

DIARRHEAL ILLNESS AMONG INFANTS AND TODDLERS IN DAY CARE CENTERS: EFFECTS OF ACTIVE SURVEILLANCE AND STAFF TRAINING WITHOUT SUBSEQUENT MONITORING

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From October 1981 to September 1984, the authors conducted a three-year longitudinal study of diarrhea among infants and toddlers attending day care centers in Maricopa County, Arizona. In the third year of study, they evaluated the effects on diarrhea rates of staff training without external monitoring and of active surveillance conducted throughout the study. From 21 study day care centers, they randomly selected 10 ("intervention day care centers") to receive staff training in procedures to reduce transmission of infectious diarrhea. Continuing active surveillance in the 10 intervention and 11 control day care centers found no difference between diarrhea rates in intervention day care centers in the pre- and posttraining years and no difference between diarrhea rates in the two groups of centers either before or after the training intervention. Biweekly family-based surveys during the two months after training also demonstrated no difference between infant-toddler diarrhea rates in intervention and control day care centers. These surveys found the 21 study day care centers to have significantly higher diarrhea rates than did day care homes or households not using day care, but significantly lower rates than day care centers not included in the active surveillance. Continuous surveillance without training was associated with a significant decrease in diarrheal illness during the course of longitudinal study. One-time staff training without subsequent monitoring did not result in additional decreases and did not lower day care center diarrhea rates to the levels observed in day care homes and households not using day care.

day care; diarrhea; *Giardia*

Infectious diarrhea is an important problem in child day care centers, particularly

those caring for children who are not yet toilet trained (1, 2). In such centers, many

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opportunities exist for introduction and transmission of enteric pathogens. From 1981–1984, we conducted a three-year longitudinal study of diarrheal illness among infants and toddlers attending day care centers in Maricopa County (metropolitan Phoenix), Arizona. Using continuous active surveillance for infant-toddler diarrhea, in the first two years of study we found that day care centers adhering to specific hygiene procedures, especially child and staff handwashing, had lower risk of diarrheal illness than those that did not (2). In the second year, we also compared the rates of infant-toddler diarrhea in our day care center sample with those among age-matched children in day care homes and others cared for at home and found the rate of infant-toddler diarrhea to be significantly higher in day care centers than in the other settings (3).

Black et al. (4), in a study of four Atlanta day care centers, have shown that staff training in handwashing and hygiene, combined with close monitoring of staff compliance, is associated with a significant decrease in infant-toddler diarrhea. However, monitoring day-to-day staff practices in the more than 20,000 day care centers in the United States would clearly exceed the resources of public health agencies. Therefore, in the third year of study, we conducted a controlled trial of day care center staff training in handwashing and other hygiene practices without monitoring staff practices after training. We then evaluated the effect of this training using two ap-

proaches, active day care center-based surveillance and family-based surveys. The purpose of this phase of study was to determine whether this training strategy would result in a significant reduction of the infant-toddler diarrhea rate and whether this rate could be reduced to levels experienced by children in day care homes and in households not using day care. This study phase also permitted assessment of the impact of surveillance itself on day care center diarrhea rates.

MATERIALS AND METHODS

Study populations

Day care centers. For the first two years, our study was conducted in 22 day care centers randomly selected from the 108 day care centers in Maricopa County licensed to care for infants and toddlers. To conduct the training intervention study, we divided these 22 study day care centers into three strata, based on surveillance rates of infant-toddler diarrhea in the preceding 12 months. Half of the centers in each stratum were then randomly assigned to the intervention group. After this procedure, one of the centers in the high-rate stratum randomized to the intervention group withdrew from the study and was not replaced.

Because all day care centers in the intervention and control groups had already participated in study of diarrheal disease for at least one year before the intervention study, we also created a third comparison group ("new" day care centers) of four centers randomly selected from infant-toddler day care centers that had never participated in our surveillance. The three groups of day care centers did not differ significantly in several important characteristics including mean total enrollment, mean infant-toddler enrollment, operating hours, percentage accepting drop-in children, percentage accepting public agency payment, and percentage of study children enrolled for six months or less at the beginning of study year 3. At the beginning of study year 3, there were 196 infants and toddlers enrolled in intervention day care centers and

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178 in control day care centers. Based on surveillance rates of diarrhea in the preceding year, this sample was adequate to detect a 25 per cent reduction, with $\alpha = 0.05$, power of a test = 0.90. Infant-toddler enrollment in the new day care centers was 75.

Day care homes A total of 30 day care homes were randomly selected from listings compiled by private, nonprofit, and public agencies. Each day care home cared for two or more children aged 0–36 months. The day care home sample was matched geographically to the day care center sample by zip code to provide socioeconomic comparability. If a day care home closed, withdrew from the study, or ceased to have two or more children in the study age group, we recruited a replacement using the same selection process. At the beginning of study year 3, the day care home sample included a total of 85 infants and toddlers.

Households not using day care. A sample of children aged 0–35 months who did not attend day care and whose parents did not provide child care in their home was enrolled by random selection from county birth records combined with random telephone calling. This sample was geographically matched to the day care center and day care home samples by zip code. At the beginning of study year 3, the household sample included 111 infants and toddlers in 97 households.

Day care center staff training

The training program was implemented in the intervention day care centers during the last two weeks of September 1983. Training provided background information on infectious diarrhea and fecal-oral transmission and participatory learning of specific tasks for diarrheal disease prevention and control. The training sessions, using a standard protocol, were conducted by the principal investigator (A. V. B.) and study nurses with the assistance of training specialists.

In the first phase of training, day care center directors were taught management

procedures for disease control including separation of child groups, physical organization of diapering and toilet areas, requirements for environmental cleaning, management of ill children, communication of policies to parents, supervision of staff practices, and training of new workers. Directors were also taught the hygiene-related tasks their classroom staffs would learn.

The directors then participated in the training sessions for their infant-toddler classroom staffs. These sessions taught schedules and procedures for caregivers' tasks, including staff and child handwashing, diapering, food handling, environmental cleaning, and other child care hygiene practices. Posters depicting the handwashing and diapering procedures were provided to each intervention center, and handouts describing the caregivers' tasks and schedules for performance of the tasks were provided to each participant.

One week after training, an examination was administered to all trained staff. Correct description of 80 per cent of the caregivers' tasks and correct execution of all steps of the handwashing and diapering procedures were required to pass this examination. New workers in intervention centers were trained at the time of employment and required to pass the same examination. This examination was also repeated unannounced eight months after the original training.

Since training might result in an increase in diarrhea reporting in intervention centers, during the last half of September 1983 we visited each control day care center to give a presentation reviewing surveillance procedures already in place, but providing no instruction in disease prevention or management.

Ascertainment of diarrheal illness

In both the day care center-based surveillance and the family-based survey, a case of diarrhea was defined as occurrence in a study child of stools that were unusually loose or frequent compared with the

usual pattern for that child, as determined by the respondent caregiver.

Day care center-based surveillance. Methods of active surveillance in our intervention and control day care centers were identical with those used during the first two years of study (2). Briefly, this surveillance included weekly visits and daily telephone calls to each center on Monday through Thursday to identify diarrheal illness among children present that day and to record attendance in each age group. Informed consent was obtained from a parent of each child involved in the study. Stool specimens and epidemiologic data were obtained from all children with sporadic cases of diarrhea and from all ill and well children in groups experiencing diarrhea outbreaks (three or more cases in one day or five or more cases in any seven-day period in the same day care center). Stool specimens were tested for *Salmonella*, *Shigella*, *Campylobacter*, rotavirus, and *Giardia lamblia* by methods previously described (2). If a pathogen was identified in a sporadic case, all asymptomatic children in the same group were tested for that pathogen. In both intervention and control day care centers, management of infected children was mandated by state regulation and county policy, which required excluding such children from the day care center until negative stool specimens were documented after the end of symptoms and treatment (if appropriate).

Family-based survey. This survey was developed and used in study year 2 to provide uniform ascertainment of illness among children attending different types of child care facilities. After day care center staff training, student nurses trained to administer the family questionnaire surveyed the families of all children aged 0–36 months in each of the 25 day care centers, the 30 day care homes, and the 97 households that did not use day care. These questionnaires were administered every two weeks during October and November 1983, the time of highest diarrhea incidence in our previous two years of study. Student nurses were

blinded in regard to “intervention” or “control” status of the day care centers.

Survey questionnaires identified diarrheal illness in each study child and obtained information on the number and ages of other family members and the occupation of the principal wage earner. If illness occurred, information was obtained regarding specific effects of that illness on the family. The questionnaires for the household sample also asked whether the study child had begun out-of-home care during that two-week period; if so, that family continued to be surveyed, but questionnaires administered after the child began day care were excluded from comparisons with children in day care centers and day care homes.

In the day care centers and day care homes, the survey included the families of all infants and toddlers actively enrolled. Study children who left a day care center or day care home during the survey period no longer participated in the survey; questionnaires completed for such children before they left were included in the analysis. Children newly enrolled in a day care center or day care home in the sample were entered in the survey at the time of the next questionnaire. In day care centers and day care homes, questionnaires were distributed and collected at the facility; questionnaires were administered by telephone to families of study children not in attendance on the days of the survey. Biweekly questionnaires were distributed directly to individual families in the household sample. Based on actual attendance records, completion rates for these surveys were greater than 95 per cent in all three groups of day care centers and in day care homes and 93 per cent in households not using day care.

Statistical analysis

The proportions of specimens with pathogens identified and the attack rates in outbreaks were compared using the chi-square test. Illness rates were calculated for actual child-months of observation and compared using the *z* test for differences in

proportions, with correction for the number of groups compared. Results of the post-training family-based survey were also analyzed in stepwise logistic regression models (BMDP Statistical Software, Inc., Los Angeles, CA).

RESULTS

Diarrhea rates in study child care settings

Day care center-based surveillance. The rates of infant-toddler diarrhea identified by surveillance in intervention and control day care centers during the pre- and post-training years are shown in table 1. There were no significant changes in overall infant-toddler diarrhea rates or in rates in the infant or toddler stratum from the pre-training to the posttraining year and no significant differences in these rates between intervention and control day care centers in either year.

Pathogen testing of children revealed differences suggestive of impact of staff training. In the pretraining year, the percentages of infant-toddler diarrhea cases in which one or more pathogens were identified were almost identical in the intervention and control day care centers (14.5 per cent of 138 cases vs. 16.0 per cent of 144 cases). In the posttraining year, the percentage of pathogen-positive cases declined substantially in the intervention day care centers (9.2 per cent of 152 cases), while it remained essentially unchanged in the control day care centers (16.9 per cent of 154 cases). This posttraining difference in pathogen-positive specimen rate approached but did not achieve statistical significance ($p = 0.07$). However, in the post-training year, intervention day care centers experienced a significant decrease in the number of infections by *Giardia lamblia*, the most commonly identified enteric pathogen in our study. This decrease resulted in the *Giardia* identification rates among ill study children and their asymptomatic contacts being significantly lower in intervention day care centers than in control day

TABLE 1
Rates of diarrhea identified by active surveillance of infants and toddlers attending intervention and control day care centers, Maricopa County, October 1982 to September 1984

	Pretraining year				Posttraining year			
	Child-years of observation	Diarrhea rate (cases per child-year)	95% CI	Range of rates in individual day care centers	Child-years of observation	Diarrhea rate (cases per child-year)	95% CI	Range of rates in individual day care centers
Intervention day care centers								
Infants	64.2	0.73	0.62-0.84		73.8	0.94	0.89-0.99	
Toddlers	133.6	0.68	0.60-0.76		139.4	0.60	0.52-0.68	
Total	197.8	0.70	0.64-0.76	0.10-2.37	213.2	0.71	0.65-0.77	0.05-2.00
Control day care centers								
Infants	46.2	0.93	0.86-1.00		47.2	0.99	0.96-1.02	
Toddlers	137.3	0.74	0.67-0.81		141.8	0.74	0.67-0.81	
Total	183.5	0.78	0.72-0.84	0.05-2.21	189.0	0.81	0.75-0.87	0.05-2.03

care centers in the posttraining year (table 2).

Surveillance identified an additional difference between intervention and control day care centers in diarrhea outbreaks. There were nine outbreaks in study day care centers in both the pre- and posttraining years; three outbreaks in the pretraining year and five in the posttraining year occurred in intervention day care centers. In the pretraining year, the attack rate in outbreaks did not differ significantly between intervention and control day care centers: 11 of 24 children (46 per cent) became ill in groups experiencing outbreaks in intervention day care centers versus 36 of 97 (37 per cent) in control day care centers. In the posttraining year, the attack rate in intervention day care centers was significantly lower than in control day care centers: 50 of 91 children (55 per cent) versus 67 of 81 children (83 per cent). However, this difference was due to a significant increase in attack rate in control centers, rather than to a decline in attack rate in intervention centers.

Family-based survey. Consistent with the surveillance data, the biweekly family-based survey conducted during the two months after training also found the rates of infant-toddler diarrhea in intervention and control day care centers to be virtually identical (figure 1). When considered as a group, the 21 study day care centers had an infant-toddler diarrhea rate significantly

higher than that in day care homes ($p < 0.01$) and in households not using day care ($p < 0.001$). However, the highest rate occurred in the four new day care centers which had not previously been part of our study; their rate was significantly higher than that in the centers participating in ongoing surveillance ($p < 0.001$).

The proportion of family survey child-months of observation accounted for by infants was 20 per cent in intervention day care centers, 16 per cent in control day care centers, 18 per cent in day care centers not previously studied, and 20 per cent in households not using day care. In day care homes, infants accounted for a significantly greater percentage of family survey child-months (38 per cent). However, in day care homes, there was no significant difference in diarrhea rates in the infant and toddler strata (24.2 vs. 27.0 cases per 100 child-months), and the different age distribution in day care homes therefore did not contribute significantly to the differences in diarrhea rates between day care homes and other settings.

The surveys revealed significant differences in the number and ages of other children in families using different types of child care. We therefore examined these surveys in a multivariate logistic regression model with occurrence of diarrheal illness as the dependent variable and with type of child care and presence of other children by age group as the independent variables.

TABLE 2

Identification of Giardia lamblia among study children with diarrhea and their asymptomatic contacts in intervention and control day care centers, Maricopa County, AZ, October 1982 to September 1984

	Children with diarrhea		Asymptomatic children in contact with ill child		Total	
	No. positive/ no. tested	%	No. positive/ no. tested	%	No. positive/ no. tested	%
Pretraining year						
Intervention day care centers	15/149	10	35/158	22	50/307	16*
Control day care centers	20/203	10	23/127	18	43/330	13
Posttraining year						
Intervention day care centers	11/189	6	4/50	8	15/239	6*†
Control day care centers	27/167	16	9/94	10	36/261	14†

* Comparison of pre- and posttraining year intervention day care centers, $p < 0.001$, chi-square test.

† Comparison of posttraining year intervention and control day care centers, $p < 0.001$, chi-square test.

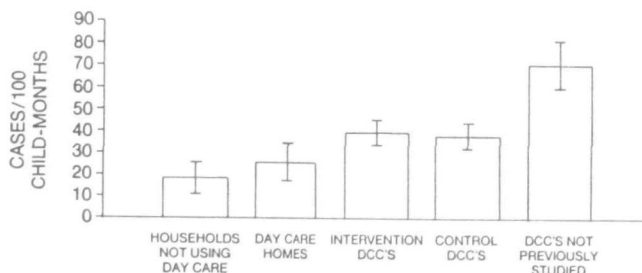


FIGURE 1. Rates of infant-toddler diarrhea by child care setting, Maricopa County, AZ, October to November 1983 (posttraining family-based survey). (I = 95% confidence interval).

In this model, risk of diarrhea was still significantly associated with type of child care. Compared with occurrence of diarrhea among children in households not using day care, in day care homes the odds ratio was 1.33 (95 per cent confidence interval (CI) = 0.73–2.40), in control day care centers the odds ratio was 2.12 (95 per cent CI = 1.30–3.48), in intervention day care centers it was 2.23 (95 per cent CI = 1.37–3.63), and in day care centers not previously studied it was 4.88 (95 per cent CI = 2.92–8.17). Risk of diarrhea in the 21 study day care centers was significantly greater than that in day care homes ($p < 0.02$) and in households not using day care ($p < 0.01$) and significantly less than in day care centers not previously studied ($p < 0.01$). In this model, again there was no significant difference in risk of diarrhea between day care homes and households not using day care.

These surveys also assessed the impact on the family of diarrheal illness in a study child. The rates of physician visits, medication usage, and subsequent diarrheal illness in other household members were actually higher in intervention than in control day care centers, although these differences were not significant (table 3). In day care centers not previously studied, each of these effects occurred at a rate significantly higher than in either of the other two groups of day care centers ($p = 0.001$ – 0.015). With the exception of physician visits, rates in day care homes were lower than in any of the day care center groups; rates were generally lowest in households not using day care.

Staff recall of training content

In accordance with our study protocol, we did not monitor staff compliance with the procedures taught in the training. To assess recall of these procedures during the posttraining year, we compared the results of the examination administered one week after training with those of the same examination administered eight months later. A total of 41 of 44 originally trained workers passed the initial examination on their first attempt. Eight months later, none of the remaining 28 originally trained workers and none of 14 subsequently trained workers passed the same examination. However, in the second examination, 17 of 42 workers correctly demonstrated the handwashing procedure taught in the training, and 15 of 42 correctly demonstrated the diapering procedure.

Impact of surveillance on diarrhea rates

The finding that the rate of diarrheal illness was significantly higher in day care centers not previously included in our study than in those previously included was consistent with the hypothesis that two previous years of surveillance had affected the rate of infant-toddler diarrhea in our day care center sample. To evaluate this hypothesis, we compared the yearly rates of infant-toddler diarrhea identified by active surveillance in the day care centers. The surveillance rates of diarrhea in the pre-training year (0.80 cases per child-year, 95 per cent CI = 0.76–0.84) and the posttraining year (0.76 cases per child-year, 95 per cent CI = 0.72–0.80) were not significantly

TABLE 3

Rates of occurrence of household effects associated with diarrheal illness in study child, by type of child care used, posttraining family-based survey, Maricopa County, AZ, October to November 1983

Effect	Rate of occurrence per 100 child-months				
	Intervention day care centers	Control day care centers	Day care centers not previously studied	Day care homes	Households not using day care
Adult missed work	7.0	7.0	13.6	3.0	0
Child required visit to physician	10.4	4.3	21.7	5.4	0.5
Child required medication	10.4	5.0	16.7	3.0	0.5
Other household members with diarrhea or vomiting (≤ 14 days after study child)	15.2	7.7	28.3	4.2	4.6

different. However, both these rates were significantly lower than that in our first year of surveillance (1.20 cases per child-year, 95 per cent CI = 1.16–1.24).

DISCUSSION

The trend toward increasing utilization of group day care for young children has caused concern about the potential for transmission of infectious diseases in day care settings. Staff training has frequently been proposed as one of the principal methods for reducing such disease spread. However, previous studies of the impact of training day care center workers have not separated the effect of training from that of monitoring or have not evaluated the impact of training and monitoring on morbidity (4, 5). Thus, the approach and results of our study differ importantly from those of previous investigations.

In 1976–1977, Black et al. (4) determined diarrhea rates among infants and toddlers in four Atlanta day care centers over a two-month period. Two of these day care centers then received staff training in hand-washing and hygiene, and staff practices in these two centers were “rigorously monitored” (p. 446). During a nine-month follow-up period, the diarrhea rate in the intervention day care centers declined significantly, becoming significantly lower than that in the control day care centers. In 1974–1975, Aronson and Aiken (5) trained selected staff members from 123 day care programs (at least 120 of which were day

care centers) to modify health and safety practices in their respective settings by acting as “health advocates” (5, p. 318). Systematic evaluation of practices in the advocates’ child care settings and in 19 comparable settings in which training did not occur was conducted before and one year after training. The periodic evaluation process alone was associated with significant improvement in the practices under study; training combined with the evaluation process was associated with additional significant improvement. Rates of disease and accident occurrence in the children before and after training were not measured.

These studies have suggested that training combined with outside monitoring of child care practices can modify staff behavior as well as disease occurrence. However, neither study addresses the impact of training in the absence of such monitoring. Our approach avoided external monitoring after training; we initially trained directors of our intervention day care centers and had them participate as cotrainers of their own workers so that they might provide internal monitoring of the practices of their staff. However, in terms of the principal outcome variable of our study—occurrence of infant-toddler diarrhea—both day care center-based active surveillance and family-based survey found no overall impact of this training strategy in day care centers that had already participated in two years of surveillance.

Our results suggest possible impact of training on certain aspects of infectious diarrhea transmission. The significant reduction in identification of *G. lamblia* in intervention centers may reflect the complex epidemiology of this pathogen in day care centers; *Giardia* can be transmitted by children with diarrhea, but also by asymptomatic shedding of cysts in stools or by cysts surviving in a contaminated environment (6–8). In addition, the posttraining year attack rates in diarrhea outbreaks in intervention day care centers were significantly lower than in control day care centers; it is possible that, during a time when diarrheal illness was prominent in intervention centers, the procedures learned during training were more effective or more consistently practiced. However, this finding is difficult to interpret because of the increased attack rate in control day care centers.

Although this study indicates a failure of staff training without subsequent monitoring to reduce diarrhea rates, it does not differentiate between failure of the training to modify staff practices and failure of modified practices to reduce diarrhea occurrence. The fact that none of the trained workers passed the eighth month follow-up examination suggests that these workers were not using the practices learned in training, although the examination results may not reflect modifications in their actual child care procedures. This failure to retain training content contrasts with the study of Aronson and Aiken (5), in which the performance of the trained health advocates on a seventh month follow-up examination nearly equaled that immediately posttraining. This difference might be explained by differences between the health advocate trainees—who were selected for interest in health issues and many of whom had training in child development, education, social work, or nursing—and more typical child care staff. The fact that our trainees did not know that they would be reexamined might also explain these different findings. Failure of training to modify

unmonitored behavior is perhaps not surprising since one study has documented failure of physicians and hospital staff to practice handwashing, even in medical intensive care units (9).

While our training intervention did not lower diarrhea rates, several lines of evidence suggest that surveillance itself did. First, the infant-toddler diarrhea rate in study day care centers was significantly higher in the first study year than in years 2 and 3. A similar decline in diarrhea rates during the course of surveillance without training was observed by Sullivan et al. (10) in a longitudinal study of 60 day care centers in Houston. Second, diarrhea rates in our original study day care centers were significantly lower than in day care centers not previously studied.

The finding that the day care centers under our active surveillance, like the day care centers trained and monitored by Black et al. (4), experienced a significant reduction in diarrhea rate indicates that this rate can be lowered. In day care centers not participating in surveillance, training alone without subsequent monitoring might contribute to reduction of diarrheal illness. However, even with training added to the effect of surveillance, infant-toddler diarrhea rates in study day care centers were not as low as those in the small group settings of family day care homes; rates of diarrhea in day care homes did not differ significantly from those of children cared for at home. This result is consistent with findings in our second year of study (3), and with other studies which have found diarrheal illness (11), respiratory infection (11, 12), and invasive *Haemophilus influenzae* type b disease (13) to be significantly more common in the large child groups associated with day care centers than in the smaller groups characteristic of day care homes. The findings of our family survey that diarrheal illness among approximately 500 infants and toddlers in 25 day care centers during two months resulted in 88 adults missing work, 108 physician visits, and 100 courses of medication indicate that

diarrheal illness in day care centers is a substantial medical and public health concern.

These results may have important implications for the direction of infant-toddler care. They indicate that type of day care and size of child groups deserve attention in future studies of infectious diseases among young children receiving out-of-home day care. In addition, they suggest that further attention must be directed to effective promotion of hygienic practices among day care center workers without external monitoring. Finally, additional study is needed to identify specific practices other than handwashing that reduce introduction and transmission of infectious agents in child care groups.

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