Impact of an infection control program in a specialized preschool

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Background: The purpose of this study was to design and implement a comprehensive infection control program and measure its effects on the number and types of infectious illnesses experienced by children attending a specialized preschool program.
Methods: Participants in the study were children with Down syndrome enrolled in a school-based early intervention program. The ages of the children ranged from 6 weeks to 5 years. Through a series of parental questionnaires, the number and types of infections in the children were chronicled for a year before and a year after the implementation of an infection control intervention program. Interventions included infection control lectures, handouts, posters, and attention to environmental cleaning and disinfection, with an emphasis on toys. Compliance with these measures was monitored and recorded.
Results: During the interventional year the median number of total illnesses/child/month decreased significantly from the baseline year (0.70 vs 0.53, $p < 0.05$), with a trend toward a decrease in the number of respiratory illnesses (0.67 vs 0.42, $p < 0.07$). Significant decreases were also seen for the median number of physician visits (0.50 vs 0.33, $p < 0.05$), courses of antibiotics administered (0.33 vs 0.28, $p < 0.05$), and days of school missed as a result of respiratory illness (0.75 vs 0.40, $p < 0.05$).
Conclusions: This study demonstrates a decrease in infection rates with the implementation of a comprehensive educational and environmental infection control program in a day care setting. (AJIC Am J Infect Control 1996;24:167-73)

The number of preschool children enrolled in school-based educational programs and child care centers has increased steadily over the past two decades.[1] A number of studies have documented an increased risk of respiratory, ear, and gastrointestinal infections in these settings.[2-6] Intervention programs aimed at educating staff about the importance of handwashing and hygienic practices in toilet and diaper changing areas have been shown to be effective in reducing diarrheal infections in child care settings.[7-9] Many investigators have pointed out the potential role of the contaminated environment in the transmission of pathogens in day care centers.[10-13] Enteropathogens, including rotavirus, have been isolated from commonly touched items.[11,12] Investigators have also pointed out the role that contaminated environmental surfaces and objects may play in the transmission of common respiratory pathogens.[14-16] Therefore more detailed infection control interventions, which include attention to environmental cleaning and disinfection beyond toilet and diaper areas, may be beneficial in decreasing infectious illnesses in such a setting.

Our 2-year study was undertaken to prospectively design and implement a comprehensive

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infection control program and measure its effects on the number and types of infectious illnesses experienced by children with Down syndrome attending a specialized preschool program.

MATERIAL AND METHODS

Study population

The study was conducted at a school-based early intervention program for children with Down syndrome located in Nassau County, New York. The school is divided into 16 classrooms and provides educational programs for children aged 6 weeks to 5 years. Children are assigned to classrooms on the basis of age, with an average child-to-teacher ratio of between 5 and 6 to 1. The infant room was additionally staffed by parents of some of the babies. Multiple personnel (e.g., occupational therapists, speech therapists, aides, teachers) are also involved with the students. The children attend the school daily throughout the year, with short vacation periods.

The study design was approved by the institutional review board at North Shore University Hospital and the executive board of the school. All parents were invited to participate in the questionnaire portion of the study. The only requirement was the parent's willingness to complete a series of questionnaires about their child's health. Questionnaires regarding illnesses in the children were obtained by mail after meeting with the children's parents and after written informed consent was obtained.

Data collection

The investigation was designed to monitor the number and types of illnesses in study participants over a period of 2 years. The preintervention year (November 1991 to October 1992) involved the collection of baseline data before any interventions were instituted. During the intervention year (December 1992 to November 1993), a number of educational and environmental disinfection programs were initiated to help reduce the number of infectious illnesses in the school. Between the baseline and intervention year, a 1-month period (November 1992) was allowed for the implementation of the programs as described below.

Questionnaires were mailed by the school to participating parents. They were coded to maintain anonymity but to allow for tracking. At enrollment, a baseline questionnaire that detailed the child's underlying medical conditions, family structure, household environment, after-school activities, travel arrangements, and toilet training was completed. At 3-month intervals participating parents were asked to complete a questionnaire that described their child's illnesses during that 3-month period. Questionnaires were administered at 3-month intervals to minimize the response burden on the parents and therefore to increase compliance. Parents were required to report the specific dates of their child's illnesses to increase the reliability of their responses.

The questionnaires were used to collect information that detailed the number and types of infections, injuries, days of school missed as a result of illness, symptoms, physician visits and diagnosis, and antibiotic use. An illness was considered respiratory in nature when the principal symptoms were cough, runny nose, wheezing or rattling in the chest, ear pain, and sore throat. It was considered gastrointestinal when the symptoms primarily consisted of vomiting and diarrhea (two or more loose stools in 24 hours).

Viral surveillance

As a marker of the occurrence of community-acquired viral illnesses for the 2 years studied, we tabulated the isolation rates of different viruses as recovered in our hospital-based diagnostic laboratory over the 2-year period of study. The laboratory test specimens were from a number of different hospitals and included both inpatients and outpatients from private practices, as well as hospitalized patients.

Infection control intervention program

Four site visits were made to the school in the spring and summer of 1992 to assess the standard infection control procedures that were being used. Classrooms were evaluated for safety hazards, the availability of handwashing sinks, condition of diapering and food preparation areas, and overall cleanliness.

School personnel were observed for their attention to issues such as diapering and food preparation techniques, as well as handwashing, cleaning, and the use of disinfectants. The school's infection control policies and procedures were obtained, reviewed and revised as necessary. On the basis of observations noted during the initial assessment, a program aimed at improving infection control practices in the school was developed for use during the subsequent intervention year. The program's major components were the education and training of school personnel in issues of infection control, an increased emphasis on environmental cleaning and disinfection, and compli-

ance monitoring. Specific groups associated with the study were addressed in the following manner.

Teachers and aides. The initial in-service session presented to teachers and aides provided an orientation to disease transmission, handwashing, and cleaning and disinfection techniques. Lectures were developed from the American Public Health Association and the American Academy of Pediatrics guidelines.[13] As an adjunct to the lecture, each person also received an infection control manual that contained the newly revised school policies and procedures.

A true-false test, administered after the first lecture, demonstrated an excellent understanding in the areas of disease transmission and handwashing. Subsequent in-service presentations focused on cleaning and disinfection procedures, a review of proper diapering techniques, and safe food preparation, storage, and disposal. Additionally, timely and seasonal topics of interest were presented. In-service presentations occurred approximately every 4 to 6 weeks of the interventional year.

Environmental service workers. On inspection of the janitorial supply closets, a variety of products such as ammonia, cleanser, bleach, and a quaternary disinfectant product were found. All existing products were removed and replaced with Lysol Disinfectant Spray, Lysol Basin Tub and Tile Disinfectant/Cleaner, Lysol Disinfectant, and Lysol Toilet Bowl Cleaner (Reckitt and Colman, Inc., Montvale, N.J.). These were used exclusively for the duration of the study. Educational presentations that stressed the proper use and, as needed, use of dilutions of cleaners and disinfectants were provided for the school's environmental service staff. The frequency of cleaning and disinfecting was not changed and continued to be performed on a per school-day basis. However, some existing cleaning procedures were modified to maximize the potential benefit of thorough cleaning and disinfection. For example, it was recommended that the infant classroom be cleaned first followed by all other classrooms. Bathrooms were to be cleaned last. Mop water was changed after every fourth classroom. The school did not have access to a washer and dryer. It was recommended that, when all mopping was finished for the day, mops were to be soaked at least 10 minutes in a freshly prepared bucket of Lysol Disinfectant solution, rinsed, and wrung out as much as possible and air dried with the mop head in an upside-down position. Mop buckets were also to be cleaned, disinfected, rinsed, and air dried overnight.

School bus drivers. The bus company that transported the children was contacted. Educational presentations for the bus drivers focused on disease transmission and decontamination techniques to be followed. A protocol was developed with Lysol Disinfectant Spray, latex gloves, and paper towels used three times per week. Drivers were instructed to disinfect specific internal areas of the bus, such as the child safety seats and all hand rails. Before this protocol was instituted, the cleaning and disinfection of buses was not routinely performed. Only obviously soiled areas were addressed as necessary.

Toy cleaning crew. During the initial assessment of the school, it was noted that the classrooms contained a large number and variety of toys. These toys are used daily in many of the educational programs developed for the children. It has been suggested that toys may serve as an intermediate in pathogen transmission in this setting.[11-13] The school had no routine policy or procedure for cleaning and disinfecting toys unless they had been mouthed. However, numerous instances were observed when toys were mouthed but were not cleaned or disinfected by the teachers or aides because of time constraints. Therefore a cleaning service was hired to decontaminate toys three times per week. Teachers and aides were instructed to remove immediately from circulation toys that had been mouthed by any of the children.

Educational presentations for the toy cleaning crew included disease transmission, handwashing, gloving, and a review of the written cleaning and disinfection policies that we developed for toys. These policies assured that toys were safely and thoroughly cleaned, followed by the application of disinfectant spray and air drying. Paper towels and clean cloth towels were used to clean and disinfect toys in each classroom and were not used from room to room.

Study-site monitor. The study monitor received in-service education on all aspects of the intervention program. This included disease transmission, cleaning and disinfecting, handwashing, appropriate use of gloves, diapering technique, food preparation and storage, and proper waste disposal. The use of a data collection worksheet was reviewed. The worksheet was used to record compliance by personnel performing specific functions at various sites throughout the school. The monitor spent 5 to 6 hours in the school twice a week, every week, visiting each classroom at random times. In addition, the monitor evaluated

the performance of the cleaning service and bus drivers. The monitor was instructed to take questions from the staff but not to offer instruction. Compliance issues and questions from the staff were communicated to the study investigators for review and response. These issues and questions were then incorporated into subsequent in-service presentations.

Additional educational materials. As an adjunct to lectures and written policies, procedural posters were strategically placed in classrooms, above sinks and diaper changing areas, and in all bathrooms. These posters helped to reinforce proper handwashing and diapering practices. Additionally, cartoon-like poster reminders were placed throughout the classrooms. They depicted colorful images of bacteria residing on surfaces such as diaper changing areas, tabletops, toys, and bathrooms. Each poster contained a tag line reinforcing the concept of the potential role of fomites in disease transmission and the need to comply with recommended standards. In an effort to address the transmission of infectious diseases in the home, each parent was supplied with a manual outlining basic infection control recommendations.

Statistical analyses

The data on the extent of compliance at various sites throughout the school collected by the site monitor were analyzed and subjected to periodic review by use of a statistical computer program (Epi Info version 5.01a; Centers for Disease Control and Prevention, Epidemiology, Program Office, Atlanta, Ga.). Compliance threshold values were established during the washout period (November 1992) by calculating a mean plus or minus one standard deviation for each monitored activity. Values that exceeded a threshold during the course of the intervention period provided information on noncompliance. Depending on the perceived severity of the noncompliance, information was either forwarded to the school's administrator for immediate action or addressed at the next scheduled in-service program. All other data management and analysis was completed by use of SAS (SAS Institute, Cary, N.C.).

To calculate the rate of infection, the number of infections (respiratory, gastrointestinal, sinus, middle ear, and total) reported by families who consented to complete the questionnaires were counted for the appropriate time period. This was then divided by the number of months the surveys covered. In this manner, all rates of infection were per month. Only children who had at least 6 months of data were included in the analysis.

The distribution of the rates of infection (respiratory, gastrointestinal, ear, sinus, and total illnesses) for the intervention period, was compared to the baseline period by use of Mann-Whitney tests. The number of physician visits and antibiotics used were also compared by use of the Mann-Whitney test. The children in the two different study years were compared with respect to a number of demographic factors, including toilet training, exposure to cigarette smoke, time spent in the school bus, after school care, underlying condition (e.g. respiratory or heart disease), age (grade), and home living environment. Chi-squared testing for proportions or the Fisher's exact test was used as appropriate.

RESULTS

The school had 100 to 110 children enrolled during each of the 2 years under study, with no change in the number of teachers or classroom size from year to year. Questionnaires were completed for 33 children during the first (baseline) year of the study and for 38 children during the second (interventional) year. A participation rate of more than 33% with a mailed questionnaire is considered good for this type of survey.[17] Five sets of questionnaires were used in the first year that did not include at least 6 months of data and were therefore considered incomplete data sets. Similarly, in the second year two sets of questionnaires were used that were not complete. These were not included in the analysis. There were no significant differences between the two groups with regard to age, number of siblings, toilet training, bus travel, exposure to cigarette smoke at home, number with their own bedroom at home, underlying cardiopulmonary disease, additional day care attendance, or number of years at the school (Table 1). It should be noted that the number of study participants who were in their first year in the school's program increased in the interventional year. The distribution of children by grade in the school was also similar for the two years (Table 2). No prolonged absences (greater than 2 weeks) occurred in any child in the study.

Table 3 summarizes the results obtained from the questionnaires and details the number and types of infectious illnesses. This translates to a median of 8.40 total illnesses/child/year (8.04 respiratory and 0.96 diarrheal) in the baseline year and a median of 6.36 total illnesses/child/year (5.04 respiratory and 0 diarrheal) during the

Table 1. Demographics of participants

	Baseline	Intervention period
No. of participants	33	38
Mean age ± SD (in mos.)	38.3 ± 15.2	41.6 ± 15.5
Participants first year in the program	7/33 (21%)	12/38 (32%)
Mean no. of siblings	1.1 ± 0.96	1.1 ± 0.93
Cardiopulmonary disease	10/33 (30%)	9/38 (24%)
Toilet trained	30/33 (91%)	37/38 (97%)
Travel on school bus	27/33 (82%)	25/38 (66%)
Have own room	25/33 (76%)	26/38 (68%)
Parents smoke	4/33 (12%)	8/38 (21%)
Additional day care	1/33 (3%)	3/38 (8%)

intervention year. The median number of total illnesses/child/month decreased significantly from the baseline year to the interventional year. Downward trends were reported in respiratory illness and gastrointestinal illnesses from the first to the second year. Significant decreases were also reported for the number of physician visits, antibiotics used, and school days missed as a result of respiratory illness during the interventional year. Trends toward fewer cases of physician-diagnosed otitis media and sinusitis were also observed in interquartile ranges during the second year. Overall, absenteeism was consistent from year to year (data not shown), suggesting that no unusual outbreaks of disease were occurring in the community.

In evaluating the isolation of different viruses from our diagnostic laboratory over the 2 years, specific viruses were reviewed as indicators of the major cause of infections in this age range (Table 4). The overall rates of viral isolation were not significantly different from one year to the other ($p > 0.05$, chi-square), with the exception of adenovirus, which was higher in the interventional year ($p < 0.001$).

Assessment of infection control practices was done with an on-site monitor. Compliance with recommendations was generally consistent throughout the course of the intervention year. The overall compliance rate per classroom was 87.2% ± 4.5%. Among all the rooms, a mean of 780 ± 214 observations were made per room over the intervention year.

DISCUSSION

It is generally agreed that implementation of infection control practices in preschool settings is important in minimizing disease transmission. However, documentation of the benefits of such a program has been incomplete. Two studies to date have demonstrated a beneficial effect in decreasing diarrheal disease with increased attention to handwashing. Black et al.[7] were able to document a decrease in diarrheal illnesses in two day care centers after the institution of a handwashing program, as compared with two control centers. Assessment of efficacy was based on observations of stool consistency in the attendees at the centers. Using a more complete handwashing educational program and protocol, Butz et al.[8] observed a decrease in diarrhea and vomiting in centers given the intervention compared with controls. The latter study also relied on symptom observations to monitor the effectiveness of the program. Although they observed a decrease in gastrointestinal symptoms, they were unable to ascertain any changes in a respiratory symptom (runny nose) in the children. Bartlett et al.[9] also noted a decrease in diarrheal illness in child care settings associated with infection control surveillance and suggested that ongoing contact with health personnel may have contributed in large part to improved hygienic practices.

Table 2. Distribution of questionnaire responders by grade in school

Grade	Baseline year (n = 33)	Intervention year (n = 38)
1	7	14
2	7	11
3	7	6
4	8	7
5	4	0

Our study differed from these investigations in a number of ways. We performed this study prospectively in a single site over a 2-year period, thereby attempting to reduce possible bias as a result of differences in physical structure, personnel ratios, enrollees, or preexisting cleaning pro-

Table 3. Illnesses reported in baseline vs interventional years (expressed as median with 25% to 75% interquartile range)

Illness*	Baseline year	Intervention year	p Value
Total illnesses	0.70 (0.42-1.08)	0.53 (0.40-0.75)	<0.05
Respiratory	0.67 (0.33-0.83)	0.42 (0.33-0.67)	<0.07
Gastrointestinal	0.08 (0.0-0.14)	0.0 (0.0-0.10)	NS†
Otitis media	0.08 (0.0-0.33)	0.08 (0.0-0.16)	NS
Sinusitis	0.0 (0.0-0.08)	0.0 (0.0-0.0)	NS
No. of visits to doctor	0.50 (0.29-0.83)	0.33 (0.25-0.50)	<0.05
Courses of Antibiotics*	0.33 (0.25-0.67)	0.28 (0.17-0.42)	<0.05
Days Absent from School*	0.75 (0.42-1.50)	0.40 (0.10-1.08)	<0.05

*Per child/month.
†Not statistically significant.

Table 4. Isolation of viruses used as indicators of community-acquired infection

Virus	Baseline year	Intervention year	p Value
RSV	78	74	NS
Influenza	23	29	NS
Adenovirus	25	51	<0.001
Parainfluenza	12	16	NS
Total respiratory specimens	**918**	**876**	
Enterovirus	23	18	NS
Total stool specimens	**377**	**403**	

Data compiled from North Shore University Hospital Viral Diagnostic Laboratory.

tocols among different centers. We performed more extensive interventions than previous studies. In addition to reinforcing existing handwashing procedures, we attempted to educate staff and families about other issues of infection control, including environmental surface cleaning and disinfection. We paid special attention to toys because they were observed to have been frequently mouthed and hence were a potential major source of disease transmission. Disinfection of environmental surfaces in school buses was also addressed. For determination of illness rates we relied on parental reports of illness and physician diagnoses.

The children in this study had Down syndrome and were attending a preschool program that offered experiences not routinely found in most day care settings (e.g., physical, occupational, and speech therapies). In addition, children with Down syndrome have the potential for increased susceptibility to illness.[18] Despite these factors, which could have predisposed these children to higher infection rates, the frequencies of respiratory and gastrointestinal illnesses observed during the noninterventional year were strikingly similar to those reported for other day care groups.[4-6] It is also likely that the school's staff and the families of children with Down syndrome are more aware of infection control issues than those at traditional day care centers. Even with these constraints, the implementation of our infection control program was able to demonstrate a decrease in infection rates in this setting. Additionally, we believe that the Hawthorne effect was not an issue in this study because the staff was observed during the baseline year. Any "effect" on the interventional year should have been minimized by this baseline period.

It could be argued that the differences in detected illness rates reflect year-to-year variabilities in the occurrence rates of such infections. This is contrary to the striking consistency of infection rates in our baseline year from reported rates in prior studies in other populations and at other times.[4-6] Additionally, viral isolates from our hospital viral diagnostic laboratory revealed no difference in rates of isolates from year to year. Hospital-based viral isolation has been previously shown to correlate with patterns of viral disease in a community.[19] Thus these data suggest that the reductions seen in our interventional year were not a result of significantly lower infection rates in the community.

With this infection control program we were

able to demonstrate a significant decrease in total infections. We recorded a marked decrease in respiratory infections, as indicated by parental reports of such illnesses, a decrease in days missed from school as a result of respiratory illness, and trends toward a decrease in reported cases of physician-diagnosed otitis media and sinusitis. Total reported illnesses were significantly decreased during the interventional year, as were reported physician visits and antibiotics used. Although the rate of gastrointestinal illness was relatively low both years, we also observed a trend toward a decrease in this illness rate. All of these reductions in disease-related end points would potentially result in a positive economic impact, as well as an improved quality of life for the children and their families. This study was not designed, however, to ascertain which components of the program most contributed to the improvements detected or to determine the cost-effectiveness of such a program.

Respiratory infections are the most common cause of illness and school days missed in young children. The ability to demonstrate a decrease in the occurrence of such infections with the infection control program we have described looms as a potentially important observation. Future studies should determine whether this type of infection control program, or portions thereof, could be applied successfully in other preschool and day care settings.

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