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IDEAS FOR THE FORMULATION OF A PLAN FOR THE CONTROL OF GASTRO-INTESTINAL DISEASES, INCLUDING ENVIRONMENTAL SANITATION MEASURES, EPIDEMIOLOGY, HEALTH EDUCATION, AND EARLY DIAGNOSIS AND TREATMENT

AN EPIDEMIOLOGIC BASIS FOR THE CONTROL OF ACUTE DIARRHEAL DISEASE

by

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Aside from contributions to field research, epidemiology has a major practical usefulness as an instrument for action in the control of community disease. To this end, pieces of knowledge from clinic, laboratory and field are fitted together to give a pattern of disease behavior within populations. A considered program for control then evolves through identifying various features in a complex of causality which is multifactorial, with variables individually related to an agent of disease, to the human host and to the environment which encompasses both. A recent analysis of chickenpox (1) is in illustration. Epidemiology, so employed, serves as the diagnostic discipline of public health (2) through operational as contrasted to investigative activities (3).

The purpose now is to present the diarrheas and the dysenteries of man, especially those of infants and young children, from this viewpoint. The intent is to assemble recorded knowledge, to make free use of opinion and interpretations of many colleagues, and to supplement these findings where appropriate with personal observations that have extended from arctic (4) to tropics (5), and over many years (6). Research interests will be touched upon only to indicate gaps in knowledge pertinent to control. In simple terms, the aim will be to state what to do now with the information at hand: to examine the behavior of diarrheal disease in nature an the application of that knowledge to prevention and control in human populations.

The attempt to control the acute diarrheal diseases involves more than a restriction of the morbidity and mortality they cause. The attendant disability has important economic consequences. In lesser developed countries where diarrheal disease is highly prevalent, a recognized synergism with nutrition bears strongly on general health (7). The resultant deterioration in nutritional status, frequently to the level of malnutrition, is reflected in impaired resistance to other infections and to precipitation of specific nutritional disorders, notably kwashiorkor. A community program for the control of diarrheal disease is thus tied intimately to general health activities, its relative emphasis to be correlated with the broader effort. It is more than an action of itself, whether at the national, provincial or local level. As with most public health activities, the start to advantage in drafting a program for control is by considering the clinical aspects of the disease.

ACUTE DIARRHEAL DISEASE A CLINICAL SYNDROME. Whether prevailing at high or low incidence, the endemic diarrheas everywhere are mainly of acute evolution. Chronic diarrheal disease is minimal, in lesser developed regions an inconsequential part of the whole, and not included in this discussion. Like most acute infections, rabies in man being one of the few exceptions, diarrheal disease follows a biological gradient from clinically undetectable, inapparent infection to severe manifestations with an appreciable fatality. By arbitrary definition, crude clinical separations are possible into mild, moderate and severe forms of the disease.

Acute diarrheal disease includes a proportion of specific enteric infections, such as shigellosis, salmonellosis and enteropathogenic coliform disease, but it consists mainly of undifferentiated disease with no demonstrable specific infectious agent. The significant feature is that the same divisions in clinical effect occur with all endemic diarrheas, whether of demonstrated specific etiology or otherwise. No characteristic clinical pattern distinguishes one etiologic entity from another, as with measles among the acute exanthemata, nor the total of specific entities from cases without a known infectious agent.

It is true in Guatemala that severe cases are more likely to be related to Shigella than to any other infectious agent and that cases with a demonstrated agent include more than a proportionate share of severe infections. However, a severe case has nothing to mark it as shigellosis, other than the greater probability of isolating an organism; and greater numbers of severe cases are of indeterminant microbial origin than of defined etiology.

Epidemics in a general population ordinarily are superimposed on an endemic base. Consequently, various pathogens are isolated in the course of an outbreak. In our experience no epidemics have been encountered without predominance of some particular infectious agent among those identified, although by no means in a majority of cases; which is to say that no epidemics of purely non-bacterial disease have been seen other than food poisoning of toxicogenic origin. Again, from a practical standpoint, diarrheal disease in epidemic form as seen in lesser developed countries has not been distinguishable clinically from endemic cases.

This is not to discount recognition by Hardy (8) and most others who have worked in the two situations that the diarrheas in preindustrial countries with poor environmental sanitation and a prevailing malnutrition differ importantly in clinical form and severity from those of more favored areas. The infectious agents broadly encountered are much the same, suggesting that clinical variations relate mainly to host resistance and size of infecting dose (9).

Among malnourished children of retarded development, the disease is not ordinarily an isolated episode of acute evolution. Systemic manifestations often seem less pronounced than in the well nourished child, but the attack tends to persist. Instead of the prompt rebound characteristic of the well nourished child, a low-grade indisposition often continues for a month or more, sometimes for as long as 3 months, with irregularly recurring loose stools, a progressively depleted nutritional state and occasional recurrent acute episodes. Dehydration and electrolyte imbalance are more frequent and more difficult to correct. Two or 3 such events during a year are frequent in young children and some have as many as 8 or 10. Because of this, the usually deficient diet is further restricted, which contributes to maintaining the situation. A bloody or mucopurulent exudate in stools is commoner than in the mild undifferentiated diarrheas of developed areas.

Clinically considered, acute diarrheal disease is a syndrome, occurring universally and in different degrees of severity, with essential differences characterizing specific areas and different environmental conditions. In any single situation, clinical entities cannot be distinguished, although etiologically distinct diseases exist. This circumstances is neither unique among infectious diseases nor does it necessarily limit specific action. In acute sore throat or typhoid fever, for example, laboratory means compensate for the clinical deficiency. As will become evident, that is not the case with the acute diarrheal diseases.

SPECIFIC ETIOLOGY OF ACUTE DIARRHEAL DISEASE. The designation of acute diarrheal disease as a clinical syndrome in no way precludes the existence of exactly determined disease entities within the group. Aseptic meningitis is an illustration of a common clinical reaction induced by many different infectious agents, some one of which is demonstrable in most instances.

On the other hand, the common cold is also a clinical syndrome, a collection of diseases. It includes several recognizable specific infectious disease entities, those due to the syncytial viruses, parainfluenza viruses, rhinoviruses and reoviruses and a number of others, each irregularly represented in the totality of common colds at a particular time or a particular place. However, the syndrome includes a much greater aggregate of cases, with good reason judged infectious and communicable, and yet with no demonstrable infectious agent. No inconsiderable number are suggestively noninfectious, or at least scarcely communicable, notably those of allergic origin.

Acute diarrheal disease at a particular time and place is of the order of the common cold, a clinical syndrome of characteristic behavior, including a minority of known disease entities, a predominating bulk of undifferentiated presumably infectious diarrheas and an indefinite number of noninfectious processes. The proportions are by no means fixed; the pattern is dynamic, frequently changing and with no characteristic distribution of its elements either locally or generally.

The recognized specific infectious diseases, shigellosis, salmonellosis, Esch. coli diarrhea and amebiasis ordinarily constitute a minor part of the whole. Under endemic conditions in preindustrial regions with prevailing high rates of incidence, the 3 bacterial agents with their multiple serotypes often are demonstrated in less than 20 per cent of cases. The usual frequency is slightly in excess of that level; a proportion of 40 per cent is occasional; and to find 60 per cent of diarrheas associated with any one of the specific bacterial pathogen is exceptional.

In a Guatemalan Indian village one or another of the 3 pathogens was present in 24 per cent of 578 cases (Table 1), as observed in children under 5 years of age during a period of 17 months. A single specimen of feces, usually obtained by rectal swab, was cultured on 3 different mediums. An additional 115 cases were subjected to intensive examination, by methods beyond any practical field application. Both rectal swabs and stools were used, as many as 5 serial specimens were collected and two augmented lines of culture mediums employed. The result was isolation of a pathogen in 35.6 per cent of cases, the gain being mainly in numbers of Salmonella and Esch. coli, the less frequent members of the group. The demonstration of Shigella was not significantly increased.

Isolation of a pathogen from stools of a patient does not, of course, establish an etiologic relationship. Diarrhea of other cause can occur in a bacterial carrier. Furthermore, in no less than 12 per cent of cases of diarrhea in the Guatemalan experience, where a recognized pathogent was demonstrated, had 2 or more present concurrently, with the open question of which, if either, was the responsible agent. Enteroviruses were frequently associated with bacterial agents; and indeed more often than not a pathogenic bacterium when present was accompanied by a protozoan or other intestinal parasite. High or low incidence of diarrhea was not a determining factor.

In addition to this varying proportion of commonly reconized intestinal pathogens, the intestinal flora of man in health as well as in acute diarrheal disease, contains a presumably major fraction of commensal organisms, normal inhabitants of the intestinal tract and without accepted pathogenicity, mainly coliform organisms. Between these extremes is a group of infectious agents of indeterminate and irregular pathogenic power, poorly evaluated as to numbers and of diverse kinds. They include certain serologically distinct Esch. coli, other bacilli, enteroviruses in profusion, coagulase-positive staphylococci, occasional fungi and ubiquitous protozoa and helminths. As a group, they are of low-grade pathogenicity with evidence to suggest that if they attain pathogenic activity it is mainly through favoring host or environmental factors. Conceivably this includes impaired host resistance, specific and nonspecific. Unpublished pathological observations by Dammin and Feldman (10) at INCAP suggest a mechanism analogous to that in cholera, an overgrowth to produce huge numbers at all levels of the intestinal tract.

Table 1. Bacterial pathogens present in 578 cases of acute diarrheal disease in a rural Guatemalan village February 1961 - June 1962.

Bacterium	Acute diarrheal disease	
	Number of cases	Percent of all cases
Sh. dysenteriae I	10	1.7
Sh. dysenteriae II	4	0.7
Sh. sonnei	9	1.6
Sh. boydi	5	0.9
Sh. flexneri I	2	0.3
Sh. flexneri 2	23	3.8
Sh. flexneri 3	32	5.5
Sh. flexneri 6	36	6.2
Salmonella	1	0.2
Esch. coli	17	2.9
None	439	76.0

Remote infections of other systems, principally of the respiratory tract and its appendages, conceivably have the capacity to light up intestinal disorders. Measles has a prominent place among such parenteral infections.

Foods, of themselves and through their contained nutrients, have the capacity to induce acute diarrhea other than through infection. Excess of a nutrient is rarely involved, a deficiency being more usual as in pellagra, beriberi and especially kwashiorkor. Some foods induce diarrhea through content of roughage and a few are themselves poisonous, as some varieties of mushrooms and fishes.

Toxins formed in foods by growth of staphylococci and other bacteria are a common source of epidemic diarrhea and to an ill-defined degree of endemic disease. The diarrheas of emotional origin are others of noninfectious origin.

The inability to distinguish, among acute diarrheal diseases, clinical entities sufficiently distinct to permit and individualized program for control has been noted. Acute diarrheal disease can be delineated satisfactorily but not its elements, which other evidence shows to exist. The recourse is to interpret the group as a clinical syndrome.

The summary of etiologic agents just given likewise discounts the possibility that laboratory procedures of today are able to compensante for clinical deficiencies as happens with some other infectious processes. Although research has been largely microbiologic, an impressive effort has had the practical result that only a relatively small part of the acute diarrheas of the world can be distinguished as disease entities. Still more important, those which are identified lack other characteristics separating them from the bulk of undifferentiated diarrheal disease. To center control activities on specific entities is to ignore the main problem. The possibility remains that the group has enough common epidemiologic characteristics by which to establish principles for general control, and that recognizable epidemiologic patterns exist within the complex, of sufficient importance and magnitude to warrant individualized measures in their control.

ACUTE DIARRHEAL DISEASE AS AN EPIDEMIOLOGIC ENTITY. The universal occurrence of acute diarrheal disease in all populations of the world suggests as much as anything innate host characteristics, physiological and biological, conducive to the disease and common to all mankind. For the same reasons, the expectation also is of fundamental features in human behavior, aside from the artificial variations introduced by time and place, in cultural practices and in the social environment of aggregates of man, all with a bearing on propagation and presence of the condition.

Such individual diseases as may be separated within the complex show no differences one from another or in relation to the whole so far as potential effect on a general population is concerned. All produce epidemics. In endemic form they are a feature in varying degree of populations everywhere;

and under favoring circumstances of external environment and nutrition they prevail at hyperendemic levels in much of the universe.

Not all acute diarrheal diseases are of infectious origin, but most of them are. Considered as a group, and despite indefinite and diverse infectious agents, the reservoir of infection is almost wholly man. Some few cases are of animal origin, notably salmonellosis, but this disease also comes from the infected person. In all recognized specific diarrheal disease, carriers have a significant place along with cases in the community reservoir of infection. In Guatemalan villages carrier rates in the general population of children without diarrhea under 5 years of age were 7.8 per cent for Shigella, 0.1 for Salmonella and 3.4 per cent for enteropathogenic Esch. coli (Table 2). Epidemiologic evidence gives strong support that the situation holds generally for diarrheas of indeterminant infectious etiology. The immediate source of infection, the materials by which infection is transferred, is of common nature in all infectious diarrhea, namely feces, and whatever the method of transfer.

All infectious diarrheas, whether etiologically distintc or an undifferentiated enteritis, have common modes of transmission. Only food poisoning has an individual means of spread. Noteworthy differences occur, however, according to patterns of distribution. Endemic and sporadic diarrheal disease is transferred predominantly by direct contact, hand to mouth infection. Indirect contact through objects freshly contaminated with feces has minor significance. The agency of flies is scarcely to be compared with direct contact.

Epidemic diarrheal disease is classically of common source origin, through water, milk or solid foods, with the outbreak rising and falling abruptly. By contrast, numerous epidemics in lesser developed areas are due to contact spread. Characteristically they are of slow evolution, fail to reach the high peak of common source outbreaks, and follow a protracted course, occasionally over a period of 3 or 4 years.

The incubation period is among the more regular epidemiologic characteristics. In epidemics, Salmonella infections may have an interval no longer than 12 hours, but sporadic cases occur after 2 or 3 days, which is usual for the undifferentiated group and most others specifically identified. For example, the usual incubation period in shigellosis is less than 4 years.

The duration of communicability in acute diarrheal disease is not too well known. Most of the evidence relates to shigellosis, where infectiousness is essentially for the duration of symptoms and briefly thereafter. Chronic convalescent carriers are stated to be few and the carrier state to end within days or weeks. However, existing observations relate mainly to adults and to patients in good nutritional state. The longer clinical course among malnourished children, and the tendency of the disease to relapse, suggest that communicability may be appreciably longer under such conditions, a possibility supported by the high carrier rates in many communities, of the order of 8 per cent. The subject needs investigation. Limited studies

Table 2. Carriers of enteric bacterial pathogens, children without diarrhea, by age, three Guatemalan highland villages, 1959 - 1962.

Age in years	Number of Children	Shigella		Salmonella		Esch. coli		Total	
		No.	%	No.	%	No.	%	No.	%
Under 1	647	10	1.5	1	0.2	31	4.8	42	6.5
1	690	61	8.8	0	---	38	5.5	96	13.9
2	678	71	10.5	1	0.1	25	3.7	93	13.7
3	676	69	10.2	0	---	24	3.6	90	13.3
4	459	35	7.6	2	0.4	14	3.0	47	10.2
Total	3,150	246	7.8	4	0.1	132	4.2	368	11.7

suggest that carrier rates for Esch. coli may be greater than indicated by the infrequent cases. Salmonella carriers in acute diarrheal disease have had minor attention. Serial studies of families, as in the INCAP observations, should provide information on communicability of the undifferentiated diarrheas.

The known facts about resistance and susceptibility to acute diarrheal disease are also limited. In lesser developed regions, relatively few cases occur during the first 6 months of life. During the second 6 months, few persons escape. Thereafter, incidence decreases with age so that attack rates in late childhood are much lower and incidence in the adult population still less.

Repeated attacks in the course of the first and second year are the rule in underdeveloped countries. Almost every child can be certain of a bout of diarrhea during each of the first 3 years of life; and the time may extend through the 5th year. About one-half will have repeated, numerous attacks, during the second year, and one child out of 3 in any of the preschool years. It is evident that one attack gives no general immunity and yet it is equally certain that resistance increases with age; older children and adults have far less diarrhea. The suggestion is of a pattern of resistance comparable to that in influenza, where a matrix of resistance is filled out with age, the elements to a degree specific and enduring, and effective because it eventually accounts for most of the prevailing agents. A particular pattern holds for a particular place. Transfer to another area and contact with a new set of infectious agents results in fresh need to accomodate, as evidenced by the well known "traveler's diarrhea."

The reaction of populations to the complex included withing the acute diarrheal syndrome exhibits in most features a common behavior fitting with accepted ecologic principle and sufficient to justify interpretation as an epidemiologic entity. Epidemiologic characteristics, as evidenced in a representative developing area of Latin America, with a prevailing high level of malnutrition are provided by the long-term prospective incidence studies of recent years under auspices of the Institute of Nutrition of Central America and Panama.

EPIDEMIOLOGY OF ACUTE DIARRHEAL DISEASE IN GUATEMALA. The behavior of acute diarrheal disease, all forms, now to be presented is based on field observations of rural indian populations in the Guatemalan highlands during the past 7 years. In most instances the data were collected by resident, non-medical workers visiting homes twice monthly, with professional and laboratory services supplied by a staff based at the Institute of Nutrition of Central America and Panama (INCAP). Because of the altitude, the climate is temperate. The general area is representative of a lesser developed region of Latin America.

Incidence of Acute Diarrheal Disease. The outstanding feature of attack rates in these communities, as presented in Table 3, is the extent to which the disease centered at ages 6 months through the 2nd year of life. This is the period of weaning (5). Acute diarrheal disease was relatively infrequent during the first 6 months when these children were almost wholly breast fed. After weaning was completed, usually early in the 3rd year, incidence declined sharply, so that at age 6 years, the year of entering school, the attack rate was only 21.2 per 100 children of that age per year. School children of 7 to 14 years had only a fraction of the rates characteristic of early childhood, while for adolescents and adults past 15 years incidence was essentially half that of school children. This progressive decline with age is well authenticated for many parts of the world. What is not so well recognized is the concentration of cases during the period of weaning. This comes about because of the common statistical practice of grouping results of the 2nd to 5th years as a unit. The dangerous 2nd year of life is thus obscured.

Death Rates for Acute Diarrheal Disease. Disease-specific mortality rates from acute diarrheal disease followed the same trend as case incidence. In 3 other villages for which information is available over a 10-year period, death rates were greatest in the 2nd year of life, Table 4. Indeed, they were more than twice those of the 1st year and were maintained at a high level in the 3rd year. Thereafter a sharp drop occurred to a level of 9.63 per 1,000 population deaths during the 5th year. For school children and adults the rates were only fractionally those of the earlier years of life.

The significance of deaths from acute diarrheal disease in the general health of these communities is brought out in different fashion by determining the proportion of deaths from this cause to deaths from all causes. For the general village population, 27 per cent of deaths were due to diarrheal disease, a finding in agreement with the frequently cited national rate for Guatemala where diarrheal disorders are the first cause of death and the highest for any Latin American country. Despite a high attack rate in infancy, fatalities from this cause accounted for only 14 per cent of total deaths, less than the average for the general population, 27 per cent. For the critical period of ages one to 4 years, the proportion was 46 per cent and in two of the years, the 3rd and 5th, it was more than a half. These data are especially meaningful. Although death rates from acute diarrheal disease were greatest in the 2nd year of life, in the subsequent preschool years the proportion of deaths due to that cause to all deaths was even greater. The situation during school age, 5 to 14 years, demands special attention. The age-specific death rate was highly favorable compared to earlier years, and yet the proportion of diarrheal deaths to all deaths was exactly the same, 41 per cent, as in the 2nd year when diarrheal death rates were at a maximum.

The true significance of the situation is often difficult to appreciate through abstract figures, presented as rates for this and rates for that. The importance of these acute infections of the intestinal tract in countries like Guatemala is perhaps better understood by comparing (Table 4) relative frequencies of death from this cause with those prevailing in more favored

Table 3. Attack rates: Cases of acute diarrheal disease per 100 persons per year by age, four Guatemalan villages, 1956 - 1959.

Age group	Number of persons	Cases of diarrhea	Attack rate cases/year/100
0 - 5 months	92	43	46.7
6 - 11 months	79	87	110.7
1 year	135	162	120.0
2 years	122	129	105.7
3 years	119	66	55.4
4 - 6 years	406	86	21.2
7 - 14 years	839	69	8.2
15+ years	2,390	109	4.6
Total	4,182	751	18.0

Table 4. Deaths from acute diarrheal disease per 1000 population per year, by age, 3 Guatemalan villages, 1950 - 1959, inclusive. Cumulative population, 106, 456.

Age in years	Deaths from acute diarrheal disease	Diarrheal deaths per 1000 population per year	Percent diarrheal deaths of all deaths	Ratio Diarrheal death rates, Guatemalan villages and U. S. A., 1960
Under 1 year	87	16.98	14	25
1 year	123	35.63	41	
2 years	102	27.97	53	
3 years	44	12.17	43	
4 years	34	9.63	55	
1 - 4 years	303	21.27	46	519
5 - 14 years	70	2.55	41	
15+ years	117	1.95	16	
Total	577	5.42	27	115

societies. For infants under one year, the death rate in this experience was 25 times that for infants in the United States. For the preschool group it was 519 times greater; and for the general population, the excess in Guatemala was 115 times.

To stress further the magnitude of this health problem in terms of death and disability in Guatemala and in comparable countries seems purposeless. Its concentration in the early preschool years is evident and should be the guide in developing an effective program for control. To this end, other characteristics of behavior as a community disease are now examined.

Index Case in Acute Diarrheal Disease. Knowledge of the manner in which an infectious disease progresses through a community is one of the decisive factors in formulating a program for control. The usual sequence of events in family outbreaks of the common communicable diseases of childhood is an initial illness contracted by a school child, less commonly by an adult, and then secondary cases, frequently among preschool children and proportionately among older members of the family according to immunity state. Acute diarrheal disease in the villages shows a striking departure from this behavior.

The usual index or primary case was not an older child or adult. In 71 per cent of 390 family outbreaks during 12 months (11), the disease first appeared in a preschool child, aged 0 to 5 years. School children introduced the disease into the family less frequently than did adults, but the differences were inconsequential, 12 per cent for school children and 17 per cent for adults. These frequencies were out of all proportion to numbers within a family. Adults and school children together made up 80 per cent of members of households; they provided the index case in only 29 per cent of family outbreaks.

No less than 1/3 of total index cases were infants less than one year old. More than 1/2 were children in the first three years of life. Because of the system of expanded families, where several closely related units were represented within one household, there were few families with only preschool children. In 27 such familes there were 22 family epidemics of diarrheal disease and a preschool child was the index case in 19 of them. Diarrhea appeared 12 times in the 28 familes with only adult members.

Multiple index cases, the appearance of the disease in more than one member of a family within a period of 24 hours, occurred in only 5 of 390 family outbreaks, Multiple index cases are characteristic of common source epidemics, as from water or milk. The scant frequency in this experience supports a conclusion that contact spread was the major means of transmission.

Several possibilities attract attention in explanation of this behavior. The reservoir may be a healthy adult or older child acting as a carrier and themselves immune through previous attack. A host factor may be at fault, as poor nutritional state, permitting clinical disease with an infectious agent not ordinarily pathogenic, or first experience with a similar

agent favored by a deficient environmental sanitation. The necessary facts are not at hand; a detailed study of family outbreaks experienced by children from birth to school age is a suggested approach.

Secondary Attack Rates. Secondary cases are those occurring in susceptible members of a family within an accepted incubation period following a primary or index case. Secondary attack rates for acute diarrheal disease are necessarily computed from total family members excluding the index case, because of inability to identify susceptibles. The incubation period was taken as 1 to 7 days. On this basis, the overall secondary attack rate for the 390 family outbreaks was only 1.4 per cent, suggesting either that most family members were immune or a low communicability of the agent. A more reliable datum is based on children of preschool age who may be judged as more regularly susceptible. The secondary attack rate for that age group was 4.1 per cent. Similar age specific secondary attack rates were 1.3 per cent for school children and 0.3 per cent for adults 15 years or older. Of 450 cases in families 86.7 per cent were primary cases, only 7.5 per cent were secondary infections and 5.8 per cent were tertiary or subsequent cases. A case was recognized as a new or primary case when the interval between cases was more than 7 days, the maximum incubation period.

The spread of infection within the family was no greater when preschool children were the index case than when an older person introduced the disease. The secondary attack rate when the primary case was a child under 6 years, was 1.2 per cent, a school child 1.6 per cent and after an adult index case, 1.8 per cent. There is suggestion that most older family members were immune to the prevailing agents of diarrheal disease; at least, in these communities diarrheal disease does not usually spread within families to adults regardless of the age of index case.

These observations departed so much from anticipated results that the study was repeated over a period of 17 months in another community where attention was primarily to diarrheal disease in children under 5 years of age. Among 504 invaded families the preschool child was found to be the first or primary family case in 94.5 per cent of instances, influenced evidently by the bias incident to the manner of selection but in accord with the preceding series. The concentration of index cases again was high among children of the first 3 years of life; no multiple index case was noted; and the secondary attack rate was 8.4 per cent, as before predominantly preschool children.

Endemicity and Epidemicity. Interest in manner of spread extends naturally from family unit to community. Acute diarrheal disease in Guatemala commonly is described as endemic or more precisely as hyperendemic. Actually, it is neither. If communicable diseases of this general class are recognized as fluctuating endemic processes, continuously present but with occasional and irregularly interspersed epidemics, then acute diarrheal disease is not that either.

Death from acute diarrheal diseases were examined over a 10-year period for some 20 village communities, the data being obtained directly from local

village registers in consultation with the official recording the information. Analysis showed that what happens is a succession of epidemics of fairly regular periodicity, commonly 3 outbreaks every 10 years, each of relatively long duration with deaths occurring throughout a year or more, and often over a 2- or even 3-year period. In no epidemic examined, even those essentially restricted to a single year did the outbreak develop sharply, last a few months and end about as abruptly as it began, which is characteristic behavior of common source outbreaks related to water or other vehicle. Rather, the epidemic evolved slowly, and continued active through many consecutive months. The experience of 4 villages, including both small and larger communities is illustrated in Figure 1. The broad behaviour is better characterized as fluctuating epidemicity rather than fluctuating endemicity.

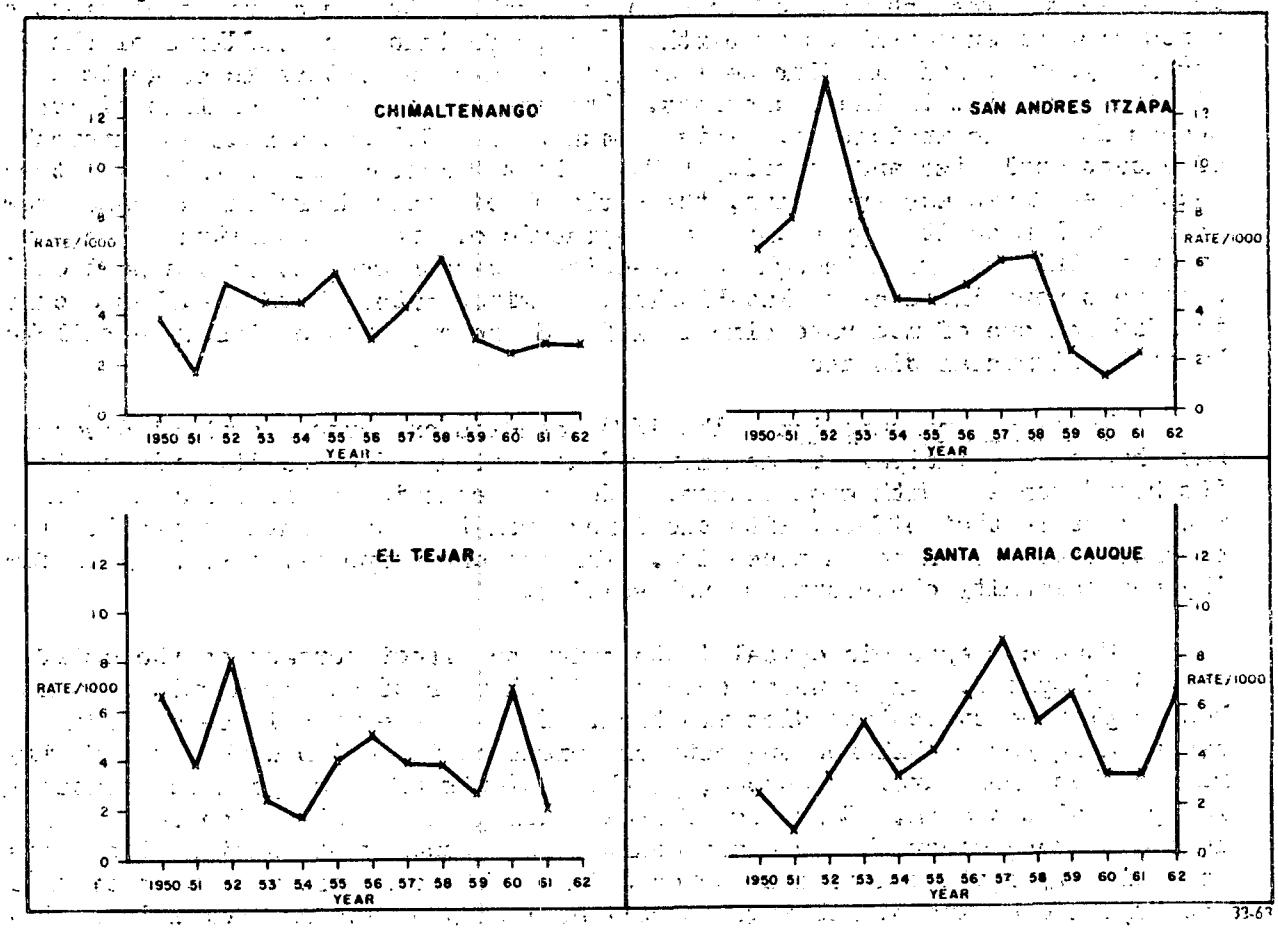
The behavior of acute diarrheal disease was comparable to that of measles which in the same region has a similar periodicity, about 3 outbreaks in 10 years. The behavior of measles is usually attributed to development of a new crop of susceptibles by birth. The predominance of toddlers of the 2nd and 3rd year of life in diarrheal as well as measles outbreaks suggests a similar mechanism in the 2 diseases. The experience of the village of San Andres Itzapa is indicative. This community in 1952 had a measles outbreak of exceptional size and severity (12). About 2 months later, indeed as the measles epidemic was subsiding, the outbreak of acute diarrheal disease shown in Figure 1 made its appearance, and epidemic of greater magnitude than any other in this study, although the associated events suggest that a part of the diarrheas were incident to kwashiorkor. A minor outbreak of measles occurred in 1955 and one of moderate size in 1957-58, an experience closely paralleled by acute diarrheal disease.

Modes of Transmission. The INCAP studies on acute diarrheal disease have had as a principal aim an improved definition of causality, viewed in its broad sense. With good reason, modes of transmission have had a prominent place in that effort, with the direct relation they have to practical control measures an added incentive. For present purposes, a summary of family and community observations must suffice.

Numerous epidemiological facts point to direct contact as the chief method of spread. The general course and behavior of observed epidemics is best explained by contact dissemination. The extreme prevalence of index cases among young children suggests an origin of infection within the family, rather than from outside sources, in that infants of this age have relatively few general contacts. Carriers of known pathogens are at a high level and numerous among older children and adults. The paucity of multiple index cases is decidedly against a common source origin. Perhaps most important of all, the hygienic habits of siblings as well as family adults are compatible with spread by personal contact, a feature abetted by the limited amounts of water usually available.

Common source epidemics apparently do not contribute materially to the bulk of acute diarrheal disease in these communities. Milk as a vehicle is

Figure 1. Death rates from acute diarrheal disease, as compiled from local registers of 4 Guatemalan communities, 1950 - 1962. Populations: Chimaltenango, 14,838; San Andres Itzapa, 5,277; El Tejar, 1,923, Santa María Cauqué, 923.



largely eliminated because little is available, and when it is, the source is usually the family cow. Common eating establishments scarcely exist in the villages, and such food-borne infection as occurs is thereby restricted in large part to the family group. Water is the chief consideration. Common sources are usual in the villages and known to be frequently contaminated. The commonly observed age of attack is heavily weighted within the 1st 3 years of life, and is not the broad age of distribution characteristc of water-borne infection. Children of this age are not the heavy water drinkers of the population, but rather the working adult where cases were few. Epidemics as observed are not of the common source type. In one village, Santa María Cauqué of Figure 1, with a proven contamited water supply, forceful and successful effort was made in 1960-1961 to provide a safe water supply which did not, however, prevent the development of the 1962 epidemic, primarily due to the Shiga type of dysentery bacillus.

These observations are not intended to imply that water, food and milk have no part in the genesis of diarrheal disease in these village communities. What does appear certain is that the consistently high rates for diarrheal disease cannot be attributed to appreciable epidemics of common source origin.

The part of flies in mechanical transmission of acute diarrheal disease under conditions of the usual Guatemalan village is as yet ill-defined. It would appear to be a secondary consideration, ranking below contact spread and the agency of food, water and milk. The seasonal peak of the disease occurs in May and June (Table 5) before flies are prevalent. Flies appear in late June and attain their greatest numbers in September, a time when the monthly incidence of diarrhea is declining.

Obviously, the significance of all modes of transmission relates to care and efficiency in disposal of human feces. Many features of environmental hygiene and sanitation have an influence on the frequency of acute diarrheal disease, among them disposal of wastes other than feces, food storage and preparation, housing and rodent control in addition to water and flies already mentioned. Feces disposal is singled out for consideration because in the final analysis, it is basic to all.

Attack rates from acute diarrheal disease in village families having privies were compared with families who lacked such facilities. This was not an experiment of introducing privies and seeing what happened. A health department program for construction of outdoor toilets had been undertaken several years previously, and privies were no innovation. The results in Table 6 show that for children under one year of age the presence of a privy in the household compound was associated with numerically more diarrheas than in households without that facility, although the difference was not statistically significant. Children 1 to 5 years old had more diarrhea when they lived in a home without a privy, but only at a 5 per cent level of significance. This disappeared when children in the 2nd year of life were deleted. The data thus give no indication that privies as used in the village had any influence on the diarrheas of children in the first 2 years of life, which is the important part of the problem. For adults and for the population as a whole, they were of benefit.

Table 5. New cases of diarrhea by month in 3 Guatemalan highland villages, as determined by home visits, May, 1959 - April, 1963

Month	Santa María Cauqué		Santa Catarina Barahona		Santa Cruz Balanyá		Total 3 villages	
	Cases of acute diarrheal disease	Percent annual total	Cases of acute diarrheal disease	Percent annual total	Cases of acute diarrheal disease	Percent annual total	Cases of acute diarrheal disease	Percent annual total
January	148	7.3	32	5.8	76	7.1	256	7.0
February	181	8.9	44	8.0	117	10.9	342	9.4
March	192	9.5	77	14.0	80	7.4	349	9.5
April	137	6.8	49	8.9	78	7.2	264	7.2
May	248	12.2	63	11.5	97	9.0	408	11.2
June	164	8.1	51	9.3	114	10.6	329	9.0
July	164	8.1	50	9.1	90	8.4	304	8.3
August	196	9.6	61	11.1	100	9.3	357	9.8
September	185	9.1	48	8.7	76	7.1	309	8.5
October	160	7.9	26	4.7	70	6.5	256	7.0
November	145	7.1	33	6.0	123	11.4	301	8.2
December	109	5.4	16	2.9	55	5.1	180	4.9
Total	2,029	100.0	550	100.0	1,076	100.0	3,655	100.0

Table 6. Acute diarrheal disease, annual case rates per 100 persons at risk, by age, in households with and without privies, 4 villages of rural Guatemala, 1956 - 1959

Age	With privies			Without privies		
	Persons at risk	No. of cases	Rate per 100 persons	Persons at risk	No. of cases	Rate per 100 persons
Under 1 year	136	123	80.7	35	21	52.8
1 - 5 years	524	365	60.3	122	107	80.3
6 - 14 years	795	81	8.3	180	24	11.7
15+ years	2109	113	4.6	410	35	7.3
Total	3564	682	16.8	747	187	22.4

Food has been considered briefly as a mechanism in common source epidemics of acute diarrheal disease and as such judged unimportant in the village populations. Two other relations are significant; first the part of food in spread of the ordinary sporadic disease, especially among infants and youn children; and second, the place of inadequate nutrition in favoring clinical disease after infection.

Nutritional State and Diarrheal Disease. Perhaps no clinical impression is more firmly fixed among physicians working in preindustrial populations than the belief that acute diarrheal disease is a more frequent and a more serious disease among the malnourished than in persons of normal nutritional state. Few quantitative data have been advanced in support of that hypothesis. Using a standard classification based on weight (13), the frequency of acute diarrheal disease in children was determined on the basis of 3 degrees of malnutrition, where weight deficiency was more than 10 per cent and less than 25 per centy by the accepted standard; where the deficiency was between 25 per cent and 40 per cent and where it exceeded 40 per cent.

By the standards used, most of the children in the group suffered an appreciable degree of malnutrition. This is in accord with numerous other and extensive investigations (14) of nutritional state in this area whereby it becomes evident that infants do well nutritionally during the first 6 months of life, in general conforming to the standard, but thereafter and especially during the weaning period, they depart broadly and consistently from the accepted scale. Table 7 shows that diarrheal disease occurred with significantly greater frequency in the malnourished than the normal, that attack rates increased progressively the greater the degree of malnutrition, and that these relationships held at all preschool ages.

The related question of greater severity of diseases among the malnourished is considered through data of Table 8. Diarrheas were recognized as mild or moderate according to duration of less or more than 4 days, mucus and blood in the stools being absent. Patients with either of these findings were classed as severe, irrespective of days of duration. A difference was established between frequency of a severe form of diarrhea in the malnourished as compared with normal children; it increased regulary with advancing age, nutritional deficiency presumably being longer continued. The significance is discounted by the small numbers of persons in the normal group and a heavy loading with those in the first year of life. Also, serious diarrhea was numerically less frequent in persons with moderate nutritional deterioration than in the group with the beginning condition.

Weanling Diarrhea. Most Guatemalan highland children are breast fed from birth, in this experience 98.7 per cent of 301 infants for whom adequate data were available. The weaning process begins ordinarily at about 6 months of age, with addition of foods other than breast milk, and ends about the close of the second year, breast feeding ceasing, the mode being 25.5 months. For some children in this experience, the weaning process continued past the 36th month, Table 10. The stress induced by weaning is of 2 orders. An initial experience with a contaminated food after safe breast milk is one source

Table 7. Attack rates: Cases of acute diarrheal disease per 100 persons per year, by age and by degree of malnutrition. Santa María Cauqué, 1961.

Age in years	Number of persons	Cases of diarrhea	Attack rate cases/year/100
		Normal	
Under 1 year	22	19	86.4
1	0	0	----
2	1	0	----
3	1	2	200.0
4	1	1	100.0
Total	25	22	88.0
		1st degree malnutrition	
Under 1 year	16	39	243.8
1	14	28	200.0
2	20	20	100.0
3	12	22	183.3
4	12	12	100.0
Total	74	121	163.5
		2nd degree malnutrition	
Under 1 year	2	22	1100.0
1	20	65	325.0
2	16	40	250.0
3	16	39	243.8
4	17	12	70.6
Total	71	178	250.7
		3rd degree malnutrition	
Under 1 year	1	1	100.0
1	3	14	466.7
2	3	8	266.7
3	2	3	150.0
4	0	0	----
Total	9	26	288.9

Table 8. Distribution of cases of severe diarrheal disease by degree of malnutrition. Santa María Cauqué, February, 1961 - June, 1962.

Degree of malnutrition	Total number of cases	Number of severe cases	Percent severe cases
Normal	35	8	22.9
1st degree	172	65	37.8
2nd degree	254	74	29.1
3rd degree	35	14	40.0
1st degree - 3rd degree	461	153	33.2

of difficulty. The second is through substitution of food of poorer quality and commonly insufficient to meet currente requirements.

Infants and young children fed wholly on breast milk had relatively low attack rates for acute diarrheal disease, as shown in Table 9, including those continuing at an older age, with due allowance for the small numbers and the probability, despite history to the contrary, that they received some foreing foods. The frequency with which supplementary feeding is instituted at about the 6th month is indicated by the decided decline during 6 to 9 months in the numbers stated to be wholly breast fed during that period. No child was wholly breast fed past the 14th month.

Initiation of the weaning process, the addition of other foods beside breast milk, was associated with a greatly increased frequency of diarrheal disease whether weaning began at an early age or relatively late. Table 10 shows that in general the rates more than doubled. Few children in this experience received milk as a supplementary food. Other liquids in the form of gruels or semisolid pastes were common but various solid foods were the main addition and almost without exception.

The highest rates for acute diarrheal disease prevailed during the time that weaning was being completed; namely, when breast feeding ended and the child was transferred to a completely independent diet. The rates shown in Table 11 are measurably greater than those for corresponding ages when weaning was in process and the child still partially breast fed. The 3-month period immediately following that in which weaning was completed also was associated with high rates, numerically less than during the more stressful period when the transfer was made, but still statistically the same.

The results just presented on the relation of breast feeding and the weaning process to incidence of acute diarrheal disease agree closely in principle with a similar comprehensive field study in the rural Punjab area of India (5), although attack rates were regularly greater in Guatemala and death rates less. In relation to total deaths, diarrheal deaths were in much the same proportion in the 2 areas, if anything the proportion greater in Guatemala for the 2nd and 3rd years, where weaning was completed later, the mode in India being 19.5 months.

The relative significance of increased opportunity for infection incident to the weaning process and a deteriorating nutritional state with change in diet is not determinable on the basis of present information. Further analyses are underway. What is definite is that the diarrheas of these lesser developed countries occurring at the time of weaning are the main consideration in the general problem, that they possess characteristics sufficiently individual to justify recognition as an epidemiologic unit, here termed weanling diarrhea, and that specific measures directed to their management are an essential feature of general programs for control of acute diarrheal disease.

Table 9. Cases of acute diarrheal disease among wholly breast-fed children, by quarter years, 3 Guatemalan highland villages, 1959 - 1962.

Ages in months inclusive	All children breast fed	Breast milk only		Cases of acute diarrheal disease among breast-fed children only	Incidence: cases per 100, wholly breast-fed children per year
		Number	Percent		
0 - 2	294	284	96.6	51	71.8
3 - 5	290	239	32.4	100	167.4
6 - 8	288	95	33.0	45	189.5
9 - 11	280	13	4.6	7	215.4
12 - 14	261	3	1.1	3	400.0
15 - 17	221	0			
Total		634		206	130.0

Table 10. Cases of acute diarrheal disease and incidence per 100 children per year, among breast-fed children in course of weaning, 3 Guatemalan highland villages, 1959 - 1962

Age in months inclusive	All children breast fed	Breast milk supplemented with other foods		
		Number of children	Cases of acute diarrheal disease	Incidence: cases per 100 per year
0 - 2	294	9	1	44.4
3 - 5	290	48	17	141.7
6 - 8	288	190	103	216.8
9 - 11	280	264	187	283.3
12 - 14	261	254	178	280.3
15 - 17	221	220	164	298.2
18 - 20	169	168	124	295.2
21 - 23	124	123	79	256.9
24 - 26	72	72	36	200.0
27 - 29	44	44	31	281.8
30 - 32	23	23	15	260.9
33 - 35	9	9	10	444.4
36 - 38	5	5	3	240.0
39 - 41	2	2	0	0.0
42 - 44	0			
45 - 47	0			
48 - 50				
Total	2,082	1,431	948	265

Table 11. Cases of acute diarrheal disease, incidence per 100 per year, among originally breast-fed children at age weaned from breast, and during subsequent quarter year, 3 Guatemalan highland villages, 1959 - 1962

Age in months inclusive	All Children breast fed	Weaned from breast this period			Weaned in preceding 3 months		
		Number	Cases of acute diarrheal disease	Incidence: cases per 100 per year	Number	Cases of acute diarrheal disease	Incidence: cases per 100 per year
0-- 2	294		0				
3 - 5	290		0				
6 - 8	288		0				
9 -11	280	1	1	400.0			
12 -14	261	3	4	533.3	1	1	400.0
15 -17	221	8	5	250.0	2	4	800.0
18 -20	169	13	14	430.8	4	1	100.0
21 -23	124	20	13	260.0	13	11	338.5
24 -26	72	24	19	316.7	15	6	160.0
27 -29	44	18	7	155.6	20	16	320.0
30 -32	23	13	6	184.6	16	7	175.0
33 -35	9	6	6	400.0	12	5	166.7
36 -38	5	2	1	200.0	6	0	0.0
39 -41	2	2	1	200.0	2	0	0.0
42 -44		2	0	0.0	2	0	0.0
45 -47					2	0	0.0
Total		112	77	275.0	95	51	214.5

PROGRAM FOR CONTROL . A common error in the control of community disease is to attempt in areas without well organized health services procedures which have been demostrated as successful but under much better circumstances. Equally, effort in highly developed health agencies sometimes extrapolates scientific fervor beyond practical promise of accomplishment. The recommendations now made are directed primarily to the 7/8 of the world where acute diarrheal disease prevails at high levels and existing facilities are limited. The collection at the local level of basic data on frequency of occurrence is the first step toward control.

Reporting of Diarrheal Disease. The aim fostered by many good health departments of requiring individual case report of acute diarrheal disease by etiological agent has the common result of discouraging notification. Even under optimal conditions, as in the military services, this has not proved possible or practicable (15). A better idea of the prevailing situation is ordinarily to be had through report as undifferentiated diarrheal disease, but for this to be informative a change needs to be made in the Standard List of diseases (16) whereby the several conditions to be regarded as acute diarrheal disease are grouped under diseases of the gastrointestinal tract or under the acute infections. The former is preferred because, as has been brought out, all are not of infectious origin.

Individual case report in communities without local health services or with the limited facilities of so many technically underdeveloped countries is likely to prove little more than a gesture. The better reliance is on report of epidemics rather than cases, by the procedure outlined in Control of Communicable Diseases in Man of the American Public Health Association (17). Although epidemic report is just as impractical as individual case report without some organized responsibility for health, the concept can be accomplished by judgement based on deaths rahter than cases. Most countries have a designated registrar of births and deaths, even in the smaller communities. Based on accumulated experience of sufficient years for the particular area, an arbitrary number of deaths from acute diarrheal disease, according to population and within a specified time, can be established as constituting an epidemic and report made to the next higher jurisdiction by the most uninformed official.

Methods of Control. Control resolves into measures for limiting numbers of cases and thereby deaths; and secondly a direct attack on mortality through medical care. It is well to appreciate that no disease has ever been controlled by treating all patients, no matter how effective the available measures; and prevention has yet to attain eradication although successful for some few diseases in limited areas for indefinite times. The question of priority, one over the other, in a general approach should not intrude; a comprehensive program for control includes both. A further broad division of control activities is between those for which society takes responsibility through its official health agencies and those measures which of necessity the individual must undertake himself.

Preventive Measures. We choose to depart from tradition in placing health education of the public first in rank among preventive measures. The reason is two-fold. In the first place, many of the important preventive measures relate directly to personal hygiene and personal health practices, applicable only through initiative of the individual. The second reason is that control measures originating as a community effort and instituted through official agencies of society, frequently fail of their potential usefulness because the individual person is deficient in knowledge of their proper use or unconvinced of their value. Illustrations have been given earlier.

This opinion of the primary importance of health education traces back to an axiom originating with Haven Emerson, who said that "the first thing to do in public health is to persuade people to get up out of their own dirt." The implication is clear, that this depends upon the individual himself, that his incentive is from imparted knowledge and acceptance of the worthwhilness of the idea, and that provision of sanitary facilities is the means to an end, not the basic consideration. Health education finds its place in all of the measures to follow, from prevention to epidemic control, with reason to believe that it is not excluded from the high level of international protective measures.

The principal age of attack in the first years of life, the high fatality at that time, and the association with the weaning process, make maternal and child health practices a main feature of control programs. Spread by contact predominates and thus involves a clear relation to hygienic practices by mother and other attendants. Breast feeding presently is close to universal in most of the lesser developed countries, but cultural changes in many areas lead to substitution of artificial feeding with disastrous results before an improved personal hygiene and sanitary practice are able to keep pace with the change. Breast feeding through 12 months is important, but as the main reliance not to be continued beyond a point where the amount of breast milk provides an adequate nutrition. Cleanliness in preparation of food supplements has more than usual importance in this first contact of the infant with enteric pathogens, solid foods being generally recognized as more hazardous than substituted milk. Areas are known where the milk is always boiled but not the water with which it is diluted.

The traditional acceptance of environmental sanitation as the fundamental feature in long term control of acute diarrheal disease in total populations is wholly justified. Its short term effect on that part of the population most affected, the weanling diarrhea of infants and young children, is not so definite. The value of improved sanitary facilities has repeatedly been dissipated by lack of coordination with health education to assure proper use.

The water-borne epidemics so prominent a feature in metropolitan communities are apparently of lesser consequence in the diarrheal disease of well studied rural populations of lesser developed countries. Emphasis also is too frequently on purity of water to the neglect of quantity and how

readily water is available. Personal hygiene has been stressed as a prominent control measure. It requires adequate amounts of water. When supplies have to be transported several kilometers in small earthen jars, carried on the head, quantity is necessarily limited and detracts from practice of ordinary cleanliness.

Disposal of human feces is a critical concern and yet the construction of privies often results in acquiring an edifice instead of an institution, a monument to Hygea, but not something that the people understand, use and appreciate. Evidence has been introduced of a minimal effect of privies in restricting the frequency of diarrhea among infants and young children where the disease exerts its major effect.

Disposal of wastes other than feces enters into sanitary control as a means of controlling fly breeding. Other fly control has significance in many localities.

Improved housing can be expected to influence favorably incidence rates of diarrheal disease. Dirt floors and creeping children are a bad combination.

Food and nutrition necessarily attain greater prominence among control measures as the place of weanling diarrhea within the total problem becomes better appreciated. The greater incidence and severity of acute diarrheal disease among malnourished children than among well nourished infants and toddlers puts emphasis in attempted control on a diet adequate in nutrients and in amount. The addition to the infant diet of foods other than breast milk also increases the likelihood of infection. Supplementary feeding during the weaning stage needs to depart from the haphazard process so common in underprivileged populations, with substitution of an orderly regimen accomplished through health education and the guidance of workers in maternal and child health. The critical period is when breast feeding ends and the child transfers to a general diet. In lesser developed regions, nutritional state usually has deteriorated measurably by that time from the normal growth curve. An appreciable risk of diarrheal disease continues in the months that follow, and is still a factor in later preschool years.

Preventive methods are directed toward both mother and child. Mothers benefit from instruction in how properly to prepare foods which provide the supplement to breast feeding and equally after weaning; in protecting food from flies, rodents and other sources of contamination; in the storage and preservation of food; and the management of leftovers. In many cultures, food prejudices and superstitions are such that certain foods unwarrantedly are considered dangerous. Their prohibition leads to nutritional difficulties. In other circumstances food itself is considered the cause of the acute diarrhea, which it may well be although for other reasons, with the result that food is withheld from the sick child for long periods, malnutrition exaggerated, and the infectious process aggravated even to the point of death.

Children require training at an early age in food habits, from hand washing before eating to such elementary matters as prohibition of food dropped on the floor.

Care of Patient, Contacts and the Immediate Environment. As fundamental a principle as any, is to appreciate that the problem of control in the lesser developed countries, relates primarily to the community and not to the patient, nor to the family contacts and the household environment, which constitute the basic population unit. The period of communicability of the sick individual is short, the other sources of infection are multiple, and the secondary attack rate has been demonstrated to be small.

Insolation and quarantine are difficult to impose under the conditions of village life, even the elementary prohibition of food handling, but happily, for reasons just stated, they are of lesser consequence. No specific immunization of contacts is known, and attempts to institute chemoprophylaxis in the protection of contacts, while occasionally reported favorably in shigellosis, have failed to demostrate its worth when tested under controlled conditions. A principle proved useful in numerous other diseases where specific preventive measure are lacking, is close observation of contacts and prompt institution of full therapy at the first evidence of illness. Concurrent or terminal disinfection, other than ordinary cleaning has little value, again because of multiple sources of infection.

The part of a control program relating to the patient resolves essentially into clinical treatmen of the acute illness with the major anticipated result being fewer deaths, and a minor contribution to control from a somewhat shortened period of communicability. Modern methods of management, especially rehydration, contribute notably, although less so in the diarrheas of malnourished children who respond slowly to usual measure.

Recommended procedures on clinical management fail many times to recognize that the great bulk of patients with diarrheal disease in lesser developed countries lack access to hospital facilities, an organized clinic or the medical care characteristic of metropolitan centers. Those areas with high rates for diarrheal disease, taking the world as a whole are rural rather than urban, 85 per cent in India and 70 per cent in Guatemala. Medical care in many such situations is mainly with the practitioner of folk medicine, the local midwife, or the village wiseman. A conviction arising from experience in many such areas suggests the need to develop and test a simple program of management applicable to the particular local conditions, capable of use in the absence of a physician, and disseminated through health education to mothers of young children.

Most deaths from acute diarrheal disease are from dehydration. Rehydration is the basis of all good treatment, and thus of any plan of home management. The first consideration is to inform mothers of young children of the dangers of dehydration, how to recognize it, how to prevent it, and how to correct it at least in its early stages.

In the event of acute diarrhea, feeding initially is to be discontinued and fluids given by mouth: water with sugar and small amounts of salt and locally available fruit juices, in small amounts, repeated frequently day and night, until the child can take larger amounts and food tolerance returns. After 6 to 12 hours, diluted boiled milk is begun, with the concentration progressively increased during the succeeding 48 to 72 hours until whole milk is given. Concurrently, cereals, vegetables, fruits and meats are offered in increasing amounts until by the 3rd day the child is receiving and adequate diet for age in accordance with local availability of food and food habits of the population. This regimen is to be followed even in the presence of loose stools. The severity of the diarrheal process and its complications are frequently due to an over-restricted diet, and children sometimes die more from starvation than from diarrhea itself. If drugs are used, and they are available these days even in isolated villages, the recommendation is for sulfonamides.

A survey of the customary practices of the area in care of children with diarrhea is included to advantage in the investigation of epidemics, next described. Some are distinctly harmful. In Guatemala, administration of purgatives is usual, and still worse, strong vermifuges in the mistaken belief that the ascarids so frequently expelled by children in early diarrhea are the real cause of the disease. These practices, along with severe dietary restriction and failure to recognize dehydration, are the main reasons for the high mortality from diarrheal disease in rural Guatemala.

Epidemic Measures. The recognition to be accorded epidemics in a general program for control of acute diarrheal disease in lesser developed countries is not the overwhelming outbreaks of common source origin, so common in towns or cities and involving hundreds and often thousands of persons, as in the recent San Pedro Sula, Honduras, (18) episode. They demand emergeny action with such facilities as are available from central authority, if not from local, and international aid often comes into play.

The commoner epidemic is the outbreak which occurs with regularity in thousands of small communities the world over, most of them rural and in the lesser developed countries. The usual circumstance is that they remain unrecognized locally until they have reached their height, for they are of slow evolution, of long duration and spread by direct personal contact. The epidemic commonly runs a natural course, for the popular tendency is to view them as an unavoidable feature of life in these localities.

Recognition of such events requires a system of reporting not now existing in most places where they occur. A special means has been suggested. To attempt investigation and control of all outbreaks in the numbers that exist is wholly impractical. That would overwhelm the resources of most health departments in affected regions. What is suggested is designation of one physician of a health agency, to operate under a policy of continuing investigation of some of the outbreaks sufficient to give an understanding of representative geographical distribution and seriousness.

The immediate accomplishment in limiting incidence and the costs in death and disability would be inconsequential. The problem is just too great in the areas most affected. The main objective is educational, to engender among village residents an appreciation of this health problem, to show that control is feasible and therapeutic measures possible, thereby encouraging preventive action against the otherwise certain outbreaks of the future. The direct gain is improved understanding of the size and nature of the problem regionally, an assessment of deaths not to be had from the usual vital statistics, and the practicability of control within locally available resources.

The field methods of an operational epidemiology (19) are the basic reliance. Laboratory aid in sufficient amount to determine a dominant organism and the proportion of cases demonstrably infectious is useful but not essential to the stated objectives. What needs to be recognized is that much of the information necessary for control is to be had in the absence of facilities more directly concerned with research. The things to be learned are who gets the disease, who dies, modes of transmission, the periodicity of epidemics and principles to be applied in preventing epidemic recurrence.

International Measures. An international Salmonella center under auspices of the World Health Organization exists in Copenhagen, Denmark and national centers in representative parts of the world. Several of them also serve for Shigella. They are concerned primarily with microbiological research; they function as reference laboratories for identification and classification of strains received from the field; epidemiologically they provide information on the geographical distribution of serotypes. An increasing realization of the broad range of infectious agents in acute diarrheal disease, that factors other than microbiological have great importance in causality, and that all are in constant change, suggests the need to expand the sphere of activities. Microbiological services should make provision for enterophatogenic Esch. coli as well as Salmonella, and Shigella, desirably extended to include facilities for enteroviruses and intestinal parasites. Better still, the existing centers are a promising nucleus around which to develop Epidemiological Centers for Acute Diarrheal Disease, concerned chiefly with microbiological interests but expanding their activities to field investigation and participation in some of the problems next mentioned.

Research. This discussion has raised questions whose answer relates directly to more efficient control. Others are evident. While still adhering to the declared intent of considering only control measures based on available knowledge, the history of preventive medicine shows a continuing dependence on acquiring new facts. Research is therefore an integral part of any comprehensive control program.

In recent years investigation of the acute diarrheal diseases has put primary emphasis on modern scientific method as applied in laboratory and clinic. This is admirable, has been productive and has contributed to

control. Research has followed the indicated trend because that is the kind of investigation best fitted to existing opportunity in the advanced countries where most research is done. Acute diarrheal disease is there neither highly prevalent nor clinically serious. The more direct need of regions with much diarrhea is for the ordinary facts of behavior of the disease in nature, to be derived from operational epidemiology (19), and with a direct bearing on the practical problem of control. This is in 4 possible directions:

1. In selected hyperendemic areas, periodic surveys of a few representative rural and urban populations to determine how much diarrheal disease exists, the dominant mode of transmission, the influence of maternal and child health practices and the relation of nutritional state. Periodic study, perhaps annually, is desirable because of the dynamic movement of the disease and to measure the effect of such control measures as may have been instituted. Such studies are a logical obligation of national health departments. They function to advantage under provincial auspices and are possible by established urban health agencies. Expert research competence is not required. Complicated laboratory facilities are unnecessary; there need be none, or no more than enough to determine the proportion of specific infectious diarrheas. The objective is to define the size and seriousness of the problem and the nature of proyected control measures. Investigations of this kind could well be fostered by the national and international diarrheal disease centers just proposed, through professional consultation and planning, and if need be, through augmentating local resources.

2. Concentrated and continuing prospective epidemiologic investigations of a small selected group of family cases observed until infection disappears, case study being interpreted as a concern with patient, close contacts and the immediate environment. The community prevalence survey, short term and cross-section, is believed to have been much overdone; that such fundamental information as may be had by this means is at hand; and that the more promising approach to causality is by intensive study of family outbreaks from index case until the last carrier. Such studies to advantage combine field and laboratory procedures. They are profitable as wholly ecologic investigations, which is to disparage the frequently expressed "we can't do anything because we haven't anything to do with". The basic requirements are a clear brain and a little sweat.

3. This presentation has referred to three long term prospective studies of a fixed population over a period of years: in India, in the Arctic and in Guatemala. From a world standpoint, comparable investigations in lesser developed areas of Africa, South America and in Asia should be useful. The Cleveland investigations of Dingle et al. (20), and those by Hardy and Watt (21) and by Goodwin (22) in a rural area of the United States developed new facts suggesting the value of similar investigations in representative rural and urban areas of Europe.

4. Epidemics traditionally have provided a favored opportunity for research. While the primary objective of epidemic study is control, a policy of intensive study of occasional outbreaks in areas of high incidence is included to advantage, and again by field methods rather than microbiological.

Field research has had emphasis, in these suggestions, because it is within the facilities of official and other health agencies in developing countries, and because there the main need is for better information on local conditions. Also, it happens to relate so directly to practical control. There is, however, no suggestion that field research is a substitute for the carefully ordered investigations of laboratory and clinic. The ideal combines the three, upon which rests the earlier recommendation of augmented responsibilities for the present Salmonella and Shigella centers.

SUMMARY. If generalization is permitted of present day approaches to the control of acute diarrheal disease, emphasis has been too much on the obligations and duties of public health agencies, with too little appreciation that much of control rests with people themselves. Stated perhaps colloquially, the pressure has been on what society should do for the people and too little on what they must of necessity do for themselves, as good epidemiologic evidence shows.

This belief does not disparage the wholly constructive measures resident in the building of privies, the improvement of water supplies, provision of laboratory facilities, and the pasteurization of milk. What is implied is that correction of faulty practices in personal hygiene, an understanding of dietary requirements, a better command of maternal and child health procedures and the elimination of cultural prejudices have special significance in diarrheal disease at the ages where it is most prevalent, among infants and the children of immediately succeeding years.

The two objectives of public and personal effort are not in conflict, nor are they separate and independent. The argument here is for equal attention to people and to things. Both are within recognized public health activities, for the medium for improved personal hygiene, health education of the people, is definitely a function of health agencies. The two interests complement each other: the provision of physical facilities without the sympathy and understanding of the people who are to use them has repeatedly proved ineffective; the cultivation of a hygienic way of living brings demand for the physical facilities with which to accomplish it.

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