

Special Article

Strategies for Safe Living After Solid Organ Transplantation

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Abbreviations: CMV, cytomegalovirus; DEET, N,N-Diethyl-meta-toluamide; HBV, hepatitis B virus; HCV, hepatitis C virus; HIV, human immunodeficiency virus; HPV, human papillomavirus; HSV, herpes simplex virus.

Introduction

Infections remain a risk to the recipients of solid organ transplantation, long after the initial posttransplant period. Factors that affect risk include the recipient's net state of immunosuppression, epidemiologic exposures and the consequences of the invasive procedures to which the recipient has been subjected (1–4). Infections can be due to endogenous organisms that reactivate during periods of excess immunosuppression, donor-acquired organisms which are discussed in section 3 of these Guidelines, or from the environment, whether it be in the hospital setting or the community after discharge. They may also develop opportunistic infections with exogenously acquired organisms if exposed to a high inoculum or particularly virulent microbes, even during periods of minimal or maintenance immunosuppression. A major goal of transplantation is to be able to lead as healthy and normal a life as possible; accordingly the risk of exposure to infectious agents will always be present. However, various measures can be taken to reduce high-risk epidemiologic exposures in the hospital and in the community, and transplant recipients should be counseled in ways to minimize the risk of infection. Furthermore, strategies for safe living must be carefully woven with the transplant recipient's attempts to regain normal function and return to an active and productive life.

Information on specific infections is available in other sections of these Guidelines, whereas this section will deal with infectious exposures that are encountered in daily life. Unfortunately, "hard data" and controlled studies regarding safe living practices after solid organ transplan-

tation are lacking. Guidelines for preventing opportunistic infections in other immunocompromised populations such as hematopoietic stem cell transplant recipients (4) and in persons infected with human immunodeficiency virus (5) have been drafted by various working groups that include the Centers for Disease Control and Prevention, Infectious Diseases Society of America, United States Public Health Service and American Society of Blood and Marrow Transplantation, and can be extrapolated to the solid organ transplant population. In addition, published guidelines on isolation precautions (6), hand hygiene (7) and environmental control of infection (8) provide valuable insights, although they focus primarily on health care settings. The following recommendations are based on anecdotal clinical experience, available knowledge of the mode in which various infectious agents are transmitted, the opinions of respected authorities (9), and common sense [III]. They take into account the general recognition that solid organ transplant recipients are at greatest risk of infection during the first 6 months after transplantation or when their immunosuppression is augmented for episodes of rejection. Guidelines for the prevention of infection in solid organ transplant recipients should be tailored to the individual recipient by their health care providers with special consideration of the patient's degree of immunosuppression and personal circumstances.

Prevention of Infections Transmitted by Direct Contact

Most organisms are acquired from direct contact (particularly on hands or from fomites), ingestion, or inhalation. Frequent and thorough hand washing is imperative as a means of preventing infections that are transmitted by direct contact [II-3, III]. Hands should be washed with soap and water. Hygienic hand rubs are an acceptable alternative for maintaining clean hands, except when there is visible soiling of the hands or when contact is made with organisms that are known to have a spore stage (e.g. *C. difficile*; Ref.7). Gloves should be worn whenever handling heavily contaminated materials such as soil, moss or manure. Going barefooted outside should be avoided. Shoes, socks, long pants and long sleeved shirts should be worn while doing gardening, yard work, farming or being in parks or wooded areas [III].

Hands should be washed [including after gloves are used]:

- before preparing food and before eating,
- before and after touching wounds (whether or not gloves are used),

- before touching mucous membranes,
- after touching or cleaning up after pets and animals,
- after gardening or touching plants or soil,
- after changing diapers (though ideally other family members should change diapers rather than the transplant recipient),
- after touching secretions and excretions, including nose-blowing, and
- after touching items that have had contact with human or animal feces, (e.g., bedpans, bedding, toilets, litter boxes).

In addition, there is considerable potential for transmission of infections via percutaneous exposures. Transplant recipients should avoid intravenous or intradermal drug use not only due to the health consequences of using illicit drugs but likewise the risk of acquiring blood-transmitted infections such as HCV and HBV. Body piercings, and tattoos represent a break in the skin, which can lead to infection as well (9). If body piercing or tattoos are to be obtained, reputable centers should be used and close attention to sterile technique used. Self-piercing or tattooing or sharing of needles should be avoided.

Prevention of Respiratory Infections

Microbes that cause respiratory infections are transmitted by either inhalation of aerosolized organisms or direct contact from contaminated hands to mucous membranes. Accordingly, transmission of respiratory pathogens can be reduced by:

- Frequent and thorough hand washing, particularly before touching mucous membranes [II-3].
- Avoiding close contact with persons with respiratory illnesses [II-2]. If contact is unavoidable, ideally both the infected person and the transplant recipient should wear a standard surgical mask [III].
- Avoiding crowded areas, such as shopping malls, subways, elevators, where close contact with persons with respiratory illness is likely [III]. Though continually avoiding these areas is unrealistic, caution is advised during periods of enhanced immunosuppression. Likewise, caution should be increased when viruses are circulating in the community such as epidemic influenza.
- Avoiding tobacco smoke. Smoking and exposure to environmental tobacco smoke are risk factors for bacterial and community-acquired viral infections [III]. Marijuana smoking should also be avoided because of its association with exposure to fungal spores from *Aspergillus* spp and other organisms [III].
- Avoiding exposure to persons with known active tuberculosis and avoiding activities and occupational settings that increase the risk of exposure to tuberculosis, e.g. working in prisons, jails, homeless shelters, and certain health care settings [III].

- Avoiding, if possible, other occupational risks including working in certain animal care settings, construction, gardening, landscaping, and farming. Decisions to work in high risk areas should be made jointly by the patient, transplant team and primary care physicians so that the risks and benefits can be appropriately discussed, and precautions implemented if the patient chooses to accept these risks.
- Avoiding construction sites, excavations, or other dust-laden environments where there may be a high concentration of spores from molds (e.g., *Aspergillus*, *Histoplasma*).
 - Home remodeling projects which may lead to increased risk of *Aspergillus* in the environment need to be planned cautiously. Although data are not available on specific risk, it would be prudent for the transplant recipient to avoid exposure particularly early after transplantation or rejection treatment or after lung transplantation. Although clinicians may counsel patients to temporarily move out of their homes when visible mold is detected and during mold-abatement procedures, the level of infectious risk is not known.
- Avoiding exposure to fungal spores (*Cryptococcus*, *Histoplasma*, etc.) by avoiding plant and soil aerosols (such as mulching), pigeon and other bird droppings, chicken coops, and caves.
- Consideration for wearing a mask if exposure to above high risk areas is unavoidable [III].

Water Safety/Exposure to *Cryptosporidium*

Waterborne infections most often occur from consumption of contaminated drinking water or inadvertent water ingestion during recreational activities such as swimming, diving, or boating. Less frequently, infection can result from inhalation or direct contamination of the eye or a wound. In particular, cryptosporidiosis has been increasingly recognized in both healthy and immunocompromised hosts. Although only a few studies have focused on solid organ transplant recipients (10), *Cryptosporidium* can cause severe, chronic diarrheal disease in immunocompromised hosts, particularly those receiving corticosteroids (11). *Cryptosporidium* is resistant to chlorine and other chemicals and can be problematic even with treated water sources. Therefore, it is prudent for solid organ transplant recipients to decrease their exposure to this pathogen as well as others that might be found in water sources. Even treated municipal tap water may not be completely free of *Cryptosporidium*; however, there are no data to support a recommendation that all tap water be avoided unless a "boil water" advisory is issued by local authorities. To completely eliminate the risk of *Cryptosporidium* contamination, one should only drink water that has come to a rolling boil for at least one minute [I]. Persons avoiding untreated tap water should be aware that ice, and fountain beverages served at restaurants, bars,

theaters, sporting events, etc., are prepared with tap water. Personal-use filters and/or bottled water may serve as alternatives to boiling water to eradicate *Cryptosporidium* and other water-borne pathogens, but careful attention must be paid to selecting effective filters and high-quality bottled water. A list of filters certified under NSF Standard 053 for cryptosporidial cyst removal may be obtained by contacting the NSF International consumer line at 800-673-8010 or http://www.nsf.org/consumer/drinking_water/contaminant_cryptosporidium.asp. Information regarding bottled water can be obtained from the International Bottled Water Association at 703-683-5213 or (<http://www.bottledwater.org>). For individuals who have treated water supplies, the expense of buying bottled water is usually not warranted.

Specific recommendations for water safety include:

- Close attention should be paid to directions given during local governmental recommendations for “boil water” advisories for any waterborne pathogen.
- Well water from private or public wells in areas that are not screened frequently for bacterial pathogens should be avoided if possible because of potential risk of *Cryptosporidium*, *Giardia* and bacterial coliform contamination.
- Transplant recipients should not drink water directly from lakes or rivers because of the risk of *Cryptosporidium*, *Giardia* and bacterial coliform contamination [III].
- Waterborne infection might also arise from inadvertent swallowing of water during recreational activities such as swimming in lakes, rivers or pools, or going on water rides at amusement parks [II-2]. Transplant recipients should avoid swimming in water that is likely to be contaminated with human or animal waste, and should avoid swallowing water during swimming [II-2].
- To avoid spreading infection to others, transplant recipients who have had diarrhea should not use public recreational water facilities for 2 weeks after symptoms have resolved [III].
- Hot tubs have been associated with several infection risks, including *Pseudomonas* folliculitis, legionellosis (12) and mycobacterial infections (13); and should be avoided.
- Standing water in the home or basement, such as may occur with flooding, should be promptly cleaned up to avoid growth of mold, *Legionella* and other pathogens. Ideally someone other than the transplant recipient should perform the cleaning. If the transplant recipient cannot avoid exposure then waterproof boots and gloves should be worn during the cleaning process.
- When traveling to countries with poor sanitation, drinking tap water as well as inadvertent consumption from ice cubes or during showering should be avoided.

- Abrasions incurred during bathing in ocean or fresh water should be thoroughly cleaned with an uncontaminated water source due to risk of infection with organisms such as *Vibrio* species, *M. marinum* or *Aeromonas*.

Food Safety

Many of the following recommendations also apply to healthy individuals. Transplant recipients should avoid:

- Drinking unpasteurized milk, fruit or vegetable juice/cider in order to decrease their risk of infection with *E. coli* 0157:H7, *Salmonella*, *Brucella*, *Listeria*, *Yersinia* and *Cryptosporidium* [II-2].
- Eating cheeses made with unpasteurized milk (such as the soft cheeses such as brie, camembert, feta) to decrease the risk of *Listeria*.
- Eating raw or undercooked eggs including foods containing raw eggs (e.g. uncooked cake and cookie batter and some preparations of Caesar salad dressing, mayonnaise, or hollandaise sauce) particularly a risk for *Salmonella* infection [II-2].
- Eating raw or undercooked meat, poultry or fish with particular risk not only for bacterial contamination but also for parasitic infections such as *T. gondii*, and Tapeworms.
- All raw or undercooked seafood (oysters, clams, mussels) to prevent exposure to *Vibrio* species, viruses that cause gastroenteritis or hepatitis, and parasitic infections including *Cryptosporidium*.
- Ingesting raw seed sprouts (alfalfa sprouts, mung beans).
- Cross-contamination when preparing food (e.g. keep cooked and raw foods separate; use cleaned or separate cutting boards).
- Uncooked pate, meat spreads, cold cuts and smoked seafood.
- This website on food safety is a very user friendly resource to review current outbreaks as well as general food safety recommendations: <http://www.foodsafety.gov/~dms/lmrisk5.html>.

In addition to the above recommendations recent outbreaks of *Listeria*, *Salmonella* spp, toxigenic *E. coli* and *Campylobacter jejuni* show that it is prudent for transplant recipients to carefully wash lettuce and vegetable products even when they come bagged labeled as “prewashed.”

Although not all outbreaks can be anticipated, transplant recipients and their families should pay particular attention to local recommendations when outbreaks occur to avoid exposure to contaminated foods such as occurred with the widespread *Listeria* outbreak associated with cantaloupe in the United States in 2012 and the outbreak of *E. coli* 0104:H4 in Germany in 2011.

Vaccination against hepatitis A should be sought before transplant if possible to offer the best protection against hepatitis A as a foodborne virus.

Animal Contact and Pet Safety

Occupational risk

Transplant recipients who work with animals (veterinarians, pet store employees, farmers, slaughterhouse or laboratory workers) should, if possible, avoid working during periods of maximal immunosuppression [III]. When returning to work, transplant recipients should minimize their exposure to potential pathogens by using proper precautions, including hand hygiene and the use of gloves and masks as indicated.

Pet ownership

Health care providers must balance the psychological benefits of pet ownership with potential risks for transmission of infection when counseling solid organ transplant recipients on the safety of maintaining pets. There are a variety of zoonoses that can be transmitted to the transplant recipient from pet animals (14). The veterinarian should be viewed as a colleague, both to the transplant clinician and the transplant recipient, because maintenance of pet health can help reduce human risk (15).

In general, transplant recipients should:

- Avoid contact with animals that have diarrhea [III].
- Keep their pets healthy by feeding them food that is not contaminated or spoiled, and seeking veterinary help at the first signs of illness.
- Wash hands carefully after handling pets.
- Avoid cleaning bird cages, bird feeders, litter boxes, and handling animal feces. If this is not possible, the use of disposable gloves and a standard surgical mask should be used.
- Avoid stray animals.
- Avoid animal bites and scratches (do not pet stray animals).
- Ensure that areas near the home are free of raccoon latrines.
- Avoid contact with non-human primates (monkeys).
- Wear gloves to clean aquariums or have someone else in household do the cleaning.
- Consider waiting to acquire a new pet until a period when the patient is on stable immune suppression (at least 6–12 months after transplantation).
- Consider the type of pet and specific risks for infections.
 - Reptiles (snakes, iguanas, lizards and turtles) have a high risk of *Salmonella* infection and should be avoided.
 - Chicks and ducklings have a risk of transmitting *Salmonella* infections.

- Rodents have a risk of transmitting lymphocytic choriomeningitis virus.
- Young cats have risk of transmitting *Bartonella henselae*.
- Cats have a risk of transmitting *Toxoplasma gondii*.
- Puppies, kittens and chicks have a risk of transmitting *Campylobacter* infections.

Cats can spread *Toxoplasma*, *Cryptosporidium*, *Salmonella*, *Campylobacter* (contaminated feces) and *Bartonella* (fleas and scratches). Young cats carry the highest risk for transmitting *Bartonella* (cat scratch). Cat litter boxes should be changed daily (preferably not by transplant recipients), because it takes longer than 24 h for *Toxoplasma* oocysts to become infectious. Although dogs are generally considered safer pets than cats, birds, and reptiles, there are documented instances of infections transmitted by dogs without a bite, such as cases of *Bordetella bronchoseptica* (the agent of “kennel cough”) in lung transplant recipients (16). Although dogs classically have this disease, kittens likewise can be infected and transmit the bacteria. Puppies can transmit *Campylobacter* infections. Birds can transmit infections such as psittacosis or cryptococcosis, which may be a particular risk for lung transplant recipients. Despite the risk of infection from animals, many benefits of pet ownership have been shown and transplant recipients have often had family pets without transmission of infection. Published literature is biased toward reports of infection without denominator data on the number of transplant patients who safely maintain pets in their household. Attention to hand hygiene after contact and ensuring that pets are in good health should be emphasized.

Safer Sexual Practices

Many infections can be transmitted during sexual contact. Some of these can be reduced by having a long-term monogamous relationship or decreasing the number of sexual partners.

Sexually active transplant recipients should:

- Always use latex condoms during sexual contact outside of long term monogamous relationships to reduce exposure to CMV, hepatitis B and C, HIV, HPV, HSV and other sexually transmitted infections [II-2].
- Consider using latex condoms during sexual activity with long-term monogamous partners during periods of increased immunosuppression [III].
- Avoid exposure to feces during sexual activity [II-2].
- Immunize against HBV and HPV at appropriate ages, and when possible before transplantation to achieve greatest efficacy (see section 31, Immunizations).

Education in safer sex practices is an important component of medical care, particularly for adolescents with recent or imminent sexual debut (17). Immunization against HPV is

particularly warranted in adolescents and young adults and has been shown in immunocompetent individuals to be most efficacious when administered before initiation of sexual intercourse. In addition, transplant recipients are at increased risk for malignancy from HPV accordingly prevention is prudent.

Travel Safety

Travel to developing countries poses substantial risk to transplant recipients, particularly during periods of maximal immunosuppression [III]. Expanded recommendations can be found in the comprehensive review by Kotton et al. (18) and the sections on Travel Medicine (section 33) and Parasitic Infections (section 28) in the current Guidelines. Plans to travel should be discussed with the transplant recipient's physician at least 2 months before the planned departure date. All items discussed above are applicable for safe living during travel. Updated travel advisories should be obtained from the Centers for Disease Control and Prevention website, www.cdc.gov.

Particular attention should be paid to access to hand-washing facilities, food and water consumption, updating vaccinations and potential interactions that might occur between prophylaxis medications and their routine medicines.

Travelers should take with them a sufficient supply of medications that they may require. A copy of their medication list, signed by a physician, should also be taken in case they are questioned about their medications, particularly if their medications are no longer in the original prescription bottles. Plans for evacuation in the event of medical emergency and should be formulated.

Transplant recipients should be advised about all preventive measures that pertain to their anticipated exposures (e.g. protection against arthropod vectors, swimming precautions, etc.). The use of effective insect repellents and mosquito netting may be crucial in certain areas.

Work- and School-Related Issues

The above sections have touched on many topics relevant to potential infection hazards in the workplace and in school for children. Individualized occupational counseling is important for transplant recipients contemplating return to work in such areas as health care, construction, outdoors work and other fields. Whereas some recipients may be willing to consider a career change (e.g. leaving a temporary job in a pet store), others may be strongly attached to their line of work for multiple reasons such as psychological, financial, or social. In some cases, a return to work is necessary for the transplant recipient to maintain family financial stability and their health insurance. Few guidelines

exist for decisions of this nature, but the vast majority of jobs can be made safer by simple measures. These include restricting patient contact for the initial phase of returning to work in a health care environment, wearing masks when there are potential exposures to fungal spores, respiratory viruses, or other transmissible illnesses, and sometimes reassignment to other duties particularly during periods of intensified immunosuppression. Often co-workers can be encouraged to receive influenza vaccinations to help protect the recipient as well. The clinician can help by adopting an attitude of working with the transplant recipient to make the proposed work situation safer, rather than issuing an unconditional order to change jobs (with occasional exceptions).

School attendance is of major importance for children who have received transplants and often is a concern for the family. For this reason it is imperative that pediatric transplant teams discuss this issue with parents early during the pretransplant evaluation and again well in advance of discharge from the hospital so that plans can be made with the schools. The timing of return to school is impacted upon by the type of transplant, the level of immunosuppression and the age of the child. In most cases, children are able to return to school several months after the transplant. It may be prudent however, to avoid returning to school during influenza season. In general a close working relationship with the school nurse is needed so that they are aware of any medical issues about the child as well as to have them inform families about infectious disease outbreaks and to remind classmates about the importance of receiving all of their required vaccinations.

Sports and Recreation

The risks of hobbies such as hunting, fishing, scuba diving, or spelunking should be discussed with the transplant recipient (9).

In general, athletic activities have been noted to be both safe and beneficial for many transplant recipients (20), with some notable exceptions. In addition to the psychological and health benefits to the individual of sporting activities, the existence of the World Transplant Games has been reported to have increased the public's knowledge and favorable opinion of transplantation (20). Returning to an appropriate level of recreational and athletic activity can help the transplant recipient's self-esteem and guard against depression. Transplant centers often offer specific restrictions related to the outdoors, as mentioned above, and in addition may choose to advise against certain activities due to risk of physical injury, such as rugby and boxing (21). In addition, the overall physical state and level of immunosuppression of the particular recipient should be considered. Occasionally unexpected consequences might occur, such as the physical effects from direct contact of climbing

harnesses with kidney allografts, leading to concern about the possible effects of rock climbing, rappelling and challenge courses (22).

Precautions to Prevent West Nile Virus and Other Mosquito-borne Infections

West Nile virus (WNV) can cause severe disease in transplant recipients, who have a much higher risk of central nervous system involvement than the general population (23). Other arthropod transmitted infections can also be severe in immunocompromised hosts. Several simple measures can help to prevent infection with these pathogens. Transplant recipients should avoid going out at dawn or dusk, during peak mosquito feeding and should use effective insect repellents that contain DEET. On average, the duration of protection offered by DEET at different concentrations is as follows: 5, 4, 2 and 1.5 h for products with DEET concentrations of 23.8%, 20%, 6.7% and 4.5%, respectively (24). In addition, transplant recipients should wear protective clothing during the high-risk season and in areas where transmission is occurring. Sources of standing water, such as old tires, should be removed from yards and property belonging to transplant recipients. Specific prophylaxis when traveling to areas with endemic mosquito borne infections such as malaria is discussed in the chapters on Parasitic Infections and Travel Medicine (sections 28 and 33).

Patient Contacts: Family, Friends and Healthcare Workers

Although prevention of infection is often aimed at interventions applied directly to the recipient (host-related interventions) it is also important to recognize that close contacts can transmit infections that can be particularly harmful to the transplant recipient. Accordingly, it is worth educating close contacts about ways to maintain their own health. All healthcare workers should receive ongoing education about hand hygiene and standard precautions when caring for people in the health care environment. Vaccination against influenza is encouraged for everyone but particularly for those involved in the care of transplant recipients. Many institutions have developed mandatory immunization policies against this virus. Vaccines for other infectious agents are also routinely offered by health care systems particularly against Hepatitis B virus, measles, mumps, rubella, varicella and more recently acellular pertussis vaccine as part of diphtheria and tetanus vaccination (see section 31, Immunizations). All household contacts should be instructed on good hygiene precautions including, hand-washing, cough and sneezing etiquette and covering open wounds. They should all receive yearly influenza vaccination and to ensure that their other standard immunizations are up to date including vaccinations against pertussis, measles and varicella. Contacts at work and school should also be encouraged to receive their immunizations.

Conclusion

With the increasing longevity of transplant recipients, more and more recipients are returning to active lives, to work and to recreational activities. Inevitably potential infection risks are present with the expansion of permissible activities. Careful thought and detailed patient education can prevent many of these risks. Occupational counseling can enable transplant recipients to find safer ways to do the jobs that they love, and that they need to maintain financial stability and insurance coverage. Knowledge of the risks of food, animal exposures and other environmental exposures can help transplant recipients stay out of the hospital and lead healthy, meaningful and long lives.

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