sanitation protects against most enteric infections while vaccination is still strictly disease-specific.

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Soiled Disposable Diapers: A Potential Source of Viruses

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Introduction

The average production of solid waste in the United States is 5.3 pounds per capita per day, or more than 300 million tons annually.[1] Although it is recognized that the disposal of solid waste is fundamentally a health problem,[2] the biological threat to health caused by human pathogens carried by or in association with the waste has not been explored. Excreta and products of animals have long been a part of municipal solid waste. The appearance of soiled disposable diapers in this waste creates a situation that increases the amount of human excreta in solid waste, and thus adds another dimension to the health hazard of the solid waste. Viruses, in particular, are a source of concern since babies are the most effective carriers of enteroviruses and have generally been immunized with live polio vaccine. In an early study that we conducted in 1971 on the occurrence of viruses in municipal solid waste, the expected enteric virus density in this waste was calculated to be about 32 virus units per 100 gm.[3]

The present investigation describes the amount of soiled disposable diapers found in municipal solid waste, the amount and types of enteric viruses found in these diapers, and the implication to public health of their appearance in solid waste.

Materials and Methods

Sampling of Waste and Detection of Virus

Municipal solid waste collected from an area in Cincinnati, Ohio (area A), and from an area in northern Kentucky (area B) was delivered to a pilot laboratory where the waste was separated. The diapers picked from the waste were placed in sterile plastic bags and brought to the laboratory for processing. A 5-gm portion of fecal material was removed from each disposable diaper and concentrated for virus by methods described elsewhere.[3–6]

Results and Discussion

Amount of Soiled Disposable Diapers in Municipal Solid Waste

A total of 8.2 tons of waste was separated. The results obtained from the studies showed that, by wet weight, 0.6 to 2.5 per cent of solid waste was soiled disposable diapers (Table 1). Because approximately 33 per cent of the diapers contained fecal matter and each pound (wet weight) of feces-soiled diapers contained an average of 60 gm of feces, the average amount of fecal matter in solid waste was calculated to be about 0.2 gm per 1 pound (wet weight).

Isolation of Viruses from Fecally Contaminated Disposable Diapers

Of the 84 fecally contaminated disposable diapers tested, nine contained viruses (Table 2). Viruses were detected in 15 per cent and 2.9 per cent of samples from area A collected during February and April, respectively; 16.7 per cent of samples from area B contained viruses during July.

Poliovirus 3 was recovered from disposable diapers in both sampling areas and echovirus 2 was found in two

TABLE 1—Amount of Soiled* Diapers in Municipal Solid Waste, 1971

Sampling			Amount of Diapers	
Area	Date	Total waste Separated	Soiled	Feces-contaminated
		lb†	% total waste‡	
A	February	800	2.5	1.0
A	April	9,200	0.9	0.3
B	July	2,800	0.6§	0.2§
B	July	3,600	0.8§	0.3§

* Includes diapers contaminated with urine or feces.
† Pounds (wet weight).
‡ Percentage (wet basis).
§ Mean values obtained from multiple samples.

TABLE 2—Percentage of Virus Isolations from Fecally Contaminated Disposable Diapers, by Area and Month, 1971

Sampling			Samples Containing Viruses	
Area	Date	No. of Samples Tested	No.	%
A	February	20	3	15.0
A	April	34	1	2.9
B	July	30	5	16.7

TABLE 3—Isolation of Viruses from Fecally Contaminated Disposable Diapers from Areas A and B, 1971

Area	Month	Sample No.	Total PFU/Gm	Virus Types
A	February	29	320	Polio 3
		31	160	Polio 3
		39	16	Polio 3
B	April	53	32	Polio 3
B	July	90	1920	Polio 3
		94	240	Polio 3
		98	65	Polio 3
		107	1440	Echo 2
		112	960	Echo 2

samples from area B (Table 3). The poliovirus 3 density varied from 16 to 1,920 plaque-forming units (PFU) per gm, with an average of about 390 PFU per gm. The average virus density in the spring months was 130 PFU per gm and that in July 740 PFU per gm (Table 3). These densities were considerably lower than those reported in direct examination of feces of older children.[7,8] Since the fecal matter removed from these collected diapers was usually mixed with urine and since the latter invariably had a strong ammonia odor, the lower virus densities detected in this study could result from dilution of feces with urine and from a rise in pH. Kelly and Sanderson[9] have shown a maximum enteric virus density of 20 units per 100 ml of sewage during the cold months and 400 units per 100 ml during the warm months. This difference reflects the difference and nature of the virus carriers who contributed the viruses to these two types of wastes.

Seven strains of the poliovirus 3 isolated from diapers were tested for their d and T (rct/40) markers in an effort to determine whether the strains isolated were of vaccine or wild types.[10] The results indicated that six of the isolates had clearly defined d+ marker characteristics, and one was doubtful (d±); six strains showed T+ markers, and one was T± (Table 4). These results suggest either that some of the vaccine strains of poliovirus 3 have yielded progeny with reverted dT markers or that wild strains were circulating in areas A and B. If poliovirus 3 vaccine accounted for the positive tests, the isolates were progeny with both markers different from the vaccine strain. Studies have shown that a significant portion of vaccinated children excrete viral progeny with reverted dT markers.[11] Upon serial human passage, these strains may undergo a further change associated with a further increase in neurovirulence and eventually reach a degree of virulence comparable to that of wild polioviruses.

The effect of polio vaccination on virus recovery and the relationship between the relative incidence of viral infections and the prevalence of viruses in solid waste cannot be assessed from these studies. A continuing surveillance of virus in solid waste together with that of families for polio vaccination and infections might thus clarify these points and point to the role of solid waste in the spread of virus infections and disease. Hopefully, such a study will be initiated.

Until such diapers are excluded from solid waste or until an effective method can be developed to disinfect such diapers before they are mixed with the solid waste, these virus-laden materials will continue to present a potential threat to the health of those who handle the solid waste during collection and constitute a feeding ground for disease vectors and a source of contamination of ground water when the waste is disposed in improperly constructed

TABLE 4—Genetic Character of Poliovirus 3 Isolates

	Log_{10} Virus Titer			Markers	
	Bicarbonate overlay, 37°C				
Strain	High	Low	High bicarbonate overlay, 40°C	d	T
February isolates (area A)	5.8	5.8	5.7	+	+
	5.9	5.8	5.8	+	+
	6.0	5.8	5.7	+	+
April isolate (area A)	5.3	4.9	4.3	+	±
July isolates (area B)	5.3	4.0	5.3	±	+
	5.7	4.9	5.3	+	+
	5.6	5.0	5.3	+	+

landfills. The alternative for management of these and other virus-containing wastes should be carefully assessed before any definitive action is undertaken.

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Evaluation of Screening Programs for Childhood Lead Poisoning by Analysis of Hospital Admissions

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Hospitalization of children for treatment of lead poisoning is one endpoint of a screening program that can provide a measure of the impact of such programs; this is well demonstrated by the experience in Newark, New Jersey, over a 4-1/2-year period.

Charts with the discharge diagnosis of lead poisoning were reviewed in four Newark hospitals caring for children with this problem from 1967 through the first 6 months of 1972. This time period spanned several stages of the Newark screening program: the absence of mass screening before 1969, the institution of some urine testing for δ-aminolevulinic acid in that year, and, from 1970 on, an increasingly intensive mass screening program using blood lead analyses.

Every blood lead determination made on Newark residents was available for comparison with hospital data. Information on each test included these items relevant to the evaluation of screening: the blood lead level, the child's age and ethnic group, the date, and the facility submitting the specimen.

The categories of blood lead levels used have operational significance for Newark: under 40 μg per 100 ml