Part 3

Recommended Immunization

Recommended Immunization Schedules

Few measures in preventive medicine are of such proven value and as easy to implement as routine immunization against infectious diseases. Immunization carried out as recommended in the following schedules will provide good basic protection for most children against the diseases shown.

Following a standard schedule ensures that the maximal achievable protection is achieved. However, modifications of the recommended schedule may be necessary because of missed appointments or intercurrent illness. Interruption of a recommended series does not require starting the series over again, regardless of the interval elapsed. Children, youth and adults with interruptions to their vaccines should be vaccinated to complete the appropriate schedule for their *current* age.

Similar vaccines are now available from different manufacturers but may not be identical. It is therefore essential for the user to read the appropriate chapter in this *Guide* as well as the manufacturer's package insert.

Table 1. Routine Immunization Schedule for Infants and Children

Age at vaccination	DTaP-IPV	Hib	MMR	Var	HB	Pneu-C-7	Men-C	Tdap	Inf
Birth					Infancy 3 doses				
2 months	⊙	✦			★	⊠	⊙		
4 months	⊙	✦				⊠	(⊙)		
6 months	⊙	✦				⊠	⊙ or ⊙		6-23 months ⊗ 1-2 doses
12 months			■	●		⊠ 12-15 months	⊙ if not yet given		
18 months	⊙	✦	■ or ■		or				
4-6 years	⊙								
14-16 years					Pre-teen/ teen 2-3 doses		⊙ if not yet given	▲	

Table 2. Routine Immunization Schedule for Children < 7 Years of Age Not Immunized in Early Infancy

Timing	DTaP-IPV	Hib	MMR	Var	HB	Pneu-C-7	Men-C	Tdap
First visit	◉	✦	■	●	★	⊠	⊙	
2 months later	◉	(✦)	■		★	(⊠)	(⊙)	
2 months later	◉					(⊠)		
6-12 months later	◉	(✦)			★			
4-6 years of age	(◉)							
14-16 years of age								▲

Table 3. Routine Immunization Schedule for Children ≥ 7 Years of Age up to 17 Years of Age Not Immunized in Early Infancy

Timing	Tdap	IPV	MMR	Var	HB	Men-C
First visit	▲	⬟	■	●	★	⊙
2 months later	▲	⬟	■	(●)	(★)	
6-12 months later	▲	⬟			★	
10 years later	▲					

Table 4. Routine Immunization Schedule for Adults (≥ 18 Years of Age) Not Immunized in Childhood

Timing	Tdap	Td	MMR	Var	Men-C	Pneu-C-23	Inf
First visit	▲		■	●	(⊙)		
2 months later		◧	(■)	●		(◘)	(⊗)
6-12 months later		◧					
10 years later		◧					

Notes

( ) Symbols with brackets around them imply that these doses may not be required, depending upon the age of the child or adult. Refer to the relevant chapter for that vaccine for further details.

◉ **Diphtheria, tetanus, acellular pertussis and inactivated polio virus vaccine (DTaP-IPV):** DTaP-IPV(± Hib) vaccine is the preferred vaccine for all doses in the vaccination series, including completion of the series in children who have received one or more doses of DPT (whole cell) vaccine (e.g., recent immigrants). In Tables 1 and 2, the 4-6 year dose can be omitted if the fourth dose was given after the fourth birthday.

✦ ***Haemophilus influenzae* type b conjugate vaccine (Hib):** the Hib schedule shown is for the *Haemophilus* b capsular polysaccharide – polyribosylribitol phosphate (PRP) conjugated to tetanus toxoid (PRP-T). For catch up, the number of doses depends on the age at which the schedule is begun (see *Haemophilus Vaccine* chapter). Not usually required past age 5 years

■ **Measles, mumps and rubella vaccine (MMR):** a second dose of MMR is recommended for children at least 1 month after the first dose for the purpose of better measles protection. For convenience, options include giving it with the next scheduled vaccination at 18 months of age or at school entry (4-6 years) (depending on the provincial/territorial policy) or at any intervening age that is practical. In the catch-up schedule (Table 2), the first dose should not be given until the child is ≥ 12 months old. MMR should be given to all susceptible adolescents and adults.

● **Varicella vaccine (Var):** children aged 12 months to 12 years should receive one dose of varicella vaccine. Susceptible individuals ≥ 13 years of age should receive two doses at least 28 days apart.

★ **Hepatitis B vaccine (HB):** hepatitis B vaccine can be routinely given to infants or pre-adolescents, depending on the provincial/territorial policy. For infants born to chronic carrier mothers, the first dose should be given at birth (with hepatitis B immunoglobulin), otherwise the first dose can be given at 2 months of age to fit more conveniently with other routine infant immunization visits. The second dose should be administered at least 1 month after the first dose, and the third at least 2 months after the second dose, but these may fit more conveniently into the 4 and 6 month immunization visits. A two-dose schedule for adolescents is an option (see *Hepatitis B Vaccine* chapter).

⊠ **Pneumococcal conjugate vaccine – 7-valent (Pneu-C-7):** recommended for all children under 2 years of age. The recommended schedule depends on the age of the child when vaccination is begun (see *Pneumococcal Vaccine* chapter).

▪ **Pneumococcal polysaccharide – 23-valent (Pneu-P-23):** recommended for all adults ≥ 65 years of age (see *Pneumococcal Vaccine* chapter).

⊙ **Meningococcal C conjugate vaccine (Men-C):** recommended for children under 5 years of age, adolescents and young adults. The recommended schedule depends on the age of the individual (see *Meningococcal Vaccine* chapter) and the conjugate vaccine used. At least one dose in the pimary infant series should be given after 5 months of age. If the provincial/territorial policy is to give Men-C to persons ≥ 12 months of age, one dose is sufficient.

▲ **Diphtheria, tetanus, acellular pertussis vaccine – adult/adolescent formulation (Tdap):** a combined adsorbed "adult type" preparation for use in people ≥ 7 years of age, contains less diphtheria toxoid and pertussis antigens than preparations given to younger children and is less likely to cause reactions in older people.

◧ **Diphtheria, tetanus vaccine (Td):** a combined adsorbed "adult type" preparation for use in people ≥ 7 years of age, contains less diphtheria toxoid antigen than preparations given to younger children and is less likely to cause reactions in older people. It is given to adults not immunized in childhood as the second and third doses of their primary series and subsequent booster doses; Tdap is given only once under these circumstances as it is assumed that previously unimmunized adults will have encountered *Bordetella pertussis* and have some pre-existing immunity.

⊗ **Influenza vaccine (Inf):** recommended for all children 6-23 months of age and all persons ≥ 65 years of age. Previously unvaccinated children < 9 years of age require two doses of the current season's vaccine with an interval of at least 4 weeks. The second dose within the same season is not required if the child received one or more doses of influenza vaccine during the previous influenza season (see *Influenza Vaccine* chapter).

⬟ **IPV Inactivated polio virus**

Immunization of Adults

Prevention of infection by immunization is a lifelong process. There are a number of vaccines that all adults (≥ 18 years) require. There are also other vaccines that need to be tailored to meet individual variations in risk resulting from occupation, foreign travel, underlying illness, lifestyle and age.

Immunization does not stop at childhood!

Childhood immunization programs have significantly reduced vaccine-preventable diseases among children, but Canada's population has an increasing number of adults who remain vulnerable to these diseases. For example, a random digit dialing telephone survey conducted in 2002 among Canadians aged ≥ 18 found that only 54% of respondents had adequate coverage for tetanus, and this rate was lowest in those aged ≥ 60. Furthermore, although overall rates of vaccination are rising as compared with previous years, only two-thirds of Canadians aged ≥ 65 surveyed in 2000/2001 reported receiving influenza vaccination, and only 47% of those aged ≥ 20 with at least one chronic complication placing them at increased risk of influenza had been vaccinated.

Reasons for adults not being immunized

The following are common reasons for incomplete immunization in the adult years:

- lack of recommendation from their physician
- misrepresentation/misunderstanding of the risks of vaccine and benefits of disease prevention in adults
- lack of understanding of vaccine safety and efficacy
- missed opportunities for receiving the vaccine at health care encounters in physicians' offices, hospitals and nursing homes
- lack of publicly funded vaccine and reimbursement to health care providers
- lack of coordinated immunization programs for all adults
- lack of regulatory or legal requirements
- fear of injections
- lack of availability of up-to-date records and recording systems.

Health care provider as health advocate

Health professionals have the responsibility to prevent vaccine-preventable diseases in those under their care. Failure to maintain adult immunization results in significant individual risk, increased mortality and community

risk for preventable diseases. Society not only expects health practitioners to promote newly approved interventions that maintain health and prevent disease but also to ensure that the population under their care has continuing and updated protection through appropriate immunization. Health care providers are recognized as leaders in their community, and their behaviours and attitudes can be a positive force for health promotion. They must present factual information concerning immunization and vaccines and also be able to review the benefits and risks of these interventions. This must be done in a manner that promotes the well-being of the individual, the family and the community.

Strategies to improve vaccine uptake in adults

Four categories of effective intervention that increase vaccine uptake have been described by Shefer et al. Interventions that increase the demand include community education, patient reminders, incentives and patient-held records. Educational programs for health care providers are also effective. However, the two interventions that had the greatest success in enhancing access to immunization were programs that decrease costs and those that include legal or regulatory interventions. Stone et al. in their meta-analysis of controlled clinical trials concluded that organizational changes, such as the introduction of specific clinics and the participation of non-physician staff to execute the specific prevention strategies, were the most effective ways to enhance uptake. Johnston and Conly have conducted an excellent review of these issues.

All adults should be counselled concerning their personal immunization status. Health care providers should regularly review the patients under their care to ensure not only that their immunization status is up to date but also that they have been made aware of new vaccines. Practitioners should regularly audit their patients' immunization records during clinical encounters that coincide with a mid-decade birthday (i.e., 15, 25, 35, 45, 55 years etc.).

There are a number of patient encounters/situations that provide opportunities for general vaccine counselling in adults:

- "new" patient/client encounter as part of the "history";
- patient hospitalization, especially when the diagnosis is a chronic disease;
- patients requesting specific vaccination(s), e.g., pneumococcal vaccine or influenza vaccine;
- patients with evidence of "risk taking" behaviour, such as illicit drug use or a sexually transmitted disease;
- individuals requesting advice concerning international travel;
- periodic health examinations;
- visits for chronic disease management;
- management protocols on admission to nursing and long-term care institutions;

- pregnancy and the immediate post-partum period;
- assessment of new immigrants to Canada;
- new employee assessments in health care and health care-related facilities;
- parents attending their children's vaccination visits.

Immunizations recommended for adults – routine

All adults should be immunized against diphtheria, tetanus, pertussis, measles, mumps, rubella and varicella. The schedule for adults who have no record or an unclear history of prior immunization as well as for booster dosing of those who have completed a prior primary series is shown in Table 5.

All Canadian adults require maintenance of immunity to tetanus and diphtheria, preferably with combined (Td) toxoid and a single dose of acellular pertussis vaccine. The first priority is to ensure that children receive the recommended series of doses, including the school leaving dose at 14 to 16 years of age, and that adults have completed primary immunization with Td. Currently, only a single dose of acellular pertussis (given as Tdap) is recommended in adulthood because the duration of protection from Tdap has yet to be determined. For adults not previously immunized against pertussis only one dose of Tdap is required as it is assumed that most adults will have some degree of immunity due to prior pertussis infection.

Combined measles, mumps, rubella vaccine (MMR) is preferred for vaccination of individuals not previously immunized against one or more of these viruses. Adults born before 1970 may be considered immune to measles. Adults born in 1970 or later who do not have documentation of adequate measles immunization or who are known to be seronegative should receive MMR vaccine. One additional dose of vaccine should be offered only to adults born in 1970 or later who are at greatest risk of exposure and who have not already received two doses or demonstrated immunity to measles. These people include travellers to a measles-endemic area, health care workers, students in post-secondary educational settings and military recruits. MMR is recommended for all adults without a history of mumps or mumps immunization. MMR vaccine should also be given to all adults without a history of rubella vaccination. Female adolescents and women of childbearing age should be vaccinated before pregnancy or post-partum, unless they have documented evidence of detectable antibody or prior vaccination. In addition, it is also important that health care workers of either sex be actively immunized against rubella because they may, through frequent face-to-face contact, expose pregnant women to rubella.

A history of chickenpox infection is adequate evidence of varicella immunity. Serologic testing should be performed in adults without a history of disease, as the majority of such adults will be immune and do not require the varicella vaccine. It is particularly important to promote varicella immunization with immigrants and refugees from tropical countries, women of

Table 5. Adult Immunization Schedule – Routinely for All

Vaccine	Dosing schedule (no record or unclear history of immunization)	Booster schedule (primary series completed)
Tetanus and diphtheria (page 312) given as Td; and pertussis given as Tdap	Doses 1 and 2, 4-8 weeks apart and dose 3 at 6-12 months later; one of the doses should be given as Tdap for pertussis protection	Td every 10 years; 1 dose should be given as Tdap if not previously given in adulthood
Measles, mumps and rubella (page 231) given as MMR	1 dose for adults born in or after 1970 without a history of measles or those individuals without evidence of immunity to rubella or mumps; second dose for selected groups (page 231)	Not routinely required
Varicella (page 335)	Doses 1 and 2, at least 4 weeks apart for susceptible adults (no history of natural disease or seronegativity)	Not currently recommended

childbearing age, those who are at occupational risk of exposure, including health care and child care workers, household contacts of immunocompromised persons, those with cystic fibrosis, and those susceptible adults exposed to a case of varicella. There are no data at present to guide recommendations for varicella booster dosing in adults following the primary vaccination series.

Immunizations for adults – specific risk groups

There are several specific groups of adults for whom certain vaccines are recommended because of the presence of risk factors for disease, and these are summarized in Table 6. In many cases, individual factors, and in particular the presence of underlying co-morbid illnesses, define groups that specifically benefit from certain vaccines. However, there are two commonly encountered groups of healthy adults who require assessment for a series of vaccines: health care workers and international travelers. In both of these groups, the priority should be to ensure that routinely recommended immunizations are completed and booster doses provided as indicated.

Health care workers, including hospital employees, other staff who work or study in hospitals (e.g., students in health care disciplines and contract workers), other health care personnel (e.g., those working in clinical laboratories, nursing homes and home care agencies) and child care workers, are at risk of exposure to communicable diseases because of their contact

with patients or material from individuals with infections, both diagnosed and undiagnosed.

Hepatitis B is the most important vaccine-preventable infectious occupational disease for health care workers. The risk of being infected is a consequence of the prevalence of virus carriers in the population receiving care, the frequency of exposure to blood and other body fluids and the contagiousness of hepatitis B virus. Hepatitis B vaccine is recommended for health care workers and others who may be exposed to blood or blood products, or who may be at increased risk of sharps injury, bites or penetrating injuries (for example, clients and staff of institutions for the developmentally challenged). Annual influenza immunization is recommended for all health care personnel who have contact with individuals in high-risk groups. Such personnel include physicians, nurses and others in both hospital and outpatient settings; employees of chronic care facilities; and providers of home care, visiting nurses and volunteers. Influenza immunization of health care workers has been shown to reduce the mortality and morbidity of patients under their care in long-term settings and to reduce worker illness and absenteeism during the influenza season. Other vaccines may be indicated for certain workers at particularly high risk of exposure, such as laboratory workers in specialized reference or research facilities. These include but are not limited to typhoid, meningococcal, BCG, rabies, and smallpox vaccines. An individualized risk-benefit assessment is required.

International travelers represent another defined group requiring specific vaccine consideration. Ensuring that traveling adults have completed a primary series of routine vaccinations is the first priority (Table 6). This is particularly important because many vaccine-preventable diseases remain endemic in developing countries. Although completion of primary polio vaccination is adequate in most adults, a one-time polio booster (> 10 years since primary vaccination) is recommended for adults who have not had a previous booster and are traveling to polio-endemic countries. It is also important that travelers who are in specific risk groups for routine vaccines (such as pneumococcal and influenza vaccines in those ≥ 65) receive the ones indicated. With travel-specific vaccines, an individualized approach is required that considers a patient's health status, risk of exposure and complications from vaccine-preventable illness, as well as location and duration of travel. Most commonly these include consideration for immunization against yellow fever, Japanese encephalitis, typhoid, cholera, meningococcal disease, rabies, and hepatitis A and B, as listed in Table 6.

Adults ≥ 65 years of age and those with conditions that increase their chances of complications should receive one dose of pneumococcal vaccine and yearly influenza vaccine. Opportunities to increase influenza vaccination should be taken; it is estimated that less than one-half of high-risk Canadians receive influenza vaccine annually. Increasing the rate of influenza vaccination of health care workers and household contacts of individuals with increased risk of influenza complications will not only

affect the vaccinated individuals but may also result in substantial secondary benefit to others.

Hepatitis A vaccination is recommended for those at increased risk of exposure (see *Hepatitis A Vaccine* chapter). Universal immunization against hepatitis B is recommended in childhood in Canada, and opportunities should be provided for adults to receive hepatitis B vaccine. Adults who are at increased risk of exposure to hepatitis B by virtue of their occupation, lifestyle or environment should receive the vaccine at the earliest possible clinical encounter. Patients may be vaccinated simultaneously for hepatitis A and B using a combined vaccine. Because of their increased risk for complications, all non-immune patients with chronic liver disease should be vaccinated against hepatitis A and B.

Cholera vaccine should be considered for high-risk travelers to cholera-endemic countries (please refer to the *Immunization of Travellers* chapter).

Meningococcal C conjugate vaccines are recommended for immunization of young adults to prevent the increased risk of serogroup C meningococcal disease in these age groups. Meningococcal vaccine is recommended for certain groups with increased risk of meningococcal disease (please refer to the *Meningococcal Vaccine* chapter). Such individuals include those with functional or anatomic asplenia; persons with complement, properdin or factor D deficiency; military recruits; research, industrial and clinical laboratory personnel who are routinely exposed to *Neisseria meningitidis* cultures; and travelers to high-risk areas. In cases in which risk is restricted to group C disease, monovalent serogroup C meningococcal conjugate vaccine may be preferred. Meningococcal vaccine is also used for outbreak management.

Although oral poliovirus vaccine is no longer used in Canada, individuals who have received a primary vaccination series with this vaccine are considered immune. Immunization of adults against poliovirus should be considered for those at increased risk (see *Poliomyelitis Vaccine* chapter).

Rabies vaccine should be offered, before exposure, to those individuals at high risk as a result of occupational or travel exposure to rabid animals. These may include veterinarians, laboratory workers, animal control and wildlife workers, spelunkers, trappers and hunters, and travelers to endemic countries where there may be limited access to safe and effective post-exposure prophylaxis.

Typhoid vaccine is recommended for high-risk international travelers, including those with prolonged (> 4 weeks) exposure in an endemic region or those with shorter duration of stay in particularly high-risk situations (please refer to the *Typhoid Vaccine* chapter). Although routine vaccination of health care workers is not required, laboratory workers who frequently handle live cultures of *Salmonella typhi* should be vaccinated.

Table 6. Adult Immunization Schedule – Specific Risk Situations

Vaccine or toxoid	Indication	Schedule
Influenza (page 209)	Adults ≥ 65 years; Adults < 65 years at high risk of influenza-related complications, their household contacts, health care workers, and all those wishing to be protected against influenza.	Every autumn using current recommended vaccine formulation
Pneumococcal polysaccharide (page 267)	Adults ≥ 65 years; Adults < 65 who have conditions putting them at increased risk of pneumococcal disease	1 dose
Hepatitis A (page 179)	Occupational risk, life-style, travel and living in areas lacking adequate sanitation. Outbreak control, post-exposure immunoprophylaxis. Patients with chronic liver disease.	2 doses 6-12 months apart
Hepatitis B (page 189)	Occupational risk, life-style, post-exposure immunoprophylaxis. Patients with chronic liver disease.	3 doses at 0, 1 and 6 months
Bacille Calmette-Guérin (BCG) (page 149)	Rarely used. Consider for high-risk exposure in selected cases.	1 dose
Cholera (page 158)	High-risk exposure in travelers to endemic area(s)	1 oral dose of live attenuated vaccine; 2 doses at least 1 week apart but not greater than 6 weeks of oral inactivated vaccine
Japanese encephalitis (page 221)	Travel to endemic area(s) or other exposure risk	3 doses at days 0, 7 and 30
Poliomyelitis (page 277)	Travel to endemic area(s) or other risk group	Primary series doses 1 and 2, 4-8 weeks apart and dose 3 at 6-12 months later; 1 booster dose if > 10 years since primary series
Meningococcal conjugate	Young adults	1 dose
Meningococcal polysaccharide (page 239)	High-risk exposure groups	1 dose
Rabies, pre-exposure use (page 285)	Occupational or high-risk travelers	3 doses at days 0, 7 and 21
Typhoid (page 317)	High-risk travelers to endemic area(s) or other high-risk exposure	Parenteral capsular polysaccharide 1 dose; live attenuated 3-4 oral doses depending on preparation

Table 6. Adult Immunization Schedule – Specific Risk Situations

Vaccine or toxoid	Indication	Schedule
Yellow fever (page 343)	Travel to endemic area(s) or if required for foreign travel	1 dose with booster every 10 years if required
Smallpox	Laboratory staff working with vaccinia or other orthopoxviruses	1 dose

Naturally occurring smallpox has been eradicated worldwide, and as a result vaccination is highly restricted. Laboratory workers who handle vaccinia or other orthopoxviruses should be considered for vaccination.

Selected references

Canadian Association for the Study of the Liver. *Canadian Consensus Conference on the Management of Viral Hepatitis*. Canadian Journal of Gastroenterology 2000;14(Suppl B):5B-20B.

Committee to Advise on Tropical Medicine and Travel (CATMAT). *Statement on poliomyelitis vaccination for international travellers (evidence-based medicine recommendations)*. Canada Communicable Disease Report 1995;21(16):145-48.

Committee to Advise on Tropical Medicine and Travel (CATMAT); National Advisory Committee on Immunization (NACI). *Statement on new oral cholera and travellers' diarrhea vaccination*. Canada Communicable Disease Report 2005;31(ACS-7):1-11.

Coulibaly N, De Serres G. *Coverage of anti-tetanus vaccinations in adults in Canada – year 2002*. Canadian Journal of Public Health 2004;95(6):456-59.

Health Canada. *Smallpox vaccination of laboratory workers*. Canada Communicable Disease Report 2004;30(19):167-9.

Johansen H, Nguyen K, Mao L et al. *Influenza vaccination*. Health Reports 2004;15(2):33-43.

Johnston BL, Conly JM. *Routine adult immunization in Canada: recommendations and performance*. Canadian Journal of Infectious Diseases 2002;13(4):226-31.

Lau DT, Hewlett AT. *Screening for hepatitis A and B antibodies in patients with chronic liver disease*. American Journal of Medicine 2005;118(Suppl 10A):28S-33S.

National Advisory Committee on Immunization (NACI). *Statement on recommended use of meningococcal vaccines*. Canada Communicable Disease Report 2001;27(ACS-6):2-36.

National Advisory Committee on Immunization (NACI). *Statement on smallpox vaccination*. Canada Communicable Disease Report 2002;28(ACS-1):1-12.

National Advisory Committee on Immunization (NACI). *Prevention of pertussis in adolescents and adults*. Canada Communicable Disease Report 2003;29(ACS-5):1-9.

National Advisory Committee on Immunization (NACI). *Update on varicella*. Canada Communicable Disease Report 2004;30(ACS-1):1-26.

Shefer A, Briss P, Rodewald L et al. *Improving immunization coverage rates: an evidence-based review of the literature*. Epidemiologic Reviews 1999;21(1):96-142.

Spira AM. *Preparing the traveller*. Lancet 2003;361(9366):1368-81.

Statement on travellers and rabies vaccine. Canadian Medical Association Journal 1995;152(8):1241-45.

Stone EG, Morton SC, Hulscher ME et al. *Interventions that increase use of adult immunization and cancer screening services: a meta-analysis*. Annals of Internal Medicine 2002;136(9):641-51.

Immunization of Children and Adults with Inadequate Immunization Records

Many people present to health care providers and public health officials with inadequate immunization records. In the absence of a standardized approach to their management, they may be under- or over-immunized. The concern with over-immunization relates to vaccination against diphtheria, pertussis or tetanus because of the potential for a higher incidence of local adverse reactions. Local reactions increase with the number of doses administered. These local reactions can include large swelling at the injection site, but pain is generally limited, and such reactions are not a contraindication to continuing the recommended schedule. Recent studies have indicated that tetanus and diphtheria booster doses given in a combination product with acellular pertussis and administered at intervals of less than 5 years do not result in increased local reactions in adolescents.

In every instance, an attempt should be made to obtain the person's immunization records from his or her previous health care provider. Written documentation of immunization is preferred for both children and adults. In some instances, information obtained by telephone from the health care provider with the exact dates of immunization may be accepted. For children, parental recall of prior immunization, in the absence of documentation provided by the administrator of the vaccine, correlates poorly with immunizations received and should not be accepted as evidence of immunization. Adults without immunization records should also be considered unimmunized. Additional information on the immunization of people who have newly arrived in Canada can be found in the chapter entitled *Immunization of Persons New to Canada*, page 144.

Routine serologic testing to determine immunity of children and adults without records is generally not practical. Instead, the following approach is recommended:

- All children and adults lacking written documentation of immunization should be started on a primary immunization schedule as appropriate for their age. For more information, please refer to the *Recommended Immunization Schedules* chapter, page 93.
- Measles, mumps, and rubella (MMR), polio, *Haemophilus influenzae* type b conjugate, pneumococcal conjugate, meningococcal conjugate, hepatitis B and A, varicella and influenza vaccines can be given, if indicated, on the basis of age and/or risk factors without concern about prior receipt of these vaccines. This is acceptable because adverse effects of repeated immunization with these vaccines have not been demonstrated.
- Persons who develop a serious adverse local reaction after administration of vaccines containing tetanus, diphtheria and pertussis should be individually assessed before they receive additional doses of these vaccines. The benefit of continuing the series needs to be weighed against

the risk of further adverse reactions. Serologic testing for diphtheria and tetanus antitoxin levels may demonstrate immune status and guide the need for continued immunization. There are no established serologic correlates for protection against pertussis.

- Pneumococcal polysaccharide vaccine should be given, if indicated when a record cannot be found, since in most studies local reaction rates after revaccination have been similar to rates following initial vaccination. For more information, please refer to the *Pneumococcal Vaccine* chapter, page 267.

Immunization in Pregnancy and Breast-Feeding

Introduction

Pregnancy provides a situation in which engagement in medical care may be greater than at any time in an otherwise healthy adult woman's life. It allows for evaluation of the woman's vaccine status as well as consideration of vaccines that may be beneficial to the neonate, if given to the woman, in order to decrease the risk of neonatal vaccine-preventable illness.

This chapter will review general issues regarding immunization in pregnancy, but particular issues will be addressed in vaccine-specific chapters. It is important that the obstetric care provider be familiar with both the potential risks of vaccination in pregnancy and the potential benefits in preventing disease at that time and providing neonatal protection. Ideally, this planning should occur before conception. If a woman of reproductive age presents with the intent to become pregnant, the adult immunization schedule should be reviewed and vaccines updated as indicated. For more information, please refer to the *Recommended Immunization Schedules* chapter, page 93.

Maternal benefits

Although pregnancy is an immunologically altered state, there are no data to support an inadequate response to vaccines. This is supported by data from trials of tetanus toxoid and polio vaccine in which normal adult immunologic responses were observed in pregnant women. There are a number of indications for immunization of pregnant women for the benefit of their own health. Recommendations include hepatitis B vaccine in a person with ongoing exposure risks, hepatitis A vaccine in a traveler or close contact of a person with hepatitis A, tetanus toxoid, meningococcal vaccine in an outbreak setting, and pneumococcal and influenza vaccines for all adult indications.

Maternal safety issues

There does not appear to be any evidence of increased risk of adverse reactions to vaccines administered in pregnancy. Reactions to vaccines in pregnancy are usually limited to local reactions, and no increase in anaphylactic reactions or events that might induce pre-term labour has been observed.

Safety and benefit of immunization in pregnancy for the fetus/infant

A major issue to consider regarding immunization in pregnancy is the risk or benefit of the vaccine for the fetus or neonate. There are no published data showing that any of the currently approved vaccines are teratogenic or embryotoxic, or have resulted in specific adverse pregnancy outcomes. In contrast, there are a good deal of data supporting the beneficial effects of antenatal vaccines on the prevention of disease in the neonate. In order for a vaccine to be beneficial to a neonate, a protective concentration of maternal antibody needs to be transferred to the infant transplacentally. It is known that all subclasses of IgG are transported from mother to infant across the placenta, but the majority of transfer occurs during the third trimester. Active placental transfer of IgG is specific and has variable efficacy. The mechanism is not well understood but can result in a range of cord blood levels that can be 20% to 200% of maternal levels. Maternal IgG typically has a half-life of 3-4 weeks in the newborn, waning during the first 6-12 months of life. Current pediatric vaccine schedules take into consideration the potential effect that maternally transferred antibodies may have on infant vaccinations and incorporate this into the vaccine schedules and dosing.

Risks associated with vaccines in pregnancy are primarily theoretical risks associated with the administration of live virus vaccines. There are circumstances in which vaccination with a live-attenuated product may be considered (e.g., yellow fever vaccine). If live vaccine is inadvertently given to a pregnant woman, termination of the pregnancy is not recommended (see specific chapters for details).

Immunization in pregnancy: review of specific vaccine categories

1. Live-attenuated vaccines

In general, live-attenuated virus vaccines (such as measles, mumps and rubella (MMR) or varicella) are contraindicated in pregnancy as there is a theoretical risk to the fetus. However, it is important to mention that to date, there is no evidence to demonstrate a teratogenic risk from such vaccines.

- **Rubella vaccine: please see the *Rubella Vaccine* chapter, page 298**

  Rubella vaccine is available in combination with measles and mumps (MMR). It is a live attenuated vaccine and therefore contraindicated during pregnancy. The vaccine is indicated post-partum or pre-conception in susceptible women. It is advised that women should delay pregnancy by 1 month following such immunization.

Inadvertent rubella vaccinations in pregnancy were reportable to the U.S. Centers for Disease Control and Prevention between 1971 and 1989. Analysis of the accumulated data revealed that subclinical infection was detected in 1%-2% of fetuses but that there was no evidence of congenital rubella syndrome in any of the offspring of 226 inadvertently vaccinated women. In addition, in a prospective study by Motherisk in Toronto, infants of 94 women immunized 3 months before conception or during pregnancy did not have an increased rate of malformation compared with an unexposed cohort. Termination of pregnancy should not be recommended following inadvertent rubella immunization on the basis of fetal risks. However, given the small theoretical fetal risk, immunization with the rubella vaccine is best delayed until after delivery. Breast-feeding and Rh immune globulin administration are not contraindications to immunization. Nevertheless, because of possible decreased immunogenicity of the vaccine in the presence of Rh immune globulin, it is recommended that rubella antibody status be checked at 2 months post-partum.

- **Varicella vaccination: please see the *Varicella Vaccine* chapter, page 327**

  Immunity to varicella should be reviewed in women of reproductive age, and vaccination should be recommended to non-pregnant women. Since the varicella vaccine is a live attenuated virus vaccine, its use should be avoided in pregnancy. A program to ensure that varicella vaccine is administered to the susceptible post-partum woman should be developed, with two doses given at least 4 weeks apart. In women receiving Rh immune globulin postpartum, an interval of 2 months should elapse before varicella vaccine is given. This is because of a theoretical risk of interference with immunogenicity.

  Breast-feeding is not a contraindication to vaccination nor is household contact with a newborn.

  In a study of 362 women, no cases of congenital varicella occurred as a result of inadvertent exposure to the vaccine in pregnancy. Inadvertent exposure to the vaccine, therefore, does not constitute a reason to recommend pregnancy termination. However, it is recommended that non-pregnant women who are vaccinated should delay conception by 1 month.

  Following exposure of a pregnant woman to varicella, a history of previous vaccination or of chickenpox illness should be sought, as it has been shown to correlate well with seropositive immune status. In the absence of such a history, the mother's immunity should be verified by testing for varicella IgG. Exposed susceptible women should be offered varicella immunoglobulin (VarIg) within 96 hours of exposure in an attempt to prevent the disease or reduce the severity of their infection. The recommended dosage is 125 IU for each 10 kg body weight up to a maximum of 625 IU. Although a study has shown that congenital varicella syndrome did not occur in the fetuses of 97 pregnant women

given VarIg, this study is too small to conclude that VarIg will prevent or alter disease in the fetus (please refer to the *Passive Immunizing Agents* chapter, page 353, for more specific recommendations). Susceptible pregnant women should be given varicella vaccine after delivery as long as 5 months have passed since VarIg administration.

- **Other live attenuated vaccines:**

  Other live attenuated vaccines must be evaluated on an individual risk/benefit ratio. For instance, if a pregnant woman **must** travel to an area endemic for yellow fever, the vaccine may be administered when the risk of exposure is high and the travel cannot be postponed.

2. Inactivated viral and bacterial vaccines, toxoids

There is no evidence to suggest a risk to the fetus or to the pregnancy from maternal immunization with these vaccines.

- **Influenza vaccination:**

  All pregnant women who are at high risk of influenza-related complications should be particularly targeted for influenza vaccination (see *Influenza Vaccine* chapter, page 209). Recent trends have indicated an increase in maternal age and higher rates of multiple gestation, both of which may present an increased risk of medical complications, including cardiorespiratory diseases, that would warrant influenza vaccination as per the adult indications. There is some evidence, although limited, suggesting that healthy pregnant women are at increased risk of complications from influenza. Mortality rates among pregnant women in the 1918 and 1957 pandemics were reported to be as high as 45%. This is presumably because pregnancy is associated with significant cardiovascular and respiratory demands, with increased stroke volume, heart rate and oxygen consumption. A more recent report demonstrated that the need for hospitalization was 4 times greater in pregnant than non-pregnant women with influenza. The risks were, in fact, calculated to be equivalent to those of non-pregnant women with high-risk conditions for whom immunization has traditionally been recommended.

  However, given these limited data, more research is needed to clarify the feto-maternal advantages of influenza vaccine. The data regarding safety of the vaccine appear to be reassuring. A study of 252 pregnant women vaccinated during pregnancy at a mean gestational age of 26.1 weeks (range 14-39 weeks) had no adverse events and no difference in perinatal outcomes compared with a non-vaccinated group.

Immunization and breast-feeding

Breast-feeding is considered safe following immunization of the mother and has not been shown to adversely influence the maternal immune response. Therefore, breast-feeding does not represent a contraindication to any maternal immunization, and breast-feeding women who have not

received all recommended adult immunizations may be safely immunized. Infants who are breast-fed should receive all recommended vaccines at the usual times.

Passive immunization

There is no known risk to the fetus and/or mother from administration of immune globulin for passive immunization during pregnancy. Therefore, these products should be administered as required.

Table 7. Indication for Use in Pregnancy

Vaccine	Indication for use in pregnancy	Comment
Measles,mumps,and rubella (MMR)	Contraindicated Immunize susceptible women post-partum.	No known fetal effects but live vaccine – theoretical risk. Not reason for termination of pregnancy.
Varicella	Contraindicated Immunize susceptible women post-partum.	No known fetal effects but live vaccine – theoretical risk. Not reason for termination of pregnancy.
Poliomyelitis Salk (IPV)	Not contraindicated	To be considered if pregnant woman needs immediate protection (high-risk situation/travel). No known fetal effects.
Yellow fever	Generally contraindicated unless travel to high-risk endemic area is unavoidable.	No data on fetal safety although fetuses exposed have not demonstrated complications. Not a reason for pregnancy termination.
Influenza	Safe	No adverse effects.
Rabies	Not contraindicated for post-exposure prophylaxis.	Prudent to delay pre-exposure immunization unless substantial risk of exposure.
Hepatitis A	No apparent risk	To be considered in high-risk situations in which benefits outweigh risks.
Hepatitis B	No apparent risk	Vaccine recommended for pregnant women at risk.
Pneumococcal polysaccharide	No apparent risk	Vaccine recommended for pregnant women in high-risk categories.
Meningococcal	Polysaccharide vaccine safe and effective in pregnancy. Conjugate vaccine: no data available.	Polysaccharide vaccine to be administered as per general guidelines for non-pregnant women. Conjugate – considered in situations in which benefit outweighs risk.

Table 7. Indication for Use in Pregnancy

Vaccine	Indication for use in pregnancy	Comment
Cholera	No data on safety.	To be used in high-risk situation only (e.g., outbreak).
Typhoid	No data on safety. Some preparations are live.	To be considered only in high-risk cases (e.g., travel to endemic areas).
Diphtheria/tetanus	No evidence of teratogenicity.	Susceptible women to be vaccinated as per general guidelines for non-pregnant women.
Pertussis	Lack of data confirming the safety and immunogenicity of acellular pertussis vaccine in pregnant women	Warranted when the risk of disease outweighs the risk of vaccine both for the mother and the fetus
Japanese encephalitis Live	No data on safety.	To be considered only in high-risk cases (e.g., travel to endemic areas if benefit outweighs risk).
Vaccinia (smallpox) Live	Contraindicated	Has been reported to cause fetal infection.

Selected references

Bar-Oz B, Levichek Z, Moretti ME et al. *Pregnancy outcome following rubella vaccination: a prospective controlled study.* American Journal of Medical Genetics 2004;130(1):52-4.

Centers for Disease Control and Prevention. *Measles, mumps and rubella vaccine use and strategies for elimination of measles, rubella, and congenital rubella syndrome and control of mumps: recommendations of the Advisory Committee on Immunization Practices (ACIP).* Morbidity and Mortality Weekly Report 1998;32(RR-8):32.

Freeman DW, Barno A. *Deaths from Asian influenza associated with pregnancy*. American Journal of Obstetrics and Gynecology 1959;78:1172-75.

Harris JW. *Influenza occurring in pregnant women: a statistical study of thirteen hundred and fifty cases.* Journal of the American Medical Association 1919;72(978):980.

Kanariou M, Petridou E, Liatsis M et al. *Age patterns of immunoglobulins G, A and M in healthy children and the influence of breast feeding and vaccination status*. Pediatric Allergy and Immunology 1995;6(1):24-9.

Munoz FM, Greisinger AJ, Wehmanen OA et al. *Safety of influenza vaccination during pregnancy*. American Journal of Obstetrics and Gynecology 2005;192(4):1098-1106.

Neuzil KM, Reed GW, Mitchel EF et al. *Impact of influenza on acute cardiopulmonary hospitalizations in pregnant women.* American Journal of Epidemiology 1998;148(11):1094-1102.

Pabst HF, Godel J, Grace M et al. *Effect of breast-feeding on immune response to BCG vaccination.* Lancet 1989;1(8633):295-97.

Pabst HF, Spady DW. *Effect of breast-feeding on antibody response to conjugate vaccine.* Lancet 1990;336(8710):269-70.

Shields KE, Galil K, Seward J et al. *Varicella vaccine exposure during pregnancy: data from the first 5 years of the pregnancy registry*. Obstetrics and Gynecology 2001;98(1):14-9.

Immunization of Infants Born Prematurely

Premature infants whose clinical condition is satisfactory should be immunized with age-appropriate doses of vaccine at the same chronological age and according to the same schedule as full-term infants, regardless of birth weight. In premature infants, maternally derived antibody is present at lower titres and for a shorter duration than in mature infants. As well, the severity of vaccine-preventable illnesses may be greater in this population. Therefore, immunization of premature infants should not be delayed.

Antibody response to immunization is generally a function of chronologic age and not of maturity. Although studies demonstrate conflicting results, premature infants may have lower antibody responses than full-term controls to several vaccinations. Despite this, vaccine efficacy remains high. Several recent studies have demonstrated that healthy premature infants generally tolerate immunizations well, with low rates of adverse events that are similar to those of full-term infants. These studies have evaluated the pentavalent combination vaccine products, hepatitis B vaccine and the newer conjugated pneumococcal and meningococcal vaccines.

Premature and very low birthweight infants (i.e., 1500 g) still hospitalized at the time of immunization, however, may experience a transient increase or recurrence of apnea and bradycardia following vaccination. This subsides within 48 hours and does not alter the overall clinical progress of the child. The risk of these events is greater among infants with ongoing cardiorespiratory issues at the time of vaccination, but such events can also occur in those who are clinically stable. Given these findings, it is recommended that hospitalized premature infants have continuous cardiac and respiratory monitoring for 48 hours after their first immunization.

Hepatitis B

The response to hepatitis B vaccine may be diminished in infants with birth weights < 2000 g. Routine immunization of infants of mothers known to be negative for hepatitis B surface antigen (HBsAg) should be delayed until the infant reaches 2000 g or 1 month of age. Premature infants born to women who are HBsAg positive should, however, still receive hepatitis B immune globulin (HBIg) within 12 hours of birth and the appropriate dose of vaccine starting at birth. These infants require a fourth dose of hepatitis B vaccine (please refer to the *Hepatitis B Vaccine* chapter, page 189, for more information).

If the mother's status is unknown, the vaccine should be given in accordance with the recommendations for the infant of an HBsAg-positive mother. The maternal status should be determined within 12 hours, and if the mother is HBsAg positive the infant should also receive HBIg.

Influenza

All children < 2 years of age are now considered to be at high risk of significant morbidity and mortality from influenza and should be immunized starting at 6 months of age. This includes infants born prematurely. Household contacts of all infants < 23 months of age, including those < 6 months of age, who are too young to receive influenza immunization themselves, should also be immunized to prevent household transmission to the infant (please refer to the *Influenza Vaccine* chapter, page 209, for more information).

Respiratory syncytial virus (RSV)

Infants born at 32 weeks and 0 days' gestation or earlier who are ≤ 6 months of age (with or without bronchopulmonary dysplasia [BPD]) at the start of the RSV season, infants born between 32 and 35 weeks' gestation in isolated communities where hospital care is not readily accessible, as well as children ≤ 24 months of age with BPD who required oxygen and/or medical therapy for that illness within the 6 months preceding the RSV season and children < 2 years of age with hemodynamically significant cyanotic or acyanotic congenital heart disease should be considered for monoclonal anti-RSV antibody, palivizumab, to decrease the likelihood of serious RSV infection requiring hospitalization, and supplemental oxygen therapy (please refer to the *Passive Immunizing Agents* chapter, page 353 for more information).

Immunization of Patients in Health Care Institutions

Taking an immunization history from those admitted to hospital or attending outpatient clinics and vaccinating them before discharge provides an important opportunity to maintain up-to-date immunization for all patients. For patients without regular sources of care or those followed in specialized clinics, the only opportunities for immunization may be during clinic visits or hospitalization. There is good evidence that using provider reminders and standing orders, and evaluating vaccine coverage with feedback to providers improves vaccine uptake. Immunization status should also be verified during emergency department visits and vaccine offered as appropriate.

The admission of elderly patients and others at high risk of influenza complications or pneumococcal disease is an opportunity to ensure that these people are immunized. Effective programs to immunize such patients before discharge will guarantee that they do not miss immunization in the community during the limited influenza vaccination period.

All pregnant women should be screened for chronic hepatitis B virus (HBV) infection, and newborns of HBV-infected women should receive hepatitis B immune globulin and start a course of vaccine within 12 hours of birth. As well, administering the first dose of hepatitis B vaccine, before discharge, to other newborns at high risk of exposure to hepatitis B virus may be considered. Please refer to the *Hepatitis B Vaccine* chapter, page 189, for more information on the timing of vaccination and on other recommended recipients.

Women susceptible to rubella or varicella should receive vaccine post-partum before discharge. Please refer to the *Recent Administration of Human Immune Globulin Products* chapter, page 53, for specific recommendations for women who have received Rh immune globulin post-partum. Arrangements should also be made for the parents, other adolescent or adult family members, and other caretakers of the newborn to receive, as soon as possible, one dose of pertussis-containing vaccine formulated for adolescents and adults if they have not already received one.

Residents of long-term care institutions, like members of the general population, should receive all routine immunizations appropriate for their age and individual risk status. Annual immunization against influenza is essential for residents of long-term care institutions, and robust programs to ensure that this occurs should be put in place. As well as the proven strategies of provider reminders, standing orders, and evaluation of vaccine coverage with feedback to providers, it is advisable to inform patients or their surrogate decision makers of the facility's immunization policy on admission and every effort made to obtain informed consent before the influenza season.

In both acute-care and long-term care settings, it is most important that immunization efforts be part of organized care plans within each department, with clear accountability for program planning, implementation and evaluation.

Selected references

Centers for Disease Control and Prevention. *Recommendations of the Advisory Committee on Immunization Practices: programmatic strategies to increase vaccination rates – assessment and feedback of provider-based vaccination coverage information*. Morbidity and Mortality Weekly Report 1996;45(10):219-20.

Task Force on Community Preventive Services. *The guide to community preventive services*. URL: <www.thecommunityguide.org/vaccine/default.htm>. Accessed February 5, 2006.

Immunization of Immunocompromised Persons

The number of immunocompromised people in Canadian society is steadily increasing for a variety of reasons. These include our increased understanding of "normal" and altered immunity; recognition of the subtle immunodeficiencies associated with chronic illnesses (e.g., liver disease, renal disease); increased numbers of individuals with absent or dysfunctional spleens; the expanding range of illnesses treated with immunomodulatory agents (e.g., autoimmune diseases, inflammatory conditions); the HIV pandemic; increased numbers of long-term survivors after organ transplantation; and the increased use of ablative therapy for cancer and other conditions.

The number of immunizations to which immunocompromised people are likely to be exposed is also increasing. There is an ever-enlarging spectrum of vaccines available, and an increasing number of vaccines are included in routine programs. Efforts are under way to fully immunize adolescents, adults and the elderly. As well, individuals with significant illness can now travel with relative ease, for example, people infected with HIV. For more information, please visit http://www.phac-aspc.gc.ca/tmp-pmv/catmat-ccmtmv/index.html.

Therefore, the frequency and complexity of questions dealing with immunization in immunocompromised hosts will only increase with time. Still further complexity is added by the fact that the relative degree of immunodeficiency varies over time in many people. The decision to recommend for or against any particular vaccine will depend upon a careful, case-by-case analysis of the risks and benefits. Consultation with a specialist with expertise in vaccination should be considered when immunizing immunocompromised persons.

There is potential for serious illness and death in the underimmunization of immunocompromised people, and every effort should be made to ensure adequate protection through immunization. However, the inappropriate use of live vaccines can cause serious adverse events in some immunocompromised hosts as a result of uncontrolled replication of the virus or bacterium. Children with a known or suspected family history of congenital or hereditary immunodeficiency that is a contraindication to vaccination with live virus should not receive live vaccines unless their immune competence has been established. As many congenital immunodeficiencies are autosomal recessive, the history of immunodeficiency may not be present in first-degree relatives. Vaccine providers should also be alert to such clues as multiple neonatal or infant deaths in a family. Although questioning about personal or family history of immunodeficiency is recommended before any live vaccine is administered, the family history is of paramount importance if such vaccines are to be given before 1 year of age, as signs or symptoms of congenital immunodeficiency may not be present in younger

children. Immunization of those with significant immunodeficiency should be performed only in consultation with experts.

General principles

Several general principles apply to the immunization of immunocompromised individuals:

- maximize benefit while minimizing harm;
- make no assumptions about susceptibility or protection
  - a history of childhood infection or previous immunization may be irrelevant;
- immunize at the time when maximum immune response can be anticipated
  - immunize early, before immunodeficiency begins, if possible
  - delay immunization if the immunodeficiency is transient (if this can be done safely)
  - stop or reduce immunosuppression to permit better vaccine response, if appropriate;
- consider the immunization environment broadly
  - vaccinate household contacts when appropriate (see below for specific recommendations)
  - consider the immunization status of both the donor and/or recipient in the setting of hematopoietic stem cell transplantation;
- avoid live vaccines, unless
  - data are available to support their use
  - the risk of natural infection is greater than the risk of immunization;
- monitor vaccinees carefully and boost aggressively
  - the magnitude and duration of vaccine-induced immunity are often reduced in immunocompromised individuals.

Approach to vaccination of immunodeficient individuals

Chronic liver disease

Hepatitis A and B immunizations are recommended in people with chronic liver disease, since they are at risk of fulminant hepatitis. Vaccination should be done early in the course of the disease, as the immune response to vaccine is suboptimal in advanced liver disease. For more information, please refer to the hepatitis A and B chapters, pages 205.

Chronic renal disease and patients undergoing dialysis

Bacterial and viral infections are a major cause of morbidity and mortality in patients who have renal disease or who are undergoing chronic dialysis. Many of these infections are vaccine preventable. All the standard immunizations are required (see *Recommended Immunization Schedules*, page 93).

Particular attention should be paid to ensuring that there is optimal protection against varicella, hepatitis B, influenza and pneumococcal diseases. Influenza immunization is recommended yearly; household members should also be vaccinated. The schedule proposed for immunization against pneumococcal disease in patients with splenic disorders (see below) should be followed for people with chronic renal disease and for dialysis patients. Some data suggest that there is a poor response to hepatitis B vaccine in the dialysis population and that hepatitis B surface antibody levels might decline rapidly. In adults, immunization with a higher dosage is recommended (see the *Hepatitis B Vaccine* chapter for details). Data on alternative vaccination schedules for children undergoing hemodialysis are limited. The antibody level to hepatitis B surface antigen should be measured yearly and booster doses should be given if the level decreases to less than 10 IU/L (see the *Hepatitis B Vaccine* chapter for details). Varicella vaccine should be given to susceptible transplant candidates before transplantation because varicella is a significant cause of morbidity and mortality, but the vaccine is contraindicated in immunosuppressed patients after transplantation (see below). See section on solid organ transplantation for renal transplant recipients.

Splenic disorders

Asplenia or hyposplenism may be congenital, surgical or functional. A number of conditions can lead to functional hyposplenism. These include sickle cell anemia, thalassemia major, essential thrombocytopenia, celiac disease and inflammatory bowel disease. There are no contraindications to the use of any vaccine for patients known to be functionally or anatomically hyposplenic. Particular attention should be paid to providing optimal protection against encapsulated bacteria (*Streptococcus pneumoniae*, *Haemophilus influenzae* type b [Hib], *Neisseria meningitidis*), to which these individuals are highly susceptible. They should also receive all routine immunizations and yearly influenza vaccination. Careful attention should be paid to immunization status when "elective" surgical splenectomy is planned so that all of the necessary vaccines can be delivered at least 2 weeks before removal of the spleen. In the case of an emergency splenectomy, vaccines should be given 2 weeks after the splenectomy. If the patient is discharged earlier and there is a concern that he/she might not return, vaccination should be given before discharge.

The following immunization schedule is recommended for hyposplenic and asplenic individuals.

- **Meningococcal disease:**
  - Children < 2 years of age with asplenia or hyposplenia should be vaccinated with Men-C-C as described in the routine infant schedule (please refer to the *Recommended Immunization Schedules* chapter, page 93 and then receive quadrivalent Men-P-ACYW at 2 years of age and at least 2 weeks after the Men-C-C.
  - Children > 2 years of age and adults should receive both the Men-C-C and the Men-P-ACYW. The Men-C-C should be given first and the Men-P-ACYW at least 2 weeks later. If the Men-P-ACYW vaccine is given first, an adequate response to Men-C-C has been observed after a delay of 6 months in adults, and this remains the recommended interval until further data are available.
  - A booster dose of Men-P-ACYW is recommended every 2 to 5 years depending on the age at immunization. Please refer to the meningococcal chapter, page 237, for more information on recommended usage.
- **Pneumococcal disease:**
  - Children ≤ 23 months of age: Pneu-C-7 is recommended as described in the routine infant schedule (please refer to the *Recommended Immunization Schedules* chapter, page 93). They should receive the Pneu-P-23 at 2 years of age and ≥ 8 weeks after the last dose of Pneu-C-7.
  - Children 24 to 59 months not previously vaccinated: two doses of Pneu-C-7, administered 2 months apart, followed by one dose of Pneu-P-23 administered ≥ 8 weeks after the second dose of Pneu-C-7.
  - Children 24 to 59 months who have completed the Pneu-C-7 vaccination series before age 2: one dose of Pneu-P-23 (≥ 8 weeks after the last dose of Pneu-C-7).
  - Children aged 24 to 59 months who have already received Pneu-P-23 but not Pneu-C-7: two doses of Pneu-C-7 administered 2 months apart. Vaccination with Pneu-C-7 should be initiated ≥ 8 weeks after vaccination with Pneu-P-23.
  - Children ≥ 5 years of age and adults who have not previously received pneumococcal vaccines should be vaccinated with Pneu-P-23. Pneu-C-7 is not contraindicated in children ≥ 5 years of age with high-risk conditions. When circumstances permit, some experts suggest that the conjugate vaccine may be given as the initial dose followed by the polysaccharide vaccine, as this may theoretically improve antibody response and immunologic memory. However, the polysaccharide vaccine is the vaccine of choice for these individuals, and if only one vaccine can be provided it should be the polysaccharide vaccine.

- A single booster with Pneu-P-23 is recommended after 5 years in those aged > 10 years at the time of initial immunization and after 3 years for those who received their initial vaccine when they were ≤ 10 years.

- **Haemophilus influenzae type b:**

  Vaccination with the age-appropriate primary series of Hib conjugate vaccine should be completed (if not already complete) for all children < 5 years of age with asplenia. Despite limited efficacy data and the low overall risk of Hib sepsis in individuals > 5 years of age, especially in the era of high Hib immunization coverage in the population, some experts recommend that all asplenic individuals > 5 years of age receive a single dose of conjugate Hib vaccine, regardless of previous Hib immunization.

Congenital immunodeficiency states

This is a varied group of conditions that includes defects in antibody production (e.g., agammaglobulinemia, isotype and IgG subclass deficiencies, common variable immunodeficiency), complement deficiencies, defects in one or more aspects of cell-mediated immunity and mixed deficits. Individuals with defects in antibody and complement have unusual susceptibility to the encapsulated bacteria and members of the Enteroviridae family (e.g., polio, coxsackie and echoviruses), and individuals with mixed and T cell defects are particularly susceptible to intracellular pathogens (virtually all viruses and some bacteria, fungi and parasites). Although the defects and susceptibility patterns are very different, the approach to immunization is quite similar for these individuals. Component and inactivated vaccines can and should be administered in all of these conditions, despite the fact that many vaccinees will respond poorly, if at all. Live vaccines are generally not recommended for these patients, although some exceptions exist (see below).

- **Antibody defects:**

  Immune response to a vaccine might be decreased and antibody levels might decrease more quickly in people with congenital B cell deficiency. As a general rule, people with antibody defects can be protected from many of the vaccine-preventable infections with the use of intravenous immunoglobulin (IVIg) or pathogen-specific Ig preparations. However vaccination is recommended in these people to increase the level of protection.

  Particular attention should be given to ensuring that individuals with these conditions are immunized against pneumococcal, meningococcal and Hib diseases. Yearly influenza vaccine is also recommended. Although oral poliovirus vaccine (OPV) is no longer used in Canada, it remains an approved product and is used in many other countries. OPV should not be used in the affected individual or any of his or her family members. Measles (available as MMR) and varicella vaccines should be

considered if the patient is not receiving regular Ig replacement therapy (which may affect the efficacy of the vaccines); but all other live vaccines are contraindicated (except in isolated IgA deficiency).

- **T cell, natural killer and mixed cell-mediated antibody defects:**

  All live vaccines are contraindicated. Inadvertent live vaccine administration and exposure to natural infections can be dealt with by rapid administration of serum Ig or pathogen-specific Ig with or without appropriate antiviral or antibacterial treatment. Yearly influenza vaccine is recommended.

- **Phagocytic defects:**

  Live bacterial vaccines (BCG [Bacille Calmette-Guérin] and oral typhoid vaccine) are contraindicated. Yearly influenza vaccine is recommended.

- **Complement deficiency:**

  There are no contraindications to the use of any vaccine. However, immunity can decrease over time. Measurement of antibody titres and re-immunization, if needed, should be considered. Individuals with complement deficiency should receive meningococcal vaccine because of increased susceptibility to this pathogen (see the section on high-risk groups in the meningococcal chapter for details). Immunizations against common bacterial pathogens such as pneumococcus and Hib are also recommended.

- **Household contact:**

  Even if contraindicated for the patients, household contacts can receive MMR vaccine if indicated. Varicella vaccine is recommended for susceptible contacts of immunocompromised individuals. No precautions need to be taken after vaccination unless the recipient develops a rash. In such circumstances, the rash should be covered and the vaccine recipient should avoid direct contact with the immuncompromised person for the duration of the rash. Yearly influenza vaccination and up-to-date routine immunizations are also recommended for household contacts of immunocompromised individuals

Immunosuppressive therapy

Long-term immunosuppressive therapy (e.g., long-term steroids [discussed below], cancer chemotherapy, radiation therapy/azathioprine, cyclosporine, cyclophosphamide/infliximab) is used for organ transplantation and an increasing range of chronic infectious and inflammatory conditions (e.g., inflammatory bowel disease, psoriasis, systemic lupus erythematosis). These therapies have their greatest impact on cell-mediated immunity, although T cell-dependent antibody production can also be adversely affected.

There is no contraindication to the use of any inactivated vaccine in these people, and particular attention should be paid to the completion of childhood immunizations, annual influenza immunization and pneumococcal immunization (with a booster after 3-5 years). Ideally, all appropriate vaccines or boosters should be administered to these individuals at least 14 days before the initiation of therapy. If this cannot be done safely, a period of at least 3 months should elapse after immunosuppressive drugs have been stopped before administration of both inactivated and component vaccines (to establish immunogenicity, although inactivated vaccines can be administered if required for post-exposure or outbreak management) and live vaccines (to reduce the risk of dissemination). However, the interval may vary with the intensity of the immunosuppressive therapy, underlying disease and other factors. If immunosuppressive therapy cannot be stopped, inactivated or component vaccines should be given when the therapy is at the lowest possible level. Live vaccines are generally contraindicated, although the risk-to-benefit ratio for several of these vaccines can favour immunization if only low doses of immunosuppressive drugs are required and there is significant risk of wild-type infection (e.g., varicella vaccine in seronegative individuals).

Children with acute lymphocytic leukemia may be vaccinated with the varicella vaccine if the disease has been in remission for ≥ 12 months, the patient's total lymphocyte count is ≥ 1.2×10^9/L, the patient is not receiving radiation therapy, and maintenance chemotherapy can be withheld for at least 1 week before to 1 week after immunization. Two doses of the vaccine are recommended, 1-3 months apart, since North American studies suggest that two doses are more immunogenic than a single dose in these patients. For more information refer to the *Varicella Vaccine* chapter, page 327.

- **High dose steroids:**

  High-dose, systemic steroids (e.g., a prednisone dose of ≥ 2 mg/kg per day or ≥ 20 mg per day for ≥ 14 days) can interfere with vaccine-induced immune responses. Of course, reasonable clinical judgment must be exercised in the risk-to-benefit review of each case. Topical, inhaled and locally injected (intra-articular, bursal or tendon injection) steroids do not have an impact on vaccines unless there is clinical or laboratory evidence of immunosuppression from such therapy. A period of at least 1 month should elapse between high-dose steroid use and the administration of both inactivated and component vaccines (to establish immunogenicity, unless needed for post-exposure or outbreak management) and live vaccines (to reduce the risk of dissemination). Children with adrenogenital syndrome and those receiving physiologic replacement doses of glucocorticoids can follow the routine immunization schedule without restriction.

Hematopoietic stem cell transplantation

If time permits, careful consideration must be given to the pre-ablation immunization status of the patient and, in the case of allogenic bone mar-

row transplantation (BMT), the donor. It is well established that disease and immunization histories in both the host and the donor (i.e., in adoptive transfer) can influence immunity after ablation or transplantation. Antibody titres to vaccine-preventable diseases decline after allogenic or autologous hematopoietic stem cell transplantation if the recipient is not re-vaccinated. Hematopoietic stem cell transplant recipients are at increased risk of certain vaccine-preventable diseases (e.g., pneumococcal and Hib infections).

Recommendations for post-transplantation immunizations in this setting include the following:

- DTaP (< 7 years old) or one dose of Tdap followed by two doses of Td (persons ≥ 7 years old) should be given starting 12 months after transplantation. Three doses are required, at 12, 14 and 24 months after transplantation.
- Hib vaccine is recommended 12 months after transplantation. Three doses are required (12, 14 and 24 months after transplantation).
- Inactivated polio vaccine (IPV) should be given 12 months after transplantation. Three doses are required, 12, 14 and 24 months after transplantation.
- Pneumococcal vaccine is recommended for all persons 12 months after transplantation. Adults and children > 5 years of age should receive the Pneu-P-23. Children < 5 years should be immunized with the Pneu-C-7 according to the recommended schedule for their age, as if they had not been previously immunized. Children 2 to 5 years of age should receive both conjugate and polysaccharide vaccine (see *Pneumococcal Vaccine* chapter, page 267, for recommended schedules). Because antibody response to pneumococcal vaccination is known to be poor in these patients, some experts recommend that all transplant patients > 2 years of age receive a booster dose of polysaccharide vaccine 1 year after their initial Pneu-P-23 immunization.
- Meningococcal vaccine should be given 12 months after transplantation if indicated (see meningococcal chapter, page 237, for age-specific recommendation). At this time, there are a number of choices for immunization to prevent meningococcal disease, and new conjugate vaccines are being developed (see NACI Web site for future updates).
- Inactivated influenza vaccine should be given annually during early autumn, starting at least 6 months after transplantation.
- Hepatitis B vaccine should be given to all patients. Vaccination should be started 12 months after transplantation, and three doses are required, at 12, 14 and 24 months after transplantation.
- MMR should be given at least 2 years after the transplantation and only if the recipient is deemed to be immunocompetent by the transplant specialist. It should not be given to those with chronic graft-versus-host

disease or those taking immunosuppressive therapy for chronic-graft-versus host disease. A second dose should be given 6-12 months later.

- Varicella vaccination of recipients at ≥ 2 years after transplantation may be considered, provided there is minimal immunosuppression and no graft-versus-host disease. Until further data are available, the same age-appropriate dosage schedule as for healthy children may be followed. Currently, the only varicella vaccine approved in Canada for use in select immunocompromised people is Varilrix®.
- Other live vaccines (BCG, yellow fever and oral typhoid vaccine) are usually contraindicated in hematopoietic stem cell recipients with active graft-versus-host diseases or immunosuppression. If such vaccines are required, consultation with a specialist is recommended.
- Non-immune household contacts should be immunized against measles, mumps, rubella, varicella and influenza. IPV and hepatitis A vaccine should be administered if indicated.

Solid organ transplantation

The ideal is to immunize all recipients before transplantation. However, many children undergo solid organ transplantation before completion of their immunization schedule. Solid organ recipients usually receive lifelong immunosuppression. No formal recommendations have been developed about when to resume immunization. In general, vaccination should not be re-initiated until at least 6-12 months after transplantation.

Recommendations in this setting include the following:

- IPV: recommended in children and adults before or after transplantation to complete the routine immunization schedule.
- DTaP in children < 7 years old and Td (first dose as Tdap) in persons ≥ 7 years old: recommended in children and adults before or after transplantation to complete the routine immunization schedule.
- Hib vaccine: recommended in children before or after transplantation to complete the routine immunization schedule. Hib vaccine should be administered to all lung transplant recipients.
- Pneumococcal vaccine: recommended before or after transplantation because of the increased risk of invasive pneumococcal disease in these patients. See the schedule described in the section on asplenic patients. A booster with Pneu-P-23 should be given once after 3-5 years (see *Pneumococcal Vaccine* chapter).
- Meningococcal vaccine: recommended before or after transplantation if routinely indicated (see *Meningococcal Vaccine* chapter for age-specific recommendation). At this time, there are a number of choices for immunization to prevent meningococcal disease, and new conjugate vaccines are being developed (see NACI Web site for future updates).

- MMR vaccine: recommended before transplantation for children, contraindicated after transplantation. Some experts consider using MMR in seronegative females before pregnancy ≥ 2 years after transplantation, when the patient is deemed to be taking minimal immunosuppressive therapy.
- Inactivated influenza vaccine is recommended yearly.
- Hepatitis B vaccine: recommended in children and adults before or after transplantation to complete the immunization schedule (see *Hepatitis B Vaccine* chapter).
- Hepatitis A vaccine: recommended for all transplant candidates with chronic liver diseases and for other transplant candidates if indicated. It can be considered for all solid organ transplant candidates before or after transplantation.
- Varicella vaccine: recommended before transplantation for non-immune (as determined by serology) children and adults but not recommended after transplantation. However, it may be considered ≥ 2 years after transplantation, when the patient is deemed to be taking minimal immunosuppressive therapy. Until further data are available, the same age-appropriate dosage schedule as for healthy children may be followed. Children awaiting renal and liver transplants may be immunized with one to two doses of varicella vaccine (depending on their age), the last dose being given at least 4-6 weeks prior to transplantation. They should not be receiving immunosuppressive treatment at the time of vaccination. As there is currently insufficient information regarding varicella immunization of cardiac and lung transplant candidates, no firm recommendation can be made at this time for these patients.

Other live vaccines are usually contraindicated after transplantation. However, if some live vaccines are needed, consultation with a specialist is recommended.

Household contacts who do not have immunity should be immunized against Hib, measles, mumps, rubella, varicella and influenza. IPV, hepatitis A and hepatitis B and any other vaccines should be administered if indicated.

Illnesses that progressively weaken the immune system (e.g., Human Immunodeficiency Virus (HIV), myelodysplasia)

With the exception of BCG, there are no contraindications to the use of any vaccine (including MMR) early in the course of these illnesses. With progression of these conditions, the risk of using live vaccines increases. Therefore, the risks and benefits of a particular vaccine (and the alternative therapies available) need to be carefully considered.

Early immunization is not only safer but is also more effective in these conditions. There is no contraindication to the use of inactivated or component vaccines at any time. Particular attention should be paid to the

completion of childhood immunizations, pneumococcal immunization (see *Pneumococcal Vaccine* chapter), annual influenza immunization and possibly booster doses against Hib. In the case of HIV, consensus "cut-offs" have been determined for the use of some live vaccines. Infants infected with HIV who are asymptomatic should receive routine MMR vaccination. In addition, MMR is recommended for most symptomatic HIV-infected persons, including children who are symptomatic without evidence of severe immunosuppression. Please consult an infectious disease specialist/immunologist for more specific advice on MMR immunization for HIV-infected people.

Varicella vaccine should be considered in children > 12 months of age with asymptomatic or mildly symptomatic HIV infection (CDC class N1 or A1) and with age-specific CD4 percentages of > 25%. Two doses need to be given 3 months apart. Although theoretical concerns have been raised about increases (probably transient) in HIV viral load, which can occur after a number of routine immunizations, these changes are transient and should not influence the decision regarding immunization.

Immunocompromised travellers

Although the degree and range of infectious disease risks can increase dramatically when an immunocompromised individual travels to other countries or continents, the basic principles already outlined still apply. Evidence is accumulating to suggest that several live vaccines (including yellow fever vaccine) can be considered for people with HIV infection whose CD4+ T cell count is > 200/mm^3. However, the risks and benefits of each live vaccine must be carefully evaluated for every traveler. When a certificate of yellow fever vaccination is required but this vaccine is contraindicated, a letter of deferral should be supplied to the patient.

Selected references

American Society of Transplantation. *Guidelines for vaccination of solid organ transplant candidates and recipients*. American Journal of Transplantation 2004;4(Suppl 10): S160-63.

Ballout A, Goffin E, Yombi JC et al. *Vaccinations for adult solid organ transplant recipients: current recommendations*. Transplantation Proceedings 2005;37(6):2826-27.

Campbell AL, Herold BC. *Immunization of pediatric solid-organ transplantation candidates: immunizations in transplant candidates*. Pediatric Transplantation 2005;9(5):652-61.

Castagnola E, Fioredda F. *Prevention of life-threatening infections due to encapsulated bacteria in children with hyposplenia or asplenia: a brief review of current recommendations for practical purposes*. European Journal of Haematology 2003;71(5):319-26.

Centers for Disease Control and Prevention. *Guidelines for preventing opportunistic infections among hematopoietic stem cell transplant recipients*. Morbidity and Mortality Weekly Report 2000;49(RR-10):1-125.

Centers for Disease Control and Prevention. *Recommendations of the Advisory Committee on Immunization Practices (ACIP): use of vaccines and immune globulins*

Table 8. Vaccination of Individuals with Immunodeficiency

Vaccine	HIV/AIDS	Severe immunodeficiency	Solid organ transplantation	Post -BMT	Chronic renal disease/dialysis	Hyposplenism or asplenia
Inactivated/component vaccines						
DTaP, Tdap, Td°	Routine use*	Routine use	Routine use	Recommended†	Routine use	Routine use
IPV	Routine use	Routine use	Routine use	Recommended	Routine use	Routine use
Hib	Routine use	Routine use	Routine use	Recommended	Routine use	Recommended for children < 5 years. Consider for all
Influenza	Recommended	Recommended	Recommended	Recommended	Recommended	Recommended
Pneumococcal	Recommended	Recommended	Recommended	Recommended	Recommended	Recommended
Meningococcal	Routine use	Recommended	Routine use	Routine use	Routine use	Recommended
Hepatitis A	Recommended (MSM, IDU)	Use if indicated**	Use if indicated**	Use if indicated	Use if indicated	Use if indicated
Hepatitis B	Recommended (MSM, IDU)	Routine use	Routine use	Recommended	Recommended (higher dosage)	Routine use
Live vaccines						
MMR	Routine use‡ (if no significant compromise)	Contraindicated	Recommended before transplantation. Contraindicated after***	Consider at 24 mo (no suppressive Rx, no GVHD)	Routine use	Routine use

Table 8. Vaccination of Individuals with Immunodeficiency

Vaccine	HIV/AIDS	Severe immunodeficiency	Solid organ transplantation	Post -BMT	Chronic renal disease/dialysis	Hyposplenism or asplenia
Varicella	Consider in asymptomatic and mildly symptomatic disease	Contraindicated	Recommended before transplant. Consider at 24 mo (min suppressive Rx)	Consider at 24 mo (no suppressive Rx, no GVHD)	Recommended	Use if indicated
Oral typhoid	Contraindicated (use IM vaccine instead)	Contraindicated (use IM vaccine instead)	Contraindicated (use IM vaccine instead)	Contraindicated (use IM vaccine instead)	If indicated use IM	If indicated use IM
BCG	Contraindicated	Contraindicated	Contraindicated	Contraindicated	Use if indicated	Use if indicated
Yellow fever	Contraindicated	Contraindicated	Contraindicated	Contraindicated	Use if indicated	Use if indicated
Oral cholera	Contraindicated	Contraindicated	Contraindicated	Contraindicated	Use if indicated	Use if indicated

BMT: Bone marrow transplantation; MSM: Men who have sex with other men; IDU: intravenous drug users; GVHD: graft-versus-host disease; IM: intramuscular.

° Product used would depend on age.

* Routine vaccination schedules should be followed with age-appropriate booster doses.

† Vaccination and/or re-vaccination recommended with or without verification of serologic response.

** Recommended for transplant candidates with chronic liver diseases.

‡ Most HIV-positive children can receive the first MMR vaccine without significant risk. Administration of the second MMR dose (particularly in adults) must be evaluated on a case-by-case basis.

*** Consider at 24 mo (no suppressive therapy, no GVHD) in seronegative females before pregnancy.

for persons with altered immunocompetence. Morbidity and Mortality Weekly Report 1993;42(RR-4):1-18.

Committee to Advise on Tropical Medicine and Travel. *Statement on travellers and HIV/AIDS*. Canada Communicable Disease Report 1994;20(17):147-49.

Duchini A, Goss JA, Karpen A et al. *Vaccinations for adult solid-organ transplant recipients: current recommendations and protocols*. Clinical Microbiology Reviews 2003;16(3):357-64.

Fivush BA, Neu AM. *Immunization guidelines for pediatric renal disease*. Seminars in Nephrology 1998;18(3):256-63.

Gershon AA, Steinberg SP. *Persistence of immunity to varicella in children with leukemia immunized with live attenuated varicella vaccine*. New England Journal of Medicine 1989;320(14):892-97.

Keeffe EB. *Acute hepatitis A and B in patients with chronic liver disease: prevention through vaccination*. American Journal of Medicine 2005;118(Suppl 10A):S21-27.

LaRussa P, Steinberg S, Gershon AA. *Varicella vaccine for immunocompromised children: results of collaborative studies in the United States and Canada*. Journal of Infectious Diseases 1996;174(Suppl 3):S320-23.

McFarland E. *Immunizations for the immunocompromised child*. Pediatric Annals 1999;28(8):487-96.

Melles DC, de Marie S. *Prevention of infections in hyposplenic and asplenic patients: an update*. Netherlands Journal of Medicine 2004;62(2):45-52.

Mileno MD, Bia FJ. *The compromised traveler*. Infectious Disease Clinics of North America 1998;12(2):369-412.

Molrine DC. *Recommendations for immunizations in stem cell transplantation*. Pediatric Transplantation 2003;7(Suppl 3):S76-85

Molrine DC, Hibberd PL. *Vaccines for transplant recipients*. Infectious Disease Clinics of North America 2001;15(1):273-305.

National Advisory Committee on Immunization. *Statement on recommended use of meningococcal vaccines*. Canada Communicable Disease Report 2001;27(ACS-6):2-36.

National Advisory Committee on Immunization. *Statement on recommended use of pneumococcal conjugate vaccines*. Canada Communicable Disease Report 2002;28(ACS-2):1-32.

Neuhauss TJ. *Immunization in children with chronic renal failure: a practical approach*. Pediatric Nephrology 2004;19(12):1334-39.

Rangel MC, Coronado VG, Euler GL et al. *Vaccine recommendations for patients on chronic dialysis*. Seminars in Dialysis 2000;13(2):101-107.

Sartori AM. *A review of the varicella vaccine in immunocompromised individuals*. International Journal of Infectious Diseases 2004;8(5):259-70.

Somani J, Larson RA. *Reimmunization after allogeneic bone marrow transplantation*. American Journal of Medicine 1995;98(4):389-98.

Weber DJ, Rutala WA. *Immunization of immunocompromised persons*. Immunology and Allergy Clinics of North America 2003;23(4):605-34.

Yeung CY, Liang DC. *Varicella vaccine in children with acute lymphoblastic leukemia and non Hodgkins lymphoma*. Pediatric Hematology and Oncology 1992;9(1):29-34.

Immunization of Persons with Neurologic Disorders

The Institute of Medicine (IOM) has conducted evidence-based reviews and has rejected any causal associations between the following vaccines and neurological disorders:

- Measles, mumps and rubella (MMR) or thimerosal-containing vaccines and autism spectrum disorders in children;
- influenza vaccine and demyelinating neurological disorders in children aged 6-23 months (the age group studied);
- hepatitis B or influenza vaccines and incident or relapse of multiple sclerosis in adults.

The IOM concluded that the evidence supported a causal relation between the 1976 swine influenza vaccine and Guillain-Barré syndrome (GBS) in adults. The data they reviewed were insufficient to either refute or support any association between GBS and influenza vaccines used after 1976. However, a study by other investigators has estimated the vaccine-associated GBS incidence in adults as one extra case of GBS per million influenza vaccine doses administered. Data on GBS incidence after influenza vaccination in children are not available.

For the purposes of immunization, people with neurologic disorders may be considered according to the following two categories: those with pre-existing neurologic conditions and those in whom the onset of symptoms of a new condition followed immunization.

Pre-existing neurologic conditions

Disorders that usually begin during infancy, such as cerebral palsy, spina bifida, seizure disorder, neuromuscular diseases and inborn errors of metabolism, may have symptom onset before the administration of the vaccines routinely recommended in the first year of life. Other conditions, such as autism spectrum disorders, acute demyelinating encephalomyelitis, transverse myelitis, multiple sclerosis and GBS, often appear later in childhood or adulthood and may occur before or after the administration of the vaccines given to adolescents and adults (e.g., hepatitis B, tetanus, diphtheria and acellular pertussis (Tdap)).

Neurological disorders whose onset clearly precedes immunization are not contraindications to subsequent immunization. People with these disorders are at risk of added morbidity and mortality from vaccine-preventable infections due to *Haemophilus influenzae* type b, *Neisseria meningitidis* serogroup C, *Streptococcus pneumoniae* (vaccine serotypes), pertussis, measles

and rubella. Recent studies have demonstrated that children with neurologic conditions are at risk of varicella and influenza infections severe enough to require hospitalization. Consequently, people with pre-existing neurologic disorders should receive all routinely recommended immunizations without delay. In addition, adults and children ≥ 6 months of age with neurologic conditions that compromise clearance of respiratory secretions should receive yearly influenza vaccination. Please refer to the *National Advisory Committee on Immunization Statement on Influenza Vaccination* available at www.naci.gc.ca for more information.

Neurologic events following immunization

Rarely, neurologic events occur in the 8 weeks following immunization. Because these occur so close in time to the vaccine administration they are said to be "temporally associated". This temporal association alone is not evidence that the vaccine caused the neurologic events. Please refer to the *Vaccine Safety* chapter, page 59, for more information. Children who experience hypotonic-hyporesponsive events (HHE), febrile and non-febrile seizures or prolonged, inconsolable crying after receiving acellular pertussis vaccines or any other vaccine may receive the next dose(s) of vaccines without delay, as these events are not associated with any long-term problems and therefore are not considered contraindications to further immunization. Such events have occurred with equal frequency after either DTaP or DT vaccines, and children have received acellular pertussis vaccines safely after previous HHE episodes.

People with encephalopathy or encephalitis that develops within 7 days after immunization should be investigated. Those who have an alternative etiology for the encephalopathy (e.g., viral infection) or who recover fully by the next scheduled vaccination may be immunized without deferral. People with encephalopathy that persists or who have no alternative etiology should be referred to a specialist for further consultation and may be immunized if their condition is stable and found not to relate to immunization.

Children admitted for investigation of encephalopathy at the 12 participating pediatric tertiary care centres in Canada are captured by the Immunization Monitoring Program ACTive (IMPACT) surveillance system. IMPACT identified four children between 1997 and 2002 with encephalopathy that began within 7 days after immunization with acellular pertussis vaccines. All had concomitant infections or conditions that could have accounted for the encephalopathy. Two of the cases had concomitant influenza A infections, one had a diarrheal illness without any identified pathogen, and the last case was due to hypoglycemia secondary to adrenal insufficiency. Thus, encephalopathy temporally associated with whole cell or acellular pertussis vaccines appears to be very rare in Canada, and these data indicate that an alternative etiology is usually established.

A causal association has not been established between tetanus or currently available influenza vaccines and GBS. However, at the present time it is prudent to withhold tetanus vaccinations from children and adults in whom GBS developed within 8 weeks of a previous tetanus vaccine and to withhold influenza vaccination from children and adults whose GBS developed within 8 weeks of a previous influenza vaccine dose. People who have GBS that developed outside this interval or who have an alternative cause identified (e.g., *Campylobacter jejuni* infection) may receive subsequent tetanus and influenza vaccinations.

Since the IOM has rejected any causal association between the vaccines identified above and autism spectrum disorders or demyelinating disorders (including multiple sclerosis), children and adults with these disorders may receive further immunization with MMR, hepatitis B and influenza vaccines, as well as other routinely recommended vaccines, without deferral.

Immunization of Persons with Bleeding Disorders

While certain factors must be considered before immunizing individuals with bleeding disorders, these persons should receive all the recommended immunizations according to routine schedules. For all children, before giving the first immunization at 2 months of age, clinicians should ensure that there are no symptoms or signs compatible with an undiagnosed bleeding disorder. If these are present, a diagnosis should be established before commencing immunization.

Individuals receiving low doses of acetylsalicylic acid therapy and long-term anticoagulation with either coumadin or heparin are not considered to be at higher risk of complications and may be safely immunized through either the intramuscular or subcutaneous route without discontinuation of their anticoagulation therapy.

Route of administration of immunization

The risks and benefits of administering intramuscular injections to individuals with a bleeding disorder must be weighed before choosing the route of administration. In general, subcutaneous injections are preferred over intramuscular injections in this population and should be considered when the efficacy is known to be the same for both routes, especially if an individual has a bleeding disorder that is not correctible. For more information on immunizations that are available for subcutaneous administration please refer to Table 1, in the *General Considerations* chapter, page 7. In individuals with non-correctible bleeding disorders intramuscular gluteal injections should be avoided if possible.

Correction of bleeding disorder

When immunizations are to be given by the intramuscular route or when there is a concern that injection may stimulate bleeding, the immunization should be given following anti-haemophilia therapy or correction of the bleeding disorder when possible.

Method of immunization

Immunization should be carried out using a fine-gauge needle of appropriate length. After the injection, firm pressure should be applied, without rubbing, to the injection site for at least 5 minutes.

Immunizations to be considered in individuals with bleeding disorders

Although currently available plasma-derived products are all tested for viral contamination prior to administration, any patient with a bleeding disorder should still be considered at higher risk of contracting hepatitis A or B and should be offered these vaccines. Even when recombinant therapeutic products are being used, immunization is still recommended in case the recombinant supply is unavailable and patients are required to switch to plasma-derived products at short notice. Please refer to the *Hepatitis A* chapter, page 179, and *Hepatitis B* chapter, page 189, for information on dosage.

Selected references

Makris M, Conlon CP, Watson HG. *Immunization of persons with bleeding disorders.* Haemophilia 2003;9(5):541-46.

Immunization of Travellers

A detailed discussion of immunization and other preventive measures recommended for travellers to other countries is beyond the scope of this *Guide*. Current information on immunization requirements and recommendations should be obtained from travel health clinics or public health agencies.

Readers are referred to the Travel Medicine Program section on the Public Health Agency of Canada (PHAC) Web site, http://www.travelhealth.gc.ca. This Program provides extensive information, including statements on travel medicine and tropical medicine, from CATMAT (Committee to Advise on Tropical Medicine and Travel).

Readers are also referred to *Health Information for International Travel* (U.S. Centers for Disease Control and Prevention, www.cdc.gov/travel) and *International Travel and Health: Vaccination Requirements and Health Advice* (World Health Organization, www.who.int/ith).

There is no single schedule for the administration of immunizations to travellers. Each schedule must be personalized. The immunization recommendations for travellers will vary according to the traveller's age, immunization history, existing medical conditions, countries to be visited, the duration and nature of travel (whether the traveller is staying in urban hotels or visiting remote rural areas), the legal requirements for entry into countries being visited and the amount of time available before departure.

With some notable exceptions, most immunizing agents can be given simultaneously at different sites. Concerns about individual vaccines and their potential compatibility with other vaccines or antimicrobials (including antimalarials) are dealt with in the specific vaccine chapters of the *Guide*.

A health care provider or travel medicine clinic ideally should be consulted 2 to 3 months in advance of travel in order to allow sufficient time for optimal immunization schedules to be completed. Even if a traveller is leaving at short notice, a pre-travel consultation will be beneficial. A listing of travel clinics across Canada can be found in the Travel Medicine Program section of the PHAC Web site, http://www.travelhealth.gc.ca.

It must be emphasized that the most frequent health problems faced by international travellers are not preventable by immunizing agents. As well, immunization is not a substitute for careful selection and handling of food and water.

Travel is a good opportunity for the health care provider to review the immunization status of infants, children, adolescents and adults. Unimmunized or incompletely immunized travellers should be offered vaccination as recommended in the specific vaccine chapters in this *Guide*. A pre-travel assessment is also a good opportunity to review safer sex practices.

Immunizations related to travel can be divided into three general categories: those that are considered **routine** (part of the primary series of immunizations or routine booster dose), those **required** by international law and those **recommended** for maintenance of health while travelling.

Routine immunizations

The following section specifically discusses the indication for "extra" or booster doses of routine immunizations or a change in the routine immunization schedule as it applies to travellers.

Accelerated primary vaccination schedule — infants

For infants embarking on travel, the primary vaccination series with diphtheria, tetanus, acellular pertussis, polio, *Haemophilus influenzae* type b (DTaP-IPV-Hib) and pneumococcal conjugate can be started as young as 6 weeks of age.

Hepatitis B — adults

Travel is a good opportunity to offer hepatitis B immunization to adults who have not been previously vaccinated. It should be recommended particularly to travellers who will be residing in areas with high levels of endemic hepatitis B or working in health care facilities, and those likely to have contact with blood or to have sexual contact with residents of such areas.

Hepatitis B — infants and children

The age at which infants, children and adolescents are offered hepatitis B vaccine varies from jurisdiction to jurisdiction in Canada. Since hepatitis B carrier rates are much higher in developing countries, every effort should be made to arrange full hepatitis B immunization for children of any age who will live in an area where hepatitis B is endemic.

Measles, mumps, rubella — adults

Measles, mumps and rubella are endemic in many countries. Protection against measles is especially important for people planning foreign travel, including adolescents and adults who have not had measles disease and have not been adequately immunized. Two doses of measles-containing vaccine (MMR) are recommended for all unimmunized adult travellers who were born in or after 1970 and who are en route to a measles-endemic area, unless there is serologic proof of immunity or physician documentation of prior measles. Similarly, protection against rubella is especially important for women of childbearing age who are not immune to the disease.

Measles — infants and children

Measles vaccine should be given at an earlier age than usual for children travelling to countries where measles is endemic. Measles-containing vaccine (MMR) may be given as early as 6 months of age, but then the routine series of two doses must still be re-started after the child is 12 months old.

Pertussis

For adults who have not previously received a dose of acellular pertussis vaccine, it is recommended that the tetanus and diphtheria booster dose (Td) be replaced by the combined Tdap vaccine.

Poliomyelitis

The risk of polio for travellers has substantially decreased as we move towards global polio eradication. A single booster dose of poliomyelitis vaccine (IPV) in adulthood is recommended for international travellers who plan to visit regions of the world where poliovirus continues to circulate in either epidemic or endemic fashion. The need for subsequent boosters of poliovirus vaccine has not been established.

Tetanus and diphtheria — adults

Adult travellers should be vaccinated against tetanus and diphtheria with a Td vaccine booster dose every 10 years for optimal protection.

Required immunizations

The following may be a requirement of international law, or proof of immunization may be considered a visa requirement.

Cholera

Cholera vaccine has not been required for border crossing under International Health Regulations since 1973. Some travellers to parts of Africa have reported being asked to provide a certificate of immunization against cholera. This "requirement" is not usually the policy of the national government but, rather, of local authorities. Given the related risks of immunization in some countries, certain travel clinics provide a cholera "exemption certificate", which is used to help travellers avoid being given cholera vaccine while abroad.

Meningococcal disease

As a condition of entry, Saudi Arabia requires proof of meningococcal immunization for pilgrims to Mecca during the Hajj. Quadrivalent polysaccharide vaccine is recommended. For other indications for this vaccine see the Recommended Usage section in the *Meningococcal Vaccine* chapter, page 237.

Yellow fever

Yellow fever is the only vaccine required as a condition of entry under the World Health Organization's International Health Regulations. A valid International Certificate of Vaccination, issued within the previous 10 years, is mandatory for entry into certain countries in Africa and South America. Other countries have requirements for proof of immunization from travellers who have passed through yellow fever endemic zones. Please refer to the maps in the *Yellow Fever Vaccine* chapter, page 343, for more information.

The period of validity of the International Vaccination Certificate for yellow fever is 10 years, beginning 10 days after primary vaccination and immediately after re-vaccination. Only Yellow Fever Vaccination Centre clinics designated by PHAC can provide the International Certificate of Vaccination in Canada. A list of these centres can be obtained from PHAC's Travel Medicine Program Web site (http://www.travelhealth.gc.ca).

The decision to immunize against yellow fever will depend on the itinerary of the individual traveller and the specific requirements of the country to be visited (including stopovers). As well as being necessary for entry into certain countries, immunization against yellow fever is recommended for all travellers who are visiting or living in countries in Africa and South America where yellow fever infection is officially reported. It is also recommended for travel outside of urban areas in countries that do not officially report yellow fever but lie in the yellow fever endemic zones (see maps, page 344-345).

Recommended Immunizations

On the basis of a risk assessment of the itinerary, the style of travel and the traveller's underlying health, the following vaccines should be considered in consultation with a health care provider.

Bacille Calmette-Guérin (BCG)

Immunization with BCG may be considered for travellers planning extended stays in areas of high tuberculosis prevalence, particularly where a program of serial skin testing and appropriate chemoprophylaxis may not be feasible or where primary isoniazid resistance of *Mycobacterium tuberculosis* is high. Travellers are advised to consult a specialist in travel medicine or infectious diseases when considering a decision for or against BCG immunization. Please refer to the *Bacille Calmette-Guérin Vaccine* chapter, page 149, for more information.

Cholera

In specific, limited circumstances (e.g., high-risk ex-patriots such as relief and aid workers or health professionals working in endemic countries),

the oral cholera vaccine (Chol-Ecol-O, Dukoral™) may be considered. A detailed, individual risk assessment should be made in order to determine which travellers may benefit from immunization.

The Chol-Ecol-O vaccine has been shown to provide limited, short-term protection against diarrhea caused by enterotoxigenic *Escherichia coli*. A detailed, individual risk assessment should be made in order to determine which travellers may benefit the most from this vaccine as a preventive strategy for travellers' diarrhea. Please refer to the *Cholera Vaccine* chapter, page 158, for more information.

Hepatitis A

Hepatitis A is the most common vaccine-preventable disease in travellers. Protection against hepatitis A is highly recommended for all travellers to developing countries, especially to rural areas or places with inadequate sanitary facilities in countries where the disease is endemic. Protective antibodies are detectable within 2 weeks of administration. Given the long incubation period of hepatitis A (2 to 7 weeks), the vaccine can be administered up to the day of departure and still protect the majority of travellers.

The advent of active immunizing agents has made the use of immune globulin virtually obsolete for the purposes of travel prophylaxis. The only exceptions would be people for whom hepatitis A immunization is contraindicated or may not be effective (e.g., immunocompromised travellers and infants < 1 year of age). Immune globulin provides protection for only 3 to 5 months and should be given immediately before departure.

Influenza

People at high risk of influenza complications embarking on foreign travel to destinations where influenza is likely to be circulating should be immunized with the most current available vaccine. Influenza transmission is enhanced in the crowded conditions associated with air travel, cruise ships and tour groups. In the tropics, influenza can occur throughout the year. In the southern hemisphere, peak activity occurs from April through September and in the northern hemisphere from November through March. Vaccines prepared specifically against strains that are predicted to circulate in the southern hemisphere are not currently available in Canada.

Japanese encephalitis

Japanese encephalitis is the leading cause of viral encephalitis in Asia, but the disease is rare in travellers. Its incidence has been decreasing in China, Korea and Japan but increasing in Bangladesh, India, Nepal, Pakistan, northern Thailand and Vietnam. It occurs in epidemics in late summer and early fall in temperate areas and sporadically throughout the year in tropical areas of Asia. Immunization should generally be considered for those who will spend 1 month or more in endemic or epidemic areas during the transmission season, especially if travel will include rural areas. In special

circumstances, immunization should be considered for some people spending < 1 month in endemic areas, e.g., travellers to areas where there is an epidemic, travellers making repeated short trips or people with extensive outdoor rural exposure.

Meningococcal disease — adults

Quadrivalent meningococcal polysaccharide vaccine is recommended for travellers planning a prolonged stay in areas with a high incidence of meningococcal disease. Short-term travellers (< 3 weeks) on business or holiday (including safaris) who will have little contact with local populations are at minimal risk, and therefore immunization is not routinely recommended. When doubt about the nature of exposure exists, it may be prudent to offer immunization. However, in special circumstances, immunization should be considered for short-term travellers if (a) there will be close contact with the local population in endemic areas, (b) there will be travel to epidemic areas or (c) the traveller will be providing health care to others.

As noted previously, proof of meningococcal immunization may be required by certain countries e.g., Saudi Arabia for pilgrims to Mecca during the Hajj. Outbreaks of meningococcal disease have affected these pilgrims in the past, involving serogroup A in 1987, and both serogroups A and W135 in 2000 and 2001.

Meningococcal conjugate C vaccine was approved in Canada in 2001. This vaccine only protects against serogroup C and therefore is not appropriate for protection of travellers, as it does not protect against serogroups A, Y or W135. Travelers should therefore receive a quadrivalent vaccine that provides protection against serogroups A, C, Y and W135.

Meningococcal disease — infants and children

Because of the relative inability of very young children to respond to polysaccharide vaccine, infants aged 2 to 12 months should be immunized with the appropriate doses of meningococcal C conjugate based on age and vaccine manufacturer, if not previously received. However, bivalent meningococcal polysaccharide AC vaccine or quadrivalent ACYW135 may be considered for children as young as 3 months who are travelling to regions where broader protection is needed. Please refer to the *Meningococcal Vaccine* chapter, page 237, for more information.

Rabies

Pre-exposure immunization should be considered for travellers intending to live or work in areas where rabies is enzootic and rabies control programs for domestic animals are inadequate, or where adequate and safe post-exposure management is not available. Children, particularly those who are too young to understand the need to avoid animals or to report bites, should also be considered for pre-exposure immunization. After exposure to a rabid animal, administration of two additional doses of rabies vaccine is

imperative as soon as possible. For someone who has received a full course of pre-exposure immunization, rabies immune globulin is not indicated. Please refer to the *Rabies Vaccine* chapter, page 285, for more information.

Typhoid

Typhoid vaccine is recommended for travellers who will have prolonged exposure (> 4 weeks) to potentially contaminated food and water, especially those travelling to smaller cities and villages or rural areas off the usual tourist itineraries in countries with a high incidence of disease. Individuals billeted with or visiting families in such areas may be at particularly high risk. Immunization should also be considered for travellers with reduced or absent gastric acid secretion. Immunization is not routinely recommended for business travel or short-term (< 4 weeks) holidays in resort hotels in such countries. Parenteral inactivated and live oral vaccines are available.

Travellers who are immunodeficient

In general, live vaccines should be avoided in individuals who are immunodeficient. These vaccines include yellow fever, oral typhoid, varicella, MMR and BCG. For more detailed information, see the *Immunization of Immunocompromised Persons* chapter, page 117, for recommendations on the use of vaccines in individuals who are immunodeficient.

Travellers who are pregnant

In general, live vaccines should be avoided in pregnancy, whereas inactivated (killed) vaccines are considered safe. For more detailed information, see the chapter on *Immunization in Pregnancy and Breast-Feeding*, page 107, as well as the individual vaccine chapters for recommendations for and contraindications to vaccines in pregnancy.

Malaria prophylaxis

There is no approved vaccine against malaria currently available.

Four components of malaria protection should be discussed with travellers: (a) the risk of acquiring malaria, (b) personal protective measures to prevent mosquito bites, (c) chemoprophylactic drugs (where appropriate) and (d) the need to seek early diagnosis and treatment of a febrile illness. Information concerning malaria, drug-resistant strains of *Plasmodium* and recommended drugs for prophylaxis and other preventive measures is regularly updated by CATMAT and published in the Canada Communicable Disease Report. Information is also available from local health departments, travel clinics and the Travel Medicine Program section on the PHAC Web site, http://www.travelhealth.gc.ca.

All travellers should be informed that malaria should be suspected if fever occurs during or after travel. Medical attention should be sought as soon as possible, and the traveller should request that a blood film be examined for malarial parasites.

Selected references

Centers for Disease Control and Prevention. *Travelers' health: yellow book. Health information for international travel 2005-2006.* Atlanta, GA: US Department of Health and Human Services, Public Health Service, 2005.

World Health Organization (WHO). *International travel and health: vaccination requirements and health advice*. Geneva: WHO, 2005.

Immunization of Persons New to Canada

Immunization of persons who have newly arrived in Canada is challenging, since immunization records may not exist, records that exist may be difficult to interpret because of language barriers, and immunization schedules and products may differ from those used in Canada. New immigrants, refugees and internationally adopted children may be lacking immunizations and/or immunization records because of their living conditions before arriving in Canada or because the vaccines are not available in their country of origin. Only written documentation of vaccination given at ages and intervals comparable with the Canadian schedule should be considered valid. See the section on *Immunization of Children and Adults with Inadequate Immunization Records*, page 105, for additional information.

Although the potency of vaccines administered in other countries can be generally assumed to be adequate, immunization schedules vary. The age at immunization (e.g., 9 months of age for immunization against measles in some countries), the number of doses and the intervals between doses should be carefully reviewed and compared with Canadian and provincial/territorial recommendations in determining the need for additional doses of vaccines. In many countries outside of Canada, mumps and rubella vaccines are in limited use, and measles vaccine alone is generally given. *Haemophilus influenzae* type b conjugate, hepatitis B, varicella, pneumococcal conjugate and meningococcal C conjugate vaccines are also in limited use. Information on vaccination schedules in other countries can be found on the following website: http://www.who.int/vaccines/GlobalSummary/Immunization/ScheduleSelect.cfm.

Some studies of internationally adopted children have shown that, despite written documentation of adequate immunizations, serologic evidence of protection against diphtheria and tetanus is lacking in some children. Recommendations regarding an approach to vaccinating these children vary and range from the following:

- ignoring the written record and repeating the vaccinations, especially when there is doubt about the authenticity of the records or vaccines used;
- accepting the written record provided it appears valid in terms of age of administration and timing of doses; or
- judiciously using serologic tests to ensure that good protection is present when there is concern regarding the adequacy of immunization records.

The epidemiology of some infectious diseases varies in different countries. For example, compared with temperate climates, in the tropics a higher proportion of varicella infections occurs in adults. Therefore, adolescents and adults from these countries are more likely to be susceptible to varicella

and require vaccination than those who are Canadian-born. Individuals born in developing countries are more likely to be carriers of hepatitis B, necessitating vaccination of their sexual and household contacts. Hepatitis A immunity is also more likely in some foreign-born individuals, therefore testing for immunity before administering the hepatitis A vaccine to persons from hepatitis A-endemic countries should be considered.

Immigration medical examinations (IMEs) are required for children and adults seeking permanent residence in Canada. These are done within the 12 months preceding arrival in Canada for new immigrants and those seeking refugee status from abroad. In-Canada refugee claimants must undergo an IME within 60 days of claiming refugee status.

It is important to note what the IME does not routinely include:

- a review of immunization status;
- tuberculin skin testing;
- hepatitis B serologic testing.

Therefore health care providers in Canada who see persons newly arrived in the country should make the assessment and updating of immunizations a priority. As well, they should perform a complete health assessment (including comprehensive testing for a variety of chronic and non-vaccine-preventable diseases) as outlined in the references below. As part of this assessment, the following tests are particularly relevant in determining the need for some vaccines or contraindications to vaccination:

- Hepatitis B surface antigen (HBsAg), hepatitis B surface antibody, hepatitis B core antibody. Should any member of the family be found to be positive for HBsAg, the entire family should be tested for hepatitis B markers and vaccinated as appropriate.
- Hepatitis C antibody. Persons chronically infected with hepatitis C should be vaccinated against hepatitis A and hepatitis B (if not previously infected with these agents).
- Human immunodeficiency virus (HIV) serologic testing for persons from countries with high rates of HIV (if HIV status not known). HIV testing is performed as part of the IME for those 15 years of age and older and some children (those who have received blood and blood products, those whose mother is known to be HIV positive and all potential adoptees). Persons with advanced HIV infection should not receive live vaccines. Please refer to the *Immunization of Immunocompromised Persons* chapter, page 117, for more information.
- Complete blood counts, sickle cell preparation test and hemoglobin electrophoresis for persons from areas of the world where sickle cell disease and genetic hemoglobinopathies (such as beta-thalassemia) are present. Persons with sickle cell disease are at risk of serious infections with encapsulated bacteria, such as *Streptococcus pneumoniae*, *Haemophilus influenzae* and *Neisseria meningitidis*. They should be immunized with pneumococcal conjugate and polysaccharide vaccines, *Haemophilus*

influenzae type b conjugate vaccine, and meningococcal C conjugate and quadrivalent polysaccharide vaccines (see relevant chapters). Persons with sickle cell disease or thalassemia should receive yearly influenza vaccination.

Because families new to Canada may return to their country of origin to visit friends and relatives or may receive visitors from their country of origin, vaccination against hepatitis A and/or B should be considered for all members of the family if they are from a country that is endemic for these diseases. A travel medicine consultation is recommended at least 6 to 8 weeks before travel. However, persons new to Canada may not perceive a return to their country of origin as a health risk and so may be less likely to seek pre-travel consultation.

Family members traveling outside of Canada to adopt a baby should also seek pre-travel advice and receive all appropriate travel immunizations. The adoption of a new baby into a family provides an opportunity to review the immunization status of all family members.

Selected references

Aronson J. *Medical evaluation and infectious considerations on arrival.* Pediatric Annals 2000;29(4):218-23.

Barnett ED. *Infectious disease screening for refugees resettled in the United States.* Clinical Infectious Diseases 2004;39(6):833-41.

Canadian Paediatric Society. *Children and youth new to Canada: a health care guide.* Ottawa: CPS, 1999. URL (for purchase): <http://www.cps.ca/english/publications/Bookstore/ChildrenNewToCanada.htm>.

Centers for Disease Control and Prevention. *Travelers' health: yellow book. Health information for international travel, 2005-2006.* Atlanta, GA: US Department of Health and Human Services, Public Health Service, 2005; chapter 8. URL: <http://www2.ncid.cdc.gov/travel/yb/utils/ybGet.asp?section=children&obj=adoption.htm&cssNav=browseoyb>.

Chen LH, Barnett ED, Wilson ME. *Preventing infectious diseases during and after international adoption.* Annals of Internal Medicine 2003;139:371-78.

Stauffer WM, Kamat D, Walker PF. *Screening of international immigrants, refugees and adoptees.* Primary Care 2002;29(4):879-905.