



Infectious diseases and daycare and preschool education

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Abstract

Objective: To describe the increased risk of acquiring infectious diseases associated with out-of-home childcare and the effectiveness of measures for the control and prevention of diseases transmission at daycare and preschool education centers.

Sources: A review of literature in the MEDLINE, LILACS and Cochrane Library databases, found using the descriptors daycare, infection, infection control and infectious diseases and focusing on studies that have compared the risk of infectious diseases for children cared for in and out of the home, related risk to the type of out-of-home care and assessed the effectiveness of preventative measures.

Summary of the findings: Children cared for at daycare or in preschool education exhibit a two to three times greater risk of acquiring infections, which impacts both on individual health and on the dissemination of diseases through the community. Among other factors, the risk is associated with the characteristics of daycare centers, and simple preventative measures are effective for reducing transmission of diseases. Recommended measures include: appropriate hand washing after exposure; employment of standard precautions; standardized routines for changing and disposal of used diapers, location and cleanliness of changing area, cleaning and disinfection of contaminated areas; use of disposable tissues for blowing noses; separate workers and area for handling foods; notification of infectious diseases; training of workers and guidance for parents.

Conclusions: In the face of growing utilization of daycare and preschool education and their association with increased risk of acquired infections, control measures are indispensable to the prevention and control of infectious diseases.

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Introduction

Over recent decades, the number of children in collective out-of-home daycare has increased significantly all over the world.¹⁻⁶ The impact of this situation is manifest in the behavior of infectious diseases in the community,⁷⁻¹⁰ in the form of increased risk of acquiring infectious diseases to

which those involved in this care are exposed, which has been widely recognized as a public health problem.^{11,12}

The scientific literature also recognizes that control measures to reduce transmission of infectious diseases are effective and necessary to minimize the unfavorable consequences for collective health that can result from

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daycare in groups,¹³⁻¹⁵ recommending infection control standards and practices for environments in which children are cared for together.¹⁶⁻¹⁹

Daycare centers and disease transmission

Establishments that provide out-of-home care for preschool age children are known to be environments with special epidemiological characteristics, since they have populations with characteristic profile and with specific risks for the transmission of infectious diseases: children in groups being cared for collectively.¹¹ The risk applies to any institution or establishment that provides daytime care for children in groups, irrespective of whether it is called daycare or nursery/preschool education, or whether it is public or private.^{20,21}

A large number of diseases and infectious agents that have been described as occurring in association with daycare and, it has been accepted since the 1940s that there is a higher frequency of infectious diseases among children in collective out-of-home care.²² The risk is independent of factors such as age, race, social class and others that may be of relevance to the incidence rates of the diseases in question.²³

Small children have habits that facilitate the dissemination of diseases, such as putting their hands and objects in their mouths, very close interpersonal contact, fecal incontinence during the phase prior to the acquisition of sphincter muscle control, the absence of the habit of hand washing and other hygienic practices and the need for constant direct physical contact with adults.²⁴ Furthermore, they also exhibit factors specific to their age such as an immature immune system and dysfunction of the Eustachian tube during upper airway infections, predisposing towards acute otitis media (AOM).²³ Infants and pre-schoolchildren are especially susceptible, since they do not yet have immunity to the most common infectious agents due to a lack of previous exposure. They may also even be susceptible to those agents for which vaccines already exist, because they are under the age at which vaccination is indicated or because vaccination has been neglected.

In the majority of cases, the risk of an infectious agent being introduced to a daycare center is directly related to its prevalence in the population in which the center functions and to the number of susceptible individuals at the center. Small children are often asymptomatic carriers of many diseases, serving as a community reservoir of infectious agents. Groups of children therefore become the focus of the multiplication of cases of infectious diseases and their dissemination to the surrounding community.¹⁰

Once an agent has been introduced into a daycare environment its further transmission depends partly on the characteristics of the microorganism itself, such as mode of propagation, number of microorganisms needed to cause an infection, survival in the environment and frequency of asymptomatic infections (number of healthy carriers). Transmission of an infectious agent within a child care center is also influenced by the characteristics of the children attending, including age, sex, immunological status, presence of siblings at home, parents' educational level and families' socioeconomic level and length of time enrolled at the center, being further influenced by characteristics of the center itself, such as the total number of children, class sizes, number of workers per child, and, in particular, on the hygiene involved in handling children and care taken with the environmental.^{20,23,25,26}

Diseases that have been described as occurring in daycare centers can be classified according to the system or organ affected, the pattern of occurrence¹² or the mode of transmission²⁵ (Table 1).

Diseases whose risk is increased for children

Children who attend childcare centers have an increased risk of acquiring respiratory infections, AOM, diarrheal disease, invasive bacterial disease from *Haemophilus influenzae* and *Streptococcus pneumoniae*, hepatitis A and infections by CMV and varicella-zoster.^{3,12,20}

Furthermore, children with congenital heart disease, chronic lung diseases or other underlying diseases are at greater risk of severe infectious complications.²⁷

Respiratory infections

Respiratory infections of the upper airways (colds, pharyngitis, sinusitis) and of the lower airways (bronchitis, bronchiolitis, pneumonia), together with AOM, are responsible for the majority of the episodes of infectious disease that occur at daycare, and are the most common cause of childhood disease in the general population.^{28,29} The microorganisms responsible for these infections are the same ones that attack children cared for at home. Children who attend daycare, especially before 3 years of age, suffer infectious episodes that are more severe and greater in number, approximately double.^{6,20,30,31} The risk increases in relation to the number of hours spent in daycare.^{32,33}

With respect to infections of the lower respiratory tract, a significant cause of hospital admissions among infants and small children,³⁴ there is also evidence of increased risk for children in daycare.⁶

Otitis media

Otitis media is one of the most common bacterial infections in childhood, causing major medical, economic and social problems.³⁵ Acute otitis media affects approximately 50% of children during the first year of life, 9% of whom will suffer three or more episodes, to the extent that, at 3 years of age, approximately 71% of children will have had at least one episode of the disease.³⁶ There are intrinsic and environmental factors that affect individual susceptibility, and an early first episode has been linked with an increased number of repeat episodes, which, in turn, can lead to otitis media with effusion (OME) and subsequent loss of auditory acuity and difficulties with speech development.³⁷

Otitis media with effusion is also one of the most common diseases among children and is a common cause of loss of auditory acuity in childhood.³⁸ Generalized use of antibiotics has reduced the infectious complications of AOM, and the

duration of OME is the strongest predictive factor of the probability of sequelae.³⁹ Inner ear effusion can last for weeks or months after the acute condition has disappeared. The frequency and duration of effusion during the first 6 to 12 months of life is strongly associated with poor performance in language tests later in life.³⁷

The effects of upper airway infections on tube function and the inner ear are already established. Children with upper airway diseases, even a simple case of rhinitis, are at increased risk of acquiring OME.^{38,40} The degree of exposure to infection appears to be the predominant etiologic factor of this disease in childhood, defining not just its occurrence, but also its clinical course.⁴¹

Studies describe an increase of two to three times in risk of acquiring AOM and OME if children attend daycare.^{30,42} The association is not merely between attendance at daycare and occurrence of otitis, but also between the child's age at the

Table 1 - Principal infectious diseases that have been described as occurring in daycare centers

System affected	Disease	Pattern of occurrence	Mode of transmission	Increased risk at daycare?
Respiratory system	Upper airway infection	Infection manifests in children, workers and family members	Droplets (majority-)	Yes
	Infections of lower respiratory tract	Infection manifests in children, workers and family members	Droplets (majority)	Yes
	Acute otitis media	Infection primarily manifests in children	Droplets (majority)	Yes
Multiple organs and systems/invasive bacterial disease	<i>Haemophilus influenzae</i>	Infection primarily manifests in children	Droplets	Yes
	<i>Neisseria meningitidis</i>	Infection manifests in children, workers and family members	Droplets	Probably
	<i>Streptococcus pneumoniae</i>	Infection manifests in children, workers and family members	Droplets	Yes
Gastrointestinal system and liver	Diarrheal disease	Infection manifests in children, workers and family members	Contact/enteric (fecal-oral)	Yes
	Hepatitis A	Infection is generally unnoticed in children, manifesting in adult contacts	Contact/enteric (fecal-oral)	Yes
Multiple organs and systems/viral disease	Cytomegalovirus	Infection is generally unnoticed in children and adults, but with serious consequences for the fetuses of pregnant contacts	Contact with blood and other non-respiratory secretions	Yes
	Varicella-zoster	Infection primarily manifests in children	Contact/aerosols	Yes
Skin	Scabies	Infection manifests in children, workers and family members	Direct contact	Probably
	Herpes simplex	Infection primarily manifests in children	Direct contact	Yes
	Impetigo	Infection manifests in children, workers and family members	Direct contact	Probably
	Pediculosis	Infection manifests in children, workers and family members	Direct contact	Probably

Source: Adapted from Holmes et al.²⁰ and Goodman et al.¹²

first disease episode and with the rate of adenoidectomy, tympanostomy with tube insertion, procedures used to treat recurrent cases.^{39,43,44}

Diarrheal disease

The majority of cases of acute diarrhea and of deaths caused by diarrhea occur in children under 5 in developing countries.^{45,46} These diseases are a significant problem in daycare centers, where they appear in the form of sporadic cases or outbreaks.⁴⁷ Diarrhea can be caused by many different agents: outbreaks due to *Shigella*, *Giardia*, rotavirus, *Campylobacter*, *Clostridium difficile*, *Salmonella*, *Cryptosporidium* and *Escherichia coli* have all been described.^{48,49} Rates of attacks among children who attend daycare vary from 50 to 71%, during outbreaks, whereas rates of secondary attacks among home contacts vary from 15 to 71% for several different agents.⁵⁰

The organisms are transmitted by direct contact, person to person, or indirectly, by fomites or consumption of contaminated food or water. The increased incidence of diarrhea among infants and toddlers who attend daycare is due to intimate interpersonal contact between children who are too young to have learnt personal hygiene habits, resulting in the exposure of susceptible individuals to pathogenic microorganisms, generally spread by asymptomatic carriers.⁴⁸

The incidence of diarrheal disease among children under 3 who attend daycare is increased by 30 to 50%;⁵¹ approximately one half of cases can be attributed to daycare,⁵² and recent enrollment is associated with an even greater risk.^{47,53}

Other infectious diseases

In children and adults with a normal immune system, infections by cytomegalovirus (CMV) are unlikely to result in a symptomatic condition, however, it can be responsible for severe cases in fetuses and immunocompromised individuals. The prevalence of infection in the general population increases with age, and is greater in developing countries and the poorer strata within developed countries. Infection generally occurs during childhood: in populations where the majority of women are seropositive, during breast-feeding, delivery or pregnancy, or through contact with other children (among small children, prevalence is greater in populations that attend group care).⁵⁴

The virus is excreted in orderlies creations, including saliva and urine, for weeks to months after the initial infection; an acquisition is probably by direct contact with infected secretions. Susceptible children did not acquire the infection from their mothers are exposed to infected children

at daycare; children at daycare exhibit higher rates of infection and viral excretion than those cared for at home.⁵⁴⁻⁵⁶

Small children excreting CMV are a common source of infections of mothers and daycare workers,⁵⁷⁻⁵⁹ by both direct and indirect contact and by fomites, which probably also aid in dissemination;⁶⁰ CMV can be isolated from objects contaminated with saliva and diapers contaminated with urine infected over several hours.⁶¹

Infection by *H. influenzae* type b is one of the most common in children under 2 years old, and may manifest in the form of severe illness such as meningitis, epiglottitis, pneumonia and cellulitis.^{62,63} *H. influenzae* disease in daycare can be divided in primary, when it is the result of contact with an asymptomatic carrier, and secondary, when due to contact with a sick individual;⁶⁴ invasive secondary disease accounts for just 1 to 2% of cases.⁶⁵

Several risk factors have been associated with primary invasive disease: large families, high population density, low income and low educational level. Day care centre attendance is an independent risk factor, particularly for those under 2 years of age.^{66,67} Secondary invasive disease only becomes of significance when daycare contact is similar to home contact.⁶⁴

The frequency of the disease in a population is associated to the frequency of asymptomatic carriers in the same population. Although during the first years after the introduction of the vaccine there was a reduction in the incidence of the disease, not just in the target population for vaccination, but also among adults, as time passed cases of invasive disease increased progressively, although they did not reach pre-vaccination levels. After basic vaccination, children develop high titers of antibodies against *H. influenzae*; later the level of antibodies reduces, actually coinciding with the age group at risk of acquiring the disease. Unvaccinated children, or children with only basic vaccination, without the booster dose, attending daycare centers exhibited oropharynx colonized by the agent, resulting in persistence of the disease.^{68,69}

Daycare centers are also known to be sites of dissemination of hepatitis A. the disease generally manifests in epidemic community outbreaks, during which infection is transmitted from person to person via the fecal oral route.⁷⁰ Hepatitis A outbreaks in daycare centers have been observed with increasing frequency over recent years, in parallel with the increase in the number of children attending daycare centers.⁷¹

Children less than 2 years are the focus of outbreaks of this disease. Children are generally asymptomatic and easily

transmit the disease to adults, at the daycare centre and at home; during hepatitis A outbreaks at daycare centers 75% of cases can be attributed to contact with child less than 2 years old with an asymptomatic infection acquired at the daycare centre.⁷² Hepatitis A outbreaks in daycare centers are identified based on confirmed adult cases with a history of contact with the daycare centre, such as workers or parents.⁹

Hepatitis A outbreaks are more frequent in large daycare centers that accept children in diapers. Once introduced into the daycare centre, the speed with which the disease spreads is related to the number of children wearing diapers.⁷³ Seropositivity among children is related to the length of time they've been at the daycare center.⁷⁴

The hepatitis B virus is found in high concentrations in blood and in certain bodily secretions, for example, pus from impetigo sores, a skin infection that is very common in children. The infection is transmitted by exposure to blood or secretions derived from blood. Children under 5 have a 20 to 50% risk of becoming healthy carriers of the virus after acute infection. Cases of hepatitis B transmission in daycare centers have been documented by scientific studies.⁷⁵ However, the risk of transmission among children who do not exhibit aggressive behavior (there is a report of transmission by biting) or have other medical conditions that facilitates transmission is apparently low, since opportunities for contact with blood are rare.⁷³

One of the most important pathogens for children is *S. pneumoniae*, causing severe infections such as pneumonia and meningitis. Furthermore, it is the most frequent agent of otitis media. Infants, children and adults are nasal carriers of the bacteria and colonization of the oropharynx is related to acquisition of the disease; viral infection may be a trigger factor.⁷⁶ There are considerable differences in incidence rates of invasive disease between different populations, and children in developing countries are considered a high risk group, particularly the youngest children. Risk is increased for children under 2 years old who attend daycare centers.⁷⁷ Vaccination of the pediatric age group with a conjugate pneumococcal vaccine produces a reduction in the incidence of the disease in children and adults.⁷⁶

With relation to meningococcal meningitis, although there are no studies that have compared the incidence of this disease between children at daycare and children cared for at home, there is sufficient evidence to define the disease as a problem at daycare centers. Investigations of outbreaks have identified elevated rates of secondary attacks by the disease and of oropharynx colonization in contacts of index cases at daycare centers, similar to the rates observed among home

contacts.³⁰ Meningococcal meningitis patients have a greater probability of attending daycare.⁷⁸

There is also evidence to suggest that the incidence of varicella is greater among children who attend daycare than the incidence among juveniles in the general population; group exposure may be the reason that the disease has exhibited ever earlier onset during recent years.⁷⁹ Cases among vaccinated people are generally milder and less contagious; contagiousness is apparently proportional to the number of skin lesions.⁸⁰

The ease of transmission of cutaneous infestations and infections, such as scabies, pediculosis and impetigo, taken together with the close contact that occurs between children, suggests that these diseases have increased the dissemination at daycare centers, also indicated by reports of outbreaks in the literature.^{8,81}

The significance of increased risk

Although, in the majority of cases, the risk of acquiring infection that is associated with attending daycare translates as an increase in the number of episodes of infectious diseases by up to two or three times, for children under 3 years of age,⁸¹ without interfering with later development,³¹ the consequences of this increased morbidity are not so simple.

Respiratory infections, particularly pneumonia,⁸² are the principal cause of death among children under 5 years old worldwide, primarily in developing countries.

Otitis media for 3 years of age, even when treated correctly, can have adverse consequences: reduced performance at reading comprehension and/or compromised cognitive ability and can result in compromise to educational performance, in the majority of cases mild to moderate, but with possible negative effects on the child's future.⁸³⁻⁸⁶

Children who attend daycare have an increased risk of being hospitalized.⁸⁷ Rotavirus infection is responsible for 20 to 60% of hospital admissions of children due to diarrhea, progressing to dehydration with greater frequency than in gastrointestinal conditions caused by other agents.⁵¹

Invasive diseases caused by *H. influenzae*, *S. pneumoniae* – the principal cause of bacteremia in hospitalized children – and *N. meningitidis* are generally severe, frequently fatal, conditions.²⁰

Varicella, traditionally considered a benign disease, can, not so rarely, develop complications and result in hospital admissions and death.^{80,88}

The fact that transmission of infectious diseases is facilitated, by the increased exposure at daycare centers,

gains further significance in the light of the appearance of new infectious conditions in the community, caused by virulent agents resistant to the antibiotics that are traditionally used, such as infections in children caused by methicillin resistant *Staphylococcus aureus*; infections are predominantly cutaneous abscesses, but can manifest in the form of severe conditions such as pneumonia endocarditis and toxic shock syndrome.⁸⁹ Recently, another uncommon agent, the bacteria *Kingella kingae*, which colonizes the respiratory tract and oropharynx of children, occasionally causing osteomyelitis, septic arthritis bacteremia or endocarditis, was identified as having caused a cluster of invasive disease at a daycare centre, with several children being colonized; the pattern of the causal agent in the sick children was identical, suggesting transmission between them.⁹⁰

Furthermore, attendance at daycare centers has been involved with the risk of acquisition of severe diseases, in which infections have an etiologic role, involving the immune system, such as certain childhood cancers.⁹¹

In the city of São Paulo, the most common causes of death of children in daycare of infectious origin: pneumonia (29.6%), meningococcal infection (13.0%), non-meningococcal meningitis (8.5%), gastroenteritis (7.6%) and varicella (5.4%); 36.3% of deaths are concentrated within the first 3 months of attending daycare.⁹²

There is evidence of an increased risk of disease transmission among children at daycare when compared with those attending schools,¹¹ although there is no evidence that children with recurrent infections at preschool ages become more resistant to infection with age.^{93,94}

While the individual constitution is involved with susceptibility to infectious⁹⁵ and there is interference from other factors, such as climatic factors⁹⁶ and environmental pollution,⁹⁷ there is consensus that, in a fair proportion of episodes in preschool age children cared for out-of-home, infectious disease can be attributed to the daycare centre.⁹⁴ At the same time, daycare centers offer the opportunity of guaranteeing healthy children, through stimulation of development, safer environments, better nutritional support, better vaccination coverage and health promotion.^{81,98}

Diseases with risk for workers and family members

Children are not the only people involved in transmission of diseases at day care centers: family members and workers are also at increased risk of acquiring the same diseases as the children.^{20,99}

The available literature suggests that working in child care centers involves a significant risk of disease for workers.

Among occupational risks identified among adults involved with child care specific diseases including care hepatitis, cytomegalovirus, varicella, *influenza*, tuberculosis, meningitis, streptococcal infection, diarrheal disease, scabies, pediculosis and herpes infections.¹⁰⁰

With relation to CMV, an increased risk of acquisition has already been documented at daycare centers and, while it rarely results in disease in normal children or adults, it is one of the most important causes of congenital malformations. The combination of a seronegative pregnant woman and a child in the acute phase of viral infection (with the virus present in saliva or urine) can have disastrous consequences.⁹⁹ There is clear evidence that daycare workers and the parents of children who attend daycare at increased risk of infections by cytomegalovirus. Transmission from children to workers and children to parents has already been confirmed in studies that have included analysis of the strains involved;^{59,101,102} the greatest risk is related to prolonged contact (20 or more hours per week) with children under 3 years old.¹⁰³

Although just 1.6 to 3.7% of women are infected for the first time with CMV while pregnant, in 30 to 40% of maternal infections the virus is transmitted to the fetus and 10 to 20% of infected babies exhibits sequelae, making cytomegalovirus the most common cause of congenital infection worldwide.¹⁰⁴

In relation to hepatitis A, transmission of the virus from children to daycare workers has been documented,⁷¹ and the most important risk factor is changing diapers.¹⁰⁵ However, the risk of occupational exposure appears not to be significantly increased in the absence of outbreaks,⁷¹ although some evidence to the contrary also exists.¹⁰⁶

Although low, the risk of work exposure to hepatitis B does exist,¹⁰⁷ and also for AIDS.⁵²

With relation to family members, high rates of secondary attack by *Shigella*, *Giardia* and rotavirus have been described; cryptosporidiosis, which in general causes self-limited mild to moderate disease, presents a significant risk to immunocompromised individuals.⁹⁹ Parents whose children attend daycare have an increased risk of CMV infection, when compared with those who care for their children at home.^{58,108} Parents of preschool age children using diapers and attending daycare also at increased risk of acquiring infection is transmitted via the fecal oral route, such as exanthema subitum, and including meningitis.¹⁰⁹

The impact on the community

Children who attend daycare, in addition to catching infectious diseases with greater frequency and severity, also

use antibiotics more often.¹¹⁰ A high prevalence of infectious diseases at daycare centers associated with increased antimicrobial use has contributed to the appearance of a multi-resistant organisms.²⁰ Multi-resistant microorganisms have been isolated from the or oropharynx of children at daycare centers in several countries, for example, *Escherichia coli*¹¹¹ and *S. pneumoniae*.^{112,113} Attendance at daycare centers is considered an independent risk factor for colonization by resistant bacteria.¹¹⁴⁻¹¹⁶ The genetic pattern of resistant microorganisms found suggests the occurrence of cross transmission of the agent between children and also dissemination of resistance between different strains, passing beyond the confines of the daycare centre.^{117,118}

Furthermore, the increase in infant morbidity associated with daycare centers has economic implications, since an increase in diseases results in an increase in the use of health care services,^{1,119} and increased family spending on medical care and medications.¹²⁰⁻¹²² Their children's diseases can cause parents to earn less and even lose their jobs due to frequent absences.^{87,123} workers' diseases provoke high turnover rates in the sector due to the working conditions.¹⁰⁷ Costs related to disease are even greater for those under 3 years of age.¹²⁴

Costs are not restricted to the short term (medical costs, lost work days, and others); there are also long-term costs (chronic diseases, sequelae, congenital malformations) and all the human suffering related to disease¹²⁵ and, possibly, death.³⁰

The characteristics of daycare centers and risk of disease

The dissemination of infectious diseases at daycare centers is influenced by the practices employed when handling children and environmental precautions.

The available information indicates that the majority of daycare workers are part of a vulnerable population of young women of reproductive age, often with a low educational and socioeconomic level.¹⁰⁷ Few have been trained in the various healthcare-related aspects of childcare, including food handling procedures.¹¹

Direct contact, generally with the hands, is considered the principal means of transmission of the majority of pediatric infections.¹²⁶ Contamination of the hands of workers and children and of objects and surfaces in the daycare centre has been confirmed by several different studies¹²⁷⁻¹³⁰ and associated with the incidence of diarrhea.¹³¹ Studies demonstrate increased frequency of respiratory disease and diarrhea at daycare centers where hand washing is infrequent;^{132,133} a greater frequency of diarrhea has also

been confirmed at daycare centers where the same workers perform diaper changing and food handling tasks.^{134,135}

Diaper changing is considered the highest risk procedure for transmission of enteric pathogens between children and workers at daycare centers.^{50,109}

Outbreaks of hepatitis A are related to in adequate facilities for diaper changing and to daycare workers practices; handling diapers is the most important risk factor among adults.⁷³ Small children using the bathroom without supervision or washing hands afterwards, has already been implicated in the dissemination of disease in outbreaks of enteric infections.¹³⁶

The association between the population density of the children at daycare centers and the risk of acquiring diseases has been documented, primarily with relation to the number of children in classes.^{87,99}

Disease transmission at daycare centers is also influenced by the way sick children are treated and by the intensity of cleaning routines when faced with cases of infectious disease.

Furthermore, workers without specific knowledge implicated in the elevated consumption of antibiotics by children who attend daycare centers, by recommending them.¹³⁷

The effectiveness of infection control

There is strong evidence that appropriate washing reduces contamination of the hands¹³⁰ and the risk of the dissemination of infectious diseases; interventions to promote hand washing cost-effective, and it is estimated that they could save millions of lives, with a major impact on public health.¹³⁸

Traditionally accepted as an active measure for preventing diarrheal disease, hand washing has also proven capable of reducing the incidence upper airway infections, since some agents of respiratory infection can be transmitted via the fecal-oral route; furthermore hands contaminated with respiratory pathogens touch the nose and mouth contaminating upper airways.¹³⁹

Studies have demonstrated the effectiveness of infection control programs at improving control practices¹⁴⁰ and reducing the occurrence of infectious diseases at daycare centers, and some have suggested a favorable impact on costs.^{27,141,142}

Reviews of the scientific literature¹³⁻¹⁵ confirm the effectiveness of infection control practices at daycare centers, providing the basis for public investments in the creation of infrastructure and in health education.

This evidence serves as the basis for the creation of recommendations in several countries,¹⁶⁻¹⁹ which are in turn used to regulate the sector.

The principal risk factors identified by scientific studies and the respective control measures are listed in Table 2.

The recommendations include standardized routines for: (i) promotion of the health of children and workers (routine medical supervision and immunizations); (ii) hand washing; (iii) diaper changing; (iv) contact with bodily secretions; (v) cleaning of services and objects; (vi) food handling; (vii) exclusion of workers and children with infectious (including daily observation of children with direct examination); (viii) notification of infectious diseases; (ix) training in infection control.

The items of greatest relevance for infection control related to hand washing and diaper changing and include: (i) workers and children should wash their hands, at the least, in the following situations and always whenever they are

contaminated with bodily secretions: before handling, preparing or serving food; after using the bathroom or changing diapers; after helping a child to use the bathroom; before handling food; before any activity related to food (even laying the table); before meals or snacks; after handling domestic animals; (ii) children and workers should wash their hands for at least 10 seconds with soap and running water; (iii) workers should be taught about the importance of washing hands and the other measures for reducing contact with infected material; (iv) hand washing after exposure to blood or bodily fluids must be observed; (v) there must be a wash basin in every classroom; (vi) noses should be blown or cleaned with disposable tissues, which should be disposed of in covered receptacles lined with plastic; hands should be washed after this procedure; (vii) diapers should be impermeable on the outside; if plastic clothing is used, this should be changed together with fabric diapers and only used again after cleaning and disinfection; (viii) diaper changing should follow a standardized routine,

Table 2 - Summary of the principal risk factors and control measures for infectious disease control at daycare centers

Risk factors	Control measures
Number of children per class	Standards creating a maximum number of children in her class
Children cared for together irrespective of age group	Children separated into groups by age group
Incomplete vaccination	Standards and monitoring of vaccinations of children and workers
The use of cloth diapers which are not single items with impermeable lining	Use of disposable diapers
No clothes worn over diapers (greater environmental contamination)	Clothes worn over diapers
Contamination of hands after specific activities (using the bathroom, changing diapers, blowing noses)	Hand washing routine, with guidance on when washing should take place
Contact with blood and secretions	Use of standard precautions
Changing diapers	Diaper changing routine to reduced the risk of coming into contact with urine and feces
The same person changes diapers and handles food	Workers do not perform both diaper changing and food handling
Contamination of the surface where diapers are changed	A separate changing area, disinfected after each use, with appropriate disposal of used diapers
Environmental contamination	Routine for cleaning surfaces
Contamination of toys	Routine for cleaning toys

which should be displayed in a visible location close to the changing area; (ix) each class should have a separate changing area close to a wash basin; (x) used diapers should be disposed of in different receptacles from the rest of the trash, which are washable lined with plastic and covered, located close to the changing area; (xi) the changing area should never be close to food preparation areas and foods should never be placed on it; (xii) the food preparation area should be exclusively for this and separated from the area where meals are eaten and recreation areas; (xiii) nobody who had symptoms or signs of disease or wounds should handle food; (xiv) workers who prepare food must not change diapers and should carefully wash their hands before working with food; (xv) parents should inform at daycare centre if their children have diseases; (xvi) the daycare centre must notify infectious diseases.^{143,144}

Exclusion of sick children is controversial, and there is a lack of studies that confirm its cost-effect ratio. Scientific evidence recommending exclusion only exists for certain diseases.¹⁴⁵ For example, in relation to diarrhea, some authors believe that children can attend daycare as long as they are able to reach the bathroom for all evacuations or as long as diapers contain liquid feces, in contrast with others who believe that the possibility of environmental contamination does not justify the risk.¹⁴⁶ The destination of a sick child very often depends on economic causes which overrule infection control: fear of losing employment can make parents take their children to daycare centers even when sick and even hide the disease; fears of a similar nature can make daycare centre administration accept sick children.²⁵ For the public health authorities, exclusion of sick children is a problem, since they may end up at different daycare centres with less rigorous standards, spreading the disease still further; this may intensify if daycare centers are closed in response to outbreaks. Despite isolation working in the hospital environment, its use at a daycare centre is practically impossible: children are unlikely to remain confined voluntarily and they are generally no workers available to carry out the task nor with the necessary training.

In order that measures for the control and prevention of infectious diseases be implemented, routine training of the workers at daycare and preschool education centers is of fundamental importance, involving health care professionals and public health administrators at the local and even national levels.^{147,148} Studies confirm the interest of daycare centre managers in specific information on infection prevention¹⁴⁹ and have confirmed the role of trained workers in reducing transmission and number of cases of infectious diseases at daycare centers,¹⁵⁰ and also the negative contribution of those without adequate training.¹⁵¹ The need

to provide guidance for parents is also recognized.¹⁵² The participation of healthcare professionals in the dissemination of knowledge on prevention and control of infectious diseases is considered important and necessary.^{153,154} Pediatricians have a teaching role in the multiplication of knowledge and in providing precise information on the subject for parents, educators, other health professionals, legislators and others involved with out-of-home childcare, whether because of their opportunities and access to families, made possible by their involvement in medical child care or because of their access to other health professionals and other stakeholders, made possible by training and technical consultation situations. In the majority of cases, it is a pediatrician who is responsible for specific control measures, such as exclusion from daycare due to infectious diseases.^{155,156}

As the number of establishments that provide day care for small children in groups increases, not all of which can be regulated specifically for prevention and control of infectious diseases, well-informed childcare users and service providers may be the best strategy for reducing the transmission of diseases in these environments.³⁰

Conclusions

Given the importance of infectious diseases as causes of morbidity and mortality of children, and faced with the growing use of daycare and preschool education centers among the child population and the evidence of increased risk of acquiring disease associated with the growing attendance at these establishments, preventative measures and control of disease transmission in these environments in his of fundamental importance to reduce the damage done to the health of children and the dissemination of infection into the community. Training of workers, providing information for parents and involving health professionals and health administrators are necessary conditions for good infection prevention and control programs.

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