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Epidemiology of epidemic diarrhea of the newborn

William H. Weingarten
University of Nebraska Medical Center

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THE EPIDEMIOLOGY OF EPIDEMIC DIARRHEA
OF THE NEWBORN

WILLIAN H. WEINGARTEN

PRESENTED TO THE UNIVERSITY OF NEBRASKA
COLLEGE OF MEDICINE OMAHA
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INTRODUCTION

In a review of infant mortality rates in New York from 1926 to 1939 it was found that the death rate for the age group from one month to one year of life has decreased from 35.5 per 1000 births to 12.3 per 1000 births. However, during the same period of time the death rate for infants in the age group from birth to one month of life has decreased from 32.3 per 1000 births to 24.8 per 1000 births. At least part of the discrepancy is due to the existence of premature births and congenital anomalies in the younger age group. Further analysis revealed that diarrhea deaths were decreasing for the first year of life, but that they were increasing for the first month of life. It is believed that the increasing diarrheal death rate in the neonatal period is a more important factor in the death rate during this period than the premature births and the congenital anomalies. It is also believed that the most outstanding cause of diarrhea in this age group is epidemic diarrhea of the newborn. (Frant and Abramson 1944)

The first report of an epidemic of this type was made by Dick, Dick, and Williams (1928). This epidemic was characterized by the sudden onset of explosive watery diarrhea with no blood or mucous in the stools. This was associated with rapid weight loss, dehydration, and acidosis. The temperature remained normal or only slightly

elevated until the terminal stages. Every case was associated with mastoiditis or otitis media, and a terminal bronchopneumonia. The morbidity rate was 39%, and the case mortality rate was 30%. The disease was unusual in that it was so highly contagious, it did not respond to therapy, and no etiological agent could be determined. The authors believed that this was not the usual type of enteral or parenteral diarrhea even though each case was associated with mastoiditis or otitis media.

From 1928 to 1939 there were several reports of infectious epidemic diarrhea in newborn nurseries. Jampolis and Howell (1932) reported an epidemic in which fourteen of thirty-six infected infants died. The disease was characterized by explosive yellow diarrhea of sudden onset and the absence of any foci of infection either enteral or parenteral. The infants became rapidly dehydrated and acidotic in spite of adequate parenteral fluid therapy. Durand (1935) reported a similar epidemic in which fourteen of twenty-three infected infants died. Dulaney and Michelson (1935) reported an epidemic in which eighteen of twenty-six infected newborn infants died. Murphy and Mallozzi (1936) reported an epidemic in which eighteen newborn infants were affected. However, blood and mucous was found in the stools, and it was doubted if this was epidemic diarrhea of the newborn. There were no fatalities in this epidemic. Barenberg, Levy, and Grand (1936) described an epidemic in which fourteen of thirty-two infected infants died. In New York it was found that there were 3672 births between July, 1934, and December, 1936. There were 505

cases of epidemic diarrhea; a morbidity of 14%. Of these there were 234 deaths; a case mortality rate of 46%. (Frant and Abramson 1938)

Reports of diarrhea epidemics in institutions have not been uncommon in the past. However, the mode of spread, etiology, and methods of control are understood. Therefore, these epidemics have practically become extinct in recent years. Infant diarrhea epidemics referred to as "Summer diarrhea" were formerly a common occurrence in institutions. It was found that these were not caused by one specific organism, but by improperly handled food and poor sanitary conditions. Today this type of epidemic is recognized and adequate measures have been taken to prevent their occurrence. In contrast, very little is known about the epidemics involving newborn infants. They are becoming more numerous in the literature even though the sanitary precautions which prevented the others are being increased. The usual forms of treatment do not affect the course of the disease. For these reasons and because of the constant signs, symptoms, and pathological findings it is believed that this syndrome presents a new clinical entity which has been appropriately named "Epidemic diarrhea of the newborn". (Frant and Abramson 1939)

CLINICAL MANIFESTATIONS

The age of onset is from four to twenty days; the average being seven days. The earliest sign may be a failure to gain weight.

For this reason morning and evening weighings have been advocated as a preventative measure. (High, Anderson and Nelson, 1946) The infant then becomes listless and refuses food. This is followed by the sudden onset of explosive watery diarrhea. In many instances the diarrhea may be the initial sign. The stools average eight to ten per day and characteristically contain no blood or mucous. Dehydration and acidosis develop rapidly to an extreme degree regardless of adequate parenteral fluid therapy. There is usually no fever or only a one to two degree rise in temperature until the terminal stages. There is no leukocytosis. There are no demonstrable foci of infection until the terminal stages when frequently a bronchopneumonia of secondary origin is found. Death from dehydration and acidosis occurs in two to twenty days following the onset of the diarrhea. Pathological findings at autopsy are surprisingly minimal. There is a distention of the small bowel, surface hyperemia of the intestinal mucosa, and slight mesenteric lymph node involvement. A secondary bronchopneumonia is frequently found. The disease is further characterized by the lack of a common etiological factor. (Frant and Abramson 1938)

A biphasic type of epidemic diarrhea has been reported in which there is mild diarrhea, dehydration, acidosis, and prostration which responds to parenteral fluid therapy and alteration of diet. In three to five days there is clinical improvement with weight gain and normal stools. Several days later there is a severe recurrence of the symptoms which does not respond to therapy. (High, Anderson and Nelson

1946)

TREATMENT

Characteristically epidemic diarrhea of the newborn does not respond to therapy. It has been stated that the four primary objectives in treating diarrhea are: (1) Restoration of fluids, (2) control of infection, (3) Control of gastro-intestinal symptoms, (4) restoration of normal nutritional conditions. (Marriot, 1945) In the usual diarrheas fluid balance is restored and maintained by the use of parenteral fluids such as Ringer's solution, 1/6 molar lactate solution, sodium lactate Ringer's solution, etc. (Hartman 1945) Recently it has been demonstrated that the loss of potassium during severe diarrheas is greater than the corresponding nitrogen loss if cellular degeneration occurred. From this evidence it is concluded that cell membranes are not impermeable to potassium, and that the loss of potassium does not indicate irreparable cellular destruction. (Darrow 1946) Potassium added to parenteral fluids in amounts calculated to increase the serum concentration four to five milli moles per liter is sufficient to replace the intracellular potassium. Results of this treatment were negative as far as control of the diarrhea, but it was felt that the infants were able to withstand a longer seige of diarrhea which under the usual treatment would have been fatal. (Butler and Talbot, et al 1946, Govan and Darrow 1946)

Various attempts have been made to control infection by the

use of sulfa derivatives although no foci of infection has been demonstrated. It is claimed that sulfathiazole given at the very onset of the epidemic will cure the disease and prevent the spread to other infants. (Leff 1946) Succinylsulfathiazole has been recommended in conjunction with parenteral fluid therapy. Twyman and Horton (1943) reported only two deaths in a series of eleven patients treated with succinylsulfathiazole. They used an initial dose of .25 gram per kilo., and a maintenance dose .25 gram per kilo. divided into six doses for twenty-four hours given for eight days. In eleven other patients who did not receive this therapy there were four deaths. Anderson and Nelson (1944) treated twenty-eight infants during an epidemic with the same drug, one grain every four hours. They reported only one death under this therapy. Cook (1943) advocated succinylsulfathiazole 25 gram per kilo. per day for four to six days in conjunction with sulfadiazine .2 gram per kilo. per day for four to six doses. Felson and Wolarsky (1942) advise sulfathiazole prophylaxis.

In an attempt to control the gastro-intestinal symptoms and to restore the normal nutrition of infants with epidemic diarrhea a formula consisting of 1/2 ounce protein milk with 3% carbohydrate alternating with 1 ounce of 1% salt solution was given every two hours. This was an attempt to alter the bacterial flora of the intestine, for it was found that the reaction of the stools changed from acid to alkaline as the diarrhea improved. Under this therapy the case mortality was 43%. (Barenberg, Levy and Grand 1942) Felson

and Wolarsky (1942) fed infants barley water and saccharin $1\frac{1}{2}$ to 2 ounces every two hours in addition to 25cc lyophil plasma inter-muscularly for three days, and noted "Marked clinical improvement". Anderson and Nelson (1944) devised four formulas to be given success-fully in conjunction with succinylsulfathiazole and parenteral fluids. Formula A consisted of ~~glucose~~ and Ringer's solution 1 ounce to 20 ounces; B, glucose 1 ounce, casein $\frac{1}{2}$ ounce, Appella powder 1 ounce, Ringer's solution 20 ounces; C, glucose 1 ounce, Appella powder 3 ounces, skimmed milk 5 ounces, Ringer's solution 15 ounces; D, glucose 1 ounce, Appella powder 1 ounce, skimmed milk 10 ounces, Ringer's solution 10 ounces. Under this treatment there was only one death in an epidemic involving twenty-eight infants.

Reports of successful methods of treating epidemic diarrhea of the newborn are not numerous. Those that have been successful have not been repeated. The morbidity and mortality rates remain high regardless of the various types of therapy. The number of different methods reported indicates the lack of any specific therapy.

EPIDEMIOLOGY

^a Breast Fed: Artificially Fed Infants

Outbreaks of epidemic diarrhea of the newborn have been reported from all sections of the country and there is no apparent correlation between the disease and the climate or season. Also there is no predisposition to either one of the sexes. Further, there is no division as to socio-economic conditions although for the most part

epidemics are seen on ward services. Both artificially fed and breast fed infants seem to be equally affected by the disease. However, the distinction between artificially fed and breast fed infants cannot be too sharply drawn because of the common practice in most hospitals of supplementary feeding. (Rice, Best, Frant, and Abramson 1937) From a study made by Cron, Shulter, and Lahmann (1940) of an epidemic involving ~~thirty-nine~~ infants of which eighteen died, it was found that the eighteen deaths all occurred in artificially fed infants. Eight artificially fed infants who were subsequently put to breast did not contract the disease.

The origin of this epidemic was thought to be from the father of one of the deceased infants. He visited his wife during the feeding time while he was recovering from acute diarrhea and coryza. Forty-eight hours later the infant became sick, and died the following day.

The high death rate in the artificially fed infants suggests that the epidemic was spread among the patients by means of the formula or improperly sterilized bottles and nipples. The same observation was made by Lembcke, Quinlivan, and Orchard (1943) from Rochester, New York. In one of the epidemics they reported twenty-three of fifty infants were infected, and three died. It was believed that the infection was transmitted by contaminated nipples and inadequately sterilized formulas. Four formula cultures and twelve nipple cultures showed organisms of the colon bacillus group. Fecal contamination was traced to the practice of diapering prior to feed-

ing and inadequate facilities for washing hands. Lembcke (1940) had previously made this observation in an epidemic involving 105 infants with five deaths. In a second epidemic studied by Lembcke, Quinlivan, and Orchard (1943) primarily breast fed infants were affected. Some faulty technics were discovered in regard to improper breast cleaning and diapering before feeding.

Further evidence of faulty technic and contamination has been presented by Rubenstein and Foley (1947). In a ten year survey in Massachusetts from 1935 to 1945 there were 258 cases of epidemic diarrhea of the newborn with eighty-five deaths. Epidemiological studies revealed that in seven of the nurseries common rectal thermometers were used. These were supposedly sterilized in bichloride of mercury or alcohol solutions. Also common oil bottles were used and hand sterilizing solutions were insufficient. Extremely high bacterial counts were made from the thermometers and sterilizing solutions. The majority of organisms were *Escherichia coli* and *Proteus vulgaris*. *Staphylococcus aureus* and *albus* were obtained from the nipple cultures.

Geiger and Sappington (1943) reported six epidemics in hospitals in San Francisco between December, 1942, and October, 1943, in which there were 324 cases and forty-five deaths. They believed the epidemics were so wide spread because of the extreme overcrowding in the nurseries and poor nursing technic. Weymuller, Beck, and Ittner (1947) ascribed an epidemic of nineteen infants with no

deaths to a breakdown in nursing technics due to a shortage of nurses.

State of Nutrition

Gron et al (1940) made further observations as to the state of nutrition of the infected infants. Of eight premature infants on the ward, all of them contracted the disease and died. In a report by Rubenstein and Foley (1947) of the 258 cases the premature mor- bidity rate was 49%, and the mortality rate was 53%. The morbidity rate for full term infants was 21% and the mortality was 25%. Calvin and Emory (1941) described an epidemic in New Orleans in which twelve infants were involved and nine died. They observed that all except two of the mothers had infections at the time of delivery, and that all but two had abnormal deliveries. The average weight was five and one-half pounds. Felson and Wolarsky (1942) reported an epidemic affecting nineteen infants with no deaths in which the average weight was less than six pounds. Forbes and Olson (1939) observed in an epidemic in which five of eleven infected infants died that pre- maturity and difficult labors predisposed to the disease. Cook (1943) states that the severity of the disease is due to lack of de- velopment of the various systems, and an easily upset acid base balance in the newborn infant.

Age

Since the first report of the disease in 1928 by Dick et al, in which there were four infants not in the newborn age limit, very little has been reported concerning this observation. They reported that one five weeks old infant, one seven weeks old infant, one three

months old infant, and one five months old infant all contracted the disease during the epidemic. Rubenstein and Foley (1947) reported one case in an infant over one month of age that contracted the disease and died. Cron, Shulter, and Lahmann (1940) observed that older infants did not contract the disease when sick newborn infants were placed on the same ward with them during an epidemic. They concluded that older children did not contract the disease and that it was limited to newborn. Clifford (1947) states that the disease is not confined to newborn nurseries and that it is endemic in infants' hospitals where it is a constant problem.

The information in the literature concerning the incidence of epidemic diarrhea of the newborn in older infants is too meager to draw any conclusions from. The absence of this observation, with the few exceptions presented here, may be due in part to the exclusion of the older children by the very name of the disease. Unfortunately, infants with severe diarrhea and dehydration in the presence of a slight upper respiratory infection are also excluded from the classification. Further consideration of these possibilities is indicated in future investigations.

Mortality Rate

The case mortality rate in epidemic diarrhea of the newborn is reported to be 47%. (Frant and Abramson 1938) Their study, made in New York, consisted of a review of the statistics from July, 1934, to July, 1937. During this time there were 711 cases of epidemic diarrhea in twenty-three epidemics. The accompanying chart reviews the epidemics reported from 1928 to 1947. The range of mortality rates

reported varies from 0% to 85%; the average being 35.8%. The reason for these discrepancies is not apparent unless it be that in recent years the epidemics have been brought under control at an earlier date by earlier recognition and isolation or that different etiological factors vary in their virulence.

CASE MORTALITY RATES OF EPIDEMIC DIARRHEA
OF THE NEWBORN: 53 EPIDEMICS

<u>Author</u>	<u>Date</u>	<u>Case Mortality</u>
Dick, et al	1928	30%
Jampolis and Howell	1935	38%
Dulaney and Michelson	1935	66%
Durant	1935	60%
Barenberg, et al	1936	43%
McKinlay	1937	33%
Greenberg and Wronker	1938	29%
Frant and Abramson	1938	85%
Forbes and Olsen	1939	45%
Baker	1939	0
Kimberly	1939	83%
Costello	1939	42%
Crone, et al	1940	82%
*Ormiston	1940	29%
Johnson and Rothman	1940	36%
Calvin and Emory	1941	75%
Lembcky	1941	4%
Felson and Wolarsky	1942	0
**Geiger and Sappington	1943	13%
McClure	1943	12%
"	"	22%
"	"	4%
"	"	75%
Lembcky, et al	1943	10%
Anderson and Nelson	1944	2%
Bloxson	1945	50%
Weymuller, et al	1947	0
***Rubenstein and Foley	1947	33%

Average - 35.8%

- * - Three Epidemics Reported
- ** - Six Epidemics Reported
- *** - Nineteen Epidemics Reported

Etiology

Etiological and epidemiological studies have been disappointing in that no common etiological factor has been found, and that in many cases the epidemic was thought to be due to poor nursery technics. Clifford (1947) prefers to divide the reported epidemics into three large groups according to their etiology. The first group consists of those epidemics in which the bacteriologic findings consist of organisms which ordinarily would not be considered pathogenic. The second consists of those in which a virus etiology has been found or strongly suspected. The third group is the largest and into it fall those epidemics for which etiological studies have failed to reveal any inciting factor, or the findings have been unusual.

Of organisms not usually considered pathogenic for man, Hemolytic *Escherichia coli* was demonstrated as an etiological factor from four epidemics in Ontario. (McClure 1947) He concluded that these organisms were present with much greater frequency in the stools of infants with epidemic diarrhea of the newborn than in normal infants. These organisms, when fed to cats would occasionally produce diarrhea. In one hospital there were two outbreaks. The first involved twenty-six of sixty-two infants and three died. The stools of fourteen infants showed positive hemolytic *Escherichia coli* cultures. In addition, the supervisor's stool was positive for the same organism. In the second outbreak there were seven deaths from thirty-one sick infants. Bacteriological studies revealed that seven out of eight stool cultures made were positive for hemolytic *Escherichia coli*. Four of seventeen nurses showed positive cultures also. The organism was also found on

the top of the common bathing table. It was identical, by sugar reactions, with six cultures from infants and the night nurse.

Studies of the other epidemics showed similar results. It was suspected that faulty nursing technic was responsible for the spread of the epidemic when it was discovered that the diapers were rinsed in the same sink that the formula was warmed in.

A similar finding was reported from New York in a review of three epidemics between 1935 and 1938. (Baker 1939) The first involved fifty-nine of 337 exposed infants, and there were no fatalities. Bacteriological studies were considered insignificant because of the variety of organisms found. These included *Escherichia coli mutabile*, hemolytic *Staphylococcus aureus*, *Staphylococcus albus*, *Bacillus subtilis*, *Escherichia coli*, alpha-hemolytic *Streptococcus*, gamma-hemolytic *Streptococcus*, and *Aerobacter aerogenes*. There were two deaths in the second epidemic which involved thirteen infants. Stool cultures revealed hemolytic *Escherichia coli* in nine patients. Dulaney and Michelson (1935) found *B. coli mutabile* (*Esch. coli mutabile*) in the stools of 65% of twenty-seven infected infants.

Jampolis and Howell (1932) described an epidemic involving thirty-six newborn infants of which fourteen died. Bacteriologic studies revealed *Bacillus mucosus* as the etiological agent. Three nursery maids were found to have positive *Bacillus mucosus* throat cultures. When they were removed from the nursery, the epidemic stopped.

Bacillus dispar was believed to be responsible for three epidemics. (Johnson and Kaake 1935) The same organism was found in six stools during an epidemic in which there were twenty-one deaths. (Schwentker 1947) From June to October 1945, six epidemics were reported in which *Bacillus pyocyaneus* was recovered from all infants' stools, from autopsy material, from nurses' stools, and from the milk supply of the community. (Ensign and Hunter 1946) Wheeler and Foley (1945) found Lancefield Group D Streptococci as an etiological factor in an epidemic in Boston. Costello and Lind (1939) found *Proteus vulgaris* in the stomachs of eleven dead infants during an epidemic in which there were twenty-six cases.

The existence of non-pathogenic organisms as etiological factors in these highly fatal epidemics suggests that newborn infants are much more susceptible to these organisms than was formerly believed, or that there is repeated overwhelming infection. It is important to note that a great many of these organisms are found in the adult alimentary canal. It is believed that these organisms enter the nursery with adult carriers and are spread among the patients by the fecal-oral route because of a break in the nursery technic. This is due to overcrowded conditions and lack of personnel. (Clifford 1947)

A virus etiology was suggested by Barenberg, Levy, and Grand (1936). They reported an epidemic in which thirty-two of forty-three exposed infants became sick; of these, fourteen died. Extensive bacteriological studies were made and on the basis of negative results they suggested that the epidemic might have been caused by a

virus. Another report of three epidemics occurring during influenza epidemics was made by Lyon and Folsom (1941). Citrated whole blood from an adult recovering from influenza was administered to three of the sick infants. The authors reported excellent results in these three patients. High, Anderson, and Nelson (1946) reported an epidemic occurring simultaneously with an epidemic of adult diarrhea, nausea, and vomiting. The etiology was unknown in both epidemics, but a virus was suspected.

Definite evidence of virus infection was presented by Light and Hodes (1943). Filterable material was obtained from four epidemics. This material when given nasally to young calves produced diarrhea in two to five days. They were able to recover the filterable material from the calves and to produce the same results repeatedly. Cross immunity studies of the material obtained from the four epidemics revealed that the filterable agents were identical. The diarrhea lasted for about four weeks after which the calves developed an immunity to further nasal administrations.

Buddingh and Dodd (1944) isolated a similar filterable material from a mild epidemic in which there was an associated stomatitis. There were no fatalities in this epidemic. The serum from twelve of the patients reacted positively with the filterable material. This material would produce lesions on the scarified rabbit cornea. The rabbits developed an immunity to the agent in three weeks. When the material was mixed with convalescent serum, no lesion developed

on the rabbit cornea. At the time of this observation, it was thought that the rabbit-eye scarification test was specific for virus diarrhea. However, attempts to use this test in studying an epidemic of diarrhea in Michigan were not successful. (Cummings 1947) Positive results were obtained with the initial experiments, but when serial passages were attempted the results were non-conclusive. Further investigation revealed that the same scarification tests were positive with other materials such as stools and mouth washings from normal infants, various bacteria, and trauma.

Although the rabbit cornea-scarification test is not specific, it is evident from the previous observations that a virus can cause epidemic diarrhea. The experiments of Light and Hodes (1943) confirm this. The lack of a simplified test for determining the presence of a virus is preventing further investigation along these lines. The method of Light and Hodes of studying the virus by its effect on young calves is the only sure method so far proposed. However, the expense of the undertaking is prohibitive for most investigators.

The group of epidemics falling into the third group: unusual or unknown etiological factors, has been covered previously under the first part of the discussion of epidemiology. (PP 7-8-9) The conclusion to be made from these studies is that many epidemics are caused by overcrowding in the nurseries, breaks in the nursery technics, and poor hospital facilities. Clifford (1947) has attributed the breakdown in hospital technic to the great increase of hospital births during the last fifteen years. This has resulted in overcrowding the nurser-

ies at a time when they are heavily understaffed. Cummings (1947) states that filth in the nursery is the principal factor in the epidemics. He reported finding coagulase-positive Staphylococci, hemolytic Streptococci, Shigella alkalescens, Bacterium alcaligenes, and various coliform organisms in infant stools and nursery supplies and equipment. Bacterium alcaligenes was isolated from twenty-four infant stool specimens, fifteen muconium specimens, three nurses-aid stool specimens, nursery basins, enema solutions, subcutaneous saline solutions, soap solutions, table tops and hand brushes.

Control

Control of the epidemics of diarrhea in the newborn nurseries has been, in many instances, impossible until the nursery and obstetrical departments were closed to new admissions until all exposed patients were dismissed. Before reopening these departments it was necessary to clean them thoroughly and to repaint them. (Greenberg and Wronker 1938, Geiger and Sappington 1943) These measures were employed when the epidemic continued to spread in spite of all other measures. Failure to recognize the disease until the epidemic was well under way has been a definite factor in the high morbidity rate. This was due in part to the insidious onset of the disease in some epidemics making early diagnosis impossible. Thus, whole nurseries were exposed before isolation procedures were started. Also infants exposed to the disease were discharged from the hospital in apparently good health only to be admitted to another hospital with diarrhea. Before the contagious-

ness of the disease was recognized, another epidemic was under way. (Rice, Best, Frant, and Abramson 1937) It was apparent that the usual methods of dealing with epidemics in hospitals were not adequate in the control of epidemic diarrhea of the newborn. That a revision of technics was needed to control this highly contagious disease about which there is much confusion.

A plan for the control of the disease has been presented. (Frant and Abramson 1945) They state that the disease should be made reportable and that any case of diarrhea in the newborn infant nursery should be reported as soon as it is discovered. A department of health official who has had special training along these lines should have complete responsibility for the patient. The obstetric and newborn services should be discontinued when the diagnosis is made and all sick infants should be isolated and quarantined. Exposed infants should be quarantined for a sufficient period of time to permit immediate treatment as soon as symptoms are discovered. All patients dismissed from the hospital immediately prior to the onset of the epidemic or during its course should have follow-up examinations, and sick infants should be readmitted. If discharged infants are admitted to other hospitals the attendants should be notified of the nature of the illness so that isolation procedures can be started. Current newborn histories should be reviewed for evidence of cases not previously recognized, and death certificates should be examined for missed cases. Sanitary facilities should be inspected in regard to water and milk supply and food storage. The epidemic should not be considered at an end until all exposed infants have been properly

discharged and the nurseries cleaned of sick infants. Obstetric service quarters should be completely renovated and equipment sterilized.

This plan also provides for adequate etiological studies. These include routine cultures of infant and personnel excreta, and agglutination studies of sick infants' blood. In addition it calls for post mortem examination and cultures as well as virus studies.

Prevention

Realizing that the prevention of the epidemics is equally as, if not more, important than the prevention, the same authors have presented an extensive plan for the prevention of epidemics of diarrhea in newborn infant nurseries. This plan calls for separate personnel and equipment, including labor room and delivery room, for infected and clean mothers. All gynecological and surgical cases are eliminated from the obstetrical floor. There should be separate nurseries for full term and premature infants with completely separate facilities for isolation. Individual bedside equipment should be provided for each patient, and there should be a minimum of two feet on each side of every bassinet. Common dressing and diapering tables should be prohibited. Steril^d drapes should be provided on the scales before each weighing. Ante-rooms should be provided for examinations so that physicians would not have to enter the nursery. Steril^d drapes should be placed on the examining table before each examination. The formula room and the diet kitchen are to be separate, and there should be another formula room supplying sick infants. Strict surgical asepsis is required in the preparation of formulas. There

should be a separate nursery and maternity nursing staff. The nurse in the formula room should do nothing but make formulas. Those who change diapers should not feed, and those who feed should do nothing else. There should be a separate staff for the main nursery, the premature nursery, and the isolation nursery.

These are the essential points of the plan. To carry these out would require extensive reorganization and remodeling in many hospitals. For many it would be a physical impossibility. The lack of trained nurses at the present time makes it practically impossible to provide a nurse for every two patients. Especially with the increasing number of patients to be cared for in newborn nurseries. However, many of the essential points of the plan are applicable to the designing and construction of new hospitals.

Another plan for the prevention of diarrhea epidemics in newborn nurseries has been published by Clifford (1947). This plan advocates the prevention of air-borne infection by ~~ventilation~~, and sterilization of the air with propylene glycol 1:5 million. In addition, oil impregnated blankets and an oil film on the floor are recommended to decrease the bacterial count of the air. Droplet infection may be controlled by the use of cotton masks several layers thick. For isolation of infected cases in over crowded nurseries, the author suggests the use of a Chapple incubator; ^{with 1615 a unit} completely closed incubator with conditioned fresh air drawn from the outside. Infection from contaminated food or fluid can be prevented by terminal sterilization of formula in the bottle with nipple attached.

The prevention of infection acquired from personnel is a more difficult problem. Clifford (1947) suggests the limiting of one nursery unit to six to twelve patients with one nurse, and frequent health examinations for personnel. Should one infant develop diarrhea he should be immediately isolated. If another infant develops the symptom, he too should be isolated, and the unit should be quarantined. New admissions are to be stopped until all exposed infants are dismissed and the nursery cleaned. If a third infant should develop diarrhea, the board of health should be notified that there is an epidemic in progress.

This plan is more feasible under present hospital conditions and the shortage of trained personnel. It is also more applicable to the present nursery set-ups in most hospitals with regard to available space for isolation.

*D. Clifford is at present staying at the
Boston Lying-In Hospital - The Rooming-in plan
having the baby with the mother. This is a solution of
maybe*

SUMMARY

Evidence has been presented of a highly contagious epidemic diarrhea involving newborn infants. The signs and symptoms of this disease have been described. Various methods of treatment have been mentioned, and their results noted. The relation of these epidemics to unsatisfactory sanitary conditions, personnel shortage, and overcrowding in nurseries is repeatedly pointed out. The case mortality rate has been discussed. The epidemiology has been discussed in detail in regard to the age of onset, the state of nutrition, the etiology, and methods of control.

CONCLUSIONS

It cannot be stated that epidemic diarrhea of the newborn is a specific clinical entity. Etiological studies indicate that the disease is the result of infection by any one of a variety of organisms. Confirmation of this awaits: (1) the correction of the faulty sanitary precautions which have been demonstrated in the majority of epidemics. Such gross failures in nursery procedures allow for contamination with any type of organism. (2) the development of a simplified test for determining virus etiology. The rabbit cornea-scarification test has been shown to be inadequate, and the test using young calves is impractical for extensive use. Virus etiology should not be claimed on the basis of negative bacteriologic studies.

The average case mortality rate in fifty-three epidemics between 1928 and 1947 is 35.8%. This high fatality rate is due to: (1) lack of specific treatment, (2) failure to institute proper isolation procedures because of the absence of diagnostic symptoms early in the disease, and (3) the increased susceptibility of newborn infants.

The incidence of the disease in children over one month of age is questionable. Further investigation concerning this is necessary. Present reports indicate that the more underdeveloped the infant is, the more susceptible it is to epidemic diarrhea of the newborn. One could reasonably expect a higher incidence in prematures and sickly full term infants past the neo-natal age.

The proposed control measures are non-specific. They are designed to prevent the spread of infection from every approach. They are indicative of the want of knowledge of the mode of spread of epidemic diarrhea of the newborn. They are the result of the poor nursery technics and sanitary conditions revealed in epidemiological studies. They should be applied, in so far as possible, to those nurseries where these findings were made. However, many other hospitals have experienced personnel shortages and overcrowding without having had an epidemic. This indicates that they have been able to maintain proper sanitation and nursing technics without the extensive reorganization and increased personnel called for by these plans. Their methods of maintaining standards in the face of adversities should be applied to those hospitals where epidemics have occurred before the new methods are tried.

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