Evaluation of an Hygienic Intervention in Child Day-Care Centers

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The growing use of child day-care centers (CDCCs) has produced a significant rise in morbidity due to infectious diseases which carry such consequences as discomfort, disability, and parental anxiety.[1,2] Haskins conservatively estimated the cost of day-care illnesses among children to be $1.8 billion.[3] To this must be added the cost of parents' and care givers' excess illness attributable to CDCCs.

No published study describes a successful intervention to reduce the risk of upper respiratory disease in CDCCs. Although many research groups have advocated hand washing and diapering hygiene as a means of reducing the spread of enteric disease in CDCCs,[4-11] there are only two controlled studies in the literature. In their pioneering work, Black et al showed the incidence of diarrhea in CDCCs following a rigorously monitored hand-washing program to be nearly twice that in intervention centers.[12] Bartlett et al monitored the impact of hand washing in randomly assigned CDCCs and found no intervention effect. However, rates of diarrhea were significantly lower among children in the actively monitored centers regardless of intervention status.[13]

These studies share several limitations: the sources of incidence data were not blinded to center intervention status, the analyses did not statistically control for potential confounders, and non-independence of multiple diarrhea episodes in the same child were not accounted for. The purposes of our study were to develop a feasible, multicomponent hygienic intervention and to carefully measure its impact while controlling for sources of bias.

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METHODS

Design

We conducted a randomized trial of an hygienic intervention in 24 CDCCs in Cumberland County, North Carolina. Centers met the following criteria: enrollment less than 30 children, at least five children attending in diapers, and projected to operate for at least 2 years. Centers of similar enrollment were paired, and one of the pair was randomly assigned to the intervention group.

Study Population

We distributed over 800 enrollment booklets to parents that included a self-administered eligibility form; a child enrollment form about the child, his or her family, the home environment and child-care history; and a consent form. Parents who were willing to participate in a telephone survey completed the questionnaire, signed the informed consent form, and returned these to the director of their CDCC. All 389 children who met the eligibility criteria (under 36 months of age, in day care at least 20 hours per week, absence of chronic illness or medication that would predispose to infections, youngest of potentially eligible children in the same family, consenting English-speaking parents with access to a telephone, and intending to remain in day care throughout the study) were enrolled.

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Intervention

The intervention, a curriculum for care givers, was piloted at the Frank Porter Graham Child Development Center, which did not participate in the subsequent study. Workers from control centers were trained at the conclusion of the clinical trial.

Training for care givers in intervention centers began October 1, 1988. Sessions lasted 3 hours and required participants to demonstrate skills in hand washing and diapering. Pre- and post-test questionnaires were administered to measure their improvement in knowledge. Three credit hours were granted to each care giver who attended. The specific strategies that were emphasized were hand washing of children and staff; disinfection of toilet and diapering areas; physical separation of diapering areas from food preparation and serving areas; hygienic diaper disposal; availability of soap, running water, and disposable towels (a waterless, disinfectant scrub [Cal Stat™, donated by Calgon Vestal Laboratories, a subsidiary of Merck and Co, Inc], was to be used only if the alternative were not washing at all); daily washing and disinfection of toys, sinks, and kitchen and bathroom floors; daily laundering of blankets, sheets, dress-up clothes, etc; and hygienic preparation, serving, and clean-up of food.

Care givers received on-site follow-up training a week later and subsequently at 5-week intervals. This reinforcement of the didactic training included adaptations, demonstrations, and discussions of hygienic techniques; responses to care-giver's questions; and review of handouts for posting in the CDCC.

We met with directors at the intervention centers monthly to encourage their leadership and support. A separate training program was provided for food handlers. Additional training sessions were scheduled periodically for new employees.

Illness Measures and Definitions

A pilot study among 101 CDCC families undertaken between May 23, 1988, and July 29, 1988, tested recruitment procedures and the telephone survey. The survey was conducted from October 19, 1988, to May 23, 1989, by Survey Research Associates, Inc, of Durham, NC, using computer-assisted telephone interview methodology. All families were called biweekly to elicit information including diarrheal and respiratory symptoms. Each week's data were transferred to study data sets and reviewed for consistency and errors.

Diarrhea was defined as a report by a parent of an unusually loose or watery stool. Respiratory symptoms included coughing, runny nose, wheezing or rattling in the chest, sore throat, or earache. A new illness episode was defined as onset of symptoms following at least 7 consecutive symptom-free days. A severe diarrhea episode was defined as at least five loose stools during 24 hours along with vomiting, fever, or both. For each classroom, six incidence rates (number of new episodes per fortnight at risk) were computed: pure diarrhea (episodes characterized by diarrheal symptoms without any respiratory symptoms); pure diarrhea, severe (such episodes with severe diarrheal symptoms only); all diarrhea (all episodes with diarrheal symptoms, with or without respiratory symptoms); all diarrhea, severe (all such episodes with severe diarrheal symptoms); all respiratory (all episodes with any respiratory symptoms, with or without diarrheal symptoms); and all respiratory, severe (all such respiratory episodes with fever).

Other Data Collection

Information was collected by study staff using the following instruments developed and field-tested by the project: CDCC

enrollment, for size, staffing, and policy information; environmental modifications compliance, for changes in the CDCC physical environment; classroom observation, to assess enrollment, staffing, and physical characteristics of the classrooms including diapering and hand-washing facilities; and the health and hygiene event sampling form, to collect information about targeted behaviors such as diapering and toileting, general hygiene, food service, and frequency of cleaning activities. The same staff who conducted the training unobtrusively recorded observations at 5-week intervals. (Data collection forms are available upon request.) Finally, the study used the Infant/Toddler Environment Rating Scales, an instrument consisting of 35 items, each scored on a seven-point scale from 1 = inadequate to 7 = excellent, designed to give a global assessment of center quality.[14]

Analysis

Incidence rates were calculated at the classroom level. Children who changed classrooms contributed episodes and time at risk to each classroom. The effect of the intervention was estimated by comparing the mean incidence rate of intervention classrooms with that of nonintervention classrooms, adjusting for mean classroom age and for potential confounders in linear regression models in which controlling variables were centered at their means. Rate differences, expressed as mean excess episodes per child-year, and ratios were estimated.

In order to select potential confounders, variables collected with the data collection instruments were examined for associations with intervention status and with incidence rates. (The complete list of variables is available upon request.) Because variables were redundant and highly correlated, factor analyses were performed.[15] Through a series of step-wise regressions, first within each instrument and then combining variables selected from all instruments, we identified a set of factors and individual variables that were related to classroom incidence rates ($P < .15$). All variables in the confounder sets and a priori effect modifiers, such as season and age of center, were examined as interaction terms conditional on age and the appropriate set of potential confounders.

RESULTS

The families of 18 children initially enrolled were dropped because they could not be contacted or because the child was not in day care for two consecutive interviews. Among the remaining 371 families, 4046 biweekly telephone interviews were completed. There were 291 children under 24 months and 80 over 24 months at the start of the interviewing. One center withdrew from the study before its last data collection visit. Therefore, some observational data were available only for 23 centers. There were 31 intervention and 36 control classrooms that participated.

Child, family, and CDCC characteristics according to intervention status are shown in Table 1. Children were frequently nonwhite, of moderate socioeconomic status (SES), and residing in relatively uncrowded homes. The centers were large, most often nonprofit, had many children per classroom, and child-to-staff ratios of 7:1. Access to sinks was less than optimal and staff usually both diapered children and prepared food. Overall quality, based on the ITERS, was average for North Carolina.[14] Intervention and control centers were similar for most base-line char-

TABLE 1. Child, Family, Center, and Classroom Characteristics: Comparison of Intervention and Control Centers

Characteristic, Measure	N*	Intervention	Nonintervention	*P* Value‡
Age in months, mean	371	15.9	16.8	.25
Birth weight, kg, mean	369	3.3	3.4	.57
Male sex, %	371	53.9	55.8	.72
Female sex, %	371	46.1	44.2	
Nonwhite race, %	371	58.8	28.2	<.01
Length enrolled in any day care, months, mean	366	7.8	10.5	<.01
Attends other group program, %	369	19.4	20.1	.87
Attends day care beyond normal hours, %	369	6.7	7.3	.82
Has attended two or more CDCCs, %	363	25.4	22.4	.43
Two or more siblings in home, %	370	14.0	8.3	.16
Sibling in public school or day care, %	370	51.2	47.1	.43
Crowding, persons per room in home, mean	369	0.6	0.6	.40
Child sleeps in separate room, %	369	63.8	73.8	.04
SES index§, mean	369	41.5	41.3	.87
Dog or cat in home, %	367	37.8	50.3	.02
Cigarettes smoked by parents, %	351	21.3	27.0	.21
Single-parent household, %	370	26.8	15.1	<.01
Community or well water, %	367	33.3	32.7	.90
Multifamily dwelling, %	367	20.3	13.2	.07
Center enrollment, median	24	95.0	102.0	.79
Years of center operation, median	24	5.5	3.0	.64
Number of attendees in diapers, median	24	18.0	22.5	.29
For-profit management, %	24	33.3	50.0	.68
Written diarrheal illness policy, %	23	33.3	18.2	.64
Children enrolled in classroom, mean	65	11.5	12.4	.86
Additional children entered classroom, %	65	45.2	23.5	.07
Fraction of children in diapers, mean	65	62.2	71.7	.32
Child-to-staff ratio, mean	65	7.3	6.7	.36
Square feet for child, mean	65	47.2	41.7	.33
Open to other classroom, %	65	25.8	8.8	.07
Sink access	65			.03
Sink < 3 ft. from diaper area		35.5	70.6	
Sink > 5 ft. from diaper area		19.3	11.8	
No sink in classroom		29.0	8.8	
No children in diapers		16.1	8.8	
Staff both diapers children and prepares food	65	58.1	70.6	.29
ITERS score, mean	47	3.5	3.65	.95
Care giver washed own hands after diapering, %	135	83.8	79.1	.59
Sharing food avoided, %	48	79.2	87.5	.44
Toys washed every day, %	45	45.4	56.5	.40

* Number of children, centers, or classrooms with recorded observations.
‡ Chi square test, *t* test for independent samples, Wilcoxon two sample test, Fisher's exact test.
§ Hollingshead four-factor index of social position.

acteristics including hygienic behavior. However, several characteristics that might be related to greater infection rates were more frequent in intervention centers: nonwhite children, shorter time since enrollment, sharing a bedroom at home, single-parent household, residing in a multifamily dwelling, open classroom, and inadequate access to sinks.

Respiratory episodes were most frequent, followed by all diarrhea (Table 2). Severe diarrhea and pure diarrhea were infrequent. Intervention classrooms with a mean age under 24 months had lower diarrhea rates than such control classrooms, but these crude differences were not significant. After training, hand-washing behavior based on Event Sampling scores (0 = none, 0.5 = partially correct, 1.0 = as recommended in the training) improved in intervention centers both after diapering (0.75 vs 0.37, $P < .01$, t test) and after contact with mucus, saliva, vomit, etc of children (0.66 vs 0.21, $P < .01$, t test).

Adjusted for age only, there were no significant differences between intervention and nonintervention classrooms, although in every case the risk of illness was greater in the nonintervention classrooms (Table 3). When the set of extraneous variables associated with each illness outcome were controlled, nonintervention classrooms experienced significantly more episodes of all diarrhea, severe (0.5, 95% CI 0.4, 1.04) than intervention classrooms. Other illness outcomes differed little by intervention status.

The intervention effect on all diarrhea, severe was modified by three characteristics: length of the CDCC's operation, the mean age of children in classrooms, and the care-giver hand-washing factor. For centers in operation less than 6.5 years, children in intervention classrooms experienced less all diarrhea, severe than did those attending control classrooms (Table 3). This difference was not observed in centers operating more than 6.5 years. Within classrooms caring for young children (mean age under than 24 months), intervention was associated with a reduction in all diarrhea, severe but this association was not observed within classrooms caring for older children. The illness rates for all diarrhea, severe in centers with higher care-giver hand-washing scores were lower in intervention centers, but the difference was not significant.

TABLE 2. Illness Rates by Age and Intervention Status, Unadjusted

Illness Definition	Incidence Density (Episodes/Child-Year)			
	Intervention Centers		Control Centers	
	<24 mos*	>24 mos	<24 mos	>24 mos
Pure diarrhea	1.83	1.41	2.37	1.34
Pure diarrhea, severe‡	0.24	0.17	0.38	0.15
All diarrhea	4.54	2.85	5.12	2.79
All diarrhea, severe‡	0.80	0.54	1.11	0.47
All respiratory	14.78	12.87	15.66	11.77
All respiratory, severe	5.25	3.35	4.86	3.90

* Child's age.
‡ Five or more stools per day, plus fever and/or vomiting.

DISCUSSION

The intervention program was effective in reducing the most severe episodes of diarrhea, despite the fact that, after randomization, the intervention centers and their attendants had characteristics that might have predisposed them to greater rates of illness. Intervention effect was greatest in centers that had been in operation more than 6.5 years and in classrooms containing children under 24 months of age. Newer centers may have been more amenable to our recommendations or may have required fewer physical modifications. Although hand washing of children and

TABLE 3. Effect of Intervention on Illness Rates (New Episodes per Child-Year)

	Incidence Density (Episodes/Child-Year)		Mean Excess Episodes*	95% CI	Relative Risk (RR)
	Intervention Centers	Control Centers			
Pure diarrhea					
Age-adjusted	1.70	2.01	0.31	(−0.30,0.93)	1.19
Fully adjusted‡	1.99	1.64	−0.35	(−0.86,0.16)	0.82
Pure diarrhea, severe					
Age-adjusted	0.20	0.34	0.14	(−0.08,0.36)	1.79
Fully adjusted‡	0.26	0.29	0.03	(−0.21,0.28)	1.13
All respiratory					
Age-adjusted	14.13	14.79	0.66	(−0.63,1.95)	1.05
Fully adjusted§	14.86	13.98	−0.88	(−2.43,0.66)	0.94
All respiratory, severe					
Age-adjusted	4.20	4.99	0.88	(−0.26,1.84)	1.19
Fully adjusted§	4.22	4.99	0.77	(−0.62,2.16)	1.19
All diarrhea					
Age-adjusted	4.06	4.95	0.89	(−0.44,2.21)	1.23
Fully adjusted¶	3.99	4.73	0.74	(−0.48,1.96)	1.19
All diarrhea, severe					
Age-adjusted	0.64	1.03	0.39	(−0.03,0.81)	1.65
Fully adjusted¶	0.58	1.12	0.54	(0.03,1.04)	1.97‖
By age of center					
<6.5 years	0.38	1.18	0.80	(0.15,1.44)	3.10‖
>6.5 years	0.81	1.02	0.21	(−0.93,0.50)	1.14
By age of child					
<24 months	0.67	1.33	0.66	(0.50,1.29)	1.97‖
>24 months	0.47	0.77	0.29	(−0.50,1.07)	1.62

* Mean episodes per child-year in control classrooms − mean episodes per child-year in intervention classrooms.
‡ Pure diarrhea (and severe) adjusted for mean age of children, presence of a dog or cat at home, ethnicity, presence of a written exclusion policy for diarrhea, and convenience of sink to diaper-changing table.
§ All respiratory (and with fever) adjusted for mean age of children, food preparation factor, and convenience of sink to diaper-changing table.
¶ All diarrhea (and severe) adjusted for mean age of children, type of diaper pail, ethnicity, quality of home factor, and convenience of sink to diaper-changing table.
‖ $P < .05$.

handling of respiratory secretions by staff were addressed in the training, the intervention may have had less impact on child-to-child spread and on aerosol spread than on worker-to-child transmission.

This study introduced design and analytic innovations that we believe improve upon previous trials.[12,13] Specifically, parental illness reports were blind to the intervention status of their children's CDCCs, potential confounders were controlled for, and effect modifiers were examined. Finally, nonindependence of outcome events was minimized by using the classroom as the unit of observation. This study was conducted in larger centers caring for younger children, however, and may not be generalizable to smaller centers or family day-care homes.

Although hygienic behaviors of care givers improved after intervention, such changes were not shown to lead to reduction for most illness rates. Therefore, we hypothesized that the intervention was limited by physical barriers, such as the distance between diapering areas and a sink, and access to a sink in the room. During the course of the intervention, we encouraged center directors to modify these barriers. Measures of physical facilities at the end of the intervention and the proportion of care givers completing sanitation and hygiene training tended to favor younger centers, but none of these differences were significant. However, the rate of compliance with the recommended modifications was significantly better in younger centers ($P = .027$), and younger centers were more likely to have written guidelines for handling children with diarrhea (Fisher's Exact Test, $P < .05$). These observations are reminiscent of Sacks et al's[16] observation that newly installed day-care center directors were more likely to remove safety hazards from playgrounds than were directors who had been in their jobs longer.

In conclusion, the intervention resulted in moderate improvement in the mean incidence of all diarrhea, severe, especially among younger children and in newer centers. However, physical barriers and resistance of more experienced staff to behavior change may restrict the impact of training and reinforcement of hygenic behavior on illness rates in CDCCs with limited resources. To reduce the incidence of infectious disease in CDCCs, it may be necessary to address physical barriers and financial constraints along with training the care givers.

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Overview of Policies Affecting Vaccine Use in Child Day Care*

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The introduction and widespread use of vaccines has had a remarkable impact on childhood diseases in the US (Table 1). There are now nine diseases against which all children should be routinely vaccinated unless there are contraindications: diphtheria, *Haemophilus influenzae* type b (Hib), hepatitis B, measles, mumps, pertussis, poliomyelitis, rubella, and tetanus. Recommended policies for the use of these vaccines have undergone changes during the past few years. The purposes of this review are to provide an updated summary of the major new or anticipated developments in vaccination policy as they apply to day care settings, to summarize current state immunization requirements for day care, and provide data on immunization levels among children in day care.[1]

Routine vaccination at the appropriate age is the best means of averting vaccine-preventable diseases. The recommended schedules for these vaccinations have been established by the Advisory Committee on Immunization Practices (ACIP) of the US Public Health Service and the Committee on Infectious Diseases of the American Academy of Pediatrics (AAP).[2–12]

VACCINE-PREVENTABLE DISEASES IN CHILD DAY CARE

The surveillance and reporting of vaccine-preventable diseases of childhood generally do not include routine collection of information regarding day-care center attendance of children who contract the diseases and whether day-care-related transmission of the disease occurred. Consequently, for most of these diseases, overall reported cases among preschool-age children are the only

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*See also "Meeting the Challenges of Vaccine-Preventable Diseases in Child Day Care," page 1021.