Pan American Sanitary Organization

World Health Organization

XIV Pan American
Sanitary
Conference

Santiago, Chile
October, 1954

VI Meeting
Regional
Committee

Topic 11:    TECHNICAL DISCUSSIONS


B. (ii)   Control of Infant Diarrheas in
          the Light of Recent Scientific
          Progress, by Albert V. Hardy, M.D.,
          Director, Bureau of Laboratories,
          Florida State Board of Health,
          United States

## Control of Infant Diarrheas
## In the Light of Recent Scientific Progress

### PART I

### Mortality

## Introduction

Acute diarrheal diseases either have been or are now the major disease problem of infants and children in all countries. Present wide variations in total mortality in these age groups in different geographical areas are related chiefly to differences in the rapidity with which these preventable diseases have been controlled. In some cities and countries, present mortality from these causes is less than one per cent of that of earlier years. In others, for varying reasons, there is little evidence that the downward trend has been initiated.

As an example of a country which had a sharp decline the mortality experience of the United States is considered first, demonstrating the nature of the problem and a record of progress in its control. Illustrative statistical data are given next to indicate the current mortality from diarrheal diseases in other countries of the Americas. The findings appear to be identical to those observed in the U.S.A. in earlier years. Limited observations from other countries indicate that on a world-wide basis the acute diarrheal diseases are still the greatest single cause of death in infants and children. History establishes that these deaths are preventable. The major task in the prevention of diarrheal diseases is for the present and the future but past accomplishments are assurance that success is attainable.

## Mortality from Diarrheal Diseases in the U.S.A.

While acknowledging inadequacies and inaccuracies in records of mortality, these are still the best index available of past and present incidence of diarrheal diseases. Data for the City of New York are available from 1868 and Table I presents mortality from diarrheal diseases by year. Earliest records reveal in excess of 400 and reaching as high as 572 deaths per 100,000 population per annum. In the 25 years following 1875, the mortality declined from the 400 to the 200

level. In the first decade of the present century, there was a further fall from 200 to 100. A rapid and progressive reduction brought the mortality from 100 to 10 in the next 20 years. Since 1930, there has been a slow downward drop towards the present level of 2 deaths per 100,000 population from all diarrheal diseases.

Statistical data from few other cities in the U.S.A. are available prior to 1900. Table 2 records observations for the 30 years beginning in 1900 for cities selected as representative of those with low, medium, and high mortality. Everywhere there was a problem of similar nature to that in New York City but in all, during the three decades, there was a rapid decline from excessively high to moderately low mortality from these diseases. In general, rates for states as a whole were appreciably lower than in cities, since at that time the mortality from diarrheal diseases was generally less in rural than in urban populations.

At the turn of the century, mortality from diarrheal diseases was high everywhere in the United States. In some states there was early and rapid progress in control while in others, control measures employed were less effective. Thus, in later years, variation in mortality has been great, from high in a few to very low in others. This wide distribution is illustrated by data for 1936. In Puerto Rico, recorded mortality from diarrheal diseases was 480 per 100,000 population; in Arizona and New Mexico, the rates were approximately 100. In the remaining states, they varied from just under 50 to a low of 4.

Furthermore, in individual states there has been wide variation in different areas and in different population groups. Within the same geographical area, some segments of the population may have little or no enteric disease, while in others the mortality may equal that which generally prevailed more than 50 years ago. In Hidalgo County, Texas, in 1942-45 the mortality rate for diarrheal diseases in permanent residents in comfortable economic circumstances was 12 per 100,000 population while in the families of recent laborer immigrants it was 400. Similar wide variations have been evident in California on comparing the general population with the families of transient migrating laborers. In the United States, the major remaining problem is to provide effective control measures in such scattered foci of high incidence.

Illustrative age specific death rates are given in
Table 3. These provide full justification for emphasis on
the control of diarrheal disease in infants. When there were
200 deaths per 100,000 total population in New York City,
there were 4,496 infant deaths per 100,000 population under
1 year of age. It is observed, in contrast, that the death
rate in older children and young adults was low, but in indi-
viduals of more than 75 years, there was again a substantial
rise to a maximum of about 1/10 the rate for infants. An
examination of age specific rates further show that in the
decline of mortality, there was an earlier and more rapid fall
in the mortality in older children and adults as compared with
a slow and delayed decline in infants. Thus, the need for
control in infants was more urgent and attaining prevention
was more difficult.

Control of the related enteric infection, typhoid
fever, received early and concentrated attention by public
health workers. Programs designed specifically to prevent
this infection were actively applied. The control of diar-
rheal diseases has never received similar intensive attention.
This is remarkable in view of the striking contrast in the
magnitude of the problem. In New York City, the mortality
from typhoid fever throughout the years was approximately 1/10
that from the acute diarrheal diseases. While this ratio
varies in different cities, in all, the deaths from diarrheal
diseases have consistently far exceeded those from typhoid
fever. In the light of recent knowledge, it may now be empha-
sized that the specific enteric infections which give rise to
the diarrheal diseases are a much more important cause of mor-
tality than typhoid fever. Future planning demands that we
weigh accurately the relative importance of problems. If this
is done, we may anticipate that specific programs for the con-
trol of diarrheal diseases will receive even greater emphasis
than programs designed to prevent typhoid fever.

When infant mortality is high, ordinarily many infants
die without receiving medical attention. The occurrence of
these deaths may be reported, but the cause of death will be
listed either as undetermined or a symptomatic diagnosis of
uncertain reliability, as "diarrhea", may be recorded. This
was a problem of earlier decades in the U.S.A. when in some
states as many as 1/4 to 1/3 of reported infant deaths had no
secure diagnosis as to cause. Under such conditions, the com-
puted mortality rates from diarrheal diseases in infants can
not present a true picture. The problem would be even greater
than the rates would indicate. On the other hand, in cases in

which the symptomatic diagnosis of "diarrhea" is recorded,
there is no evidence whether this is a primary enteric infec-
tion, or a terminal manifestation in some other major disease.
Thus, there have been and still are problems in the interpre-
tation of recorded mortality data, particularly with reference
to diarrheal disease in infants. Mortality rates can not be
more accurate than the diagnoses recorded. Despite these limi-
tations the accumulated observations in the United States
clearly indicate the past magnitude of the problem and the pro-
gress in its control.

## Mortality from Diarrheal Diseases in Other Countries of the Americas

Limited statistical data are at hand for the other
countries of the Americas, chiefly from the 4 year reports
submitted for the Fourteenth Pan American Sanitary Conference.
The five major causes of death in 1952 have been reported by
16 countries. In 9, diarrhea and enteritis, gastro-enteritis
or diseases of the digestive system were the major cause of all
deaths and in 3 others, these diseases were second in order of
importance as a cause of death. In 4 countries only, these
diseases did not appear as one of the first five causes of
death. On the basis of this evidence, the prevention of diar-
rheal diseases must be acknowledged as the major public health
problem in most of the countries of the Americas.

The magnitude of the present problem is indicated by
the mortality data in Table 4. These are taken from a summary
of the principal causes of death in 1952 for 16 countries other
than the U.S.A. In four (Argentine, Paraguay, Perú and Uruguay)
the diarrheal diseases were not among the 5 major causes of
death and the reported mortality was apparently under 50 deaths
per 100,000 population. In two others, as shown in the table,
the rates were under 100, in 6 they were between 100 and 200,
in 2 between 200 and 300 and in 2 over 300. Considering that
these are rates for countries as a whole, the current problem
in most of the countries of the Americas apparently exceeds
that which prevailed in the U.S.A. at the turn of the century.

An evaluation of mortality statistics requires consi-
deration of the additional data given in Table 5. Except where
laboratory facilities are available and used, the major clini-
cal difference in cases dying of "dysentery", as compared with
those attributed to "diarrhea and enteritis", is that the
former have grossly bloody stools at some time in the illness.
In assessing the problem all diarrheal diseases must be con-
sidered together. Furthermore, the proportion of deaths when

the cause is ill-defined or unknown must be weighed. For example, reported mortality due to dysentery and diarrhea and enteritis combined was lower in Venezuela than in Colombia. (Table 5). However, in the former, the cause of death was classified as ill-defined or unknown in about one half of all reported deaths, while in the latter, the proportion with cause unknown was much less. Considering these percentages of deaths with cause unknown, it may be estimated that true mortality from diarrheal diseases was at least as high in Venezuela as in Colombia.

The age distribution of deaths from diarrheal diseases for selected countries is given in Table 6. As in the United States, the excessive mortality is in infants and children, and to a much less extent, in the aged. Furthermore, reporting of causes of death in general is less complete in the young and the aged. As mentioned earlier, to evaluate reports adequately one should know for each age group the per cent of deaths at that age with cause ill-defined or unknown, but these data were unavailable.

## Diarrheal Diseases Elsewhere

Highly favorable mortality reports have been presented consistently by New Zealand, Australia, the Scandinavian countries, Canada and to a lesser extent by the North European countries. The population of these countries combined is small as compared with that of Asia and Africa where insofar as is known, the mortality from infant diarrhea continues to be excessive. On a world-wide basis, the acute diarrheal diseases almost certainly still remain as the greatest single cause of infant mortality and possibly as the greatest single cause of death.

## Discussion

The public health history of numerous cities and several countries establishes beyond doubt that the mortality and morbidity from diarrheal disease of infants and children are almost entirely preventable. However, in the past, preventive measures were initiated when there was meager knowledge of the etiology or epidemiology of the disorders. Progress in control was laborious and slow. The battle was virtually won in some areas before any highly effective specific therapeutic agents became available. Now there is at hand a body of highly useful new scientific knowledge and it is therefore reasonable to believe that the gratifying progress of

some areas in preceding decades may now be attained elsewhere in a very much shorter time.

In general, where diarrheal diseases are most prevalent, the medical and public health facilities are underdeveloped and vital statistics are least dependable. Thus, an evaluation of the magnitude of the problem cannot rest on computed mortality rates alone. These are likely to understate rather than over-emphasize the task. Certainly available evidence indicates that the control of diarrheal diseases is the foremost public health problem in most of the American countries. Is this conclusion being given adequate attention in developing public health programs?

Subsequent evidence will support the opinion that severe diarrheal diseases are predominantly specific primary intestinal infections most commonly due to Shigella or Salmonella. Hence the task before us is to evolve specific programs designed to prevent these specific infectious diseases. Advances in medical science have provided new tools. Are there practicable public health programs which will assure an effective application of this new knowledge?

A measure of our success in the years ahead will be the rapidity of decline of mortality from the acute diarrheal diseases of infants and children.

## Table 1

Deaths per 100,000 Population from Acute Diarrheal
in New York City by Year

| Year | Rate | Year | Rate | Year | Rate | Year | Rate |
|------|------|------|------|------|------|------|------|
| 1868 | 488 | 1890 | 267 | 1912 | 92 | 1934 | 10 |
| 1869 | 387 | 1891 | 279 | 1913 | 81 | 1935 | 9 |
| 1870 | 475 | 1892 | 282 | 1914 | 76 | 1936 | 9 |
| 1871 | 405 | 1893 | 255 | 1915 | 81 | 1937 | 8 |
| 1872 | 572 | 1894 | 236 | 1916 | 63 | 1938 | 7 |
| 1873 | 456 | 1895 | 247 | 1917 | 68 | 1939 | 6 |
| 1874 | 379 | 1896 | 225 | 1918 | 52 | 1940 | 5 |
| 1875 | 388 | 1897 | 204 | 1919 | 49 | 1941 | 4 |
| 1876 | 379 | 1898 | 230 | 1920 | 52 | 1942 | 4 |
| 1877 | 353 | 1899 | 187 | 1921 | 39 | 1943 | 5 |
| 1878 | 282 | 1900 | 201 | 1922 | 31 | 1944 | 5 |
| 1879 | 279 | 1901 | 200 | 1923 | 27 | 1945 | 4 |
| 1880 | 364 | 1902 | 164 | 1924 | 21 | 1946 | 4 |
| 1881 | 387 | 1903 | 140 | 1925 | 21 | 1947 | 3 |
| 1882 | 363 | 1904 | 172 | 1926 | I8 | 1948 | 2 |
| 1883 | 296 | 1905 | 168 | 1927 | 14 | 1949 | 3 |
| 1884 | 321 | 1906 | 160 | 1928 | 18 | 1950 | 2 |
| 1885 | 297 | 1907 | 167 | 1929 | 15 | 1951 | 2 |
| 1886 | 297 | 1908 | 150 | 1930 | 14 | 1952 | 2 |
| 1887 | 312 | 1909 | 127 | 1931 | 10 | 1953 | 3 |
| 1888 | 287 | 1910 | 136 | 1932 | 8 | | |
| 1889 | 287 | 1911 | 106 | 1933 | 10 | | |

## Table 2

Deaths per 100,00 from Diarrhea and Enteritis for Selected Cities
1900 - 1929

| | Rates by Cities | | | | | |
|---|---|---|---|---|---|---|
| Year | Min- neapolis | St. Louis | Philadel- phia | Provi- dence | Pitts- burg | Fall River |
| 1900 | 67 | 95 | 115 | 165 | 215 | 345 |
| 1901 | 70 | 93 | 104 | 190 | 210 | 307 |
| 1902 | 42 | 86 | 96 | 165 | 221 | 315 |
| 1903 | 49 | 99 | 113 | 182 | 193 | 334 |
| 1904 | 45 | 88 | 133 | 153 | 198 | 301 |
| 1905 | 56 | 82 | 144 | 119 | 191 | 353 |
| 1906 | 69 | 90 | 172 | 155 | 230 | 334 |
| 1907 | 57 | 92 | 147 | 154 | 209 | 438 |
| 1908 | 60 | 84 | 138 | 129 | 183 | 353 |
| 1909 | 52 | 88 | 130 | 110 | 157 | 394 |
| 1910 | 93 | 105 | 168 | 140 | 201 | 401 |
| 1911 | 51 | 106 | 133 | 90 | 146 | 352 |
| 1912 | 41 | 83 | 107 | 87 | 130 | 267 |
| 1913 | 48 | 87 | 113 | 89 | 156 | 256 |
| 1914 | 52 | 74 | 120 | 89 | 120 | 325 |
| 1915 | 36 | 56 | 100 | 77 | 112 | 256 |
| 1916 | 42 | 62 | 101 | 72 | 131 | 251 |
| 1917 | 32 | 58 | 107 | 68 | 151 | 245 |
| 1918 | 25 | 51 | 104 | 74 | 139 | 269 |
| 1919 | 20 | 36 | 72 | 33 | 99 | 137 |
| 1920 | 21 | 36 | 71 | 50 | 88 | 164 |
| 1921 | 15 | 26 | 50 | 56 | 80 | 140 |
| 1922 | 13 | 20 | 50 | 28 | 56 | 133 |
| 1923 | 11 | 23 | 38 | 40 | 70 | 82 |
| 1924 | 10 | 28 | 36 | 24 | 59 | 81 |
| 1925 | 16 | 32 | 35 | 16 | 60 | 61 |
| 1926 | 11 | 28 | 27 | 17 | 42 | 66 |
| 1927 | 5 | 19 | 21 | 14 | 25 | 45 |
| 1928 | 8 | 18 | 23 | 23 | 25 | 28 |
| 1929 | 3 | 15 | 18 | 10 | 19 | 24 |

## Table 3

Age Specific Death Rates (Per 100,000 Population for Diarrheal
Diseases in New York City, by Year

| Age | 1901 | 1910 | 1920 | 1930 | 1935 |
|---|---|---|---|---|---|
| Total | 200 | 136 | 52 | 14 | 8 |
| - 1 | 4496 | 3806 | 1796 | 665 | 508 |
| 1 - 4 | 470 | 295 | 120 | 22 | 10 |
| 5 - 9 | 23 | 8 | 5 | 2 | 1 |
| 10 - 14 | 12 | 4 | 1 | .3 | 1 |
| 15 - 19 | 6 | 1 | 1 | 1 | 1 |
| 20 - 24 | 7 | 2 | 1 | 1 | 2 |
| 25 - 34 | 14 | 5 | 2 | 1 | 1 |
| 35 - 44 | 16 | 5 | 3 | 2 | 2 |
| 45 - 54 | 30 | 16 | 5 | 2 | 1 |
| 55 - 64 | 100 | 44 | 11 | 4 | 2 |
| 65 - 74 | 249 | 125 | 29 | 10 | 7 |
| 75 + | 529 | 329 | 124 | 15 | 8 |

Table 4

Deaths from Diarrheal Disease in 12 Countries of the Americas
1952

| Country | Disease Classification | Deaths per 100,000 population |
|---|---|---|
| El Salvador | Gastro-enteritis | 347 |
| Guatemala | Diarrhea and Enteritis | 298 |
| Mexico | Gastro-enteritis | 247 |
| Venezuela | Gastro-enteritis | 183 |
| Costa Rica | Gastro-enteritis | 170 |
| Honduras | Intestinal Infection (94) and Diarrhea (53) | 147 |
| Colombia | Diarrhea and Enteritis | 130 |
| Dominican Republic | Gastro-enteritis | 123 |
| Bolivia | Diarrhea and Enteritis (58) and Dysentery (20) | 78 |
| Panama | Diarrhea and Enteritis (Under 2 years) | 69 |
| Brazil | Diseases of Digestive System | 306 |
| Chile | Diseases of Digestive System | 172 |

## Table 5

Deaths reported as Due to Diarrheal Disease and Proportion
of All Deaths with Cause Ill-Defined or Unknown

| Venezuela | | | | |
|---|---|---|---|---|
| | Deaths per 100,000 Population | | | Per cent of all deaths with cause ill-defined or unknown |
| Year | Dysentery | Diarrhea and Enteritis | Diarrheal Diseases Total | |
| 1933 | 26 | 120 | 146 | 41 |
| 1938 | 11 | 101 | 112 | 62 |
| 1942 | 10 | 101 | 111 | 59 |
| 1948 | 8 | 98 | 106 | 49 |
| Colombia | | | | |
| 1935 | 24 | 155 | 179 | 16 |
| 1938 | 23 | 161 | 184 | 13 |
| 1941 | 17 | 141 | 158 | 19 |
| 1948 | 11 | 143 | 154 | 24 |

## Table 6

Deaths from Gastro-Enteritis per 100,000 Population by Age

| Age Group | Venezuela 1951 | Dominican Republic 1949 | Colombia 1948 | Costa Rica 1953 |
|---|---|---|---|---|
| TOTAL | 85 | 118 | 144 | 155 |
| - 1 | 1517 | 2116 | 2302 | 2642 |
| 1 - 4 | 193 | 220 | 363 | 326 |
| 5 - 9 | 14 | 19 | 28 | 24 |
| 10 - 14 | 3 | 6 | 10 | 2 |
| 15 - 24 | 2 | 4 | 12 | 4 |
| 25 - 34 | 3 | 5 | 15 | 3 |
| 35 - 44 | 4 | 9 | 26 | 4 |
| 45 - 54 | 11 | 10 | 23 | 14 |
| 55 - 64 | 17 | 28 | 55 | 47 |
| 65 - 74 | 37 | 46 | 141 | 165 |
| 75 + | 71 | 96 | 379 | 313 |

PART II

Etiological Considerations

An Etiological Classification of Acute Diarrheal Diseases

The acute diarrheal diseases etiologically fall into three groups as shown in Table 7. Primary infectious diarrhea is caused by different pathogens which establish themselves and grow in the lumen or wall of the enteric tract. These include the Shigella, the Salmonella, the cholera vibrio, and possibly also strains of coliform organisms and the slow lactose fermenting paracolon organisms. Amebic dysentery is a primary infectious diarrhea and other parasitic agents are known to give rise to a diarrheal disease occasionally. Knowledge of the etiological role of filterable agents is meager. In the laboratories of the New York State Health Department, specific diseases with major enteric manifestation have been proven to be due to filterable agents, presumably viral. With newer tissue culture technics in virological study, it may be anticipated that there will be a rapid accumulation of scientific data on the role of viruses as independent or associated agents in the production of primary infectious diarrheal disease.

In secondary and parenteral diarrhea, the gastroenteric disturbance is one part of a symptom complex. There may be a true secondary invasion of the enteric tract as tuberculous enteritis. The pathogenesis of the diarrhea which frequently occurs in acute infectious disease, in paranasal sinusitis, in otitis media and in other localized or general infections is not clearly understood.

Acute non-infectious diarrhea may be caused by the ingestion of toxic or irritating substances. The classical example is epidemic staphylococcal food poisoning; the symptoms, which appear early and may be very severe, are due to the ingestion of pre-formed toxin. Characteristically this disease involves adults rather than infants or children. Gross nutritional defects are undoubtedly of substantial importance in the cause of diarrheal diseases in infants, particularly in the economically poor populations. Diarrhea may be a manifestation of a specific nutritional deficiency, as for example in pellagra, although more commonly, a nutritional diarrhea in infants will be due to the ingestion of food of inappropriate quality. Such disorders tend to be mild but prolonged. The other non-infectious diarrheal diseases all tend to be chronic and ordinarily involve adults. They are of little quantitative importance in

the study and control of infant diarrhea as a public health problem.

Having in mind these causes of diarrhea, the first problem is to determine the relative importance of each. It is now evident that the etiology of diarrheal diseases varies by area, by season, and by the age of the individuals concerned. There can be no statement generally applicable as to the relative importance of etiological entities. Data from the United States, therefore, are presented only as illustrative.

During recent years, the National Institutes of Health of the U.S. Public Health Service, have maintained field laboratories for the investigation of diarrheal diseases in representative areas. Studies have been conducted in New Mexico, Louisiana, Georgia, New York City and Puerto Rico. Institutional inmates among whom clinical disease and sub-clinical infections were relatively common were studied also. These investigations have provided evidence as to the relative importance of the various etiological groups of diarrheal diseases in the populations examined.

The proportion of endemic diarrheal diseases found culturally positive for Shigella, using newer techniques to be described, is shown in Table 8. The findings in New Mexico and Georgia were similar and these data are shown together. These cases were examined culturally at least once during the acute phase of the disease. It is noted that 76 per cent of the severe and 58 per cent of the milder cases were culturally positive for some variety of Shigella. Furthermore, there was an increase in the proportion of positive cases as the number of examinations during illness increased, from 62 per cent in severe cases with one examination to 90 per cent in those with more than three examinations. In New York City, where the total incidence is low, in contrast, Shigella infections were relatively rare, particularly in infants and children. Throughout these studies, the percentage of positive findings was lower in infants under six months and particularly so in those with mild disorders.

The study of endemic acute diarrheal diseases in Louisiana emphasized the variability in etiology of acute diarrhea. Of 174 cases admitted to the Charity Hospital in the northern section of the state, 133 (76 per cent) were positive for some variety of pathogenic Shigella. Cases due to Salmonella were not found. In the New Orleans Charity Hospital some 300 miles distant, by identical methods of study during the same

months, of 428 cases, 107 (25 per cent) were positive for
Salmonella and 202 (47 per cent) were positive for Shigella.
The total proportion of culturally positive cases in the two
hospitals was similar, but in one region there was little or
no Salmonella infection and in the other it was of substantial
importance.

There is no secure evidence concerning the true etiology
of the minority of cases which were not positive for either
Shigella or Salmonella. Undoubtedly, some were additional cases
of shigellosis or salmonellosis even though careful laboratory
examinations had been negative. Some cases may have been due
to less well defined pathogens such as strains of coliform
organisms now considered by many to be pathogenic. In these
investigations the cases ordinarily were not examined for
E. histolytica. From recent findings in the study of diarrheal
diseases of infants in Puerto Rico, it is clear that this etio-
logical agent must be considered. There was little clinical
evidence that these cases of diarrheal disease were secondary
either to other infections or to nutritional disorders. As a
whole, however, despite the admitted inadequacies of knowledge
as to the true etiology of some of the cases under observation,
it was still evident that the major problem was specific enteric
infections, due primarily to Shigella, and to a less extent to
Salmonella.

The early American medical literature concerning the
diarrheal diseases is notable for the variability in findings
and conclusions. The investigation by Flexner and Holt in
northeastern United States cities in 1903 is, however, of high
significance. In their bacteriological study of 421 cases of
acute diarrheal diseases, 273 (66 per cent) were positive for
the Shiga or Flexner bacillus or for both. These results were
obtained with early culture procedures at the cost of pain-
staking and tedious labor. It must be assumed that use of
selective cultural media as now available would have very sub-
stantially increased the proportion of positive findings. These
data provide strong historical evidence that the usual cause of
the severe acute diarrheal diseases of infants in that period
was Shigella infection.

There is, therefore, a substantial body of evidence
from studies in the United States which clearly establishes
that the serious diarrheal diseases of infants and children
are predominantly specific primary enteric infections usually
due to Shigella, occasionally to Salmonella. The problem of
control is, therefore, that of the prevention of specific in-
fectious diseases.

The nature of the problem in one country or locality
does not necessarily indicate the observations to be antici-
pated in another. It is not unreasonable, however, to assume,
by analogy with the early experience in the U.S.A., that when
diarrheal disease is very prevalent in infants, it is almost
always a primary infection and the major etiologic agent is
Shigella. Specific data, nevertheless, are notably inadequate
for countries with very high mortality. A limited investiga-
tion in Puerto Rico, at a time when the reported mortality
was between 300 and 400 deaths per 100,000 population from
diarrheal disease, clearly established that problems of study
mount with increasing mortality. The population involved
tends to be relatively inaccessible and effective medical and
public health services not readily available. The limited
laboratory studies in Puerto Rico indicated that primary infec-
tious diarrhea was common but secure data as to the various
etiological factors involved were not obtained. There is still
need for further studies in populations with high mortality
from these diseases.

It is beyond the scope of this introductory paper to
review and report on the important work which has been done on
the diarrheal diseases in many Latin American countries but it
is hoped that those with first-hand knowledge of this work will
report on it at the Conference.

Laboratory Studies of Etiology

There are no differential manifestations in acute diar-
rheal diseases which permit reasonably dependable etiological
diagnoses based on clinical findings alone. Laboratory studies
are essential. Only the general nature of required procedures,
which should be understood by the administrator and clinician,
are described here.

Shipped specimens are not satisfactory for the laboratory
examination of acute diarrheal diseases. Bacteriological tests
on other than very fresh specimens are misleading rather than
helpful since Shigellae do not survive for long in passed feces.
Thus, the diagnostic facilities must be readily available to the
patient. Furthermore, to be of clinical value, techniques must
provide dependable findings at the earliest possible time. The
initial work, if it is to be handled effectively, must be done
in local laboratories.

The fecal specimens required may be obtained in two ways.
In hospital practice, passed specimens may be taken promptly to
the laboratory. These should be cultured within minutes of

passage. With delay, the possibility of obtaining positive
cultures becomes progressively less. The alternative proce-
dure is the collection of specimens by rectal swabs. This
procedure is very simple. The usual cotton tipped applicator
is employed. In infants, particularly those with diarrheal
diseases, the anal sphincter is relaxed. With the child lying
on its stomach, and with the buttocks held widely apart, the
swab is easily inserted beyond the anal sphincter. Material
for culture is collected by rotating the swab as it is swept
in a circular motion. Mucopurulent exudate is collected direct-
ly from the rectal mucous membrane. This swab is used directly
and immediately for the inoculation of culture media as described
below.

In older children and particularly in adults it may be
practicable to collect material for culture during sigmoidos-
copic examination. That obtained by swabbing areas of maximum
pathology has superior value for bacteriological purposes. In
comparative studies, approximately six positive cultures were
obtained from these specimens, as compared with five when the
same cases were cultured by rectal swab. The latter gave a few
more positive cultures than inoculations from freshly passed
fecal specimens. On the basis of convenience and reliability,
the rectal swab technique may be used with confidence in the cul-
ture examination of cases of acute diarrheal diseases.

Highly selective culture media are now available for
enteric bacteriology. The most valuable and reliable single
plating medium is the SS (Shigella-Salmonella) agar. This
grows readily all common species of Shigella and Salmonella
and, in general, inhibits coliform organisms and other non-
pathogenic species. This medium should be used in all examina-
tions of acute diarrheal diseases. It alone is adequate in
testing for shigellosis. A less selective medium, as MacConkey's
or desoxycholate agar, is needed for special studies of possibly
pathogenic coliform organisms. Two specialized media which
greatly increase the reliability of examinations for Salmonella
are also available. The initial inoculation is into an enrich-
ment broth, either tetrathionate or selenite F. Salmonellae
multiply readily in this, whereas most other enteric organisms
grow poorly if at all. After incubation, inoculation to an
additional solid selective medium is required. S.S. agar may
be used but in our hands, brilliant green agar has been of
superior value for this. Thus, a dependable examination for
Shigella is provided by the use of one culture medium, but in
studying for Salmonella and other organisms additional media
are needed.

It is convenient practice in hospitals to take a plate of S.S. agar, and, where possible, also a tube of enrichment broth, to the bedside and immediately on taking specimens to inoculate the media. The swab employed for the collection of the specimen is used directly to streak the plate and it is then placed in the enrichment broth. The inoculation must be carefully regulated to provide the maximum amount of inoculum which will still give the desired distribution of isolated colonies on the plate being used. The laboratory worker must be fully familiar with approved procedures and be expert in the application of these. This bedside inoculation of culture media is the procedure of choice.

Representative suspicious colonies on the plates inoculated from the initial specimen or from the enrichment broth, are picked to a differential solid medium. The best now available, in our opinion, is Kligler's Iron Agar with 1 per cent sucrose added. The most important and the most difficult step in the isolation of enteric pathogens is the picking of plates. This must be done by a carefully trained and very dependable worker. Reliable enteric bacteriology demands that appropriate culture media be properly inoculated and that the suspicious colonies on these be carefully picked by a competent worker.

The reactions after over night incubation of Kligler's iron agar permit an identification of the possible Shigella and possible Salmonella. The prevalent proteus organisms may provide a reaction on Kligler's which is identical to that given by Salmonella. A simple rapid urease test which may be read after one hour provides a ready method of eliminating most of these. The remaining cultures require further examination for Salmonella. In general, most cases from the same geographic region tend to be caused by a very few varieties of organisms. Thus appropriate antisera can be made available, and using a slide agglutination technique the laboratory can readily provide a presumptive diagnosis which has a high reliability.

After this preliminary screening and the presumptive serology tests, a small number of organisms of uncertain significance usually remain. Preferably the identification of these should be left to a Central Public Health Laboratory.

It is economical to perform the definitive diagnostic studies of enteric pathogens in a larger central laboratory. Organisms known or presumed to be pathogens may be sent from the small local to the larger central laboratory on the

Kligler's slants used for initial isolations. The appropriate biochemical and serological studies may be performed to provide the specific typing of Shigella, Salmonella and coliform organisms. To perform this, requires the availability of approximately 100 different antisera as well as specialized media used for biochemical studies. The exact information so obtained is valuable for epidemiological purposes, whereas the early presumptive report has high importance for the direction of clinical therapy.

The in vitro testing of sensitivity is becoming of increasing importance. If practicable, this should be a part of the work of the local laboratory, but it is often necessary to leave these tests to the larger central laboratory.

## The Organization of Laboratory Services

The diagnosis of enteric infections calls for a cooperative organization of laboratory services. Diagnostic responsibility should be shared by a local and a central laboratory. A "reference laboratory" is needed also. In the United States, laboratories at these levels are represented, first, by the hospital, local public health, and private laboratories; second, by the central state public health laboratories and; thirdly, by the laboratories of the Communicable Disease Center of the U.S. Public Health Service.

It has been emphasized that bacteriological studies of the diarrheal diseases must be performed on assuredly fresh specimens. Thus, to provide available services many laboratories must be prepared to handle the initial diagnostic service. Of particular importance are the laboratories in the hospitals with pediatric services. Likewise, health departments with clinics to which ill children are admitted should have suitable laboratory service available. The provision of such local laboratories comprises a part of the problem of bringing adequate medical services to all communities. With appropriate cooperation, such local laboratories can provide needed service with modest facilities and with personnel of limited training. In the central public health laboratory, in contrast, there must be professional personnel and facilities which will permit the application of all diagnostic tests needed for the detailed identification and for the typing of enteric pathogens. It is their responsibility, likewise, to aid the smaller laboratories by providing both guidance and diagnostic materials not easily available, as for example antisera. A true spirit of partnership and cooperation is essential.

A reference laboratory to serve a wide area is also of high importance. The scientific qualities of the laboratory's performance, and the scientific enthusiasm of their workers may be greatly elevated by a reference laboratory. Its function should be both educational and consultive. Its staff should be prepared to provide short courses of intensive instruction both at the reference laboratory and in conveniently located central or local laboratories. The reference laboratory also receives problem cultures for study. These provide a continuing contact with workers in other laboratories in the area served. Thus, there should grow up a closely related group of laboratory workers drawing their scientific leadership from highly competent scientists and teachers within the reference laboratories.

The specific nature and location of the local, central and reference laboratories may vary widely. The latter, for example, might be organized independently, might function within a school of public health or by cooperative agreement could be affiliated with some selected central public health laboratory. It is to be emphasized, however, that the provision of laboratory services calls for a balanced development of local and central laboratories with at least one accessible reference laboratory.

A "field laboratory" also may serve special purposes. It may be designed to meet emergency needs when other facilities are inadequate or it may be primarily a research activity. It has served well in making practicable the detailed epidemiological, clinical, and laboratory studies upon which more effective programs of control are based. It would be the initial laboratory in an area which would give guidance to the control program for the region.

Effective application of newer knowledge needs the participation of a laboratory. There is, however, general realization that in some countries of the Americas, often in those with high death rates from diarrheal diseases, laboratory services are seriously inadequate. Improvement in laboratory service is an essential part of the program of the Pan American Sanitary Bureau for strengthening national and local health services and it is to be hoped that in the not too distant future all countries will have the network of laboratories described above.

Nevertheless it is not to be inferred that nothing can be done if laboratory services are not available to examine all cases. What is needed is knowledge of the nature of the problem

to permit effective application of therapeutic and control
measures. Guiding knowledge may be obtained by a dependable
examination of a sample of representative cases. Even though
only a small percentage of all cases may have a definitive
diagnosis established by laboratory tests, this knowledge will
help handle more effectively those which are not tested.

## Comment and Questions Warranting Consideration

In developing a program for the control of diarrheal
diseases the first step is an assessment of the adequacy of
knowledge as to etiology in the particular country and area.
On the basis of findings in the United States it can be assumed
that severe diarrheal diseases are predominantly specific
enteric infections. Is there any conclusive evidence that
this is not true elsewhere? What proportion of cases have
been found due to Shigella or Salmonella in other countries?
To what extent are the remaining cases apparently due to other
infections? How important are nutritional factors as the pri-
mary cause of illness in fetal cases of diarrheal diseases?

Since laboratory studies are essential for an etio-
logical diagnosis of diarrheal diseases, the development of
laboratory services in countries with high mortality demands
critical consideration. This is a part of the problem of
planning for adequate medical and public health services. In
the United States local diagnostic, central public health, and
an area reference laboratory have all been found to be essen-
tial. These have been supplemented by laboratories for special
studies. Is this or some other plan of development desirable
and practicable for other American countries? What are the
immediate and pressing laboratory needs? Are trained workers
available if physical facilities could be provided?

The needs are great. In other public health crusades
as against yellow fever or malaria, special facilities for
special programs were provided. The activities were notably
successful. Should there not be a comparable emphasis on the
current major problem of the control of diarrheal diseases?
The newer scientific knowledge gives strong assurance that
such a special program also would be highly effective.

## Table 7

### A Clinical and Etiologic Classification of Diarrheal Diseases

| Group | Clinical Entities | Usual Course | Usual Severity | Etiologic Agent |
|---|---|---|---|---|
| Primary infectious diarrhea | Bacillary dysentery (acute shigellosis) | Acute | Mild to very severe | Shigella dysenteriae and paradysenteriae, chiefly varieties Shiga, Flexner, Sonne, Newcastle(Boyd 88) & Schmitz (ambigua) |
| | Salmonellosis | Acute | Mild to very severe | Salmonella-chiefly varieties in groups B and C |
| | Cholera | Very Acute | Very Severe | Cholera vibrio |
| | "Diarrhea of the Newborn" | Acute | Severe | Variety of ill-defined agents including possibly virus,"Pathogenic"coliform organisms |
| | Other bacterial infections | Variable | Mild | Slow lactose fermenting paracoli and pseudomonas are under suspicion |
| | Amebic dysentery | Acute to chronic | Severe | Endameba histolytica |
| | Parasitic diseases | Variable | Variable | Various helminths and flagellates |
| | Virus diseases | Variable | Variable | Unindentified viruses |
| Secondary and parenteral diarrhea | Tuberculous enteritis | Chronic | Severe | Tubercle bacilli |
| | Parenteral diarrhea | Acute | Moderate to severe | Various acute generalized and localized non-enteric infectious due to staphylococci, streptococci pneimococci and others |
| | Generalized infections | Variable | Variable | Variable |
| Non-infectious diarrhea | "Food poisoning" | Acute | Moderate to Severe | Toxin producing staphylococci and possibly other organisms |
| | Nutritional diarrhea | Sub-acute | Mild | Dietary deficiency and "insults" |
| | Allergic diseases | Acute to chronic | Variable | Variable |
| | Neuropsychiatric disorders | Chronic | Variable | Variable |
| | Other | Chronic | Severe | Local ulcerative or obstructive lesions as those due to neoplasn and lymphogranuloma venereum |

Table 8

The Cultural Findings for Shigella Paradysenteriae in Endemic
Diarrheal Disorders by Age, Severity of Disease and Area

| | New Mexico and Georgia cases (1) | | | | | | New York City cases (2) | | |
| | Severe | | | Milder | | | | | |
| | | Positive | | | Positive | | | Positive | |
| | Exam. | No. | % | Exam. | No. | % | Exam. | No. | % |
|---|---|---|---|---|---|---|---|---|---|
| Under 6 mo. | 41 | 26 | 63 | 27 | 9 | 33 | 57 | 4 | 7 |
| 6 - 12 mo. | 45 | 31 | 69 | 44 | 23 | 52 | 21 | 4 | 19 |
| 1 yr. | 55 | 43 | 78 | 56 | 37 | 66 | 27 | 9 | 33 |
| 2 - 4 | 30 | 28 | 93 | 61 | 42 | 69 | 38 | 26 | 68 |
| 5 - 14 | 9 | 9 | 100 | 22 | 15 | 68 | 37 | 28 | 76 |
| 15 - 44 | 49 | 37 | 76 | 43 | 25 | 58 | 7 | 5 | 71 |
| 45 and over | 18 | 12 | 66 | 11 | 2 | 18 | 3 | 2 | 67 |
| Unknown | 2 | 2 | 100 | 4 | 2 | 50 | 1 | 0 | 0 |
| | 249 | 188 | 76 | 268 | 155 | 58 | 191 | 78 | 41 |

(1) Cases first examined during acute phase of illness.
(2) All cases - chiefly first examined during acute phase of illness.

## PART III

## Epidemiology

The Epidemiology of the acute diarrheal diseases is the separate and distinct epidemiology of the different etiological entities. Attention will be limited here to shigellosis and salmonellosis for the reasons stated in the two preceding sections.

## SHIGELLOSIS

An outstanding feature of Shigella infections is the variability in manifestations in infected individuals. Previously generally held belief that bacillary dysentery is always severe is not correct. Shigellosis may result in severe to mild clinical disease, or in disturbance so trivial that the individual suffers little inconvenience. Furthermore, infection without any clinical manifestations whatsoever is common, particularly in adults. Thus an understanding of the natural history of Shigella infections must involve extensive studies of the healthy as well as those who are or have been ill.

Shigella are encountered frequently in monkeys in captivity and at rare intervals have been isolated from domestic pets. Shigellosis as it ordinarily occurs, however, is an infection which involves humans exclusively and spreads only from man to man.

## Incidence

In the course of studies in the United States culture surveys of normal population groups were conducted. Those examined were selected without prior knowledge of the presence or absence or diarrheal disease. Clinical histories were obtained, however, at the time of the examinations. In New Mexico the mortality from diarrheal diseases was approximately 100 per 100,000 population in 1937 and 1938. During these years, 2,198 "normal" individuals were examined bacteriologically for Shigella and 239 (11 per cent) were positive. In different communities and groups the percentage varied from 3 to 20. Comparable examinations in Georgia when mortality from diarrheal diseases was about 20 per 100,000 established a 3 per cent prevalence rate. In Puerto Rico, with a high mortality rate, very limited studies revealed a 4 per cent prevalence rate for shigellosis in the

general population. In New York City, by contrast, positive findings were very rare. Knowing that the average duration of untreated Shigella infection is about 6 weeks, it is evident that where diarrheal diseases were moderately or highly prevalent, the annual incidence of infection must be very high. In institutional populations where cultures could be taken at frequent intervals, virtually all persons acquired Shigella infection at least once in a years observation.

The ratio of clinical and sub-clinical infection varied markedly with age. Infants if infected usually but not always were ill. As age increased, the proportion of passive carriers increased. At 3 years of age and over, there were always more passive carriers than current or recent (within 3 months) cases. In general, for each current clinical case, a total of 9 convalescent or passive carriers were found concurrently.

"Of the 380 culturally positive persons encountered in these surveys only 2 were under the care of a physician. One, acutely ill when found on the survey, was admitted to the hospital the following day and died 2 days later. In the absence of a special study, these 2 might have been tested culturally, and thus there would have been 2 demonstrated and 378 undetected infections with Shigellae. Thus, for every known infection (manifest source) there are numerous unrecognized infections (hidden source). In the light of these findings it is not surprising that endemic diarrheal diseases commonly appear to be scattered sporadic cases. These seemingly unrelated infections may arise from a single source or be joined by a series of undetected infections. This knowledge is essential for the interpretation of the epidemiology of the acute diarrheal diseases".

The true incidence of clinical disease due to Shigella is not indicated by morbidity or mortality data even with superior reporting procedures. For each death there are several severe clinical cases. For each severe clinical case there are many mild clinical infections; for each clinical case of any degree of severity there are about two passive carriers. Thus, one death from shigellosis suggests the occurrence of scores of infections of other degrees of severity including the sub-clinical infections.

Household Attack Rates

The attack rates for shigellosis in affected households were studied in New Mexico, Georgia, and New York. Based

largely on single culture tests, about one half of the members of affected households were found positive. It seems certain that the majority of the household contacts of shigellosis would have been found infected if these tests had been repeated and continued through a period adequate to measure incidence rates. There was similar evidence in the study of small communities and institutional groups with known clinical cases.

## Age

Infection with Shigella organisms shows a relatively characteristic age distribution in the general population of areas with a moderate to high endemic occurrence. Prevalence rates are low in the first six months of life, rising during the next six months to a level which remains fairly constant during the next few years. About the fourth year, the prevalence rate gradually declines reaching a second level at about age 15 after which it remains at a fairly constant level.

Clinical disease produced by Shigellae has a different age distribution pattern. It is relatively infrequent in the first few months of life, has its greatest frequency between 6 to 18 months and thereafter falls rapidly to a much lower level. Thus, when infants acquire Shigella infection, most of them become ill, many with severe disorders or even fatal illnesses. At three years of age, severe illnesses are uncommon, mild illnesses are frequent but more than one half of the infections are subclinical. An even higher proportion of the infections in adults are subclinical.

## Season

Shigellosis is largely a "summer diarrhea". In general, the colder the winter months, the later in the summer do high rates appear. In those sections of the southern United States where the winters are mild, a rise in Shigella prevalence usually begins in March, April, or May. This is frequently followed by a sharp drop in prevalence in the very hot months (when there are few flies) followed by a secondary rise in the fall. In areas which have colder winters, there is usually a single peak occurring in the latter half of summer. The explanation of this high prevalence in the warm seasons is not fully understood. In part, but not entirely, it appears related to the variations in fly prevalence.

## Modes of Spread

Shigellosis is almost limited to humans. The organisms are discharged in the feces, often in profuse numbers. Consequently, the maintenance of a high level of Shigella infection in a group depends upon the more or less direct transfer of human feces containing Shigellae from one person to another. The major question concerns the relative importance of the various modes of spread.

Direct person-to-person transmission is regarded as the mode of spread of first importance. Cases were found with notable frequency in homes defective in personal and environmental cleanliness. The infection among institutional inmates commonly became prevalent and troublesome in buildings for the low-grade mental defectives and the deteriorated and disturbed inmates of mental hospitals. Also, in military groups, high prevalence coincided with a lack of personal cleanliness. Finger contamination with feces would be assumed under these conditions and was demonstrated culturally. E. coli was recovered in 82 per cent of 235 finger cultures obtained from clean inmates of mental hospitals. Furthermore, Shigellae were isolated from the fingers of 4 (10 per cent) of 39 persons with positive fecal cultures and from 2 (1 per cent) of 229 with negative fecal cultures. Having reached the fingers the organisms could be transferred from person to person directly or by articles handled in common. In several institutional outbreaks there was strong evidence against other possible channels of spread.

The role of the mild and unrecognized cases and the subclinical cases in the spread of shigellosis calls for emphasis. These far outnumber the identified and suspected cases combined. Clinical shigellosis usually appears in individuals with no history of exposure to preceding cases. The unsuspected human source, however, may be close at hand and the organisms may be passed relatively directly from this person to the one who develops manifest disease.

Other modes of transmission occasionally occur and assist the person-to-person spread. Water-borne outbreaks of shigellosis are rarely reported. Historically, the change from an unsatisfactory to a safe water supply was repeatedly marked by an immediate and deep decline in typhoid mortality, but without a comparable sharp drop in deaths from the diarrheal diseases.

Milk per se as a means of introducing Shigellae into homes is notably free of suspicion. In the U.S.A. the poor, who suffer most from diarrheal diseases, commonly use the highly sanitary canned and dehydrated products which in the U.S.A. are less expensive than the bottled fresh milk. On the other hand, although milk may not have significance as a mass means of spread, it, like any other food or substance which enters the mouth, may be the vehicle for transmitting infection from one member of the household to another.

Food-borne outbreaks have been reported. Although explosive outbreaks of shigellosis are rare, when they occur they are most frequently food-borne outbreaks. Feig, in a study of 476 outbreaks of bacterial gastrointestinal disease which occurred in the U.S.A. during the period 1945-1947, found only that 14 (2.9 per cent) were due to Shigella organisms and of these 14 outbreaks, 9 were food-borne. In a few of the institutional outbreaks studied, carriers among the food handlers and kitchen helpers evidently contributed to the spread of infection, but there was no indication of heavy contamination of a particular article of food.

Shigellosis and flies appear at the same seasons and in the same general environment. The Public Health Service studies in Hidalgo County established that in that area fly control on a community-wide basis resulted in about a 50 per cent reduction of Shigella infections. However, an appreciable amount of shigellosis did remain in this area in spite of the intensive efforts at fly control. In a community in which flies do not have ready access to human excrement or in which houses are well screened, flies can play only a minor role in the spread of Shigella organisms. Furthermore, among institutional inmates, a ready spread of this infection, for which neither water or food was responsible, has been observed frequently in the absence of flies. Considering all the evidence, it may be concluded that flies do spread shigellosis, that in some communities its incidence may be reduced by 50 percent by effective fly control but shigellosis can and does spread in the absence of flies.

Salmonellosis

The natural habitat of Salmonella other than S. typhosa and related paratyphoid organisms, is lower animals or birds. The infection in man is an accidental and an unusual occurrence. Of major significance in the epidemiology of salmonellosis is the determination of modes of spread from lower animals or birds to man.

Early studies of salmonellosis gave exaggerated emphasis to the role of rodents. Contamination by the excreta of mice or rats was thought to be of high epidemiological importance. It is now appreciated that this is of minor significance.

Explosive food-borne outbreaks gradually called attention to the role of fowl. It is now known that domestic fowl are often infected with varieties of <u>Salmonella</u> in addition to <u>S.pullorum.</u> Furthermore, eggs from infected birds often carry the infecting organism. Thus, dissemination to humans was frequently attained in foods containing uncooked or under cooked egg, as for example in salad dressing. The problem was accentuated through the commercial dehydration of pooled eggs. The heat required for processing did not kill the <u>Salmonella</u> and in the pooling, the infection in a few eggs, contamined the large volumes processed at one time. Thus, it was found that relatively high percentages of the dehydrated eggs were culturally positive for <u>Salmonella</u>. Numerous epidemics attributable to this food product were studied. Here, the source of the infection was fowl but the major feature of the problem was in the wide dissemination of this infection in the commercial processing of the food.

Recent studies in Florida have demonstrated essentially the same problem in the processing of meats. Prior to slaughter a comparatively small proportion of birds were infected with <u>Salmonella</u>. However, these few provided contamination to the tables, utensils and instruments used in the processing plants. It was clearly shown that this contamination spread to the edible meat. Though few of the living birds were infected, a substantial portion of the fowl prepared for the markets were contaminated with <u>Salmonella.</u>

To an even more marked degree, salmonellosis was spread among swine in the day or two before slaughter, during the course of marketing, transportation, and in the "holding pens" at the abattoirs. Furthermore, within the abattoirs a wide distribution of contamination with <u>Salmonella</u> was readily demonstrated. Thus, edible meats and especially the pooled and mixed meat used in sausage were frequently found positive for <u>Salmonella.</u> In and on such food products the viable organisms reach the kitchens. Some survive the cooking process and may account for epidemics attributed to the consumption of pork or fowl. Through other

channels the contaminant may reach other foods, thus causing sporadic cases or family outbreaks.

Commercially prepared dog meals which contain meat were frequently positive for Salmonella also. This may partially explain the wide dissemination of this infection in domestic pets in the USA. Of 1,626 normal household dogs cultured in Florida, 15 per cent were positive for Salmonella. Limited examinations indicated that the infection was prevalent in cats also.

Through these various channels, therefore, it is evident that there is frequent exposure to salmonellosis. The rarity of the clinical disease, rather than its occurrence, needs explanation. McCullough and Eisele clearly demonstrated through feeding varying doses of Salmonella to human volunteers, that the frequency of clinical disease increased with the increasing dosage of organisms. Very low dosages could be given without the organisms being demonstrable later in the feces. With increasing numbers, subclinical infection with repeatedly positive stools tended to occur while with higher doses there was clinical disease in some or all of the volunteers. All Salmonella tested were found to be pathogenic for humans but there was clinical disease in S. pullorum infection only with massive doses. Under natural conditions, clinical disease is most likely to be acquired when Salmonella multiply in human food, thus providing massive doses of the infecting agent. However, bacteriological examination of food handlers has demonstrated that subclinical infection is both widespread and common. Presumably the numbers of organisms commonly acquired at one time is less than that required to initiate disease.

In clinical and public health practice, salmonellosis comes to attention chiefly as food-borne epidemics or as sporadic infection in infants. The latter are probably explained by spread from infected adults, from contaminated kitchens or from domestic pets. Evidently as in shigellosis, the infant is more highly susceptible than the adult.

The dissimilarity in the epidemiology of these two enteric infections was illustrated by the studies of Watt and Lindsay in Texas. Fly control reduced the prevalence of shigellosis by approximately 50 per cent but had no effect on the prevalence of salmonellosis.

Comment and Questions Warranting Consideration

Etiological diagnosis is the beginning of epidemiological study. There can be no adequate understanding of the

occurrence of acute diarrheal diseases without a knowledge
of etiology and of the natural history of the etiological
agent. This has been attained in the United States by
special studies. The conclusions for one area cannot be
applied entirely to another. Thus, there is the problem
in each country to examine critically in the light of find-
ings elsewhere the epidemiology of diarrheal disease occur-
ring within its area.

Administrative control of specific infections is
based on their epidemiology. Methods must differ since
the epidemiology of different enteric infections differ.
However, in shigellosis and salmonellosis the recognized
clinical case is but one of many sources for the spread
of infection. Safe disposal of known infectious excreta is
essential, but there is no evidence to suggest that a rigid
isolation of cases occurring in a community would provide
effective control. Is there justification for using public
health time to control the isolation of these infections
which spread from so many sources?

The improvement of water supply has been given credit
for reducing the incidence of diarrheal diseases. The effect
however appears to be due to improved cleanliness from more
readily available water. Is there evidence that viable
Shigella or Salmonella (other than typhoid and paratyphoid)
are often acquired through drinking water?

Poverty and a high prevalence of acute diarrheal
diseases are commonly associated. Can this be explained
on the basis of the effect of crowding, flies, and lack of
personal and environmental cleanliness?

The epidemiology of typhoid fever has been studied in
detail in many countries. Should we not give at least com-
parable attention to the enteric infections which give rise
to diarrheal diseases and which commonly produce about ten
times as many deaths as typhoid fever?

PART IV

Clinical

The clinical descriptions of diarrheal diseases usually found in medical texts are those of hospitalized cases. During the course of field studies of these disorders carried out during the past fifteen years in the United States, clinical cases of all degrees of severity have been studied. Detailed histories were recorded and all cases were examined bacteriologically. Subsequently, they were separated into their etiological groups on the basis of the bacteriologic findings. The description following is based on the study of more than 1,000 culturally positive clinical cases.

Shigellosis

An outstanding observation in these studies was the wide variation of clinical severity. There was a full range from fulminating rapidly fatal illnesses due to Shigella to, at the other extreme, "just a few loose stools". Asymptomatic carriers with no history of preceding disease were identified frequently also.

Three clinical types of shigellosis have been described and were seen. a) In fulminating infections, a previously healthy infant or child rapidly becomes gravely ill and the total course of the illness may be less than 24 hours until death. Fortunately, these cases are very unusual and stand apart from the less severe clinical illnesses. b) The dysenteric type is bacillary dysentery as ordinarily described. The bloody, mucopurulent evacuations, tenesmus, abdominal pain and severe general manifestations point clearly to bacillary dysentery. A relatively high proportion of hospitalized cases fall in this group due to the apprehension caused by bloody stools. c) The diarrheic type of shigellosis, a simple diarrhea, is the most common manifestation of these infections in the United States. Grossly the stools are free of blood and exudate but often contain mucus. General symptoms, as fever, nausea, and anorexia, tend to be mild if present at all. Of the varying causes of this common complaint, Shigella infections are of high importance.

After an incubation period of from one day to one week, the clinical illness in shigellosis has a relatively abrupt onset. The initiating symptoms ordinarily are diarrhea, vomiting,

and abdominal pain. In infants, convulsions are not infrequent as one of the symptoms of onset. The prominent manifestation is the diarrhea. The number and character of stools vary in accordance with degree of severity. In very severe infections, there is almost continuous straining. Associated complaints include fever, particularly at the onset. A protracted fever is not unusual in infants who received no specific therapy. Anorexia, nausea and vomiting are troublesome and contribute substantially to the marked dehydration. Abnormal physical findings are notably few, other than abdominal tenderness and the signs of dehydration. Prolapse of the rectum and meningismus are occasionally observed.

## Other Diarrheal Diseases

In our studies there were no distinctive clinical findings which permitted a dependable differentiation of Shigella and Salmonella infections in the individual case. In groups of cases, the general manifestations, notably the fever, were more pronounced in salmonellosis than in shigellosis. Dysenteric stools were observed occasionally in salmonellosis but much less frequently than in shigellosis. Grave complications as meningitis occasionally were associated with salmonellosis but not with shigellosis. Apart from laboratory observations, therefore, there was no secure method of differentiating between shigellosis and salmonellosis.

Epidemics of diarrhea in new born nurseries have been reported, in some countries, with distinctive epidemiological characteristics. In the individual case, however, there were no differential clinical features of importance. The illnesses were an acute diarrhea with an early dehydration frequently proceeding to a fatal termination. It is to be hoped that by maintaining existing practices of keeping babies with mothers and not constructing large nurseries, Latin American countries will avoid such epidemics.

E. histolytica infection of young children has not been studied adequately. A distinctive feature of these cases is the mildness of clinical manifestations as contrasted with the gross abnormality in the stool. Though these signs are clinically suggestive, dependable diagnosis requires laboratory examination.

Acute infectious diarrhea commonly involves infants or children in preceding good health. A child in vigorous health one day will be acutely ill the next. This is in contrast to the diarrheal disorders occurring in association with malnutrition. The initial condition of the patient is much less

satisfactory and the diarrhea, itself, tends to be milder.
It is known, however, that there is increased susceptibility
to specific infections in children of poor general health.
It is necessary, therefore, to rule out by negative laboratory
findings the occurrence of specific enteric infections before
accepting a diagnosis of a non-infectious diarrheal disorder.

## Laboratory Observations other than Bacteriological

Microscopic examination of fresh feces in a portion
of the cases reveals many leucocytes, red blood cells and some
macrophages. This finding suggests shigellosis, but a similar
exudate may be observed in salmonellosis or other primary
enteric infections. Furthermore, the absence of this exudate
has little weight in excluding a diagnosis of shigellosis.
Microscopic findings are of high importance in identifying
promptly cases of acute amebic disease.

The total white count and the differential remains
within normal limits as a rule. Secondary anemia becomes
apparent if the illness is protracted. There are the chemical
changes in the blood which are associated with dehydration.

The important laboratory procedure is the bacteriologic
examination for enteric pathogens. Simplified techniques have
been described. This test is essential in the diagnosis of
diarrheal diseases.

## Prognosis

The case fatality rates prior to modern methods of
combatting dehydration and before the availability of specific
therapeutic agents varied widely. In our study, there were
38 (9.4%) deaths in 406 cases of proven Shigella infection in
New Mexico, one (1.5%) in 67 in Georgia and none in the 82
positive cases in New York City. In these cases the fatality
rate in infants under one year was 30.7% and in the second
year of life, 10.2%. There were no deaths in older children
or adults.

With the recent advances in the treatment of dehydra-
tion, and with the advent of sulfonamides and antibiotics, the
prognosis of shigellosis has greatly improved. In fact treat-
ment is usually so effective that occurrence of a death from
this infection suggests delay in seeking medical attention or
some defect in the medical care provided.

There is a wide range in the duration of the illness.
In general, older children and adults usually recover after
two to four days even in the absence of treatment.  In infants
without treatment, the symptoms frequently persist for two to
six weeks.  Specific therapy of shigellosis is ordinarily
followed by prompt recovery.

Differential Diagnosis

Acknowledged enteric disorders are, on the whole,
inadequately diagnosed rather than erroneously diagnosed.
A mere description of the illness as "diarrhea and enteritis",
"dysentery" or "simple diarrhea" cannot be accepted as satis-
factory when etiologic diagnoses are possible.  In clinical
medicine, the latter is a basic requirement as a guide to
specific therapy and in preventive medicine and public health,
it is essential for effective control.

A positive diagnosis of the etiology of acute diarrheal
diseases can be made only in the laboratory by the isolation
of the causative agent.  This involves delay.  Moreover,
laboratory facilities are not always available.  Therefore, as
a guide to the prompt initiation of specific therapy, satis-
factory working impressions are needed.

An accurate knowledge of the nature of a disease and of
the entities from which it must be differentiated is a pre-
requisite for clinical diagnoses.  A marked adjustment of the
prevailing concept of the findings which warrant a considera-
tion of shigellosis is needed.  It must be appreciated that
the varieties of Shigella which prevail rarely give rise to
the bacillary dysentery ordinarily described in medical texts.
A simple diarrhea with watery fecal movements is the common
manifestation of shigellosis and when this occurs this specific
enteric infection is to be considered.

Of first importance in differential diagnosis is a
secure knowledge of the prevailing types of diarrheal diseases
in the particular area and group concerned.  In the U.S.A.,
for example, prior to special studies of diarrheal diseases
in New Mexico and Georgia, bacillary dysentery was regarded
as a rare tropical disease and Shigella infections were diag-
nosed infrequently.  After demonstration that a high percentage
of the usual endemic cases of diarrhea, particularly those
which came to the attention of physicians were shigellosis,
this diagnosis was made more often.  Since the nature of diar-
rheal diseases occurring in various countries and areas may

differ widely, this type of information needs to be accumu-
lated in representative localities. This may be obtained
through the cooperation of practitioners and health depart-
ments with an effective bacteriological laboratory. Without
such studies, the diarrheal disorders will continue to be
inadequately diagnosed.

Treatment

a) Fluids and electrolytes

Effective therapy of diarrheal disease in infants
requires recognition that the major difficulty is the
metabolic disturbance, disorder in body fluids and electrolytes,
which is produced. Thus immediate, emergency attention needs
to be given to correction of this disturbance and prevention
of further losses. Detailed description of therapy of dehydra-
tion is beyond the scope of this paper but excellent references
are available and a typical plan followed at one university is
reproduced as an appendix.

The essential principles of treatment of severe cases
are:

1) Immediate treatment of "shock", restoration of
normal circulation. This is accomplished through the use of
whole blood transfusions or intravenous plasma, in combination
with glucose solution.

2) Replacement of previous losses and correction of
metabolic imbalance. This is accomplished through administra-
tion of balanced solutions of electrolytes, including potassium,
and glucose in water. The parenteral route is usually neces-
sary, at least at the beginning, but the oral route has been
used successfully far more extensively in recent years. Therapy
can begin according to general rules but control through measure-
ment of serum $CO_2$ and Chloride is highly desirable.

3) Gradual resumption of feeding, utilising a standard
milk mixture or breast feeding.

b) Sulfonamides and antibiotics

While "chemical therapy is more important in infant
diarrhea than chemo therapy", proper administration of the
latter in cases of shigellosis will materially shorten the
duration of the infection and usually of the diarrhea itself.

Sulfadiazine is the sulfonamide of choice, being more effective than the so-called slowly absorbed drugs such as sulfasucidine or sulfaguanidine. An important consideration is that an early and dangerous accompaniment of dehydration in infants is depressed circulation, which in turn is conducive to crystallization of the sulfadiazine in the kidneys, leading to renal blockage. Thus, sulfadiazine should not be administered until the child is urinating.

Appearance of sulfonamide-resistant Shigella occurred in a United Nations prisoner-of-war camp in Korea, necessitating use of various antibiotics. Under the direction of a "Joint Dysentery Unit" sponsored by the Commission on Enteric Infections of the Armed Forces Epidemiological Board of the U.S.A. it was established that chlortetracycline (Aureomycin), chloramphenicol (Chloromycetin) and oxytetracycline (Terramycin) were all effective against Shigella.

Dividing the daily dose into 3 portions at 8 hour intervals was the most effective schedule. Since the problem of renal blockage does not arise with the antibiotics it is probably desirable to use one of them first, although usual effectiveness and low cost of sulfadiazine still makes it a very useful drug for shigellosis.

In vitro sensitivity tests are highly important as a guide to therapy. Laboratory tests rather than clinical trial can indicate the therapeutic preparation of choice in the prevailing infections.

c)  "Symptomatic" therapy

Drugs for the purpose of controlling the symptom diarrhea, do not appear to be useful in children. Metals such as Bismuth are not effective in the severe case and unnecessary in the mild one. Absorbents and materials like pectin may decrease the frequency of stool excretion but do not affect the crucial loss of fluid into the bowel.

The problem of the specific treatment of Salmonella infections is markedly different. These infections remain relatively or highly resistant to virtually all available antibacterial therapeutic agents. Chloramphenicol has been used widely due to its demonstrated effect in typhoid but clearcut evidence of efficacy in other Salmonella infections is lacking. In salmonellosis, therefore, reliance must be placed on therapy of the dehydration.

Comment

     Control of infant diarrheas calls primarily for prevention but it is important also to prevent deaths through proper early treatment.  In general, infantile diarrhea requires primarily treatment of the fluid and electrolyte disturbance, for which highly effective routines have been developed.  When the diarrhea is due to <u>Shigella</u>, most common etiological agent, specific therapy with certain antibiotics and sulfadiazine is very useful.  Recent emergence of resistant strains makes desirable in vitro testing to discover the most useful agent. Unfortunately, except for typhoid fever, no effective antibiotic or chemotherapeutic agent has been found for salmonellosis.

PART V


Preventing Mortality and Reducing Morbidity


Control Measures in the Past


The methods used in the control of many communicable diseases can be stated simply. For example, in smallpox, there is vaccination and in many insect-borne infections, eradication of the vector is the method of choice. However, considering the reasons for decline of diarrheal diseases in the countries which now have low rates it is evident that multiple factors were involved. There is no quantitative measure of the relative importance of these various influences which contributed to the progressive reduction of mortality and morbidity. Conclusions must be based on a critical evaluation of all available evidence.

It is assumed widely that where diarrheal diseases have been controlled this was predominantly a by-product of the programs of community sanitation which have almost eliminated typhoid fever. Major credit is given to the installation of safe public water systems. Historically, the importance of public water supplies in the spread of cholera and typhoid fever is beyond question. In numerous cities in the U.S.A., there was an immediate and marked decline in typhoid mortality and morbidity with the availability of safe water supplies. It may be predicted with confidence that under similar conditions there would be the same decline elsewhere. However, with the change in water supply, there was no comparable evidence of any prompt decline in the mortality from diarrheal diseases. This is well illustrated by the experience of Pittsburg and Philadelphia as shown in Table 9. There is substantial evidence that the infections which produce the acute diarrheal diseases of childhood are rarely water-borne. Shigella, the predominating causative agent dies rapidly outside of the human body and authentic reports of water-borne outbreaks of shigellosis are rare indeed. Salmonella is spread predominantly in foods. Important as was the purification of water supplies, this cannot be credited with any major contribution to the prevention of the diarrheal diseases of infants in the United States.

There is some evidence that the availability of water for personal cleanliness does correlate with the incidence of

diarrheal diseases. Limited studies in labor camps in California indicated that Shigella infections were 8 times as prevalent in families who had to carry water for domestic use as compared with those who had water immediately available from faucets by or in the house.

A community water supply may contribute to the control of diarrheal diseases in two ways. Flush toilets for the disposal of human feces are usually installed soon after the water is available. Then enteric pathogens from human carriers, mild and unrecognized cases, as well as from the acknowledged case, are disposed of safely. Concurrently a basin with running water will be installed conveniently. Epidemiological evidence indicates that a relatively direct person-to-person spread of contamination by soiled hands is of substantial importance in the spread of shigellosis. Undoubtedly, improved hand washing habits resulting from convenient facilities contributes effectively to the control of diarrheal diseases. Thus, community water supplies apparently aided in the control of diarrheal diseases, not by preventing the ingestion of Shigella and related pathogens in impure water, but by providing means for a safe disposal of human feces and conveniences which resulted in an improvement of personal cleanliness.

The installation of sanitary privies for rural homes had general importance also but the downward decline in diarrheal diseases was well advanced before there was any public health emphasis on the importance of these sanitary devices.

It has long been recognized that a high incidence of diarrheal disease and a high prevalence of flies are usually associated. The characteristic high incidence in summer has suggested that flies must have an important role in the spread of infection. The studies in Hidalgo County, Texas have established what was suspected previously. There the control of flies resulted in approximately a 50 per cent reduction in the prevalence of shigellosis. Historically fly control in urban areas was brought about slowly by industrial and community development, quite as much as by public health activity. The horse gave way to the motor car. With the disappearance of stables, the most prolific source of fly breeding was removed. Programs for garbage disposal and general community cleanliness further reduced fly breeding. An increase in screening and a widespread concern with the protection of human food from flies were important. Public education, as for example, through the popularization of the slogan "Swat the fly", gave a general appreciation of the hazard of flies. Their control undoubtedly

did have and important part in reducing the prevalence of diar-
rheal diseases. In the light of findings in Hidalgo County it
is reasonable to believe that in many areas the control of flies
accounted for about one half of the reduction of shigellosis,
and of the severe acute diarrheal diseases.

As pointed out in the section on epidemiology, shigel-
losis is often serious endemic disease in the absence of flies.
Yet when flies are numerous reduction of their prevalence will
very likely have a favorable effect on the spread of the dis-
ease. Fly control is not easy. It involves general sanitation,
disposal of garbage and industrial and agricultural wastes,
and, for the individual home, adequate screening. Insecticides,
such as DDT and dieldrin are of only limited usefulness because
of the relatively rapid emergence of resistant strains of flies.
Constant attention is necessary; in the Hidalgo County studies,
even after two years, when the special program was stopped,
both fly prevalence and _Shigella_ infections returned promptly
to their previous high levels.

Developing interest in the special problems of children
resulted in simultaneous development of pediatrics as a divi-
sion of clinical medicine and of child hygiene as a community
interest. Thus, pediatricians from the beginning were as much
interested in preventive as in curative medicine. In the pre-
ventive field the early French leadership in seeking to pro-
vide health supervision for all children was paralleled by
similar developments in other countries. Networks of child
health clinics were gradually established, watching over the
health of infants and instructing mothers in safe methods of
care in the importance of cleanliness in preparing and giving
the child food. General practitioners as well as pediatricians,
have gradually adopted supervision of the well child as an in-
tegral part of their practice. Public health nurses visited
homes giving the same message and providing individual ins-
truction and demonstration. Obviously, like other essential
components of the public health program, there has been con-
siderable variation in the degree to which child health ser-
vices have been developed in different countries. It is of
importance to note that in the long-range program adopted by
the First World Health Assembly, maternal and child health was
included in the list of first priorities. This type of pro-
gram is an essential part of the broad preventive attack on
infant diarrhea.

Concurrently with the decline in mortality from diar-
rheal diseases in the U.S.A., there were broad changes in

socio-economic conditions which affected a high percentage of the population to a variable degree. There were improvements in housing and less overcrowding, refrigeration became generally available with consequent marked changes in food supply, and mothers with more available time had fewer children to care for. The public health significance of such changes can be acknowledged but their relative importance is not measurable.

Thus, in the control of diarrheal diseases in the United States, many influences were active. The factors of major importance appear to be the safer disposal of human feces, better personal cleanliness (both facilitated by installation of public water supplies) the control of flies and marked improvement in infant hygiene in the home. The accomplishment was remarkable in view of uncertainty as to etiology, lack of knowledge of epidemiology, without specific medication, and with limited help from organized public health.

Presently Available Control Measures

The advances in scientific knowledge which contribute most to the control of the diarrheal diseases are: (a) Etiology. Using new highly sensitive bacteriological technics it is now known that the acute diarrheal diseases are predominantly specific enteric infections due chiefly to Shigella, to a much lesser extent to Salmonella and in a small percentage of cases to other ill-defined pathogens probably including pathogenic strains of coliform organisms and viruses. (b) Epidemiology. The most common source for Shigella is the mild unrecognized human case and the asymptomatic carrier. Spread is from person-to-person usually through relatively direct contact, and rarely by common vehicles as water, milk or food. Flies play and important role, though of varying significance in different areas. Fecal contamination spreads much more readily than previously believed, even in modern hospital nurseries. Salmonella is disseminated from lower animals and birds, particularly through edible fowl, eggs, and meat products and to a degree through contact with domestic pets. (c) Therapy. There have been equally important advances in two lines. (1) It is now known that deaths from diarrheal diseases are due chiefly to disturbances in fluid and electrolyte balance. Proper replacement therapy can prevent deaths. (2) The commonest cause of severe acute diarrheal disease, Shigella, responds readily to sulfonamide or antibiotic therapy or to both. Salmonella is however quite resistant.

In addition to this accumulation of new scientific
knowledge, the practice of public health has matured marked-
ly in recent years. New competency in the application of
knowledge obviously has high practical significance.

In the light of the advances in scientific knowledge
and public health practice and with a consideration of avail-
able resources, control measures may be selected to satisfy
varying situations. There will be two objectives, to prevent
deaths of those already ill and to prevent the occurrence of
cases. The former will call for a prompt use of effective
therapeutic procedures, the latter primarily will demand the
use of appropriate public health measures to prevent the spread
of specific enteric infections. In the former, attention will
be concentrated on the sick individual and his care, and in
the latter, the concern will be with broad population groups
where improvements in community and home sanitation, in per-
sonal cleanliness, and infant hygiene will need to be attained.

The activities designed to attain these objectives will
flow through three different but interconnected channels, name-
ly, organized public health, medical service and socio-economic
development.

Organized public health

The responsibility for the control of diarrheal diseases
cannot be delegated to any one division. There are essential
activities which should and must involve virtually all compo-
nents of organized public health. A broad team approach is re-
quired.

Measures of proven value may be applied immediately.
Human feces must be disposed of safely and facilities which
favor personal cleanliness are to be improved. Both of these
are facilitated by the installation of public water supplies.
Control of flies and particularly the protection of infants
from flies is of major importance. All measures which will
promote better infant hygiene are indicated. To these may now
be added the adoption of every device to assure that infants
and children with acute diarrheal disease receive appropriate
therapy promptly. This program may be initiated with limited
staff and without added knowledge. These are only the begin-
ning and immediate activities, which should be followed by a
more adequate program as soon as it can be developed. For
descriptive purposes, these later activities may be grouped
as follows:

(a) Epidemiology, laboratory and vital statistics. These essentially comprise the fact finding activities. The etiology and epidemiology of diarrheal diseases vary from area to area. Preventive programs to meet particular needs can be devised only on the basis of adequate information on the local problem. Representative situations will need to be examined in the light of accumulated knowledge. The endemically occurring diarrheal diseases deserve the same epidemiological study which they would receive if they occurred in explosive outbreaks. Intensive field studies are particularly important. The diarrheal diseases, as compared with the other enteric infections, cholera and typhoid fever, have received little epidemiological attention, and evidence to guide in control is correspondingly limited. It is particularly urgent that dependable data be collected in areas of very high mortality. Often this can be best accomplished by the technique of mass survey of representative samples of the population.

Laboratory studies are essential to epidemiology but they are required also for diagnosis and the guidance of therapy. This public health laboratory service must be made readily accessible both to clinicians and to public health clinics. The laboratory played a key role in the control of diphtheria; it has a different but no less important place in the control of acute diarrheal diseases.

Vital statistics provide a relative measure of the extent of the problem and equally important a continuing record of progress in control. Greater reliability of findings can be obtained only through fostering a more complete reporting with more liable diagnoses.

(b) Sanitation. The availability of water, the means of disposal of feces, garbage collection and community fly control all require attention. For the latter, reliance should be on sanitary measures to prevent fly breeding since experience has established that insecticides will have temporary value only.

(c) MCH Activities, Public Health Nursing and Health Education. The public health physician trained in infant and child hygiene will have a key role in the control of diarrheal diseases. He and the public health nurses establish contact with parents and clinics and in home. Initially, problems in therapy as well as in infant and child hygiene will need to be handled. Centainly every necessary means will be required to assure that the ill child receives appropriate treatment promptly.

Education will be as important as the provision of individual health service. Parents must be taught how best to care for infants under existing conditions. Instruction is required on the essentials of infant and child feeding and care, the hazard of flies and the means of their control, and the importance of personal cleanliness and environmental sanitation. These must be so taught that people will act in accordance with teaching. This can be done, in part, by physicians and nurses in clinic and home. In larger and well organized health departments, the participation of a qualified health educator will be a valuable asset.

(d) Public health administration has the responsability for organization, direction and providing the means for accomplishing work. The form of organization may vary, but efficiency of operation must be assured. A comprehensive and stable official public health agency, nationally and locally, is essential to accomplish the broad program required for the control of diarrheal deseases, including all of the above activities.

## Medical Service

Knowledge is now adequate for the prevention of death in almost all cases of acute diarrheal disease. This represents a most important advance. Personnel and facilities to permit the application of this knowledge are as yet inadequate in many areas. Programs to provide these essential services will need to be developed on a national or local basis. This may call for a consideration of the better training of more physicians and their distribution and support in areas inadequately served. Mored readily available clinics and pediatric hospital beds presumably will be required. It requires time even under ideal conditions to obtain basic developments of this tipe.

The acute diarrheal diseases are predominantly specific enteric infections. Effective treatment to prevent deaths and to rapidly control sources of infection, is an acknowledged concern of public health. Thus, there should be cooperative participation of practitioners and health departments in making available the needed medical service required for the diarrheal diseases. The effective programs will be those designed to fit local conditions and to meet particular needs.

## Socio-Economic Development

In multiple ways, infant health is beneficially influenced by socio-economic improvement. This is an effective method

for the control of diarrheal diseases, but these changes also come slowly and the immediate problem is to control diarrheal diseases under existing conditions.

## Supporting Aid

The control of diarrheal diseases, involving as it does problems in home hygiene, personal cleanliness and infant care, calls predominantly for local action, but certain needed aid may properly be a part of the supporting national or international public health organization.

There is sound guidance for planning in other programs of established value. In venereal disease control in the United States, the V. D. Research Laboratory has provided leadership. The nature and present high quality of laboratory service is related to the investigation, teaching and evaluation programs of this public health organization. The first demonstration of the value of penicillin in syphilis came from this laboratory. Regional laboratories of comparable nature have been developed to serve other countries of the Americas. There is need for a similar reference, research and training center to give leadership in the control of infant diarrhea.

The functions of such an "Infant Hygiene Training Center and Laboratory" would include: (a) Research. Again, it must be emphasized that the nature of the problem varies and there are marked inadequacies in present knowledge, particularly in areas with very high mortality. (b) Development and operation of a demonstration program. This is essential both to test and to teach effective methods as part of the general public health program. (c) To serve as a reference laboratory for enteric infections. (d) To participate in training clinicians and laboratory workers both at the center and elsewhere.

A favorable location for such a center would be in connection with a school of public health and children's hospital. But of great importance is accessibility to problems in the field. The staff would need to combine the interests and abilities of the investigator, teacher, and practical public health worker.

Further aid could be provided through the fellowship program. To help to meet the problem of the control of diarrheal diseases, more pediatricians will need to obtain their basic training in public health and to have additional training in this specialty. It is to be stressed, however, there should

be provision for supplementary field training in some area
where the control of diarrheal diseases is a continuing major
problem.

Thus, the supporting aid for the control of the diar-
rheal diseases would be primarily educational.  More physicians
with better training will be a basic need.  Able leadership in
pediatrics and the MCH activities in public health will be
required.  A wide distribution in laboratory service will call
for additional qualified workers in this field.  In the
competition for public health funds, these activities directed
toward the prevention of diarrheal diseases should be given a
very high priority.

## Comment

A major need in the control of diarrheal diseases
is a general appreciation of the importance of the problem.
There would be high concern with disease producing excessive
mortality in adults, particularly if this occurred in epidemics.
The loss of infant life from diarrheal disease has never aroused
the same concern, in part, because it occurs regularly without
startling epidemic waves.  Possibly the importance of this
work should be measured in "person years" of productive life
conserved.  The high importance of protecting the lives of the
young must be stressed.  Here, there is a conservation of indi-
viduals for the complete productive life ahead, not as in the
aged merely adding years to a life already spent.

If the problem is viewed as sufficiently important, it
will receive special attention.  Up to the present, this has
not been true of the diarrheal diseases.  It is contended that
the control of diarrheal diseases due to its magnitude and due
to the need for evolving new programs to use new knowledge,
sould receive the special attention of a selected group of
clinicians and laboratory workers.  The training of these must
receive careful consideration.  With such leadership in a broad
program of public health and pediatric care, there is the possi-
bility of attaining in one decade the degree of effective control
of these diseases which was reached elsewhere only throughout
the first half of this century.

## Table 9

Mortality per 100,000 Population from Typhoid Fever, Diarrhea
and Enteritis in Philadelphia and Pittsburgh
1900 - 1919

| Year | Deaths per 100,000 Population | | | |
| | Pittsburgh | | Philadelphia | |
| | Typhoid | Diarrheal Diseases | Typhoid | Diarrheal Diseases |
|---|---|---|---|---|
| 1900 | 144 | 215 | 37 | 115 |
| 1901 | 120 | 210 | 35 | 104 |
| 1902 | 136 | 221 | 47 | 96 |
| 1903 | 133 | 193 | 72 | 113 |
| 1904 | 136 | 198 | 55 | 133 |
| 1905 | 107 | 191 | 51 | 144 |
| 1906 | 141 | 230 | 74 | 172 |
| 1907 | 131 | 209 | 60 | 147 |
| 1908 | 49 | 183 | 35 | 138 |
| 1909 | 25 | 157 | 22 | 130 |
| 1910 | 28 | 201 | 18 | 168 |
| 1911 | 26 | 146 | 15 | 133 |
| 1912 | 13 | 130 | 13 | 107 |
| 1913 | 20 | 156 | 16 | 113 |
| 1914 | 15 | 120 | 8 | 120 |
| 1915 | 11 | 112 | 7 | 100 |
| 1916 | 9 | 131 | 8 | 101 |
| 1917 | 12 | 151 | 6 | 107 |
| 1918 | 11 | 139 | 5 | 104 |
| 1919 | 7 | 99 | 4 | 72 |

**XIV Pan American Sanitary Conference**

Santiago, Chile
October, 1954

**VI Meeting Regional Committee**

Topic 11:   TECHNICAL DISCUSSIONS

B.   (ii)   Control of Infant Diarrheas in the Light of Recent Scientific Progress

## MANAGEMENT OF METABOLIC DISTURBANCE IN DIARRHEAL DISEASE IN INFANTS

I.  Principles:

1.  Treat or prevent disturbance in blood circulation and renal function.

2.  Repair losses in water and electrolytes.

3.  Maintain in equilibrium as feeding is gradually restored.

II.  Moderately ill case:

1.  Discontinue food and milk.

2.  Offer by mouth, every 3 to 4 hours, 25 ml/kilo body weight, diluted glucose-electrolyte solution:

Concentrated Solution:

| | |
|---|---|
| Na Cl | 1.5 grams |
| K  Cl | 2.0 grams |
| $H_2O$ | 15.0 ml. |
| Syrup q.s.ad. | 75.0 ml. |

(Dissolve salts in water, then add syrup.)

Before use, dilute 1 teaspoonful to 60 ml. or the whole amount to 1 liter.

In home situations, where no pharmacist is available, some benefit will result from a solution of:

| | |
|---|---|
| Salt | 1 level teaspoonful |
| Corn syrup or sugar | 2 level tablespoonfuls |
| Water | 1 liter |

The mixture should be boiled.

3. After 12 to 24 hours, if child is urinating, taking solution eagerly, and looks well, replace 1/4 of solution at each feeding with a standard milk mixture; or if baby is breast-fed, resume nursing for one to two minutes.

4. Gradually, over 3 to 4 days, replace solution completely with milk mixture or breast feeding.

III. Severely ill case:

1. Discontinue all oral intake.

2. Immediate intravenous infusion, in 30 to 60 minutes, 40 ml/kilo body weight, of either :

   a. Equal parts 0.9% Na Cl and 5% Glucose in $H_2O$, or

   b. 1 part M/6 Sodium Lactate, 2 parts 0.9% Na Cl, 3 parts 5% Glucose in water.

3. In extremely ill children follow with plasma or blood, 20 ml/kilo body weight.

4. Repeat step 2, giving 60 ml/kilo body weight, over next 4 to 8 hours.

5. Offer by mouth, every 3 to 4 hours, the diluted glucose-electrolyte solution described in II, 2, above.

If oral fluids are not tolerated, but the child is urinating, a sterile solution of

| | |
|---|---|
| Na Cl | 1.5 |
| K Cl | 2.0 |
| Glucose | 100.0 |
| $H_2O$ to make | 1000.0 |

may be given by intravenous drip, 150 ml/kilo body weight each 24 hours. This solution cannot be given subcutaneously, but a similar one, containing only 33 grams of glucose, can be given subcutaneously.

NOTE: Potassium solutions, important to recovery, may be toxic if the kidneys are not functioning well. They should not be given until urination is established.

6. During first 24 hours, total intake should be about 200 ml/kilo body weight.

7. Feeding should be resumed as under II, 3, above.

Adapted from Department of Pediatrics
School of Medicine
Louisiana State University

Topic 11: TECHNICAL DISCUSSIONS

B. (ii) Control of Infant Diarrheas in
the Light of Recent Scientific
Progress

## SUMMARY REPORT

### Control of Infant Diarrheas
### in the Light of Recent Scientific Progress

by

Albert V. Hardy

## The Problem

The acute diarrheal diseases have been, or are, a major disease hazard to infants and children in all countries. The present variations in infant and child mortality is due chiefly to differences in the rapidity with which these preventable diseases have been controlled.

Data on the major causes of death in 1952 in the countries of the Americas have been reported to the Pan American Sanitary Bureau as a part of the preparation for this conference. Enteric disorders, variously designated as diarrhea and enteritis, gastro-enteritis or dysentery, or grouped as diseases of the digestive system, were the major cause of death in 9 of the 17 countries reporting, and in 3 others they were second in importance. In Argentina, Paraguay, Peru, Uruguay and the United States the diarrheal diseases were not among the 5 major causes of death. The reported mortality in these 5 countries was under 50 deaths per 100,000 population. Of the others, in 2 the rates were between 50 and 100, in 6 between 100 and 200 and in 4 above 200, with a maximum of 347 reported deaths from gastro-enteritis per 100,000 population. Even these figures understate the problem since in some countries a substantial portion of the death certificates have no usable diagnosis, and not all deaths, particularly of infants, are reported. On the basis of available mortality data the prevention of diarrheal diseases must be acknowledged as a major current public health problem in most of the countries of the Americas.

Experience of earlier years in the U.S.A. provides a historical perspective with important general implications. At and before the turn of the century, mortality from the diarrheal diseases was high everywhere in the United States. Data for New York City, available from 1868, revealed for the earliest years in excess of 400 and reaching as high as 572

deaths per 100,000 population. There was a decline to 200 between 1875 and 1900, to 100 in the first decade of this century, to 10 by 1930, and finally to the present level of 2 deaths from all diarrheal diseases per 100,000 population per year. Available records of mortality in other cities and in the various states are generally similar to those for New York City. At the turn of the century in most the death rates from diarrheal disease were between 100 and 200, occasionally higher, rarely lower. Within the following 30 years the mortality from diarrheal diseases declined by about 90 per cent and the downward trend continued so present rates are often no more than 1 per cent of previous years. There is the evidence of history, therefore, that these diseases are almost totally preventable.

Data from the U.S.A. also emphasize the wide variation in distribution of the problem. Not only is there geographic variation in incidence, but within the same area, major segments of the population may have very little enteric disease, while the economically very poor families continue to have an excessive mortality from diarrheal disease. Moreover, age specific death rates reveal a great concentration in infants under 1 year. These rates for the second year of life are lower, but still high. Thereafter, there are comparatively few deaths except in the aged. Thus, in the control of diarrheal diseases there is urgent need for particular attention to the young and to those living under less favorable economic circumstances.

## Newer Knowledge

In this introductory statement, selected observations by my associates and me in studies supported by the U.S. Public Health Service will be used for illustrative purposes. It is hoped that during the discussion sessions to follow, the important work by investigators in Latin America will be kept to the fore.

Data now available indicate that the serious diarrheal diseases of infants and children are predominantly specific enteric infections. The major etiological agents are the Shigellae. As early as 1903 when mortality was almost 200 per 100,000 population, and only primitive relatively insensitive bacteriological technics were available, Shigellae were isolated by Flexner and Holt from 66 per cent of severe hospitalized cases in cities of the northeastern United States. Recently in our studies using the more sensitive technics now available but

working with the milder infections now prevailing, Shigellae
were isolated from 76 per cent of the moderately severe but
rarely fatal cases and from 58 per cent of mild illnesses.
When there were three or more examinations per case, up to
90 per cent were positive for Shigella. Accumulating evidence
indicates that where diarrheal diseases are prevalent, and
when previously healthy infants or children rapidly become
ill with severe diarrhea, the most common cause is Shigella.

The Salmonellae are of lesser quantitative importance,
though the frequency of their occurrence varies by area. The
investigations in Montevideo have demonstrated that the role
of these organisms in individual cases, and as a cause of
diarrheal disease in an area, must be assessed through careful
field studies.

Other infectious agents, while occurring in certain
cases and in particular localities, are of little quantita-
tive importance in the broad public health problem of diarrheal
disease as a leading cause of death. E. histolytica may be
involved in some cases. Two specific types of coliform organ-
isms and certain of the paracolons are under suspicion par-
ticularly regarding institutional outbreaks in the newborn.
The role of viruses is not established, but in view of their
etiological importance in specific diarrheal diseases of
animals, as for example, in hog cholera, it is reasonable to
believe that they also may be of importance in humans. This
is being investigated using the newer tissue culture technics
now available.

Concerning other possible causes of these enteric dis-
orders it is now acknowledged that diarrhea due to parenteral
infections is of less importance than previously thought. Gross
defects in feeding or specific nutritional deficiencies may give
rise to diarrhea, but without an associated enteric infection
this is likely to be a comparatively mild though persisting
diarrhea. Other non-infectious causes appear to be of minor
signicance in children.

The etiology of diarrheal diseases varies by area, by
season and by the age of the individual concerned. Though
there cannot be a simple statement of a single cause, still
it is amply established that the problem of the control of
diarrheal diseases is predominantly the prevention of specific
communicable diseases.

In the laboratory there have been major advances in enteric bacteriology. Now more highly specific media are available which markedly increase the sensitivity of tests for <u>Shigella</u> and <u>Salmonella</u>. Furthermore, these and other new procedures simplify culture technics and make it practicable to handle relatively large numbers of diagnostic bacteriological examinations. The major limitation is that a dependable examination for <u>Shigella</u> must be performed on assuredly fresh specimens. The use of rectal swabs for the collection of material is simple and highly effective, and such specimens proved superior to freshly passed feces. Immediate inoculation of a plate of S.S. agar and a tube of enrichment broth is recommended. Relatively inexperienced persons may be trained to collect specimens and inoculate media. Subsequent culture technics, however, are exacting and for dependability carefully trained laboratory workers in well organized laboratories are essential. A particularly important step is a proper picking of an adequate number of suspicious colonies from the original plates.

Increased sensitivity of bacteriological tests for <u>Shigella</u> has been of particular importance in epidemiological investigations. It became productive to conduct culture surveys, examining all members of selected population groups. Many thousands of persons have been tested in these survey examinations. All persons in small communities, children in representative families of large communities, institutional populations and military personnel have been so tested. This established the common occurrence of sub-clinical <u>Shigella</u> infections. In general, the total prevalence of shigellosis varied with the incidence of diarrheal diseases. In areas where there was little or no troublesome disease, little or no infection was discovered in the population; when endemic diarrheal disease required clinical or public health attention, the prevalence rates in the general population varied from about 3 to 20 per cent, with even higher findings in institutional populations. Further, single culture examinations of family contacts of known cases showed that about one half were positive.

These survey examinations of all persons in a population group further served to reveal the broad range of clinical manifestations of shigellosis. There were the totally asymptomatic infections, the clinically insignificant disorders, the troublesome cases of simple diarrhea and the severer dysentery commonly described in medical texts.

There were wide differences in shigellosis in patients of different age. Shigella infection of infants under 6 months was comparatively infrequent, but when this occurred there was commonly, but not always, severe clinical disease. From 6 months to 2 years infections were more numerous, but the severity decreased and subclinical infections were more frequent. Total prevalence of infection continued high in children of two, three and four years of age but severe clinical cases were rare, mild ones not infrequent and subclinical infections common. In later childhood total prevalence declined slowly so that prevalence among adolescents and adults was about half that of young children. In these older age groups a higher proportion of the infections were subclinical; there were some mild clinical cases but virtually no severe clinical dysentery. Most fatalities were in the first year of life, with some in the second but few thereafter.

Epidemiological studies have led to the conclusion that dissemination of shigellosis commonly involves a more or less direct transfer from one person to another of human feces containing Shigella. Finger contamination was readily demonstrated and this is considered of high importance in the direct person to person transmission. The role of flies in the spread of shigellosis has been securely established. In test communities, the prevalence of infection was reduced by 50 per cent by effective fly control. Direct person and person transfer and flies appear to be the usual channels for the spread of this infection. Shigella die rapidly in fecal discharges or in water and epidemics due to polluted water have been notably rare. Milk as a means of introducing Shigella into homes appears to be free of suspicion and food-borne outbreaks are a rarity.

In contrast to shigellosis where the natural habitat is man alone, in salmonellosis most of the infections occur in lower animals and fowl. Dissemination from the latter is through eggs and inadequately cooked fowl. Hogs are frequently infected and in processing, contamination of edible meat is common. Through these channels viable organisms may reach kitchens, the hands of those preparing food and food ready for consumption. Transmission from infected domestic pets may occur also.

In the clinical field the major new evidence is that what has been considered heretofore as just a simple diarrhea with symptoms limited to a few loose or watery stools is often

due to <u>Shigella</u>, occasionally to <u>Salmonella</u>.  By contrast, the
classical signs of bacillary dysentery are rare in the
shigellosis observed in the United States.  It must be em-
phasized in order to correct prevailing erroneous medical
opinion, that the typical bloody muco-purulent stools occur
in only a minority of <u>Shigella</u> infections.  Furthermore,
there are no clinical signs which indicate dependably an
etiological diagnosis.  Laboratory examinations are required
for specific diagnoses.

There have been equally important advances in two
aspects of therapy.  The importance of fluid and electrolyte
replacement therapy was established and effective therapeutic
procedures were developed.  Regardless of etiology, prompt and
adequate therapy of this type is often successful.  In antibac-
terial therapy the sulfonamides and broad spectrum antibiotics
were found highly specific and rapidly effective in shigellosis
but it is important to note that specific therapy has little
or no value in salmonellosis.  These advances in treatment
provide means for the successful therapeutic management of a
very high percentage of all cases of diarrheal disease provid-
ed the cases are seen without undue delay.

There is, therefore, a new body of scientific knowledge
which is adequate for the prevention of mortality and which
provides a sound basis for the planning of control measures.

## Control of Diarrheal Diseases

Here we can do no more than state briefly the measures
which appear to have been effective in the past and the more
important preventive procedures now available.  The relative
value and practicability of these in meeting current problems
under present conditions will demand detailed and critical
consideration.  It is  presumed that this will be the major
field of discussion in the technical sessions following.

It is clearly evident that multiple factors were involved
in the 'decline of the  mortality and morbidity from diarrheal
diseases in the United States.  Those of chief importance appear
to have been the safer disposal of human feces, better personal
cleanliness (both of which were facilitated by installation of
public water supplies) the control of flies and marked improve-
ment in infant hygiene in the home.  The changes were brought
about by community development and industrial change as well
as by direct public health activity.  With the introduction

of the motor car, for example, there was a reduction in the use of horses, and stables disappeared from cities and urban centers; with this the most prolific source of fly breeding was removed. Programs for garbage disposal and general community cleanliness further limited fly breeding. In addition to a reduction in their numbers, there was a new emphasis on the hazard of flies and as a result better methods were used to protect from them. The more recently available insecticides which have had such great importance in mosquito control, had little permanent value in fly control due to the relatively rapid development of resistant strains.

Installation of safe public water systems has received more credit than is warranted for a major contribution to the prevention of diarrheal diseases. There are numerous instances of an immediate and marked decline in typhoid fever with the change from a polluted to a safe water supply, but there were no corresponding prompt drops in the mortality from diarrheal diseases. This is in line with current knowledge that viable Shigella are rarely disseminated in polluted water. The improvement of water supplies did aid in the control of diarrheal diseases by making available convenient facilities for the improvement of personal cleanliness and by providing for flush toilets and a safe disposal of human feces. Thus, construction of safe community water supplies will have little significance without adequate distribution to individual living quarters.

The growth of pediatrics with its active concern for disease prevention and the care of the healthy child, and the concurrent development of child health and welfare activities in official and voluntary health organizations both had their effect. Likewise socio-economic improvements had public health significance.

These varying general measures together were slowly effective in the past in the control of diarrheal diseases. However, the present knowledge of etiology, epidemiology and therapy permits the adoption of more specific control measures which promise to be more rapidly effective.

As heretofore, socio-economic development will contribute to the prevention of diarrheal diseases, but these changes come slowly and the immediate problem is control under existing conditions.

Knowledge is now adequate for the prevention of deaths in almost all cases of acute diarrheal diseases. Programs for

medical care to effectively apply this knowledge will be
required. This may call for a consideration of the training,
distribution and support of more physicians, and the develop-
ment of readily available clinics and pediatric hospitals,
all of which requires time.

The chief responsibility for the immediate prevention
of diarrheal diseases must rest with organized public health.
In some diseases, as malaria, a single point of attack and a
limited but intensive program is effective. However, in the
diarrheal diseases multiple procedures are indicated and a
broad and well organized program is required.

In public health, as in clinical medicine the first
step is to accurately diagnose specific needs. For this,
laboratory service will be required primarily so that public
health departments may make the needed epidemiological in-
vestigations. Endemic diarrheal diseases received little
epidemiological study in the past, but they deserve as much
attention by epidemiologists as they would receive if the
same number of cases and deaths occurred in explosive outbreaks.
Knowledge needed to guide in the establishment of specific
control procedures may be obtained promptly through adequate
epidemiological surveys, including laboratory studies, in
representative areas. Laboratory service needs to be provided
to clinicians, also, to aid in obtaining specific diagnoses and
more effective treatment of individual cases. Such studies
have public health significance since often the only available
estimate of the nature of the local problem of diarrheal disease
will be found in clinical or hospital records. Such records
though valuable are admittedly inadequate for an evaluation
of the total community picture.

For the diagnosis of public health needs and progress,
the importance of dependable vital statistics warrant emphasis
also. It is fortunate that improvement of _raw_ statistical
data is the subject of one of the other technical discussions,
since accuracy of the _original_ report is the basis of accurate
statistics.

In the application of control measures, a broad program
of community and home sanitation with emphasis on the avail-
ability of water, the safe disposal of human feces, garbage
disposal, and fly control, will be required. It is gratifying
to note that the seventh World Health Assembly and the Executive
Board of the World Health Organization have taken renewed
interest in this field and have directed the various regional

offices to stimulate governmental interest in environmental sanitation.

Knowledge must also be applied directly to the individual. On a broad scale, responsibility for this will rest primarily with public health physicians and public health nurses. Initially problems in therapy, as well as of infant hygiene, will be involved; hence adequate attention must be given to pediatrics and child hygiene in training these public health workers. Education of parents will be a major task and in this the participation of qualified health educators will be a valuable asset.

Thus, at the local and on a national level a broad program by an effective public health agency is essential for a rapid control of the acute diarrheal diseases. The nature of the problem must be accurately diagnosed, this requiring the participation of the public health laboratory, epidemiology and vital statistics. Environmental preventive measures must be applied through programs of community sanitation, and this will demand the services of sanitary engineers and sanitarians. Knowledge must also be applied directly to individuals and this will be the responsibility of public health physicians, public health nurses and health educators. All this must be organized and coordinated by the public health administrator.

The contribution of international public health activities to the solution of this problem will have particular consideration at this Conference. Supplementary aid from this source presumably will be primarily educational. The importance of a combined reference and research laboratory and training center in giving leadership in communicable disease control has been clearly demonstrated in the Venereal Disease Program. There is a comparable need for an "Infant Hygiene Training Center and Laboratory", to develop, test and operate a demonstration program, to provide leadership and assistance in the provision of laboratory services and to be a major focus for medical and public health education in this field. Such a center, strategically located, as in connection with a School of Public Health, and adequately supported, should prove of major value in evolving and maintaining programs adequate to meet one of the major public health problems in most of the countries of the Americas.

Allocation of Public Health Activities

Public health resources are never adequate to meet all public health needs. Necessarily there must be a decision as

to priority of varying activities. In the past, the diarrheal diseases have not received attention comparable to the relative magnitude of the problem. Early public health activities were directed to the control of epidemic diseases, later to prevention of all communicable diseases. Diarrhea in infants heretofore was considered to be related to defective feeding, and deaths of infants were regarded as unavoidable. Now we know that the problem is one of the control of infectious diseases which are virtually entirely preventable. Thus, these communicable diseases which are the major cause of illness and deaths in many countries, warrant major public health attention.

Medical history suggests that with general improvement in homes and communities the diarrheal diseases of infants and children will decline slowly. It is reasonable to believe that with the application of newer knowledge by effective public health and medical measures there could be attained in one decade the same control of diarrheal diseases which resulted from five decades of slow improvement in the United States. A measure of our effectiveness in public health in the years ahead, will be the rapidity of decline in the mortality and morbidity from the acute diarrheal diseases of infants and children.