INTENSIVE STUDY OF SELECTED FAMILIES FOR SPREAD OF ENTERIC PATHOGENS

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SELECTED FAMILIES residing in Phoenix, Ariz., were studied from June 1960 through August 1961 to determine if intensive observation would indicate the mode of introduction and familial spread of common enteric organisms. Such information had previously been sought by studying family contacts of persons acutely ill with diarrhea who were being observed in an investigation of the etiology of diarrheal diseases (*1*). However, the interval between onset of illness and study of the family prevented collection of definitive information. Inevitably 7 to 12 days elapsed from the onset of symptoms until medical attention was sought and pathogens were identified. Monthly surveys of populations to determine prevalence of *Shigella* and *Salmonella* and of diarrhea likewise failed to provide information in sufficient detail to reveal patterns of introduction and spread of enteric organisms in families.

Methods of Investigation

Families were selected for intensive study on the basis of three major criteria: (*a*) the family was composed of husband and wife and at least three children under 5 years of age, including one child, preferably a newborn infant, under 1 year of age; (*b*) the family was permanently resident in Phoenix and contemplated remaining in the area during the proposed period of study; and (*c*) the family resided in an environment conducive to the introduction and spread of enteric pathogens. Families meeting these criteria were selected from the register of the Maricopa County prenatal clinic prior to delivery of an infant or were selected subsequent to delivery at the Maricopa County Hospital. Adult members of the family and teenage children were interviewed to obtain their interest and cooperation. To maintain cooperation, families participating in the study were paid 25 cents for each weekly specimen.

Arrangements were made to obtain a passed stool specimen for each member of the family on a specified day of each week. These stool specimens were picked up early in the morning and transported immediately to the laboratory. A public health nurse obtained additional weekly specimens by rectal swabs from all children under 5 years of age. Material from the

Table 1. Number of individuals studied and of observation weeks, with number and percentage of bacteriological examinations performed

Subjects	Number of individuals	Number of person- (or animal-) weeks of observation	Number of bacteriological examinations	Percent of possible examinations
Persons, all ages	120	2, 791	2, 660	95. 3
Under 1 year	18	375	375	100. 0
1 year	11	236	236	100. 0
2 years	9	229	224	97. 8
3 years	10	213	208	97. 6
4 years	6	139	134	96. 4
5 years	6	158	150	94. 9
6–10 years	15	387	364	94. 1
11–15 years	7	181	166	91. 7
16 years and over	38	873	803	92. 0
Household pets	11	199	190	95. 5
Dogs	6	115	111	96. 5
Cats	4	60	55	91. 7
Duck	1	24	24	100. 0

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rectal swabs was inoculated directly to MacConkey's and to SS media, and plates were streaked upon return to the laboratory, usually within an hour of collection. Standard bacteriological procedures were followed for identification of *Shigella*, *Salmonella*, and enteropathogenic strains of *Escherichia coli*. Parasitological examinations of passed stool specimens were made weekly for the first 3 weeks and biweekly thereafter. Rectal swab specimens were taken weekly from all household pets to obtain material for bacteriological examination. Families were requested to notify the investigators and to collect an additional stool specimen from each family member who had diarrhea. Diarrhea was defined to them as an increase in the number of stools or one liquid stool.

A public health nurse visited each family weekly, inquired about the health of each family member, and recorded occurrences of upper respiratory infections as well as episodes of diarrhea. Data on personal and environmental hygiene also were obtained.

Results and Discussion

Data from 14 of the 20 families observed during the first 10 months of the study were adequate for analyses. The 14 families participated for periods of 11 to 41 weeks.

Table 1 shows by age group the number of persons studied, the number of person-weeks of observation, the number of bacteriological specimens examined and the percent of examinations possible if a specimen had been received from each person studied for each week of observation. The animals studied are listed by type and by the number of weeks of observation. Specimens were obtained from persons of all ages for more than 90 percent of the weeks they were observed. Examinations were made of

Table 2. Pathogens isolated, by species and type, and number of individuals and specimens positive, by age group

Pathogen	Number of individuals positive					Number of specimens positive				
	Persons (age in years)				Animals	Persons (age in years)				Animals
	Under 1	1–4	5 and over	All ages		Under 1	1–4	5 and over	All ages	
Escherichia coli	22	48	46	116	11	47	84	72	203	14
026:B6	1	2	0	3	1	1	2	0	3	1
055:B5	4	8	9	21	3	10	10	15	35	5
086:B7	1	2	1	4	0	2	2	1	5	0
0111:B4	3	8	7	18	1	8	15	7	30	1
0112:B13	0	1	3	4	0	0	2	3	5	0
0119:B14	1	2	0	3	0	1	2	0	3	0
0125:B15	3	5	11	19	2	6	9	22	37	2
0126:B16	5	11	7	23	2	14	27	15	56	2
0127:B8	1	3	5	9	0	2	4	5	11	0
0128:B12	3	6	3	12	2	3	11	4	18	3
Shigella	2	22	8	32	0	4	58	12	74	0
B:2a	0	1	0	1	0	0	1	0	1	0
B:4a	0	2	0	2	0	0	13	0	13	0
B:6	0	4	0	4	0	0	16	0	16	0
C:2	1	3	3	7	0	2	9	4	15	0
D:1	1	12	5	18	0	2	19	8	29	0
Salmonella	1	2	4	7	2	1	2	4	7	3
All pathogens	25	72	58	155	13	52	144	88	284	17
Pathogens per 100 person-weeks	6. 67	8. 81	3. 63	5. 55	6. 53					
Specimens per 100 person-weeks						13. 9	17. 6	5. 50	10. 2	8. 54

Table 3. Distribution of parasites identified in intensive family study, by age group

Parasites identified	Under 1 year	1–4 years	5 years and over	Total
Number of persons examined	18	36	66	120
Number of persons with parasites	5	22	41	68
Percent of persons with parasites	28	61	62	57
Total parasites identified	5	46	86	137
Entamoeba coli	0	12	33	45
Entamoeba histolytica	0	0	1	1
Endolimax nana	0	9	15	24
Giardia lamblia	5	16	23	44
Chilomastix mesnili	0	3	8	11
Trichomonas hominis	0	4	2	6
Hymenolepis nana	0	2	4	6
Average number of species of parasites per infected person	1.0	2.1	2.1	2.0

persons under 5 years of age for more than 95 percent of the weeks of observation.

Table 2 lists the number and identity of bacterial pathogens isolated from persons by age group and from animals. Only the initial recovery of a pathogen was included in determining the number of individuals positive. There was no significant difference between age groups in the number of pathogens per 100 person-weeks of observation, and rates were practically equal in each age group above 5 years. Eight species of *Salmonella* were identified: *javiana*, *newport*, *oranienburg*, *st. paul*, *simsbury*, and *typhimurium* from humans, and *enteritis* and *seftenburg* from animals.

Table 3 shows the number of parasites identified during the study, the number and percentage of persons with parasites, and the average number of species of parasites per person. The greatest variety of parasites observed in one person was six different protozoa. *Giardia lamblia* was the most prevalent parasite in children under 5 years of age, and *Entamoeba coli* was most prevalent in persons 5 years and older.

Table 4 indicates, by age of patients, the number and duration of episodes of diarrhea and the number and percentage of episodes associated with pathogens. Diarrhea was attributed to *Shigella* if the organism was recovered from the patient within 1 week from onset of illness. The criterion of epidemiologic association of *Shigella* was recovery of the organism from any other family member within 1 week of an episode of diarrhea. Enteropathogenic *E. coli* was considered the etiologic agent of an episode of diarrhea on the basis of three criteria: (*a*) the patient was 2 years old or younger, (*b*) the organism was isolated within 1 week of illness, and (*c*) the serotype involved was recovered for the first time from the patient.

Of 22 primary isolations of enteropathogenic strains of *E. coli* from children under 1 year of age, the age group most susceptible to these pathogens, only 3 were associated with illness. However, *Shigella* was associated with illness in 13 of 16 episodes among children 2 years old or younger. *Salmonella* was associated with one case of diarrhea.

Table 4. Relation between duration of diarrhea and association of pathogens, by age of patient

Age group and duration of diarrhea	Number of episodes	Episodes associated with pathogens	
		Number	Percent
Under 1 year			
1–2 days	6	1	17
3–7 days	11	8	73
8 days	2	2	100
Total	19	11	58
1–4 years			
1–2 days	38	10	26
3–7 days	6	3	50
8 days	10	9	90
Total	54	22	44
5 years and over			
1–2 days	27	1	4
3–7 days	8	3	33
8 days	0	0	0
Total	35	4	11
All ages			
1–2 days	71	12	17
3–7 days	25	14	56
8 days	12	11	92
Total	108	37	34

Table 5. Number of instances, by age of persons, in which Shigella and enteropathogenic Escherichia coli were first detected and number of instances in which infections were detected subsequently in other family members

Organisms	Age of persons introducing organisms							
	Under 1 year		1–4 years		5 years and over		Total	
	A	B	A	B	A	B	A	B
	Organisms introduced by a single individual							
Escherichia coli	8	3	10	5	13	3	31	11
Shigella	0	0	9	3	1	0	10	3
Total	8	3	19	8	14	3	41	14
	Organisms introduced by 2 or more individuals							
Escherichia coli and *Shigella*	7	6	12	10	5	5	12	10

A—Number of times organism first detected.
B—Number of times other family members were infected subsequently with the same organism.

Most cases of diarrhea of 3 days' or more duration were observed in persons 2 years old or younger and were associated with a recognized enteric pathogen. The majority of these cases occurred in persons less than 1 year of age. Four children in this age group experienced episodes of diarrhea attributed to *E. coli*. Three of the episodes were associated with strain 055:B5 and one with 0111:B4. The other episodes associated with pathogens were attributed directly or epidemiologically to *Shigella*.

Table 5 indicates, by age group, the number of times *Shigella* and enteropathogenic *E. coli* were first detected in a family and the number of times the organism was isolated subsequently from other family members. In each of the 12 instances where organisms were detected initially in 2 or more family members, 1 person was between 1 and 4 years of age.

Results of the present study corroborate previous observations that domestic animals frequently are infected with enteric organisms that are pathogenic for man (*2*).

Summary

An intensive preliminary study was made of 14 families at Phoenix, Ariz., to gather information on the epidemiology of diarrheal diseases. Results from this study indicate that intensive observation of selected families can provide more precise information on the process of introduction and familial spread of enteric organisms than do community surveys or studies of families of patients with acute diarrhea. In most susceptible age groups, *Shigella* was associated with acute diarrhea more frequently than recognized enteropathogenic *E. coli;* bacterial pathogens were associated more often with diarrhea of 3 days' duration or longer than with shorter episodes; persons 2 years of age and younger contributed the majority of episodes of diarrhea observed; initial infections in families were detected in children 4 years old and younger significantly more frequently than in older persons.

REFERENCES

(*1*) Goodwin, M. H., Jr., Mackel, D. C., Ganelin, R. S., Weaver, R. E., and Payne, F. J.: Observations on etiology of diarrheal diseases in Arizona. Am. J. Trop. Med. 9: 336–342, May 1960.

(*2*) Mackel, D. C., Weaver, R. E., Langley, L. F., and De Capito, T. M.: Observations on the occurrence in cats of *Escherichia coli* pathogenic for man. Am. J. Hyg. 71: 176–178, March 1960.

Federal Publications

Air Pollution in the National Capital Area. *PHS Publication No. 955; 1962; by Gene B. Welsh; 42 pages; 35 cents.*

General factors affecting air pollution, sources and dispersion of pollutants, indications of pollution levels, and status of local control activities are described. Directed to the District of Columbia and to the suburban areas are separate lists of recommendations for controlling air pollution.

The appraisal, requested by the District of Columbia Department of Public Health, was conducted by the Public Health Service with the cooperation of the Maryland State Department of Health and the Virginia Department of Health.

Report of the Medical Exchange Mission to the USSR. Maternal and child care. *PHS Publication No. 954; 1962; 140 pages; $1.*

Services relating to maternity, infancy, and early childhood in the Soviet Union are described by six U.S. authorities on child health who visited Soviet hospitals, medical institutes, and child care centers during October and November 1960. The mission was sponsored by the National Institute of Neurological Diseases and Blindness, Public Health Service.

Also presented are the delegation's impressions of Soviet medical research activities, medical and scientific education, and methods of collecting and analyzing health data and statistics.

American Scientists in Cancer-Virus Research. A biblio-directory of current studies. *PHS Publication No. 946; 1962; compiled by Elizabeth Koenig and Lois Fritz; 80 pages; 30 cents.*

This biblio-directory, compiled mainly from the published literature, gives the institutional affiliations, research area, and specific activity of nearly 400 American scientists. It may be used with the biomedical indexes to obtain the exact citation to one or several papers, the subject of which has been indicated by the author's notation in the biblio-directory.

Mental Retardation. Activities of the U.S. Department of Health, Education, and Welfare. *1962; 77 pages; 50 cents.*

This report defines the problem of mental retardation, describes present activities of the Department of Health, Education, and Welfare in this important field of national concern, and summarizes the objectives of the President in developing a national plan to combat mental retardation.

Public Health Service Fellows, 1938–1958. Current professional status. *PHS Publication No. 931; 1962; by Ralph Simon; 81 pages.*

This report is part of a continuing study of the contribution of the NIH fellowship program to the nation's supply of medical research manpower. It presents data on the present professional activities of former fellows, their geographic location, how much time they are spending in the laboratory, at the lecture rostrum, or administrator's desk, and the types of organizations they serve.

National Institutes of Health Scientific Directory, 1962, and Annual Bibliography, 1961. *PHS Publication No. 936 (Public Health Bibliography Series No. 36); 1962; 159 pages; 50 cents.*

Intended for use by research workers in the biomedical sciences, this publication presents the broad outlines of NIH structure, names the professional staff, and lists more than 1,500 scientific and technical papers from laboratory and clinical research during 1961.

Included also are a list of staff members and authors and a subject index which reflects the scope of NIH research and provides quick reference to research areas.

Public Health Service Regulations. Part 53. Pertaining to the hospital and medical facilities survey and construction legislation. *PHS Publication No. 930–A–1; revised 1962; 65 pages; 40 cents.*

Presents the Public Health Service Regulations applicable to the construction of hospital and medical facilities under the Hill-Burton program.

Planning the Patient Care Unit in the General Hospital. *PHS Publication No. 930–D–1; June 1962; 37 pages; 35 cents.*

Describes principles and plans for the patient care unit of a general hospital. Discusses various elements to be considered in designing the unit and illustrates plans for single-corridor and double-corridor units.

Hospital-Nursing Home Relationships: Selected references annotated. *PHS Publication No. 930–G–2; June 1962; prepared by Anne Stageman and Anna Mae Baney; 25 pages; 25 cents.*

Lists and annotates publications related to coordinated programs and close working relationships developed by nursing homes and general hospitals.

This section carries announcements of new publications prepared by the Public Health Service and of selected publications prepared with Federal support.

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The Public Health Service does not supply publications other than its own.
