A DIARRHEAL DISEASE SURVEILLANCE SYSTEM IN CALI, COLOMBIA: THEORETICAL BASIS AND METHODS1,2

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Introduction

Diarrheal disease continues to be a principal health problem in the Americas. To help provide the orientation needed to solve this and other key problems, health authorities have repeatedly called for epidemiologic surveillance. The III Special Meeting of Ministers of Health of the Americas held in Santiago, Chile, in 1972 recommended that the Governments of the Hemisphere “Create and maintain epidemiologic surveillance units in accordance with the national organization and regional structure of each country, so as to ensure a continuous supply of information on the epidemiologic characteristics of health problems and the factors governing them, and thus enable timely action to be taken” (1). Two years later the XIX Pan American Sanitary Conference approved a resolution recommending that member countries “establish epidemiologic surveillance systems and laboratories for the diagnosis of enteric diseases, setting up national reference centers and a regional reference center” (2). More recently, an article appearing in this journal raised the point again, asserting that “Surveillance should play a major role in guiding and evaluating control efforts in areas of high enteric disease endemicity” (3).

Despite these urgings, established ongoing surveillance systems have thus far contributed little to diarrheal disease prevention in Latin America. One possible reason for this is that the relevant planning has been done on a large (national) scale, and so has tended to result in schemes that are not epidemiologically practicable in the specific case of diarrheal disease.

Current surveillance techniques uncover only the grossest or most general problems contributing to diarrheal disease. Such surveillance does not guide the day-to-day work of sanitarians into the most productive areas, primarily because it is based on an overall summation of morbidity or mortality data compiled by the health system. Such data do not reflect immediate factors involved in diarrheal disease transmission; moreover, the data are too general to permit some one specific factor to be singled out from the multitude that can contribute to transmission of diarrheal disease agents. The present article reviews some of the experiences and concepts leading to establish-
ment of a diarrheal disease surveillance system in Cali, Colombia, which is geared to daily health work and which offers an at least partially effective answer to this problem.

Diarrheal Disease in Cali

Results of the Inter-American Investigation of Mortality in Childhood, an investigation coordinated by the Pan American Health Organization, indicated that children under five years old in Cali had an annual mortality attributable to diarrhea of 504.9 deaths per 100,000 live births. For children under one year old the rate was 1,715.6 deaths per 100,000 live births. These rates were intermediate, being somewhat higher than in most of the other areas studied but considerably lower than the highest rates found. However, when one considers that Cali’s water and sewer services are among the most extensive in Latin America, and that the observed death rates are over 150 times greater than those found in Canada, it appears that these rates are indeed rather high.

Furthermore, considering all grades of severity, we found that rates of diarrheal disease morbidity in Cali were extremely high. Our surveys of endemic weekly incidence of new diarrheal disease episodes in working class neighborhoods with sewer systems and piped, potable water show average weekly incidences of 21 per cent in children under five years of age, 6 per cent in children ages 5-14, and 3 per cent in the older age groups. In areas without sewer and water services we have found that 30-35 per cent of children under 5 begin a new episode of diarrhea each week, as do 13-15 per cent of children 6-14, and 5-7 per cent of older age groups. In these surveys diarrheal disease is defined as stools of liquid or slimy nature more than twice as frequently as usual. Another study showed Cali schoolchildren to have a weekly diarrhea prevalence of 19 per cent. In fact, diarrheal disease is so common in this population that only when it presents complications, such as dehydration, is it taken to be something requiring health measures. Rough data indicate that only about one out of 200 or 300 diarrhea cases is seen at the health centers. The proportion of infant cases brought to the health centers is of course higher. Fortunately, the vast majority of cases are mild and indeed do not justify a medical visit.

As these circumstances imply, medical data gathered at the health centers cannot be expected to accurately describe the overall situation. This is especially true because cultural attitudes and other factors are apt to condition the decision to visit a center just as much as the severity of the symptoms. Thus medical care data will be considerably biased away from the true distribution of transmission factors by social, cultural, and demographic characteristics of the population involved.

Those who seek attention may receive a stool examination for parasites but almost never a stool culture. Since a very high proportion of the population has parasites with or without diarrhea, parasitosis is overdiagnosed as a cause of diarrhea. Even when bacterial and viral cultures are performed by routine methods, only a very small percentage of diarrhea cases can be attributed to classical agents found.

Although the population is quite completely served by sewer and water services, numerous sources of fecal contamination are evident—such as inadequate home, school, and public toilet services, open sewage canals, and foods processed or sold under unhygienic conditions. In fact, home and community visits can pinpoint literally hundreds of situations involving potential exposure to fecal material.

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5 The investigation covered the period July 1968-June 1970.
The Transmission System

Most diarrhea cases are caused by infectious agents transmitted through feces. Various mechanisms, including person-to-person and animal-to-person contact as well as indirect common vehicles, may be involved. The particular distribution of susceptible individuals and the specific mechanisms which enable existing disease agents to pass from one individual to the next constitute a transmission system. In Cali, the number of agents circulating in this system is large. The high incidence rates and numerous annual diarrhea episodes experienced by most of the city's children are probably caused by hundreds of antigenically distinct agents which are continually passing from one segment of the population to another. Some agents may behave differently; these may be entirely absent for a while, only to return again and sweep through the city. Each agent's pattern of endemicity or epidemicity will depend upon the characteristics of the agent and those of the system. Characteristics of the agent which influence its temporal geographic distribution include its ability to survive in a given environment, its virulence, and the average number of organisms required to cause a sustained infection. Characteristics of the system which affect the agent's distribution include the numbers of susceptible and immune subjects in contact with one another and the available opportunities for fecal contamination.

Since the illness produced by one agent is apt to be clinically indistinguishable from that of another, and since laboratory examination with techniques capable of identifying all currently known agents is not done, there is no way of knowing which agents are sweeping through the city at a given moment, which are bouncing back and forth between different neighborhoods, and which have a similar level of endemicity throughout the city. An agent that infected half of Cali's people in a period of eight months and caused illness in a fifth of those infected would not perceptibly change the high rates of endemic morbidity observed, unless it yielded cases of unusual clinical severity such as those produced by *Vibrio cholerae* or *Shigella dysenteriae 1*.

Gordon, et al. have compared this epidemiology of diarrhea to that of the common cold. "Acute diarrheal disease at a particular time and place is similar to the common cold in that it is a clinical syndrome of characteristic behavior including a minority of known disease entities, a predominating bulk of undifferentiated, presumably infectious, processes 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" (8).

Although only a small proportion of cases have agents identifiable by traditional means, the concept of a multitude of different agents seems sound. It is evident that the salmonellas, shigellas, invasive *E. coli*, and viruses isolated to date have marked antigenic variability. Moreover, toxigenic *E. coli* also have marked variability, and since toxigenicity is an episome-related character, the antigenic composition of these strains is continually changing (9). Now that several antigenically distinct paroviruses have been implicated in diarrhea cases, it seems likely that these also represent a large class of agents (11). Nor is there any reason why the same should not be true of the reovirus-like agents.

All of the infectious agents are spread by fecal transmission, although airborne transmission of some agents, such as the paroviruses, cannot be ruled out. The particular mechanisms responsible for transmitting human or animal feces will vary, depending on which ones most effectively transmit the particular agents involved. The effectiveness of their transmission will depend, in turn, on several factors, including the agent's ability to survive prevailing envi-
ronmental conditions and the number of organisms needed to cause an infection.

The noninfectious diarrheas are not spread by this transmission system, but they probably account for only a small proportion of total cases. For instance, Dingle, et al. (12) estimated that 75 per cent of the cases in Cleveland were infectious. Surely in Cali, where fecal transmission is far more extensive, the percentage of infectious cases must be greater.

If we say that the particular pattern of potential fecal contacts between individuals in a community constitutes a transmission system, then we can use systems analysis techniques to evaluate the diarrheal disease problem. With these techniques we can see which transmission mechanisms have a marked impact on the system and which do not greatly affect the total circulation of agents.

For example, suppose that contamination of home toilets and subsequent contamination of the toilets' other users generally causes infection of about half a family's members when a case of diarrhea is introduced into the family. This mechanism might then account for half the cases in a community. However, if the mechanism is markedly reduced or eliminated by providing cleaner toilet facilities, it may be that the other family members will be infected anyway by other mechanisms such as contamination of food or utensils. The family toilet seat would then be a "redundant" transmission mechanism. At the same time, if the family members infected by this mechanism do not proceed to infect others, the transmission mechanism would be "terminal." Because fecal contact is so much greater in the home situation than outside the home, there is reason to suspect that the majority of transmission mechanisms in the home are both redundant and terminal. It is possible that some of these mechanisms might account for a large share of the disease transmitted in a community, but if they are eliminated the total amount of disease in the community will change little.

On the other hand, some mechanisms may infect people who will subsequently infect many others or begin chains of transmission. These are called "disseminating" mechanisms. It is perfectly possible for a disseminating mechanism—such as contaminated ice cream sold to schoolchildren—to account directly for only a small percentage of cases, even though elimination of this mechanism would cause a considerable drop in total disease levels.

In all recognized specific diarrheal diseases, carriers and asymptomatic infections play a significant role—along with active cases—in providing a reservoir of infection. In general, adults will have fewer symptoms of infection than children. Asymptomatic adults, however, may be sources of infection in the home, and thus contaminated food that infects adults may cause little clinical illness while still making an important contribution to overall disease levels.

Unfortunately, we do not have enough data to tell what overall role symptomatic infections and carriers play and what transmission mechanisms are redundant, disseminating, or terminal. Even without adequate data, however, reasonable assumptions about the role of different factors can help to establish priorities for diarrheal disease control programs.

Clearly, control of disseminating factors would do most to reduce diarrheal disease; and experience gained to date with traveler's diarrhea indicates that disseminating sources are common in Latin America, at least in the relatively well-to-do areas frequented by foreign visitors. Taking United States travelers as an example, it has been shown that diarrhea rates among travelers visiting Latin America are over four times greater than the diarrhea rates among those visiting Europe (13). Enterotoxigenic \textit{E. coli} is a frequent cause of this illness
Transmission, which is relatively rare among family members, may be associated with fresh vegetable salads (15). Experience also indicates that disseminating common sources of diarrheal disease should be more frequent among poorer Latin American populations. It would thus seem that efforts to find disseminating sources should have priority in diarrheal disease prevention programs.

Alternative Methods of Diarrheal Disease Control

Both prevention and treatment are important in diarrheal disease control. Indeed, diarrheal disease appears to be one of the few medical areas where treatment enjoys a highly favorable cost-benefit ratio. Treatment and prevention activities should therefore be complementary and should in no way need to compete for funds or credits. Proper treatment with diets and hydration fluids is inexpensive and highly effective. It should also be noted, however, that improper use of antibiotics in treatment may raise transmission levels by prolonging the carrier state (16) and by inducing episomal transfers that cause strains better-adapted to the host or the environment to become pathogenic (9,17). Improper use of antibiotics can also complicate treatment by causing already pathogenic strains of bacteria to become antibiotic-resistant.

The difficult choice is not treatment versus prevention, but rather which preventive measures should be pursued. One might pursue measures that would reduce the overall level of transmission in a community, or one might attempt to protect the age groups at highest risk (the weanling age groups) against transmission.

The latter aim can be pursued through education efforts connected with maternal and child health programs. For example, educating mothers about proper sterilization of baby bottles, as well as proper cleaning of crib areas and objects that reach the infant’s mouth, should reduce the risk that a family member who brings a new agent to the home will transmit this agent to the infant. Experiences with education programs to date have been discouraging, but two programs have shown that if a high-risk group of mothers is identified and receives intense, personal education in a household setting, subsequent infant diarrheal disease can be reduced (18,19).

Better treatment of early and mild symptoms of diarrhea probably account for this reduction—detected as a decrease in subsequent medical attention required. Contamination of the infant is probably only minimally reduced by such education. Even where hygienic facilities greatly surpass those available to the population involved, the incidence of illnesses caused by secondary infection of a family’s young children with agents that can be identified in the laboratory, such as Shigella, is extremely high (20). The same is true of illness caused by unidentified agents involved in sewage poisoning episodes in developed countries (21,22).

If secondary spread cannot be stopped in homes that have sinks, soap, towels, hard floors, clothes-washing facilities, and separate kitchens, how is it to be stopped where one pipe in an open patio serves for washing hands, babies’ diapers, and dishes. In such a community, attempting to reduce the overall level of disease transmission might be a more promising approach. For if the number of pathogenic agents introduced into a home could be reduced, that would correspondingly reduce the number transmitted to the infant.

For example, consider an attempt to reduce the diarrhea transmitted by baby bottles prepared with dirty hands. Say that every day a mother has one-tenth of a chance (0.1) of transmitting diarrhea this way if she is currently carrying a pathogenic organism, and one-thousandth of a chance (0.001) if she is not. It is reasonable to assume that by washing her hands before
preparing the bottle she can reduce these risks by a factor of 10— to .01 and .0001, respectively. But it is also reasonable to suppose that nine-tenths of the disease she prevents this way might still be spread by direct handling of the infant or by contaminating other objects the infant puts in its mouth, so that the overall risk would only be reduced slightly—to .09 and .0009, respectively. If, in addition, we say that a sound education campaign involving half-hour home visits to 10,000 mothers achieves a fantastic success rate, changing the hand-washing habits of nine-tenths of the mothers nine-tenths of the time, this would produce the following results:

If a mother is carrying a pathogenic agent one-tenth of the time, there would be a daily risk of .0109 (about one-hundredth chance) of transmission before the education program. After the education program the daily risk would be very slightly reduced to .0102.

Now, say an important source of maternal infection is found and controlled, so that the average mother only carries a pathogen 8 per cent of the time. Even without the education program the daily risk of transmitting a pathogen to the infant will be considerably reduced—to .00892—more, in fact, than it was reduced by the education program. Moreover, achieving this reduction would probably involve far less effort than the 5,000 man-hours required by the education program. Also, the benefits of controlling this source of maternal infection will accrue not only to the infant, but also to the preschool child whose nutritional status will be less damaged by diarrhea, the schoolchild who will lose fewer class hours, and the adult who will avoid some minor discomforts.

Various aspects of the Cali surveillance system are designed to find disseminating sources of infection that might be controlled easily, whose control would result in decreased circulation of agents, and whose reduction would ultimately benefit infants and preschool children who are at highest risk of suffering from diarrhea—even though the surveillance data gathered do not focus chiefly upon them.

The Surveillance System

The main purpose of our surveillance system is to identify the problems that need to be remedied in order to effect diarrheal disease control. We also want the system to channel the allocation of our resources into those activities that will most effectively reduce disease levels.

The kinds of problems that surveillance systems in general can identify might be grouped as follows:

1) "problem" host characteristics that aggravate acquired disease, and deficiencies in the medical care system that impede effective treatment;

2) patterns of personal or cultural behavior and of environmental contamination that contribute to transmission of disease agents;

3) specific agent characteristics, such as antibiotic resistance or relative infectiousness, that could affect disease control efforts.

The emphasis of our surveillance work is on the second category of problems. In general it follows the suggestion of Gordon, et al.:

Since clinical and laboratory differentiation is at present possible for only a small fraction of the diarrheas, an alternative in community control, especially where facilities are limited, is to regard all diarrheal disease as constituting a clinical syndrome, "acute undifferentiated diarrheal disease" and to base control measures on the epidemiologic characteristics of the group (8).

In our setting, the sources of surveillance information useful for the control of diarrheal disease include:

1) Medical care and mortality data.
2) Outbreak investigation findings.
3) Large incidence or prevalence surveys of endemic disease in defined population.
4) Laboratory surveillance of environmental sources of infection.

Medical Care and Mortality Data

As noted earlier, medical care data will tend to reflect sociodemographic variables more than the distribution of etiologic factors. Therefore, routine tabulation of exposure data for patients with and without diarrhea is not an effective way to determine causal factors. Instead, when a situation arises that might lead to identification of a causal factor one must actively seek data in the community. As Dr. E. Roelsgaard, chief of epidemiological surveillance for the World Health Organization, has observed, While the first of these activities frequently deteriorates into a routine without meaning which is unrelated to public health activities, the latter represents the practice of epidemiology designed to discover and amplify means of effective disease control (1).

Nevertheless, changes in care rates over time may reflect changes in a causal factor’s distribution or associated attack rates. That is to say, care rate data may provide notification of an outbreak. If the factor causing the outbreak is widespread and has a high associated attack rate, a direct association may be found between the factor and the excess cases.

In one instance medical care data from a particular health center showed a sharp rise in the number of patients from one specific neighborhood. That same week, problems with a sanitary landfill resulted in an invasion of flies. Moreover, an attack rate gradient, increasing with proximity to the landfill, was observed.

Despite the example just cited, however, medical care information tends to be a very inefficient detector of diarrheal disease outbreaks. If a factor affects 2,000 people with an attack rate of 10 per cent, and if only 1 per cent of the 200 resulting cases seek attention, the two extra cases will not cause a perceptible change in care rates. On the other hand, if the 200 people ill from this factor—and the possibly 1,800 non-ill carriers—pass on their infections to 500 infants under one year old, and if care is sought for 50 of these infants, there will be a notable change in care rates. But this high care rate will not be directly associable with the factor that led to it. In view of these considerations, we do not use data on medical care rates to find causal factors of diarrhea; rather we use them to advise us of situations where active data collection might uncover such factors.

Investigation of Outbreaks

The meaning of the term “outbreak,” as employed here, does not necessarily conform to common usage. We do not limit our definition of an outbreak to situations where medical care for diarrhea exceeds the background level. We conceive of an outbreak as occurring when the attack rate in a defined population is many times the usual attack rate in that population. The population may be defined as the people in a chain of transmission, as those exposed, or as those meeting other more general demographic criteria. When the defined population is small, the number of ill people seeking medical care may not perceptibly raise rates of care above normal levels. In a certain sense, all cases of infectious diarrhea might be considered part of an outbreak under this definition. In most infectious agent-related diarrhea cases, however, one cannot define the population experiencing the outbreak of which the case is a part.

The value of using the term outbreak this way is that when an affected population can be defined, epidemiologic methods will be much more likely to find the cause. An outbreak we investigated that was spread by contamination of drinks ("refrescos") in
plastic packages provides a good example (23). In this case the source could be determined, because 93 of the 250 children included in the defined population were exposed to the causal factor, which produced illness in 17 per cent of those exposed. If we had defined a different population to be studied, in which say 60 out of 400 children had been exposed, we could not have determined that the refrescos were a causal factor.

Successful use of the outbreak investigation approach requires taking several steps. The first and most crucial is that of creatively defining the population experiencing the outbreak and doing efficient preliminary work to make sure that the definition used yields a sufficiently high attack rate.

Once the population is defined, and even during the process of definition, one proceeds to enumerate all possible sources of infection and epidemiologically useful demographic divisions within the population. In addition, samples should be taken of possibly implicated foods or environmental sources—for examination either before or after conclusion of an epidemiologic investigation, depending on resource availability.

Next an epidemiologic investigation must be designed. Usually this consists of a cross-sectional survey in which the entire population or a sample is interviewed. Diarrhea attack rates are almost never so low as to require selecting controls in a way that corresponds to ascertained cases. Sometimes, however, it may be advisable to define the population as those who are very likely to have been exposed. In such cases a cohort survey must be planned in which unexposed controls are chosen.

Once the survey has been designed, one must design a questionnaire, execute the survey, and analyze the results. If diarrhea sources are to be discovered, an epidemiologic team must be organized that can carry out this entire process in a matter of days. If these investigations are to result in the control of disease, the process must not end there; the source of the contamination must be determined; the importance of the source must be evaluated; means of control must be determined; and a decision must be made regarding allocation of resources to control the problem. All these steps are described in the previous report of our contaminated refrescos investigation (23).

Outbreak Detection

The most useful source of information for discovering outbreaks that need investigation will not be summary medical care data, because these only reflect exceptionally dramatic changes in causal factors. Follow-up of related cases, citizen reports of outbreaks of illnesses due to foods, and laboratory surveillance of environmental conditions will be more productive in discovering situations where an epidemiologic investigation can lead to control of a causal factor.

Our initial procedure in looking for related cases was to ask the patient if he knew of other cases in the home, family, neighborhood, school, work group, or other group having an onset within seven days of his. This inquiry usually revealed a probable person-to-person transmission pattern in a small group with a multitude of possible sources, none of which could be confirmed statistically because of the small population defined. (These person-to-person transmission factors are better investigated by large incidence or prevalence surveys of endemic disease in defined populations.) If related cases are defined as those having an onset within 24 hours of the index case, the number of situations where epidemiologic investigations are fruitful increases. This is because a greater percentage of such cases are tied to disseminating common sources. The principal objective in following up these cases is to see if a population can be defined which is experiencing an outbreak. Here success—as in the case of the refrescos
outbreak—is achieved 10 to 20 per cent of the time.

Bias of Outbreak Factors

Of course, the factors found to be acting in outbreaks will not be representative of all the factors causing disease. It is our hope, however, that these factors will tend to involve disseminating sources, and that their control will tend to produce widespread benefits because secondary as well as primary cases will be prevented.

A factor that acts intermittently in small populations, such as the practice of touching the mouth to a recently contaminated drinking fountain, will not be detected effectively by outbreak investigations. Such factors are better studied through large incidence or prevalence surveys of endemic disease in defined populations.

Also, successful outbreak investigations may be more likely to reveal non-disseminating common sources than disseminating common sources. The reason is that outbreaks with high attack rates, caused by agents with short incubation periods, are most easily detected because they cause a tighter grouping of cases. Toxin-related outbreaks have these characteristics more often than outbreaks caused by living agents. For example, we found an outbreak of staphylococcus intoxication spread by sausage factory workers with multiple abscesses on their hands to be exceptionally easy to track down. But although the contaminated sausages undoubtedly caused thousands of illnesses, the cases were mostly in older children and adults. And since staph intoxication is not propagated person-to-person, infants would not be secondarily affected.

Sources contaminated with toxigenic or invasive E. coli, Shigella, viruses, or some strains of Salmonella that are secondarily transmitted would be much more important than toxin contaminations, even though there might be fewer primary cases. Common sources contaminated with these transmissible agents are hard to detect, however, because in general such agents have relatively low attack rates and relatively long incubation periods.

These agents' low attack rates arise from the fact that they are common, and hence there is acquired resistance to them among adults. This resistance phenomenon is illustrated by the fact that in Lebanon U.N. observers coming from the United States and Europe suffered attack rates three times higher than those suffered by observers from South America (24). A similar difference was also found between developed and developing country participants at a conference in Mexico City (25).

Indeed, it may be difficult to find common sources of transmissible agents. Consider 1,000 soybean drinks contaminated by the hands of various different workers with agents that produce a 5 per cent attack rate in those consumers (say 20 per cent) who imbibe a contaminated product. There will be few related cases, and any outbreak is likely to be small. It will be especially difficult to find such a source if the agent's incubation period is over 24 hours, because the elapsed time will make it hard for victims with related cases or others involved to remember that they were in fact exposed. But this will not prevent the 10 daily cases and perhaps 25 asymptomatic infections caused by the product from having an impact on the total circulation of enteric pathogens. This makes it important to find such sources. And despite the fact that the search may be difficult, it is also true that continual vigilance and investigation of outbreaks should eventually permit them to be discovered.

Endemic Disease Surveys

When there is reason to suspect that a factor is spreading diarrhea through a very extensive population at a constant low level, a different strategy must be adopted. Factors
involved include those that act at only the family level, such as inadequate washing and cooking facilities. Widespread unhygienic behavior patterns that only occasionally spread disease, such as failure to wash hands before preparing meals or storing food at incubation temperatures, also fall into this category.

For investigating such factors, Gordon recommends the following strategy:

Conduct a series of repeated surveys at prescribed intervals in a few selected representative rural and urban areas in order to determine how much diarrheal disease exists, what is the dominant mode of transmission, and to what extent nutritional state and maternal and child health practices influence frequency of attack. The dynamic movement of disease and the need to measure the effect of control measures make repeated studies desirable, perhaps twice yearly over several years in order to account for seasonal differences (26).

These repeated field surveys provide a means to measure prevalence because they overcome the previously mentioned biases in rates of care. Nevertheless, since diarrhea is spread by a multitude of factors that are difficult to measure, such as unhygienic personal habits, the surveys must be large and very carefully designed and executed if causal factors are to be determined with any degree of confidence. To increase prospects for success in this respect, it is worthwhile to search out populations with an especially high incidence of disease, so that the factors responsible would be transmitting pathogens and causing disease more frequently, and would thus be easier to determine. Likewise, populations in which certain factors might be easy to measure should be sought. For example, if by historical coincidence a locality has two distinct intradomiciliary plumbing systems, that might be a good place to study. Among other things, the findings could then be used in future planning of water services.

One example of an endemic disease field survey is a study made by our surveillance system of diseases related to hygienic conditions in schools (5). We elected to study the school population not only because of a known high disease incidence and the presence of an easily measured factor that we had reason to suspect, but also because a school-transmitted agent is much more likely to disseminate further in the community than is one transmitted at home.

Even in populations with especially high endemic rates, however, such study designs will require large numbers of interviews for success. On the other hand, such surveys do not require expensive laboratory facilities, sophisticated data handling equipment, or workers with more than a basic high school or even primary education; and hence they are well-suited to application in many parts of Latin America.

Laboratory Surveillance Work

In developed countries laboratory surveillance for the microbiologic agents causing medically attended cases has often led to the discovery of contaminations causing diarrhea, especially when salmonella is involved (27,28,29). However, in most parts of Latin America (including Cali) such agent surveillance in individual cases cannot be practiced because stool cultures are infrequently performed. This lack of bacteriology is justified since identification of diarrhea agents in individual cases only rarely influences the therapy or preventive measures undertaken. In developing areas, bacteriology of individual cases is probably efficient only where the goal is to determine the major agent in an outbreak. The importance of bacteriology in such situations is demonstrated by the Central American Shigella epidemic of 1968-1969 (30).

The laboratory can play an extremely important role in diarrheal disease control when it is directed at environmental factors rather than pathogenic agents. In outbreak investigations, laboratory evaluation of
food, water, or surfaces may help implicate a causal factor in cases where epidemiologic data are ambiguous. Activities performed during the forementioned refrescos outbreak (23) provide a good example of this kind of work.

Environment-directed laboratory investigations unrelated to outbreaks can also be very important. Such investigations provide a way to identify and control disseminating causal factors of diarrheal disease that would be difficult to identify through other surveillance activities. In the case of the soybean drinks referred to earlier, routine bacteriologic examination revealed that many of the products, which were sold to tens of thousands of people daily, had more than $10^8$ fecal coliforms per ml. We did not find the product to be involved in related cases or outbreak reports; nor did we find an appropriate situation in which to conduct a cohort study. Nevertheless, the dramatic nature of the laboratory results was sufficient reason to institute control measures.

On the whole, instead of yielding dramatic findings such as these, however, bacteriologic examinations are more apt to produce ambiguous results. For example, we have found multitudes of products with fecal coliform levels ranging from 10 to 1,000 organisms per ml. And since production of most of these items is home-based and widespread, contamination is difficult to control. In these cases the laboratory performs a very useful service by studying manufacturing processes. Through examination of samples taken at consecutive steps of the process one can determine where contamination is occurring and what factors are conditioning the undue growth of bacteria. Such examinations thus provide a basis for appropriate education and control efforts. For example, in the more spectacular case of soybean drinks, we found that the major risk of contamination did not occur during the 12 hours the product was left to cool, as we had initially suspected; rather, it occurred during the processes of straining, packaging, and subsequent handling.

**SUMMARY**

A diarrheal disease surveillance system being established in Cali seeks to reduce the circulation of fecally transmitted diarrheal disease agents by identifying conditions of environmental contamination and personal behavior that spread the causal agents. The surveillance system focuses on transmission mechanisms rather than the high-risk infant population.

The system makes relatively slight use of the traditional tabulation of medical care data and esoteric identification of diarrheal disease agents. Instead, it investigates acute diarrheal disease syndromes by actively collecting incidence and exposure data among populations that are experiencing outbreaks or special endemic disease problems. The resulting disease control effort is backed up by laboratory work directed principally at finding environmental contamination that might not be detected otherwise, and at helping to determine how such contamination can be controlled.

**REFERENCES**


(7) Dover, A. S., K. N. Newell, and D. I. Clemmer. Diarrheal disease in infancy, Cali, Colombia: Relationships of infectious agents to symptoms. (Submitted for publication.)


