Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

TABLE 2-6. The Pregnant Healthcare Worker: Guide to Management of Occupational Exposure to Selected Infectious Agents[a]—*Continued*

Agent	In-Hospital Source	Potential Effect on the Fetus	Rate of Perinatal Transmission	Maternal Screening	Prevention
Varicella-zoster virus	Respiratory secretion, vesicle fluid	Malformations, skin, limb, central nervous system, eye. Disseminated or localized disease	Congenital syndrome (2%)	Varicella IgG serology; history 90% correct	Vaccine[c]; VariZIG within 96 hours of exposure if susceptible. Airborne plus Contact Precautions

AIDS, acquired immunodeficiency syndrome; FTA-ABS, fluorescent treponemal antigen-antibody test; HBeAg, hepatitis B e antigen; HBIG, hepatitis B immune globulin; HBsAg, hepatitis B surface antigen; IgG, immunoglobulin G; PPD, purified protein derivative; RPR, rapid plasma reagin test; VDRL, Venereal Disease Research Laboratory test.
[a]Employment, prepregnancy screening/vaccination is primary prevention for certain agents. Annual immunization for influenza is primary prevention.
[b]Congenital syndrome: varying combinations of jaundice, hepatosplenomegaly, microcephaly, thrombocytopenia, anemia, retinopathy, skin, and bone lesions.
[c]Live virus vaccine given before or after pregnancy.
[d]See Chapter 205, Varicella-zoster Virus.

pediatricians' offices have been published and are being updated.[84] Prevention strategies include definition of policies, education, and strict adherence to guidelines.

CHAPTER 3

Infections Associated with Group Childcare

Andi L. Shane and Larry K. Pickering

On average 11.6 million (63%) children 5 years of age or younger and 53% of children 5 to 14 years of age were in some form of group childcare on a regular basis in the winter of 2002 (National Child Care Information Center Child Care Bureau. http://nccic.org).[1] Aggregation of young children potentiates transmission of organisms that can produce disease in other children, adult care providers, parents, and community contacts. Group childcare settings may potentiate increased frequency of certain diseases, the occurrence of outbreaks of illness (Table 3-1), greater severity of illness, an increase in antibiotic use to permit earlier return to care, which results in the potential for emergence of resistant organisms, and an increased economic burden to individuals and society.[2–4] The extent of illness resulting from interaction of children and adults in group childcare depends on the age and immune status of children and adults involved, season, environmental characteristics of the childcare facility, and inoculum size and virulence potential of microbes. Children newly entered into a childcare program are at especially high risk of enteric and respiratory tract infections,[5–10] but as a consequence of these infections may be protected against respiratory tract viral infections and reactive airway diseases during subsequent years.[11] Children who are exposed to infectious pathogens of siblings and contacts in group care and often manifest clinical symptoms of frequent infections early in life may be protected against developing atopic disease in later childhood.[12]

TYPES OF GROUP CHILDCARE

The United States Census Bureau classifies regular preschool childcare arrangements by provider (relative of a child in care versus nonrelative) and location of care. Of the 63% of preschool children in a regular childcare arrangement in the winter of 2002, 40% regularly received care by a relative, 37% by nonrelatives, and 11% by both relatives and nonrelatives. The remaining 12% were not classified as receiving a form of childcare regularly. Nonrelative care can be further divided into provision of care in an organized care facility or childcare center (23%), by a nonrelative in the child's home (4%) or in the provider's home (10%).[1] Types of facilities can also be classified by size of enrollment, age of enrollees, and environmental characteristics of the facility. Grouping of children by age varies by setting but in organized care facilities usually children are separated as infants (6 weeks to 12 months), toddlers (13 to 35 months), preschool (36 months to 59 months), and school-aged children (5 to 12 years). The classification of group childcare settings has relevance to infectious disease epidemiology with regard to regulation and monitoring. Most nonrelative care provided in an organized care facility is subject to state licensing and regulation, whereas relative care in a child or provider's home may not be subject to state regulations and monitoring.

EPIDEMIOLOGY AND ETIOLOGY OF INFECTIONS

Although almost any infectious disease has the propensity to propagate in the childcare setting, diseases shown in Table 3-1 are commonly associated with outbreaks. Organisms that infect enrollees and providers may do so with a predilection for nonimmune persons of specific ages.

Enteric Infections

Outbreaks of diarrhea occur at a rate of approximately 3 per year per childcare center and are most frequently associated with organisms that result in infection after ingestion of a low inoculum. These organisms generally are transmitted from person to person[13,14] and include rotavirus, sapovirus, norovirus, astrovirus, enteric adenovirus, *Giardia lamblia, Cryptosporidium, Aeromonas, Shigella, Escherichia coli* O157:H7, *E. coli* O114, enteropathogenic *E. coli,* and *Clostridium difficile.*[14–26] These fecal coliforms[27,28] and enteric viruses contaminate the environment;[29] contamination rates are highest during outbreaks of diarrhea. The attack rates and frequency of asymptomatic excretion of these organisms in children in childcare are shown in Table 3-2. Reported attack rates depend on several factors, including methods used for organism detection.[22,23]

Enteric viruses are the predominant etiology of diarrheal syndromes among children in group care, with impact by season. In a prospective study of children enrolled in childcare in Denmark during 6 months of winter, rotavirus was the predominant organism identified in 40% of cases with a confirmed etiology, sapoviruses in 18%, and astroviruses in 7%.[30] Organisms generally associated with foodborne outbreaks, such as *Salmonella* and *Campylobacter jejuni,* are infrequently associated with diarrhea in the childcare setting. How-

TABLE 3-1. Association of Infectious Diseases with Group Childcare Settings

Disease or Infection	Risk Factors and Association with Outbreaks
Enteric	Close person-to-person contact, fecal-oral contact, food preparation practices, and suboptimal hand hygiene
Viral	
Rotaviruses, enteric adenoviruses, astroviruses, noroviruses, hepatitis A virus (HAV)	Commonly associated with outbreaks HAV and rotavirus are vaccine-preventable
Bacterial	
Shigella, Escherichia coli O157:H7	Commonly associated with outbreaks
Campylobacter spp., *Salmonella* spp., *Clostridium difficile*	Less commonly associated with outbreaks
Parasitic	
Giardia lamblia, Cryptosporidium parvum	Commonly associated with outbreaks
Respiratory tract (acute upper and lower respiratory tract infections and invasive disease)	Aerosolization and respiratory droplets, person-to-person contact, suboptimal hand hygiene
Bacterial	
Haemophilus influenzae type b (Hib)	Few outbreaks; Hib is vaccine-preventable
Streptococcus pneumoniae	Few outbreaks; invasive *Streptococcus pneumoniae* caused by serotypes in vaccine is vaccine-preventable
Group A streptococcus	Few outbreaks and low risk of secondary cases
Neisseria meningitidis	Few outbreaks; *N. meningitidis* caused by serogroups in vaccine is vaccine-preventable in persons over 2 years of age
Bordetella pertussis	Increasingly associated with outbreaks in childcare centers and schools; vaccine-preventable
Mycobacterium tuberculosis	Occasional outbreaks, usually as a result of contact with an infectious adult care provider
Kingella kingae	Outbreaks rare; oropharynx usual habitat; usually manifest as arthritis and osteomyelitis
Viral	
Rhinoviruses, parainfluenza, influenza, respiratory syncytial virus (RSV), respiratory adenoviruses, influenza, metapneumoviruses	Disease usually caused by same organisms circulating in the community; influenza is vaccine-preventable in children ≥ 6 months of age
Multiple organ systems	
Cytomegalovirus	Prevalent asymptomatic excretion with transmission from children to providers
Parvovirus B19	Outbreaks reported; risk to susceptible pregnant women and immunocompromised
Varicella-zoster virus (VZV)	Outbreaks in childcare centers occur. VZV is vaccine-preventable in children ≥ 12 months of age. Zoster lesions present low risk of infection
Herpes simplex virus (HSV)	Low risk of transmission from active lesions and oral secretions
Hepatitis B virus	Rarely occurs in childcare centers; vaccine-preventable
Hepatitis C virus	No documented cases of transmission in the childcare setting
Human immunodeficiency virus (HIV)	No documented cases of transmission in the childcare setting
Skin	Close person-to-person contact
Staphylococcal and streptococcal impetigo	Transmission increased by close person-to-person contact with lesions; outbreaks less likely with decreased incidence of varicella infections; methicillin-resistant *Staphylococcus aureus* (MRSA) disease increasing
Scabies	Outbreaks in group childcare reported
Pediculosis	Common in children attending group childcare
Ringworm	*Tinea corporis* and *T. capitis* outbreaks associated with childcare
Conjunctiva	Outbreaks in group childcare reported with both bacterial and viral etiologies

ever, a report of an outbreak of diarrhea in 14 of 67 (21%) exposed children and adult care providers associated with ingestion of fried rice contaminated with *Bacillus cereus*[31] highlights the fact that foodborne outbreaks can occur in the childcare setting, especially when food is prepared and served at the center.

Bacterial pathogens that have the potential to cause severe systemic infections, including *E. coli* O157:H7, have been associated with fecal–oral transmission in group childcare settings. An outbreak of this pathogen in a childcare center in Alberta, Canada in June 2002 likely began following introduction of the organism by a 3-year-old enrollee with farm animal contact who developed hemolytic–uremic syndrome. A diarrheal attack rate of 23% was noted among enrollees, which is comparable with attack rates of *E. coli* O157:H7 reported during previous childcare-associated outbreaks. Prolonged asymptomatic shedding and subclinical cases in concert with poor hygiene and toileting practices likely contributed to propagation of the outbreak.[32]

Shigella sonnei has been responsible for periodic multicommunity outbreaks in group childcare. A multicommunity outbreak of over 1600 culture-confirmed cases in the greater metropolitan area of Cincinnati, Ohio from May to September, 2001 had an overall mean attack rate of 10% among childcare center enrollees, with highest attack rates occurring among newly or incompletely toilet-trained enrollees and lowest attack rates occurring among diapered children. Attack rate was 6% among staff. An epidemiologic investigation revealed that a single negative stool culture may be sufficient to confirm the clearance of *S. sonnei* in convalescent, treated enrollees.

TABLE 3-2. Outbreaks of Diarrhea by Organism

Organism	Attack Rate (Enrollees) (%)	Secondary Attack Rate (Family Members) (%)	Asymptomatic Excretion (Enrollees)
Rotavirus	50	15–80	Common
Enteric adenovirus	40	Unknown	Common
Astrovirus	50–90	Unknown	Common
Calicivirus	50	Unknown	Common
Giardia lamblia	17–54	15–50	Common
Cryptosporidium	33–74	25–60	Common
Shigella	33–73	25–50	Uncommon
Escherichia coli			
O157:H7	29, 34	Unknown	Uncommon
O114:NM	67	Unknown	Uncommon
O111:K58	56, 94	Unknown	Uncommon
Clostridium difficile	32	Unknown	Common

Secondary transmission was facilitated by poor hygiene practices, including inaccessible handwashing supplies and incomplete diaper disposal practices, as well as recreational activities involving water.[33] A prolonged multistate increase in shigellosis with similar biochemical and genetic profiles occurred in the south and mid-Atlantic areas from June 2001 to March 2003. A significant proportion of cases were associated with group childcare, emphasizing the ongoing public health challenge of management and control.[34]

Spread of microbes that cause diarrhea from the childcare setting into families has been reported for many enteropathogens (see Table 3-2). The secondary attack rates range from 15% to 80% depending on the enteropathogen, mode of transmission, and length of time in the household. Children in group childcare are generally the index cases within households. A retrospective evaluation of transmission of infectious gastroenteritis (80% due to rotavirus) in 936 households in northern California revealed a secondary household attack rate of 8.8% (95% confidence interval (CI) 7.9–9.7). Older children in the households had a two- to eightfold greater risk of secondary infection than adults in the household. Clinical illness in secondary household cases usually was less severe and of decreased duration, compared with illness in the index case.[35] During outbreaks of diarrhea in childcare centers, asymptomatic excretion of enteropathogens is frequent[14,22,23,36–39] (see Table 3-2). During outbreaks associated with enteric viruses and *G. lamblia* in children younger than 3 years of age, asymptomatic infection occurs in up to 50% of infected children. In one longitudinal study of diarrhea in 82 children younger than 2 years of age in a childcare center, more than 2700 stool specimens were collected on a weekly basis.[39] Using enzyme immunoassays, 21 of 27 (78%) children infected with *G. lamblia* were found to be asymptomatic and 19 of 37 (51%) children infected with rotavirus were asymptomatic. The role that asymptomatic excretion of enteropathogens plays in spread of disease is unknown.

Acute infectious diarrhea is two to three times more common in children in childcare than in age-matched children cared for in their homes.[5,40,41] Approximately 20% of clinic visits for acute diarrheal illness among children younger than 3 years of age have been shown to be attributable to childcare attendance.[5] In addition, diarrheal illness is threefold higher among children in their first month in out-of-home childcare than in children cared for at home.[5,6]

Several factors have been reported to be associated with occurrence of diarrhea among children in group settings. Although diarrhea occurs 17 times more frequently in diapered children than in children not wearing diapers,[42] it is unclear whether diapering is a confounding factor, risk factor, or protective factor in group childcare infections. Children who are diapered are more likely to be younger than children who are not; therefore, higher attack rates may merely represent exposure of a younger, nonimmune cohort. In a multicommunity group childcare outbreak of *Shigella sonnei*, the highest attack rates were noted in rooms where both toilet-trained and diapered children were combined (14%) compared with rooms with toilet-trained children only (9%) and rooms with only diapered children (5%), despite comparable availability of sinks and toilets.[33]

A study evaluating costs associated with office visits for diarrhea in children younger than 36 months of age showed that the average cost for each episode of diarrhea was $289 in 1991, with 21% of the total cost for diarrhea in this 1-year study attributable to rotavirus diarrhea.[43] A 3-year study analyzing medical claims data for the period from 1993 to 1996 showed that the median cost (in 1998 constant dollars) of a diarrhea-associated hospitalization was $2307, and the median cost of a diarrhea-associated outpatient visit was $47.[44]

Rotavirus

Rotaviruses are the most common etiology of significant symptomatic diarrhea in children less than 2 years of age. Most symptomatic infections occur in infants and children between 4 and 24 months of age and are manifest by profuse, watery diarrhea, preceded by emesis and fever. Infections are primarily transmitted from person to person by the fecal–oral route, and are facilitated by interpersonal contact. Rotavirus can be isolated from human stools for approximately 21 days after illness begins and rotavirus RNA has been detected on toys and surfaces in childcare centers.[29]

The highest attack rates of rotaviral infections occur in infants and children who may be enrolled in group childcare, with notable transmission rates from infected contacts and significant rates of hospitalization. In one study, children in childcare centers developed predominantly homotypic antibody responses after infection with rotavirus, but as the number of rotavirus infections increased, children developed heterotypic antibody responses to G types at levels that correlate with broad protection against rotavirus infection and illness.[45] In another study, infections with rotavirus were associated with lower concentrations of antirotavirus-specific fecal immunoglobulin A (IgA), indicating a protective role for higher titers of antirotavirus-specific fecal IgA.[46]

Prevention of transmission of rotavirus infections in persons involved in group childcare includes meticulous hand hygiene and disinfection of potentially contaminated surfaces, with processing of soiled diapers and clothing in areas that are inaccessible to mobile children. Primary prevention of rotavirus may be accomplished with administration of two rotaviral vaccines licensed in 2005: a pentavalent bovine–human reassortant vaccine licensed in the United States, or a monovalent human G1 rotavirus vaccine licensed in several countries outside the United States. Large trials of both products have demonstrated both efficacy and safety, and neither vaccine appears to have an association with intussusception in vaccine recipients but this will be monitored closely[47,48,48a] (see Chapter 216, Rotaviruses).

Hepatitis A Virus

Hepatitis A virus (HAV) infections usually are mild or asymptomatic in children. Less than 5% of children younger than 3 years of age and less than 10% of children between 4 and 6 years of age with HAV infection develop jaundice. The first outbreak of HAV in a childcare center was reported in 1973 in North Carolina;[49] since then, outbreaks have been recognized throughout the United States.[50] Peak viral titers in stool and greatest infectivity occur during the 2 weeks before onset of symptoms. Outbreaks in childcare centers generally are not recognized until illness becomes apparent in older children or adults.[50] Prior to availability of hepatitis A vaccine in the United States, approximately 15% of episodes of HAV infection were estimated to be associated with childcare centers. HAV infections are transmitted in

the childcare setting by the fecal–oral route and occur more frequently in settings that include diapered children, although large size and long hours of operation are also risk factors for outbreaks of HAV infection.[51]

The mainstays for prevention of HAV infection include general measures such as maintenance of personal hygiene, hand hygiene, and disinfecting procedures. Universal administration of two doses of hepatitis A vaccine to all children, beginning at 1 year (12 to 23 months) of age, the two doses administered at least 6 months apart,[52] is recommended by the Advisory Committee on Immunization Practices (ACIP) and the American Academy of Pediatrics (AAP).[53] Administration of immune globulin during outbreaks for postexposure prophylaxis to unimmunized contacts may be indicated[54] (see Chapter 64, Acute Hepatitis; Chapter 238, Hepatitis A Virus). A case-control study to evaluate the effectiveness of a hepatitis A vaccination program targeted at childcare attendees between 2 and 5 years of age found that individuals with direct contact with a childcare center were protected against disease. Furthermore, the 6 times greater risk of hepatitis A that occurred in persons who had contact with a childcare center prior to implementation of the hepatitis A immunization program in Maricopa County, Arizona was not found in the post-vaccination case-control study.[55] Education and training of staff regarding appropriate hygienic practices, as well as modes of transmission of HAV and other enteric diseases, and frequent monitoring of hygienic practices by center directors are essential components of any preventive plan.

Respiratory Tract Infections

Children younger than 2 years of age attending childcare centers have an increased number of upper and lower respiratory tract illnesses compared with age-matched children cared for at home.[5,7,56,57] Studies have shown that approximately 10% to 17% of respiratory tract illnesses in United States children younger than 5 years of age are attributable to childcare attendance.[58,59] Another prospective cohort study found that 89% of disease episodes among children attending a childcare center are respiratory tract infections.[60]

In a retrospective cohort study of 2568 children from 1 to 7 years of age, 1-year-old children in childcare centers had an increased risk of the common cold (relative risk (RR), 1.7; 95% CI, 1.4 to 2.0), otitis media (RR, 2.0; 95% CI, 1.6 to 2.5), and pneumonia (RR, 9.7; 95% CI, 2.3 to 40.6).[56] Attendance in family childcare did not increase risk. In a prospective cohort study in France comparing the risk of upper respiratory tract illnesses (URTIs) in children in three settings – family, small center and large center – demonstrated increased risk of ≥ 5 URTIs in small center enrollers (OR2.2; 95% CI, 1.4–3.4) and modestly increased risk in large center enrollers (OR1.2; 95% CI, 0.8–1.8). In this study, the risk for children attending large childcare centers was intermediate between children in family childcare homes and smaller childcare centers, probably as a result of segregation of children in large centers into small classrooms.

Respiratory tract infections that have been studied in the childcare setting include pharyngitis, sinusitis, otitis media, common cold, bronchiolitis, and pneumonia.[7,56–58,60] Organisms responsible for illness in children in childcare settings are similar to organisms that circulate in the community and include respiratory syncytial virus, parainfluenza viruses, adenovirus, rhinovirus, coronavirus, influenza viruses, parvovirus B19, and *Streptococcus pneumoniae.* Infections due to *Bordetella pertussis* in the United States have experienced a dramatic increase, with 8296 cases of pertussis reported in 2002 and 25,827 cases reported in 2004.[61–63] Incompletely immunized infants under 12 months of age experience significant clinical disease, whereas adolescents and adults remain mildly to moderately symptomatic and infectious, accounting for a significant proportion of cases. In many group childcare arrangements adolescents and adults may be the index case for pertussis infections. In 2005, the AAP and ACIP recommended use of the two Food and Drug Administration (FDA) licensed Tdap vaccines in people, one for adolescents 10 through 18 years of age, the other for people 11 through 64 years of age.[62,63] These vaccines may impact disease in people who receive them as well as in susceptible contacts.

An adult or adolescent source may also be the index case for *Mycobacterium tuberculosis* infections in a group childcare setting, with child-to-child transmission occurring infrequently.[64,65] An outbreak of tuberculosis (TB) associated with a private-home childcare facility in San Francisco, California occurred between 2002 and 2004. Of 11 outbreak cases, 9 (82%) occurred in children less than 7 years of age; all had extensive contact with the private-home childcare facility, where the adult index patient spent significant time. Two children presented with clinical illness, 3 were identified by contact investigation, and 4 were identified by primary care providers during routine TB screening evaluations. Isolates from 4 of the pediatric patients and 2 of the adult patients shared identical molecular patterns. Thirty-six additional children and adult contacts had latent TB infections.[66] High transmissibility of TB among residents of adult daycare centers has also been demonstrated.[67]

Person-to-person transmission of *Chlamydophila pneumoniae* among children in the childcare setting has been reported without occurrence of disease.[68] *Kingella kingae* colonizes the oropharynx and respiratory tracts of young children and has been associated with invasive disease.[69] The first reported outbreak of invasive *K. kingae* osteomyelitis/septic arthritis occurred in a childcare center in 2003. Fifteen (13%) children older than 16 months of age were found to be colonized, with 9 children (45%) in the same class as the 2 children with invasive disease. Matching pulse field gel electrophoresis (PFGE) patterns supported child-to-child transmission.[70] A retrospective review of osteoarticular infectious etiologies from 1999 to 2002 of 406 hospitalized children in Paris, France demonstrated that *K. kingae* was isolated from 14% of clinical specimens. This pathogen was isolated more frequently from children younger than 36 months of age and was the second most common bacterial isolate in this population. Awareness of the clinical manifestations, laboratory requirements for growth, and risk factors for acquisition in childcare may account for the increasing incidence of *K. kingae* infections.[71]

Group A streptococcal infection among children and adult staff in the childcare setting is not a common problem, but outbreaks have been reported.[72–74] In a study of prevalence of group A streptococcus conducted in a childcare center after a fatal case of invasive disease, 25% of 258 children and 8% of 25 providers had group A streptococci isolated from throat cultures.[72] Risk of carriage was increased in children who shared the room of the index case (odds ratio (OR), 2.7; 95% CI, 0.8 to 9.4). In a study in childcare centers in Israel, the prevalence of group A streptococcus was 3% in infants and 8% in toddlers. Pharyngeal carriage was not associated with respiratory tract symptoms.[75] Group A streptococcal perianal infection and infection associated with varicella have also been reported.[69,70]

The risk of acute otitis media is significantly increased in children in childcare, especially in children younger than 2 years of age.[60,58,76–78] In one study, the incidence rate ratio for otitis media was 1.5 in children in childcare compared with that in children in home care.[58] Otitis media is responsible for most antibiotic use in children younger than 3 years of age in the childcare setting. However, implementation of the 2004 acute otitis media treatment guidelines developed by the AAP[79] may reduce use of prescription antibiotics for acute otitis media in children enrolled in group childcare. Childcare attendance has also been associated with risk of developing recurrent otitis media (more than 6 episodes in 1 year), as well as chronic otitis media with effusion persisting for more than 6 months.[80] The size of the childcare center was an important variable in the occurrence of frequent otitis media in children younger than 12 months of age, varying from 16% in small care groups to 36% in large care groups.[77] Genotypically similar strains of nontypable *Haemophilus influenzae* were isolated from throats of 127 children attending 16 childcare centers in Michigan. Rates of colonization were greater among attendees of childcare centers with > 5 classrooms, and when suboptimal hand hygiene was performed by staff and children. Colonized children who were recipients of a course of antibiotics at

the time of culturing were more likely to be colonized with a beta-lactamase-producing nontypable *H. influenzae* strain.[81]

Handwashing decreases the frequency of acute respiratory tract diseases in childcare.[82,83] A cluster, randomized, controlled trial of an infection control intervention including training of childcare staff regarding handwashing, transmission modes of infection, and aseptic techniques related to nose-wiping demonstrated a significant reduction in respiratory tract illnesses among enrollees less than 24 months of age over 311 child-years of surveillance.[84] Because most infectious agents are communicable for a few days before and after clinical illness, exclusion from childcare of children with symptoms of upper respiratory tract infections will probably not decrease spread. Exclusion should occur when illness limits the child's participation in activities or when the child's needs exceed the capacity for provision of care.

Influenza

Although influenza is responsible for disease among persons of all ages, rates of infection are highest among children less than 2 years of age and rates of complications of influenza infection are greatest among children of all ages with predisposing or underlying medical conditions. Influenza viruses are spread from person to person primarily through transmission of large respiratory tract droplets, either directly or by secondary contact with objects that are contaminated with infectious droplets. Children can shed virus for several days prior to onset of clinical symptoms and may be considered to be infectious for > 10 days following symptom onset. Transmission of infections may be increased by close contact among children who are not able to contain their secretions. Complications of influenza, including febrile seizures, encephalopathy, transverse myelitis, Reye syndrome, myositis, myocarditis, pericarditis, and death, can occur in children of preschool age.

Among preschool-aged children with influenza infections, hospitalization rates range from 100 to 500/100,000 children, with highest hospitalization rates among children aged 0 to 1 year of age.[85] Deaths from influenza uncommonly occur among both children with and without predisposing medical conditions. Reports of 153 laboratory-confirmed influenza-related pediatric deaths from 40 states during the 2003 to 2004 influenza season indicated that 61 (40%) were < 2 years of age and, of 92 children 2 to 17 years of age, 64 (70%) did not have an underlying medical condition traditionally considered to place a person at risk for influenza-related complications.[86]

Annual vaccination against influenza is the primary method for preventing influenza infection, and reducing transmission of infection among children in the childcare setting and among childcare providers. Influenza vaccine is recommended for all *children 6 to 59 months* of age, care providers of children 0 to 59 months of age in the childcare setting, and children and adolescents > 59 months of age with underlying medical conditions predisposing them to complications from influenza infection.[85] A single-blind randomized controlled trial conducted during the 1996 to 1997 influenza season in 10 childcare centers in San Diego, California revealed that vaccinating children against influenza reduced influenza-related illness among their household contacts.[87] In addition to preventing respiratory tract illness, several studies have shown the effectiveness of influenza vaccine in preventing otitis media among children in childcare.[83,84,87a] In one study of children 6 to 30 months of age in childcare centers, OR for acute otitis media was 0.69 and the 95% CI was 0.49 to 0.98 for those who received influenza immunization.[88]

Routine use of intranasal influenza vaccine among healthy children may be cost-effective and may be maximized by using group-based vaccination approaches. A prospective 2-year efficacy trial of intranasal influenza vaccine in healthy children 15 to 71 months of age demonstrated clinical efficacy as well as economic efficacy associated with focusing vaccination efforts on children in group settings.[89] Vaccinating children has been associated with protection of older persons as well.[89,90]

Effective secondary prevention of transmission of influenza can be achieved with frequent hand hygiene using either soap and water or alcohol-based hand rubs, by both childcare enrollees and providers. Respiratory etiquette with disposal of tissues and cleansing of hands after contact with secretions should be observed. Frequently touched surfaces, toys, and commonly shared items should be cleaned at least daily and when visibly soiled.

Children with signs and symptoms of respiratory tract illness should be cohorted, if possible, and excluded from group childcare if their symptoms prevent participation in activities or if their illness requires a level of care that exceeds a level that can be provided by the care provider. Ill childcare providers should be discouraged from providing care or having contact with children in group childcare. Vaccination of both child attendees and adult providers should be encouraged and both children and providers should receive frequent reminders regarding hand hygiene and respiratory etiquette to reduce influenza infections in group childcare settings.

Invasive Bacterial Infection

Studies conducted before routine use of *Haemophilus influenzae* type b (Hib) vaccine in the United States have shown that the risk of developing primary invasive infection due to *H. influenzae* type b was higher among children attending childcare centers than in children cared for at home, independent of other possible risk factors.[91,92] Risk of subsequent or secondary *H. influenzae* type b disease in the childcare setting was less convincing.[91] Incorporation of conjugated Hib vaccines into the routine immunization schedule of children in the United States has dramatically reduced the frequency of invasive disease due to *H. influenzae* type b.

Risk of disease due to *Neisseria meningitidis* may be increased in children in group childcare. Using space–time cluster analysis of invasive infections during 9 years of surveillance, from 1993 to 2001, in the Netherlands, researchers noted that clustering beyond chance occurred at a rate of 3% (95% CI 2% to 4%), and concluded that this rate was likely the result of direct transmission. Childcare center attendance was reported as the likely exposure for 8/40 (20%) of clusters, accounting for 13/82 (16%) cases of invasive disease with multiple serosubtypes.[93] Childcare attendees who develop clinical disease while enrolled in group care prompt heightened community awareness and often result in distribution of prophylaxis to family and childcare contacts.[94]

The risks of developing primary invasive disease due to *Streptococcus pneumoniae,* of nasopharyngeal carriage of *S. pneumoniae,* and carriage of antibiotic-resistant strains are increased for children in childcare centers[95–102] and childcare homes.[97] In Finland, an increased risk of invasive pneumococcal disease in children younger than 2 years of age was associated with childcare attendance (OR, 36; 95% CI, 5.7 to 233), family childcare (OR, 4.4; 95% CI, 1.7 to 112), and history of frequent otitis media (OR, 8.8; 95% CI, 2.5 to 31).[97] Resistance significantly decreased with a reduction in antibiotic use. Acute otitis media is the most common manifestation of pneumococcal infection and the source of most antibiotic prescriptions for children.[103] Secondary spread of *S. pneumoniae* in the childcare setting has been reported, but the exact risks are not known.[102,104–106] Colonization with *S. pneumoniae* in a childcare center was found in 32 of 54 (59%) children 2 to 24 months of age; 75% of the strains were penicillin-nonsusceptible.[98] In an evaluation of the childcare cohort of an 11-month enrollee with multidrug-resistant *S. pneumoniae* in southwest Georgia, *S. pneumoniae* was isolated from 19 (90%) of the 21 nasopharyngeal cultures; 10 (53%) were serotype 14 and matched the susceptibility pattern of the strain from the index child; 4 of the 10 children with index-strain carriage had shared a childcare room with the index child, suggesting person-to-person transmission.[107]

Incorporation of a conjugated pneumococcal vaccine into the routine childhood immunization schedule of children in the United States in August of 2000 has resulted in a dramatic reduction in the frequency of invasive disease.[108] The impact of vaccination on acute otitis media and reduction of penicillin-nonsusceptible pneumococcal infection is less dramatic and more variable, with evidence of

increasing nasopharyngeal colonization and respiratory tract infections caused by nonvaccine serotypes and nontypable strains of pneumococcus.[108–111]

Methicillin-Resistant *Staphylococcus aureus*

Infections due to methicillin-resistant *Staphylococcus aureus* (MRSA) were reported infrequently in the group childcare setting before 2000.[112–114] However, with emergence of a community-acquired MRSA, the incidence of infection and its predisposition for affecting individuals in crowded conditions, where sharing of fomites exists, where skin-to-skin contact occurs, and hygiene is compromised place children in group care at risk.

Echovirus

During an outbreak of echovirus 30 infection in children and care providers in a childcare center, and in exposed parents, infection occurred in 75% of children and 60% of adults, but aseptic meningitis was more frequent in infected adults (12 in 65, 18%) than in children (2 in 79, 3%).[115] A retrospective cohort study of childcare center attendees, employees, and household contacts in Germany revealed that 42% of childcare attendees, 13% of their household contacts, 5% of childcare center employees, and 2% of their household contacts were ill over a 31-day period. Thirteen percent (12/92) of childcare attendees had meningitis. This outbreak likely began among children enrolled in group childcare centers, with secondary cases occurring among their household contacts.[116]

Cytomegalovirus

Young childcare attendees shed cytomegalovirus (CMV) chronically after acquisition and often transmit virus to other children and adults with whom they have close daily contact.[117–119] Transmission is thought to occur through direct person-to-person contact and from contaminated toys, hands of childcare providers, or classroom surfaces.[120] Prevalence studies have shown that 10% to 70% of children younger than 3 years of age (peak, 13 to 24 months) in childcare settings have CMV detected in urine or saliva.[117,119,121] CMV-infected children can transmit the virus to women, with rates from 8% to 20% for their childcare providers and 20% of their mothers per year (Table 3-3)[118,121–123] compared with rates of 1% to 3% per year in women whose toddlers are not infected.

TABLE 3-3. Acquisition of Cytomegalovirus by Childcare Center Providers and Others

Study	Number of Seronegative Persons	Annual Rate of Seroconversion (%)
Childcare providers (Alabama)[122]	202	11
Hospital employees (Alabama)[122]	229	2
Childcare providers (Virginia)[118]	82	20
Hospital employees (Virginia)[118]	300	2
Childcare providers (Iowa)[123]	82	8
Childcare providers (Toronto)[121]	68	13

Bloodborne Viral Pathogens

Concern has arisen about the potential for spread of bloodborne organisms in the childcare setting: hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency virus (HIV).[124–127] The highest concentrations of HBV in infected persons are found in blood and blood-derived body fluids. The most common and efficient routes of transmission are percutaneous blood exposure, sexual exposure, and, perinatally, from mothers to offspring at the time of delivery (see Chapter 109, Epidemiology and Prevention of HIV Infection in Children and Adolescents; Chapter 111, Diagnosis and Clinical Manifestations of HIV Infection). Other recognized but less efficient modes of transmission include bites and mucous membrane exposure to blood or other body fluids.[128,129] Two case reports and a larger study have demonstrated possible transmission of HBV among children in the childcare setting.[129–131] Other investigators have failed to demonstrate transmission in childcare, despite long-term exposure to children positive for hepatitis B surface antigen (HBsAg).[132] Because of the small number of studies, the risk of HBV transmission in childcare cannot be quantified precisely. If a known HBsAg carrier bites and breaks the skin of an unimmunized child, hepatitis B immune globulin and the HBV vaccine series should be administered.[125] With implementation of universal immunization of infants with HBV vaccine beginning in 1991, horizontal HBV transmission in the childcare setting has been reduced to negligible.

As the seroprevalence of HCV infection in children under 12 years of age is estimated to be 0.2% and most acute infections are asymptomatic, the transmission risk of HCV infection in childcare settings is unknown. The general risk of HCV infection from percutaneous exposure to infected blood is estimated to be 10 times greater than HIV but less than HBV.

Areas of concern regarding attendance of an HIV-infected child in group care include the child's potential risk of transmitting HIV and of acquisition of infectious agents.[124] No cases of HIV infection are known to have resulted from transmission of the virus in out-of-home childcare. Children with HIV infection in the childcare setting should be monitored for exposure to infectious diseases, and their health and immune status should be evaluated frequently. The risk of transmission of HIV by percutaneous body fluid exposure, such as biting, is low. Complete evaluation of the source and extent of exposure should be undertaken to assess the risks and benefits of postexposure prophylaxis.[125] An infectious disease physician with expertise in HIV care can be contacted for guidance.

Precautions for the prevention of HBV, HCV, and HIV infection should be directed toward preventing transfer of blood or exudate fluids from person to person. Childcare providers should be educated about modes of transmission of bloodborne diseases and their prevention, and each center should have written policies for managing illnesses and common injuries such as bite wounds. Standard precautions for handling blood and blood-containing body fluids should be practiced in all childcare settings.[125] Children infected with HIV or HCV or children who are HBsAg carriers should not be excluded from childcare. Decisions regarding attendance at childcare and the optimal type of childcare must be made by parents and the child's physician after considering the possible risks and benefits.

Skin Infection and Infestation

The magnitude of skin infections or infestations and the rates of occurrence in children in group childcare compared with rates in age-matched children not in group childcare are not known. The most frequently recognized nonvaccine-preventable conditions are impetigo or cellulitis (due to *Staphylococcus aureus* or group A streptococcus), pediculosis, and scabies.[73,83,133] Other conditions with skin manifestations that occur in children in childcare include herpes simplex virus (HSV) infection, varicella, ringworm, and molluscum contagiosum.[73,134–137]

Unimmunized children in childcare facilities are susceptible to varicella infection; most reported cases occur in children younger than 10 years of age.[73,135] An outbreak of varicella was reported when a child with zoster attended a childcare center.[134] Although the lesions

were covered, the child continuously scratched and showed others the lesions, indicating the potential difficulties with this policy. Infection with group A streptococcus is a known complication of varicella.[73] Although universal immunization with varicella vaccine has reduced cases of both varicella infection and its associated streptococcal complications among children in group childcare,[52] several outbreaks of varicella have been reported among childcare attendees in the postlicensure era.[74,138139] An outbreak of varicella in a childcare center in New Hampshire in 2000 with a vaccination coverage rate of 66% resulted in clinical disease in 25 of 88 (28%) children. This outbreak demonstrated poor protection against overall varicella disease. However vaccination was shown to be protective against moderate or severe clinical varicella.[74] An active surveillance evaluation for vaccine effectiveness in Israel revealed 8 childcare-associated outbreaks in a 6-month time period from January to June, 2003 involving 116 children with clinical disease from 3 to 6 years of age. A vaccine coverage rate of 37% was noted among this cohort. In concordance with findings from vaccine postlicensure outbreaks in the United States, 94% of children with breakthrough varicella and 14% with natural varicella had mild disease.[138] A varicella outbreak occurring among elementary school attendees in Maine in December to January 2003 was due to failure to vaccinate. The vaccination rates were notable for a decrease from 90% of kindergarten attendees to 60% of third-grade enrollees. Vaccine effectiveness in this cohort of 296 students was 89% against all varicella disease and 96% against moderate to severe disease. This outbreak illustrates the importance of vaccination of susceptible older children and adolescents to decrease the incidence of severe disease in unvaccinated children.[139] As evidenced by these outbreaks, varicella incidence is highest in children 1 to 6 years of age. Therefore implementation of varicella vaccination requirements for childcare and elementary school attendees without evidence of immunity as recommended by the ACIP[140] would reduce the susceptible population, consequently reducing the frequency of varicella outbreaks in group care settings.

Primary HSV infection results in gingivostomatitis, most often in children 1 to 4 years of age.[136,137] In two studies, clusters of primary infections occurred in children in childcare, most frequently manifesting as gingivostomatitis.[136,137] In one study, restriction endonuclease analysis of DNA of isolated HSV revealed that a single strain of HSV-1 had been transmitted among children.[137] Molluscum contagiosum is a benign, usually asymptomatic viral infection of the skin; humans are the only source. Virus is spread by direct contact or by fomites. Infectivity is low, but outbreaks have been reported. The frequency of occurrence in the childcare setting is unknown. People with atopic dermatitis or immunocompromised hosts, including people with acquired immunodeficiency syndrome (AIDS), have increased risk for acquiring infection or for having more extensive clinical manifestations. The incidence of pediculosis capitis (head lice) among children in childcare facilities in Seattle was 0.02/100 child-weeks[141] and 0.03/child-year in San Diego.[142] Treatment of infested children and their contacts with pediculicides that are used as directed may be considered as control measures.

Parvovirus B19

Parvovirus B19, the agent of erythema infectiosum (fifth disease), can cause arthropathy, transient aplastic crisis, persistent anemia in immunocompromised hosts, and nonimmune fetal hydrops (see Chapter 214, Human Parvoviruses). Serologic evidence of past infection has been reported to be 30% to 60% in adults, 15% to 60% in school-aged children, and 2% to 15% in preschool children.[143] The virus is endemic among young children and has caused outbreaks of disease in the childcare setting.[144,145] Parvovirus B19 spreads by the respiratory route or through contact with oropharyngeal secretions. In an outbreak during which more than 571 school and childcare personnel were tested serologically, the overall attack rate among susceptible individuals was 19%, with the highest rate (31%) occurring in childcare personnel.[144] A cross-sectional study of 477 childcare staff revealed a seroprevalence for parvovirus B19 IgG antibodies of 70%. Seropositivity was associated with age, and among staff less than 40 years of age, with length of group childcare contact.[146] The greatest concern is that an infected pregnant woman could transmit the virus transplacentally, leading to fetal hydrops; neonatal illness and congenital malformations have not been linked to prenatal parvovirus B19 infection. Estimates of the risk of fetal loss when a pregnant woman of unknown antibody status is exposed are 2.5% for fetal death after household exposure and 1.5% after occupational exposure in a school.[147]

VACCINE-PREVENTABLE DISEASES

In the United States, there are 16 diseases against which all children should be immunized, unless there are contraindications: (1) diphtheria; (2) tetanus; (3) pertussis; (4) *Haemophilus influenzae* type b; (5) measles; (6) mumps; (7) rubella; (8) poliomyelitis; (9) HBV; (10) varicella; (11) *Streptococcus pneumoniae*; (12) HAV; (13) influenza; (14) rotavirus; (15) human papillomavirus; and (16) meningococcal disease.[52] Immunization of children and their care providers should be high priority (Table 3-4) and immunization is especially likely to benefit children in childcare settings.[148] High levels of immunization exist among children in licensed childcare facilities,[149] partially because laws requiring age-appropriate immunizations of children attending licensed childcare programs exist in almost all United States states, including vaccine mandates for childcare for HBV in 37 (74%) states as of April 2004, hepatitis A in 9 (18%) states as of August 2005, and varicella in 42 (84%) states as of August 2005.[150] In a study of exemptions to immunizations, children of childcare age (3 to 5 years) with exemptions to immunizations were 66 times more likely to acquire measles and 17 times more likely to acquire pertussis than were age-matched immunized children.[151]

INFECTIONS ASSOCIATED WITH ANIMALS

Human interactions with animals may be beneficial components of an educational or developmental curriculum in group childcare. However, animal exposure has been associated with sporadic zoonotic infections as well as outbreaks, injuries, and allergies, most notably in children less than 5 years of age. The increased prevalence of infections in this age group is likely due to compromised hand hygiene resulting in transmission of pathogens from animal to child. Animal interaction may occur in locations where childcare is provided, with a resident pet or visiting animal display, or in public venues where children visit, including petting zoos, aquariums, county fairs, parks, carnivals, circuses, or farms. Guidelines to reduce opportunities for transmission and infection have been developed to prevent disease transmission in many of these settings.[152]

Infections with enteric organisms pose the greatest risk for human disease from animals. A retrospective review of clinical and agricultural databases from 1966 through 2000 identified 11 published outbreaks of zoonotic disease associated with human–animal contact. A concomitant survey of state public health veterinarians revealed 16 additional outbreaks as well as a paucity of formal guidelines for the prevention of disease and injury from animal contact in the public setting.[153] A subsequent review of the years 1991 to 2005 yielded reports of more than 55 outbreaks of infectious diseases among visitors to public animal exhibits.[153a] The predominant infection was enteric, resulting from direct or indirect fecal–oral contact. Inadequate hand hygiene, suboptimal supervision of children's activities following animal contact, and hand-to-mouth activities following animal contact were risk factors for infection. Human–animal contact on public farms with inadequate hand hygiene was responsible for two *Escherichia coli* O157:H7 outbreaks in 2000. The median age of the 51 ill persons in one of these outbreaks that occurred in Pennsylvania was 4 years; 8 (16%) children developed hemolytic–uremic syndrome.

TABLE 3-4. Vaccine-Preventable Infections

	Immunization Indicated	
Organism	**Childcare Attendee**	**Childcare Provider**
Diphtheria, pertussis, tetanus	As part of the 5-dose DTaP series	Tdap booster as adolescent/young adult; then Tdap every 10 years
Haemophilus influenzae type b (Hib)	As part of the 3–4-dose series, depending on vaccine used	Not indicated
Hepatitis A	2-dose series beginning at 1 year (12 to 23 months) of age	2-dose series recommended for adults at high risk for hepatitis A virus infection; not routinely recommended for childcare providers
Hepatitis B	3-dose series beginning at birth	3-dose series recommended for hepatitis B virus infection; not routinely recommended for childcare providers
Influenza A and B	Annual immunization for all children 6 to 59 months of age and high-risk children ≥ 59 months of age; 2 doses if first influenza immunization and ≤ 8 years of age	Annual immunization with trivalent inactivated or live attenuated influenza vaccine
Measles, mumps, rubella	2-dose series starting at 12 months of age	Booster immunization if only one dose received
Meningococcal disease	Polysaccharide vaccine for children 2 to 10 years of age in high-risk groups. Conjugate vaccine if 11 to 19 years of age	Conjugate vaccine recommended for adults 20 to 55 years of age at increased risk (polysaccharide is an acceptable alternative)
Pneumococcal disease	4 doses of heptavalent conjugate vaccine for all children 2 to 23 months of age; 1 dose of conjugate vaccine for certain children 24 to 59 months of age. Polysaccharide vaccine in addition to conjugate vaccine for certain high-risk groups 2 to 18 years of age	Pneumococcal polysaccharide vaccine for high-risk groups
Poliomyelitis	4-dose series	Most adults are immune; inactivated poliovirus vaccine may be indicated in select populations
Rotavirus	3-dose series beginning at 2 months of age and completed by 32 weeks of age	Not indicated
Varicella	2 doses, one at 12 to 18 months of age and the second at 4 to 6 years of age	2 doses for susceptible persons ≥13 years of age
Human papillomavirus	3 doses for females 9 years through 26 years of age	3 doses for females through 26 years of age

Identical *E. coli* O157:H7 isolates were noted in case patients, farm animals, and the farm environment,[154] suggesting transmission of organisms to children resulting in clinical disease. During 2004 to 2005, three outbreaks of *E. coli* O157:H7 infections occurred among petting zoo visitors in North Carolina, Florida, and Arizona. A total of 173 cases, including 22 cases of hemolytic–uremic syndrome, were reported from the three states; children who visited petting zoos were predominantly affected. Both direct and indirect animal contact, including exposure in a play area contaminated with petting zoo drainage, was associated with infections. Restriction of entry into open-interaction areas of petting zoos by young children was proposed to reduce disease transmission and prevent additional outbreaks.[155]

Salmonella enteritica serotype Typhimurium, *Cryptosporidium parvum, Campylobacter jejuni*, Shiga toxin-producing *E. coli* (STEC), and *Giardia* have also been associated with infections with direct and indirect contact with zoo exhibits, farm day camps, and petting zoos.[152] In addition to enteric infections, animal exposure can result in transmission of ecto- and endoparasites, *Mycobacterium tuberculosis* in certain settings, and local or systemic infections as a consequence of bites, scratches, stings, and other injuries. Food products produced by farm animals as demonstrations should not be consumed by children unless the food has undergone appropriate pasteurization and sterilization.

Contact with animals within the childcare environment should occur where controls are established to reduce the risk of injuries and disease. Guidelines to reduce disease associated with animal contact outside and within the childcare facility have been developed and include education of staff, operators, and visitors; specialized design of exhibits where humans and animals will interface; guide to hand hygiene instructions, agents, and stations; cleansing of facilities; and use of facilities for nonanimal events. Specific recommendations for group childcare settings include close supervision of children during animal contact, strict hand hygiene after direct animal contact or contact with animal products or environment, designation of areas for animal contact that are separate from areas in which food or drink are consumed, disinfection and cleaning of all animal areas with supervision of children over 5 years of age who may be participating in this task. Animals that visit or live in childcare facilities should be certified by veterinarians and should receive routine preventive health maintenance, including appropriate rabies immunization. Human–animal contact, especially for children less than 5 years of age, should always be supervised. Amphibians, reptiles, and weasels (ferrets and mink) should be housed in a cage and not handled by children. Wild or exotic animals, nonhuman primates, mammals with a high risk of transmitting rabies, wolf–dog hybirds, aggressive wild or domestic animals, stray animals, venomous or toxin-producing spiders, and insects should not be permitted in the group childcare setting.[152,156]

ANTIBIOTIC USE AND RESISTANCE PATTERNS

Several studies have demonstrated the more frequent use of antimicrobial agents in children in childcare centers.[157] During an 8-week period of observation of 270 children, antimicrobial agents were used by 36% of children in childcare centers compared with 7% and 8% of children in childcare homes or in home care, respectively ($P < 0.001$). The mean duration of antibiotic therapy prescribed for children in childcare centers (20 days) differed significantly

($P < 0.001$) from children in childcare homes (4 days) and children in home care (5 days).[108] The estimated annual rates of antibiotic treatment ranged from 2.4 to 3.6 times higher for children in group care when compared with children in home care.[157]

Multiple studies have documented an association of childcare center attendance and colonization or infection due to resistant bacteria, including outbreaks of illness due to resistant *Streptococcus pneumoniae*[95,97,99–101,106] and *Shigella sonnei,*[21,158] as well as colonization due to resistant *H. influenzae,* [159] *E. coli,*[160–161] and MRSA.[113,114]

INFECTIOUS DISEASES IN ADULTS

Parents of children who attend a childcare facility and persons who provide care to these children have increased risk of acquiring infections such as CMV,[118,121–123,147,159] parvovirus B19,[144,145] HAV,[147,162] and diarrhea.[33,42] Childcare providers experience annual rates of CMV seroconversion ranging between 8 and 20%, compared with hospital employees who experience annual rates of seroconversion of 2%.[118,121–123] During community outbreaks of erythema infectiosum, childcare providers were found to be among the most affected occupational groups, with seroconversion rates ranging from 9% to 31%.[144,145] In a prevalence study of hepatitis A antibodies among childcare providers employed in 37 randomly selected childcare centers in Israel during 1997, 90% (402 of 446) of the childcare providers had antibodies to hepatitis A; the authors postulated a twofold risk of acquiring hepatitis A among providers.[162] During outbreaks of diarrhea in childcare centers, 40% of care providers developed diarrhea.[42] During a multicommunity outbreak of shigellosis, the overall median attack rate among employed staff of childcare centers was 6%, with a range of 0% to 17%.[33] In outbreaks of group A streptococcal infection and echovirus 30 infection[115] in childcare centers, adult providers and parents were affected. Childcare providers compared with nonproviders have a significantly higher annual risk of at least one infectious disease and lose more work days due to infectious diseases.[147,163] Childcare providers should have all immunizations routinely recommended for adults, as shown on the adult immunization schedule (see Table 3-4) (www.cdc.gov/nip).

ECONOMIC IMPACT OF GROUP CHILDCARE ILLNESS

The economic burden of illness associated with group childcare was estimated at $1.5 billion annually adjusted to 2005 United States dollars.[164] Precise mechanisms for estimating illness burden and for evaluating effectiveness of infection control interventions are rare due to multiple challenges associated with performing such assessments.[165] Attributing an outbreak to group childcare is challenging, because although these settings may promote transmission of infection, childcare attendees and staff interact with household contacts external to the childcare arrangement, thus facilitating secondary spread. For example, an economic assessment of an *Escherichia coli* O157:H7 outbreak in 1994 in rural Edinburgh, Scotland involved 71 persons with a median age range of 5 years and 7 months. In all cases children had consumed milk with increased coliform counts from a local dairy in the 2 weeks prior to illness onset. Although there was not a specific group childcare association to this outbreak, children of group childcare age were affected disproportionately. Investigating and containing the outbreak cost the community the equivalent of $296,660.[166]

In the United States, hepatitis A infections in children less than 18 years of age were estimated to range between $433 and $1492 per case. Between 11% and 16% of hepatitis A infections have been linked to the group childcare setting, although this estimate did not require a strict epidemiologic link of a case patient to the group childcare setting.[167] However, since many hepatitis A infections in young children are asymptomatic, estimates of illness burden are primarily extrapolated from the fewer children who experience more significant complications from hepatitis A infections. In addition to economic analyses of vaccine-preventable infections, an economic analysis of a childcare-associated outbreak of *Shigella sonnei* in southwestern Ohio in 2001 incurred an overall cost of $821,725 to contain the outbreak of over 1600 infections, which was the equivalent of $514 per culture-confirmed case.[168]

A prospective evaluation of 208 families with at least one childcare enrollee, conducted from November 2000 to May 2001 in the Boston area, documented 2072 viral illnesses over 105,352 person-days. Among the 834 subjects, 1683 upper respiratory infections (URI) and 389 gastrointestinal (GI) illnesses were reported during the study period, with a total mean cost of $49 per URI and $56 per GI episode. Decreased parental productivity during missed days of work to care for a child who was not in childcare accounted for a significant proportion of the nonmedical costs.[164]

Future investigations of outbreaks of illness associated with group childcare could utilize recently developed computerized models and paradigms to assess the economic impact of outbreaks. In an era of limited funding, an understanding of expenses and allocation of resources will be important information to justify utility of interventions.

PREVENTION

Specific standards should be established for personal hygiene, especially hand hygiene, maintenance of current immunization records of children and providers, exclusion policies, targeting frequently contaminated areas for environmental cleaning, and appropriate handling of food and medication. In studies in which improved infection control measures were implemented and monitored, both upper respiratory tract illness and diarrhea were reduced in intervention centers.[82,169] In addition, in children at intervention centers, 24% fewer antibiotic prescriptions were given and fewer absences from work on the part of parents occurred.[83] Educational sessions on health topics by healthcare professionals was found to be the most efficacious means of promoting health education in simultaneous surveys of licensed childcare center directors, parents, and health providers in Boston, Massachusetts.[170] A cross-sectional survey conducted in 2000 of childcare providers, parents, and pediatricians in Baltimore, Maryland revealed deficits of knowledge among all groups. Compared with national guidelines on exclusion for 12 symptoms, childcare providers and parents were overexclusive and pediatricians were underexclusive. More childcare providers and parents than pediatricians felt that exclusion would reduce transmission of disease.[171]

As asymptomatic excretion and potential for transmission precede the onset of clinical symptoms in many childcare-associated infectious diseases, strategies that involve prevention would likely be most efficacious in reducing incidence. In addition to traditional handwashing, the use of alcohol-based hand-sanitizing hand gels in healthcare and other settings is an efficacious means of achieving hand hygiene.[171] In support of this preventive strategy, a cluster randomized, controlled trial was conducted in the homes of 292 families with children who were enrolled in out-of-home childcare centers. A multifactorial intervention emphasizing alcohol-based hand sanitizer use in the home reduced transmission of GI illnesses within families. The effect on reduction of respiratory tract illness transmission in this evaluation was less pronounced and may relate to the use of hand-sanitizing gel following toileting activities but not following sneezing, coughing, or blowing/wiping of nasal secretions.[172] Molecular techniques, including DNA probes, could be used as surrogate markers to study transmission of enteric pathogens in childcare centers and from centers to children's homes.[173] Further evaluations of molecular techniques during outbreak investigations, hand hygiene strategies, and educational interventions could assist with allocation of resources to the most effective prevention regimens.

Written policies should be available, followed, and reviewed regularly for the following areas: managing child and employee illness, including exclusion policies; maintaining health, including

immunizations; diaper-changing procedures; hand hygiene; personal hygiene policies for staff and children; environmental sanitation policies and procedures; handling, serving, and preparation of food; dissemination of information about illness; and handling of animals. Local health authorities should be notified about cases of communicable diseases involving children or care providers in the childcare setting. The AAP and the American Public Health Association jointly published the National Health and Safety Performance Standards: Guidelines for Out-of-Home Childcare Programs.[174] This comprehensive manual provides guidelines regarding infectious diseases and other health-related matters pertinent to out-of-home childcare.

CHAPTER 4

Infectious Diseases in Refugee and Internationally Adopted Children

Mary Allen Staat

Each year thousands of immigrant children come to the United States to begin a new life. In this chapter, the infectious disease issues of two groups of immigrants will be discussed: refugees and internationally adopted children. Refugees are noncitizen immigrants who are unable or unwilling to return to their country of origin because of persecution or a fear of persecution.[1] In addition to refugees, there are other categories of noncitizen people in the United States. These noncitizens may be immigrants or nonimmigrants. Immigrants include refugees, licensed permanent residents, asylees, and parolees. Nonimmigrants include people who are undocumented, students, tourists, or visitors on business. Internationally adopted children are immigrants that are classified as orphans. Most of these children however are not truly orphaned, but instead have been abandoned by or separated from both parents. In most cases these children will be given United States citizenship as they arrive in the United States with their new families.

In 2005, there were a total of 53 813 refugees who arrived in the United States.[1] Of these, 38% were < 18 years of age. Nearly 80% of these refugees came from just eight countries: Somalia (19%), Laos (16%), Cuba (12%), Russia (11%), Liberia (8%), the Ukraine (5%), the Sudan (4%), and Vietnam (4%). Refugees come to the United States from all around the world, with the exception of northern Europe, Australia, New Zealand, and Canada.[2]

Over the past decade, international adoption has become an increasingly popular way to build families. More than 175,000 children have been internationally adopted in the United States since 1996.[3] In 2005 alone, 22,728 children were adopted coming from more than 20 countries, with 83% of these children coming from just five countries: China (35%), Russia (20%), Guatemala (17%), Korea (7%) and the Ukraine (4%).[3] Although there has been little variation in the countries of origin over the past 10 years, in 1990, there were very few children arriving from the current top three countries of China, Russia, and Guatemala.[3] The majority of children are adopted as infants and toddlers. With the exception of Korea and Guatemala, where most children are in foster care, children from the other countries have generally resided in orphanages prior to coming to the United States.

Because refugees and internationally adopted children come from resource-poor countries, physicians and other healthcare providers should be cognizant of the global prevalence of other infectious diseases that are seen less commonly in native-born North Americans. Both groups are at increased risk for common infectious diseases such as tuberculosis, intestinal parasites, dermatologic infections, and infestations. Hepatitis B, hepatitis C, human immunodeficiency virus (HIV), and syphilis, although seen in the United States, are far more prevalent in the countries of immigrants where there are few resources for screening and prevention.

Although there are a number of similarities in refugees and internationally adopted children, there are also important differences. Refugee children and internationally adopted children differ in terms of the general medical screening they receive before arrival in the United States. Most refugees are subjected to organized screening evaluations before emigration visas are issued.[4] For children > 15 years of age, predeparture screening includes serologic testing for HIV and syphilis and a chest radiograph to assess for evidence of tuberculosis. A physical examination is performed on children of all ages.[4] In contrast, no organized screening procedure is required for internationally adopted children. Second, because medical screening for refugees usually is sponsored by responsible medical organizations, results of such testing are typically accurate. In internationally adopted children, medical testing is often incomplete or done shortly after birth. Generally, HIV and syphilis serology and hepatitis B surface antigen test results are provided with the referral information. Although the reliability of this testing has been a concern in the past, in recent years testing done in the child's country of origin has proven to be accurate when repeated in the United States. Third, preventive measures such as immunizations, vitamin supplementation, and dental care are undertaken in most refugee children while still in the camps; in adoptees, there are inconsistencies in the receipt of these measures. Last, differences in the types of infectious diseases may also distinguish refugees from adopted children. Although both populations are susceptible to a variety of infectious agents, because the countries of origin and the living conditions differ, refugee children are more likely to have been exposed to infections such as typhoid fever, malaria, filariasis, flukes, or schistosomiasis, which occur uncommonly in internationally adopted children.

As these immigrants join our community, healthcare professionals will inevitably have the opportunity to provide care for these children and should therefore be knowledgeable of the infectious disease issues they may encounter and the need for screening for infectious diseases in these populations.

GUIDELINES FOR EVALUATION

Because of the predominance of infectious diseases in developing nations, recommendations for screening tests are weighted toward infectious disease processes, but aspects of general health, including vision, hearing, dental, and developmental examinations, also should be included.[5–7] Despite the healthy appearance of many immigrant children, children should be evaluated by a healthcare professional within 2 weeks after arrival to assure that they are screened properly and receive preventive healthcare services. Table 4-1 outlines the recommended infectious disease screening for refugees and internationally adopted children.

Hepatitis A

Virtually all inhabitants of resource-poor countries have contracted hepatitis A by early adulthood and have immunoglobulin (Ig) G antibodies. In the past, screening for hepatitis A was recommended only in children with chronic hepatitis B infection to determine the need for hepatitis A immunization. Healthcare providers in some states where hepatitis A vaccine was recommended for routine use also may have been screened for hepatitis A. Now that hepatitis A vaccine is recommended for all children ≥ 12 months of age,[8] IgG antibody testing in children > 1 year of age may be useful for all immigrants to determine who should be immunized. Age- and country-specific prevalence data are needed for both internationally adopted and refugee children to develop cost-effective screening strategies. Testing will likely be most cost-effective in older children. Screening for IgM antibodies is only useful in the diagnosis of acute infection and therefore is not used