in many Asian countries (table 4) [34]. Children who are going to live in areas of endemicity or to spend significant amounts of time in environments where JE is endemic should be considered for vaccination [18, 35].

Table 4. Age of children who receive routine Japanese B encephalitis vaccination.

<table>
<thead>
<tr>
<th>Country</th>
<th>Age of child</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>1 year</td>
</tr>
<tr>
<td>Korea</td>
<td>3 years</td>
</tr>
<tr>
<td>Japan</td>
<td>3 years⁴</td>
</tr>
<tr>
<td>Thailand</td>
<td>18 months</td>
</tr>
<tr>
<td>Taiwan</td>
<td>15–27 months</td>
</tr>
</tbody>
</table>

NOTE. From [32].
⁴ Range, 6–90 months.
The vaccine is given a 3-dose series; it is administered subcutaneously on a 0-, 7-, and 14- or 30-day schedule. The vaccine schedule for children is identical to that for adults, and the dosages are listed in table 3. Children aged 1–3 years get one-half of the adult dose.

Unusual allergic reactions to this vaccine occur in <1% of vaccinees. They can be anaphylactic and occur up to 10 days after vaccination. Highly allergic individuals may be more susceptible, so the risk must be compared with the benefit. The Centers for Disease Control and Prevention recommendations [11] include assurance of the availability of good medical care for 10 days after receipt of the last dose of JE vaccine, to ensure adequate medical care in the event of a rare allergic reaction. Limited data exist on vaccine safety and efficacy in infants aged <1 year.

OTHER VACCINATIONS

Cholera vaccine. The parenteral cholera vaccine, CVD103-HgR (Mutachol; Berna), is licensed for use in children aged >2 years in Canada and Europe. It is administered as a single-dose oral vaccine, with recommended booster doses every 6 months [36]. It contains aspartame; thus, it should not be used by persons with phenylketonuria. This vaccine has not been shown to be protective against traveler’s diarrhea due to enterotoxigenic Escherichia coli. No currently available vaccine protects against the O139 Bengal strain of cholera.

Tickborne encephalitis (TBE) vaccine. TBE is transmitted by the bite of the Ixodes rincinus tick present in forested areas of central and Eastern Europe. It can also rarely be acquired by consuming unpasteurized milk from infected cows, goats, and sheep. Symptoms of TBE range from meningitis to severe meningoencephalitis. It is seasonally (summer) acquired in areas of endemicity. In these areas, the vaccine is incorporated into the routine pediatric schedule. There are 2 available vaccines licensed for use in children, as noted in table 3 [23, 24]. TBE vaccine is not available in the United States. FSME-Immun (Baxter) is available in Canada and the United Kingdom by a special release mechanism.

References

26. Lepow ML, Perkins BA, Hughes PA, Poolman JT. Meningococcal vac-
27. Centers for Disease Control and Prevention. Prevention and control


