INFECTION CONTROL CHALLENGES IN CHILD-CARE CENTERS

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Current social and economic factors have resulted in increasing numbers of children attending child-care facilities outside of the home. In the United States over 13 million children less than 5 years of age and 60% of children less than 13 years of age are enrolled in some form of out-of-home child care.[85, 108] Children attending out-of-home care settings are at increased risk for a variety of infections.[25, 62, 79, 88] The incidence of respiratory tract infections, diarrheal disease, cytomegalovirus, hepatitis A, and bacterial meningitis is higher in children cared for outside of the home.[54, 88] Increased rates of infections result in increased morbidity of children attending child-care facilities and significant economic impact because of loss of work and cost of medical care. These costs have been estimated at 1.8 billion dollars per year in the United States.[47] Parents of children attending child-care facilities miss from 1 to 4 weeks of work per year caring for ill children.[28] Increased risk for infections in child-care settings is of public health significance because of potential transmission to adult contacts and dissemination into the community.[88] Infections acquired in child-care settings that are mild or asymptomatic in children may be severe in adults.[85]

TRANSMISSION OF PATHOGENS

Host and environmental factors and organism characteristics contribute to the transmission of infectious agents in the out-of-home care setting. Host factors include age-specific personal hygiene, immunologic maturation, and physiologic factors. Young children are known for their propensity to contaminate the environment with respiratory tract secretions, urine, and feces. Immunologically naive, they are vulnerable to infection after maternal antibodies disappear and

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before the development of their own protective antibodies. Eustachian tube anatomy and dysfunction caused by respiratory tract viruses contribute to otitis media, an important infectious syndrome in children in child-care facilities and the major condition for which children are given antimicrobial agents in the child-care setting.[77, 87]

Environmental factors include size of the facility, crowding, mixing of different age groups, and physical characteristics of the facility. Crowding has been shown to be a risk factor for infection associated with hepatitis A virus, respiratory tract pathogens, and enteropathogens. Age-mixing exposes children to pathogens that they may not come in contact with when associating with children of their own age.[77] Physical characteristics such as number and location of sinks and toilets, adequacy of ventilation, and location and cleanliness of food preparation areas are important in the spread and control of organisms. Characteristics of organisms such as ability to survive outside of the host, method of transmission, virulence mechanisms, and infective dose also are important. Many organisms can be transmitted before a child is symptomatic. In other instances, children who are asymptomatic or mildly ill may be highly infectious. Respiratory tract and enteric pathogens are the most frequently encountered infectious agents in the child-care environment. Table 1 shows pathogens that have been reported to be transmitted in child-care centers by organism and organ system.

Table 1. INFECTIOUS DISEASES STUDIED IN CHILD CARE SETTINGS

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RESPIRATORY TRACT TRANSMISSION

Infections transmitted by the respiratory route not only cause respiratory tract disease, but also may be associated with systemic or invasive disease (Table 2). Methods of respiratory tract spread include aerosolized particles, large and small droplets, and hand to mucous membrane transmission by direct transfer of infectious secretions from persons or contaminated objects.

Respiratory Tract Infections

Respiratory tract infections are the most common acute illnesses in the United States.[48] Respiratory tract infections include colds, sinusitis, pharyngitis, pneumonia, and otitis media. These infections are more frequent in children in the child-care setting than in children cared for at home, especially children less than 2 years of age.[48, 56, 70, 91] An estimated 10% of respiratory tract illnesses in the United States has been attributed to child care.[56] Although most respiratory tract infections are self-limited and not associated with long-term sequelae, their impact is significant in terms of discomfort to children, disruption of families, and direct and indirect economic costs. Viral upper respiratory tract pathogens also are a major predisposing factor in otitis media.[91]

Organisms causing respiratory tract infections in the child-care setting are reflective of those in the community and include adenovirus, respiratory syncytial virus, parainfluenza viruses, rhinovirus, coronavirus, influenza viruses, enteroviruses, and *Streptococcus pneumoniae*.[40, 69, 91] These agents are transmitted primarily by direct inoculation of infectious particles from hand to nasal, pharyngeal, or conjunctival mucosa. Infants may be infected by caretakers who transmit organisms from themselves or other infants. Toddlers, on the other hand, are effective transmitters of these pathogens because of their ambulatory status, age-specific personal hygiene, and behaviors that involve exchange of secretions.[106]

Prevention of respiratory tract infections caused by these organisms is difficult because they are encountered frequently, are highly infectious, may be shed before or after the symptomatic period, and may be able to survive for significant time periods outside the host.[40] The most effective means of preventing the spread of respiratory tract pathogens is handwashing.[37] Fomites and

Table 2. PATHOGENS TRANSMITTED BY THE RESPIRATORY ROUTE

Viruses	Bacteria
Adenovirus	*Bordetella pertussis*
Coronavirus	*Haemophilus influenzae* type b
Enteroviruses	*Mycobacterium tuberculosis*
Influenza	*Neisseria meningitidis*
Measles	*Streptococcus pneumoniae*
Mumps	*Streptococcus pyogenes*
Parvovirus B19	
Parainfluenza	
Respiratory syncytial virus	
Rhinovirus	
Rubella	
Varicella	

shared objects also may be important in transmission, so daily cleaning of shared toys and materials handled by children is recommended.[40, 56] Exclusion of children with respiratory tract illnesses from child care generally is not indicated unless a specific cause that requires exclusion is identified, the illness prevents a child from participating in the program, or the illness places too great a care need on the staff.[4, 69]

Other respiratory tract pathogens are transmitted in the child-care environment but much less frequently. *Bordetella pertussis* can be transmitted from adults whose immunity has waned to unimmunized individuals and infants less than 6 months of age who may not have completed the initial immunization series.[30, 51, 109] The predominant mode of spread is by droplets and droplet nuclei generated by coughing, but transmission can occur through handling of contaminated objects.[14] Outbreaks of pertussis in child-care centers have been documented.[52] Prevention and control of pertussis lies in maintaining a high level of immunization among children, realizing that immunity wanes as they approach adolescence.[73] Children attending child-care facilities should have pertussis immunization administered at the appropriate time as recommended by the ACIP/AAP/ AAFP in the harmonized schedule, "Recommended Childhood Immunization Schedule."[10] Children who are exposed to pertussis who are less than 7 years of age and who are not immunized or have received less than four doses of pertussis vaccine should have their immunization series completed. Chemoprophylaxis is recommended for all household and close contacts, including child-care contacts. Exposed children with a cough should be excluded from child care until evaluated by a physician, and children with pertussis should be excluded until they are treated for 5 days with an appropriate antibiotic regimen and until clinically stable.[4]

Tuberculosis. Tuberculosis in children has been noted to be on the rise,[105] although tuberculosis remains uncommon in the child-care setting. Infection primarily is spread through airborne droplet nuclei, and the source is almost always an adult with pulmonary disease. Children less than 5 years of age rarely are contagious.[91, 97] In the past 25 years, four outbreaks of tuberculosis in the child-care setting have been reported in the literature.[33, 64, 68, 76] In three of the outbreaks, the source of infection was traced to adults to whom the children were exposed; in one outbreak, no source was identified.[33] Prevention of tuberculosis in the child-care setting is achieved by screening adult contacts with tuberculin skin-testing, isoniazid preventive therapy in those with positive skin tests and contact tracing, and directly observed therapy for infected adults in the community.[21] Routine screening of children in child care has little value and is not recommended.[91] Children who are found to be infected with *Mycobacterium tuberculosis* should be excluded from child care until after initiation of appropriate therapy and determination of noninfectious status by a physician or health department official.[4, 101]

Group A Streptococci. Group A streptococcal infection can manifest as pharyngitis, impetigo, or invasive disease. In the child-care setting, outbreaks of group A streptococcal disease have been uncommon,[42] but carriage of the organism, pharyngitis, and invasive disease have been reported.[36, 110] Two studies show an overall high rate of pharyngeal carriage of the organism and apparent early acquisition of pharyngeal colonization among child-care attendees.[36, 110]

Transmission of group A streptococcus occurs by contamination with infectious respiratory tract secretions. Handwashing after contact with respiratory tract secretions is important in prevention of transmission. Infected individuals should be excluded from child-care attendance until they have received 24 hours of appropriate antimicrobial therapy and are afebrile.[4] Exposed children and

personnel who are symptomatic should be evaluated by a physician, cultured, and treated if a rapid diagnostic test or cultures are positive. Screening of asymptomatic individuals is not recommended in the nonoutbreak situation. When an outbreak occurs, selective culturing may be indicated.[59]

Parvovirus B19. Parvovirus B19 is a ubiquitous organism associated with a wide spectrum of illness. Infection may be asymptomatic or manifest as erythema infectiosum in children, acute arthritis or arthralgia in adults, erythrocyte aplasia in persons with hemolytic anemia, and chronic anemia in immunodeficient persons.[8, 79, 107] Infection of pregnant women has been associated with nonimmune hydrops fetalis, fetal death, and spontaneous abortion.[8, 65] Outbreaks of erythema infectiosum have occurred in schools and child-care centers, raising concern as to the risk for infection to pregnant child-care workers. The risk for infection to child-care and school personnel during an outbreak of erythema infectiosum has been shown to be less than that of household contacts but greater than the general population.[12, 24, 43, 79] The risk for fetal death to occupationally exposed pregnant women is estimated to be less than 1%.[8]

Transmission of parvovirus B19 occurs through respiratory tract secretions,[8] making handwashing an important preventive measure. Patients are contagious prior to the onset of clinical symptoms but usually not after the appearance of a rash; therefore, exclusion from child care of immunocompetent children with parvovirus B19 infection is not necessary.[4] Exclusion of pregnant women from child care or teaching is not recommended because of the low risk of adverse outcome, but counseling is recommended.[4, 86]

Invasive Bacterial Infections

Pathogens causing invasive bacterial infections, including *S. pneumoniae*, *Neisseria meningitidis*, and *Haemophilus influenzae* type b, are transmitted by way of the respiratory route. The seriousness of these infections makes their epidemiology in the child-care setting particularly important from an individual and public health perspective.[78]

Neisseria meningitidis. *Neisseria meningitidis* is a major cause of septicemia and meningitis in the United States. Infection may be complicated by arthritis, carditis, pneumonia, disseminated intravascular coagulation, and death. Meningococcal disease is most frequent in children less than 4 years of age, with the highest incidence in children less than 12 months of age.[7, 19, 78] The most common serogroups associated with disease are B and C.[19] An increased risk for primary meningococcal disease in children attending child-care facilities has not been established definitely. Several studies, however, have suggested an increased risk for secondary disease associated with child-care attendance.[38, 60, 63, 78]

N. meningitidis is part of the normal throat flora; colonization of asymptomatic individuals usually ranges from 5% to 10%. Colonization may approach 50% in a child-care center in which a case of invasive disease has occurred. The organism is transmitted by respiratory droplets or direct oral contact with a colonized individual.[93] Control measures during an outbreak include antibiotic chemoprophylaxis for child-care center and other close contacts. Exposed children who develop a febrile illness or other symptoms consistent with meningococcal infection should be evaluated by a physician immediately. Chemoprophylaxis should be given to child-care center contacts within 24 hours of exposure or as soon as possible. Respiratory tract cultures are not recommended.[4, 93] A quadrivalent polysaccharide vaccine that contains serogroups A, C, Y, and W-135 can be used in outbreaks. Indications for use in the child-care setting would

be as an adjunct in control of an outbreak caused by the serogroups represented in the vaccine in children more than 2 years of age.[4, 7] The group A component is immunogenic in infants more than 3 months of age, but the other components are poorly immunogenic in children less than 2 years of age; therefore, routine immunization of children in child-care facilities is not indicated. Conjugated vaccines for use in children beginning at 2 months of age are being evaluated.

Haemophilus influenzae **type b.** Since the introduction of conjugate vaccines for *H. influenzae* type b, there has been a marked decrease in invasive disease caused by this organism.[7] Systemic infection can manifest as meningitis, bacteremia, epiglottitis, cellulitis, pneumonia, or arthritis. Prior to universal immunization, several studies showed an increased risk for primary disease caused by *H. influenzae* in children in child care.[27, 57, 78, 102] The risk of subsequent or secondary disease in the child-care setting following exposure to a primary case is less clear.[78] The *H. influenzae* type b conjugate vaccine is effective in preventing disease and in decreasing carriage rates. Maintenance of age-appropriate immunizations in all child-care attendees is the most effective means of prevention of transmission and disease caused by *H. influenzae* type b. Rifampin prophylaxis is recommended if an outbreak of *H. influenzae* type b invasive disease occurs in a child-care center.[4]

Streptococcus pneumoniae. Streptococcus pneumoniae is a major cause of pneumonia, meningitis, otitis media, and bacteremia in infants and children.[103] Child-care attendance has been shown to be a significant risk factor for nasopharyngeal colonization and invasive disease caused by *S. pneumoniae*.[13, 15, 16, 18, 23, 34, 103] Of particular concern is the finding of high levels of colonization with penicillin-resistant strains of *S. pneumoniae* in child-care attendees. Additionally, there is evidence of horizontal spread of resistant strains among cohorted children.[13, 16, 34] Evidence for dissemination of a multidrug-resistant serotype and the possibility of spread of the drug-resistant phenotype to additional serotypes in child-care settings also has been reported. Although drug-resistant isolates have not been shown to cause more severe disease, they complicate the institution of effective therapy.[80] Not surprisingly, antibiotic pressure has been associated with colonization with increased proportions of penicillin-resistant strains in a child-care center.[16]

Interventions for prevention of pneumococcal disease are limited since the organism is ubiquitous, the current immunization for *S. pneumoniae* is not effective in children less than 2 years of age, and asymptomatic carriage is common, especially in the child-care setting in which colonization rates greater than 50% have been reported.[16, 34] Transmission occurs through person-to-person contact by way of respiratory droplets. The 23–valent polysaccharide vaccine is not recommended routinely in children less than 2 years of age because of poor immunogenicity in this age group. Conjugated vaccines are being tested and seem to be safe and immunogenic.[3, 11] Isolation precautions are not recommended for children in child-care facilities with pneumococcal disease nor is prophylactic antibiotic treatment of contacts effective or recommended.[6] In general, restriction of antibiotic use to bacterial infections and avoidance of broad spectrum coverage unless indicated can reduce antibiotic pressure that results in increased colonization with resistant organisms.

Varicella. A survey in 1995 suggested that the prevalence of varicella in child-care attendees was higher than in children in the general population, that disease occurred at a younger age, and that disease prevalence was higher in larger centers.[35] A varicella outbreak in a child-care center was reported after a child with zoster attended the center.[89] Infection is transmitted by the respiratory

route and direct contact with lesions. Immunocompetent persons are contagious 1 to 2 days before eruption of the rash and approximately 5 days after the onset of lesions.[9] Since varicella is contagious before the onset of the rash, exclusion of infected individuals is not entirely effective at preventing spread. Children with varicella should be excluded until 6 days after the onset of rash but may return sooner if all lesions are crusted. Children or staff members with zoster should be excluded if lesions cannot be covered. Otherwise, lesions should be covered by a dressing or clothing until crusted. Handwashing should be emphasized. Parents and child-care personnel should be informed when a case of varicella occurs, educated about the possibility of fetal damage if infection occurs during pregnancy, and informed of the greater chance of serious infection in adolescents and adults. Susceptible, pregnant staff should be referred for counseling and management, preferably within 24 hours of exposure.[4]

The varicella vaccine was licensed in March of 1995, enabling prevention of varicella. The varicella-zoster virus vaccine is a cell-free live attenuated preparation recommended for universal use in children between 12 and 18 months of age and for immunization of susceptible adolescents and adults.[9] Children in child-care facilities should receive varicella vaccine as part of the routine immunization schedule. Susceptible child-care personnel also should be immunized because they are at high risk for infection in the child-care setting.

Measles, Mumps, and Rubella. Measles, mumps and rubella potentially are transmissible to susceptible individuals in the child-care setting, although increased incidence in the child-care setting has not been established.[84] These viruses are all transmitted by respiratory droplets or contact with respiratory tract secretions that contain the virus.[45, 50, 51] The most important means of prevention of these infections in child care is strict adherence to the ACIP/AAP/AAFP immunization schedule for children and the ACIP guidelines for adult immunization for child-care providers.[4, 26] Evidence of compliance with these schedules or other evidence of immunity should be mandatory for attendance or employment.[49, 50]

If a case of measles, mumps, or rubella should occur in a child or care provider in a child-care center, the infected individual should be excluded as follows: measles, until 6 days after onset of rash; mumps, until 9 days after onset of parotid gland swelling; and rubella, until 7 days after onset of rash. Infants with congenital rubella may be infectious until 1 year of age unless cultures repeatedly are negative.

FECAL-ORAL TRANSMISSION

Diarrhea

Acute infectious diarrhea is the second most common illness involving children attending out-of-home care facilities. Children attending child-care facilities have three times the rate of diarrheal illness as children cared for at home, accounting for an estimated 20% of clinic visits for acute diarrhea in children less than 3 years of age.[85] Newly enrolled children are more susceptible to developing diarrhea than age-matched veterans of child care.[99] Organisms responsible for diarrhea in the child-care setting include rotavirus, astrovirus, calicivirus, enteric adenovirus, *Giardia lamblia,* cryptosporidium, shigella, *Escherichia coli,* salmonella, campylobacter, and *Clostridium difficile* (Table 3).[79, 85] Most episodes of diarrhea in the child-care setting result from person-to-person transmission; foodborne outbreaks are rare.[17] High infectivity of many enteric patho-

Table 3. PATHOGENS TRANSMITTED BY THE FECAL-ORAL ROUTE

Viruses	Bacteria	Parasites
Astrovirus	Campylobacter species	Cryptosporidium
Calicivirus	*Clostridium difficile*	*Giardia lamblia*
Enteric adenovirus	*Escherichia coli*	
Enteroviruses	0157:H7 and other	
Hepatitis A virus	enterohemorrhagic *E. coli*	
Rotavirus	Salmonella	
	Shigella	

gens, grouping of large numbers of susceptible individuals, asymptomatic infection, and environmental fecal contamination all contribute to the increased incidence of diarrheal disease in child-care environments,[53, 67, 71] but the most important factor seems to be the presence of diaper-aged children.[85]

Handwashing is the principal means of preventing transmission of enteric pathogens. In addition, children in diapers should be separated from older children and cared for by separate staff. Caregivers involved in diaper changing should not handle or prepare food, and food preparation areas should be physically separated from diaper changing areas. Diaper changing surfaces should be disinfected between children and sinks should be adjacent to diaper changing areas.[37, 66, 104] Vaccines to prevent disease caused by rotavirus, the most common cause of diarrheal outbreaks in child care, are being evaluated.[72]

Hepatitis A

Outbreaks caused by hepatitis A virus (HAV) in the child-care setting are well-documented. Children under the age of 6 years may be asymptomatic or manifest nonspecific symptoms following infection with HAV, permitting silent fecal-oral transmission in a child-care setting. Adult contacts of an infected child who develop the typical symptoms of jaundice, dark urine, fever, and gastrointestinal tract symptoms may be the first indication of an outbreak.[94, 95] Parents of infected children are most likely to become ill first, followed by center personnel.[79, 94] The most important risk factor for infection in adults is contact with children in diapers. Center characteristics that favor the spread of HAV are size, number of hours open, and age of children enrolled. Larger centers that are open more than 15 hours a day and enrolling children less than 2 years of age are at highest risk for the introduction and spread of HAV.[44] Once HAV is introduced into a center, the rate of spread is related to the number of diapered children and the adequacy of diaper-changing areas and hygienic practices related to diaper changing.[94] Employment variables associated with seropositivity for HAV in one study included changing diapers more than 3 days a week and working with children less than 3 years of age.[58]

In the past, prevention of infection with HAV centered on early recognition and hygienic measures and administration of immune globulin to exposed persons. Although these interventions continue to have an important role, two HAV vaccines are now available, allowing immunization of child-care personnel to prevent infection. Immunization of adults requires an intramuscular injection of one of the two FDA–approved adult formulations with a booster dose 6 to 12

months later. The role of the vaccine in post-exposure management currently is not clear.[41]

PERSON-TO-PERSON TRANSMISSION

Skin Infections-Infestations

The most common skin infections transmitted in the child-care setting are varicella, impetigo, scabies, and pediculosis (Table 4). Herpes simplex virus, *Tinea capitis, Tinea corporis,* and *Molluscum contagiosum* are less common but also may be transmitted in the child-care environment.[85] Varicella has been discussed previously.

The major etiologic agents in impetigo are group A streptococcus and *Staphylococcus aureus.* Transmission occurs by direct contact with skin lesions and therefore lesions should be covered. Children with impetigo should be evaluated by a physician and treated with an appropriate antibiotic regimen. Infected children may return to child-care facilities after they have received treatment for 24 hours.[4]

Scabies is a skin infestation caused by *Sarcoptes scabiei* var *hominis,* the human itch mite. It is highly contagious and has been associated with outbreaks in child-care centers.[90] Scabies can be difficult to diagnose, especially in children with underlying skin conditions. Definitive diagnosis is made by microscopic demonstration of the mite from skin scrapings. Transmission generally occurs through direct contact. Prevention of transmission requires a high index of suspicion and early recognition.[90] Because of the long incubation period, household and other close contacts such as children in the same child-care room should be considered for prophylactic treatment. Bedding and clothing should be laundered in hot water. Children may return to child care after treatment has been completed.[4]

Pediculosis capitis (head lice) can spread rapidly in a child-care center, although the magnitude of occurrence is not known.[85] The most important preventive measure consists of screening children on enrollment and periodically throughout the year. Other policies to decrease transmission of lice and other skin infections and infestations include: (1) no sharing of hats, coats, combs, or brushes; (2) individual areas for personal belongings such as coats and hats; (3) individually assigned bedding and stuffed toys; and (4) frequent vacuuming of mattresses, furniture, and carpet. If a case of lice occurs, children, their families, and child-care staff must be screened. Infested individuals may return to the child-care setting after treatment. Although some centers require "no nit" poli-

Table 4. PATHOGENS TRANSMITTED THROUGH SKIN CONTACT

Viruses	Bacteria	Parasites
Herpes simplex	Group A streptococcus	*Pediculus humanus capitis,*
Varicella-zoster	*Staphylococcus aureus*	*Pediculus humanus corporis,*
		Phthirus pubis (pediculosis)
		Molluscum contagiosum
		Sarcoptes scabiei subspecies
		hominis (scabies)
		Tinea capitis (scalp ringworm)
		Tinea corporis (body ringworm)

cies, which state that children be free of nits before returning to child care, these policies have not been shown to be necessary in control of head lice. Machine washing or drying with hot temperatures is recommended to disinfect clothing, bedding, and cloth toys because lice and eggs are killed by temperatures exceeding 53.5°C. Dry cleaning or storing items in plastic bags for 10 days is also an option.

INFECTIONS TRANSMITTED BY CONTACT WITH BLOOD, URINE, OR SALIVA

Cytomegalovirus

Cytomegalovirus (CMV) is the major viral cause of congenital infection resulting in severe birth defects in the United States and worldwide.[32, 79, 100] Infection usually is asymptomatic in healthy children and adults, although CMV infection may cause viral hepatitis or a mononucleosis-like syndrome in some individuals.[79]

Cytomegalovirus is of concern in the child-care setting for a number of reasons. It commonly is acquired in the child-care environment where excretion rates in urine and saliva of diapered children range from 10% to 100%.[79, 81] Molecular epidemiologic studies have confirmed horizontal transmission among children[1] from hands or contaminated environmental objects. Other studies have shown the seroconversion rates among child-care providers who care for children less than 3 years of age to range from 8% to 20%.[2, 74, 83] Parents of children in child care are also at an increased risk for infection when their children are infected. Risk is increased in parents of children less than 18 months of age.[82] Most child-care workers and mothers of children in child care are women of child-bearing age who, if susceptible, are at risk for congenital infection if they become infected while pregnant.

Most infected children are asymptomatic and may excrete virus for extended time periods making exclusion from child care impractical. Childhood infection in the immunocompetent child may provide immunity against more serious infection at an older age or infection during pregnancy; therefore, interventions to prevent transmission should be focused on child-to-worker and child-to-mother transmission.[32] Transmission is decreased by practicing good handwashing and environmental hygiene. The following is a list of pathogens transmitted through contact with blood, urine, or saliva:

Cytomegalovirus
Hepatitis B virus
Herpes simplex virus
Human immunodeficiency virus

Recommendations for prevention of transmission include: (1) frequent, proper handwashing, especially after assisting with toilet use, diapering, or contact with oral secretions; (2) cleaning and disinfecting environmental surfaces contaminated with urine or other body fluids; (3) cleaning and disinfecting toys after use when possible; (4) proper disposal of diapers or other potentially contaminated materials[32, 79]; (5) use of rubber gloves may be considered during changing of diapers and must be used when handling blood or secretions containing blood; and (6) avoidance of children's saliva by not kissing children on the lips or placing saliva-contaminated hands or objects into caregivers'

mouths.[32] Transmission within families may be decreased by washing hands after changing diapers; avoidance of kissing on or around the mouth; and not sharing food, glasses, or utensils.[79] Serologic testing of women of child-bearing age who are employed in the child-care environment can identify nonimmune individuals, allowing appropriate counseling concerning the risk for infection.[32, 79] Seronegative pregnant workers may choose to seek alternate employment or to be temporarily assigned to care for children more than 3 years of age to reduce risk for infection.[32]

Hepatitis B

Transmission of hepatitis B virus (HBV) in the child-care setting has been documented infrequently.[31, 49, 75, 96] HBV is concentrated in blood and blood-derived body fluids. The most important routes of transmission are through percutaneous blood exposure, sexual contact, and perinatal transmission, but percutaneous blood exposure is the only route important in child-care centers. Bites and mucous membrane exposure to blood or body fluids can result in transmission but not commonly.[95] Reports of transmission in surveillance studies indicate acquisition of HBV in the child-care setting is possible, but in the United States, the risk is relatively low.[39, 55, 92, 96]

Because of the small risk of transmission of HBV in the child-care setting, routine screening for HBV carriage is not indicated, and in general, exclusion of HBV carriers is not necessary. The decision to admit HBV carriers with risk factors such as aggressive behavior (biting and scratching), bleeding problems, and generalized dermatitis should be made based on input from public health authorities, the child's physician, and the center's director. The decision should be reevaluated periodically. Child-care personnel should receive thorough and regular training on the use of universal precautions in the prevention of transmission of bloodborne diseases. Specifically, disposable gloves should be used when cleaning spills of blood or body fluid; areas contaminated with blood or body fluids should be cleaned with a 1:64 diluted bleach solution (left on the surface for two minutes); avoidance of contact of open skin lesions or mucous membranes with blood or body fluids; thorough handwashing after contact with blood or body fluids; use of disposable materials for cleaning spills and disinfection of mops with a diluted bleach solution; and proper disposal of blood-contaminated material and diapers in a plastic bag with a secure tie. Supplies for and education about appropriate universal precautions should be available to all workers. These precautions should be used at all times when exposure to blood or blood-containing body fluids occurs regardless of the HBV status of the child. All children should receive HBV vaccine as a component of the routine immunization schedule and have their HBV immunization status reviewed prior to admission to child care.[4] Child-care providers also should be considered for HBV immunization.

HIV

In the United States, approximately 12,300 out of 14,920 total children born with HIV from 1978 to 1993 were alive at the beginning of 1994.[29] The number of HIV-infected children continues to increase, and with medical advances, many children are leading longer and healthier lives. Because of this, the presence of HIV-infected children in the child-care setting also is likely to increase. Concerns

regarding HIV infection in child care include risks for infection to the HIV-infected child enrolled in child care and the potential for transmission of HIV to other noninfected children and adults.[61]

Potential routes of HIV transmission in child care are contact with blood or body fluids or by bites and scratches that break the skin. Although biting has been suggested but not proven as a possible mode of HIV transmission, data are limited and the likelihood of transmission small.[98] The risk of transmission of HIV from the type of contact normally encountered among children in child-care centers and other out-of-home settings is unlikely.[98] There have been no documented cases of transmission of HIV in the child-care setting; therefore, in general there is no need to exclude HIV–infected children from the child-care environment.[85] The decision for a particular child to attend child care, however, should involve the child's physician. Factors that should be considered in the decision include: the child's propensity for aggressive biting, the presence of exudative skin lesions that cannot be covered, the likelihood of uncontrollable bleeding episodes, and the child's immune status.[98]

Prevention of transmission of HIV and other bloodborne pathogens rests on decreasing the risk for contamination by blood and body fluids by routine use of universal precautions as described in the section on hepatitis B.[85] Detailed recommendations regarding prevention of transmission of HIV and other bloodborne pathogens are available[20, 22] and should be used in the development of infection-control policies for child-care centers.

Certain infectious agents transmitted in the child-care setting are of particular concern because of their ability to cause more severe disease in HIV–infected children. Included in this list are varicella and other herpes viruses, measles, *Cryptosporidium, Salmonella, Haemophilus influenzae* type b, and tuberculosis. Vaccine-preventable diseases also are of concern.[61]

Appropriate immunizations should be required of all children, including HIV–infected children. Immunization schedules have been developed for HIV–infected children that differ from routine immunization schedules as follows: use of inactivated polio vaccine for all HIV–infected children and age-appropriate routine immunization with influenza and pneumococcal vaccines.[5, 61, 98] Varicella vaccine currently is not recommended for HIV–infected children. Prevention of other infections in HIV–infected children requires prompt recognition and appropriate management of exposures to infectious agents. Child-care staff should notify parents if exposures occur, and the health department should be notified if reportable diseases are involved.[98] The child's physician should be informed of infectious disease exposures to facilitate prompt and appropriate management.

There is no contraindication to the employment of adults with HIV infection in the child-care setting provided they do not have communicable infectious diseases or conditions that would expose others to contact with their body fluids. Infected adults who are significantly immunocompromised are at increased risk of contracting infectious diseases from children in their care and should discuss the advisability of working in the child-care setting with their physicians.

GENERAL RECOMMENDATIONS FOR INFECTION CONTROL IN THE CHILD-CARE ENVIRONMENT

Child-care centers should have an established plan to address infection control issues in the child-care environment. This plan should include written guidelines outlining infection control policies and provisions for education of

Table 5. IMMUNIZATIONS FOR ADULTS EMPLOYED IN OUT-OF-HOME CHILD CARE SETTINGS

Type of Vaccine	Dosage Schedule	Specific Indications
Polio	IPV	Consider for workers previously unimmunized and for foreign travel
Tetanus-diphtheria (dT)	Primary series then booster every 10 years	All workers
Measles, mumps, and rubella	2 doses	Persons born after 1956 without documentation of measles
Hepatitis B	3 doses	Consider for all workers
Hepatitis A	2 doses	Consider for all workers
Varicella	2 doses	All workers if not previously infected or immunized
Influenza	1 dose yearly	Consider for all workers Indicated for high-risk persons and persons over 65 years of age
Pneumococcal	1 dose	Indicated for high-risk persons and persons over 65 years of age

child-care personnel concerning methods of disease transmission and prevention. Strategies that should be utilized for prevention and control of infections in child-care settings include maintenance of appropriate immunizations of both children and child-care personnel (Table 5), strict adherence to hygienic practices (especially handwashing, diapering procedures, and universal precautions for blood spills), exclusion or cohorting of ill children as recommended (Table 6), appropriate utilization of antimicrobial agents and immunizations during outbreaks, and separation of diaper-aged children from older children.[9, 42, 85] Specific recommendations for infection control and prevention of disease transmission have been discussed previously in individual sections.

Conditions that do not require exclusion from out-of-home child care* include

Mild upper respiratory tract infections, including colds, croup, otitis media, bronchitis and sinusitis

Asymptomatic excretion of enteropathogens except *E. coli* 0157:H7 or shigella

Low-grade fever (<4 months axillary temperature <100°F; >4 months axillary or oral temperature <101°F)

Nonpurulent conjunctivitis without fever, eye pain, or eyelid erythema

Rash without fever or behavior change

Parvovirus B19 in immunocompetent host

Cytomegalovirus infection

Hepatitis B carrier (assessment made on case-by-case basis)

HIV (assessment made on case-by-case basis)

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*General criteria for exclusion from out-of-home child care include children with illnesses that prevent comfortable participation in activities or when an illness results in a greater care need than staff can provide without compromising care of other children in attendance. In addition, children should be excluded if they manifest high fever, persistent crying, lethargy, irritability, respiratory difficulty, or other signs of severe illness.

Table 6. SPECIFIC CONDITIONS THAT REQUIRE EXCLUSION FROM OUT-OF-HOME CHILD CARE SETTINGS

Condition/Infection	Period of Exclusion/Criteria for Return
Respiratory tract infections	
Pertussis	After 5 days of appropriate antibiotic treatment
Tuberculosis	Until noninfectious as determined by physician/health department official
Streptococcal pharyngitis	After 24 hours of treatment and 24 hours afebrile
Mumps	Until 9 days after onset of parotid swelling
Specific conditions with rashes	
Varicella	6 days from onset of rash or all lesions crusted
Measles	6 days from onset of rash
Rubella	7 days from onset of rash
Scabies	Until treatment completed
Impetigo	Until 24 hours after treatment
Coxsackievirus	Until lesions are dry
Gastrointestinal tract infections	
Hepatitis A	Until 1 week from onset of illness/jaundice or until immune globulin has been given appropriately
Vomiting	2 or more times in previous 24 hours until resolved or judged noncommunicable by physician
Diarrhea	
Not contained by diapers or toilet use	Until diarrhea resolves
Stools contain blood/mucus	Until diarrhea resolves
Giardia lamblia and cryptosporidium	Until diarrhea resolves
E. coli 0157:H7 and shigella	Until diarrhea resolves and two stool cultures are negative
Miscellaneous	
Mouth sores (in children unable to control oral secretions)	Until determined noninfectious by physician
Purulent conjunctivitis	Until 24 hours after antibiotic treatment
Pediculosis	Until morning after treatment
Rash with fever/behavior change	Until determined noncommunicable by physician

SUMMARY

The child-care environment predisposes young children to infection with a variety of pathogens. Factors contributing to increased incidence of certain infections include age-specific hygiene behaviors, immunologic immaturity of young children, and exposure to pathogens with high infectivity. Respiratory tract and enteric pathogens are responsible for most illnesses, but a number of other agents are also important. Hygienic interventions, especially handwashing, remain important in infection control, but maintenance of appropriate immunization levels plays a crucial role in disease prevention in the child-care setting. Future interventions will center on development of new vaccines to eliminate susceptibility of young children to as many infectious agents as possible and continued evaluation of other preventive measures.

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