The Etiology of the Summer Diarrhoea of Children.

While doing dispensary work in Liverpool during 1856 and 1857 I was struck by the immense number of cases of diarrhoea of children that were brought for treatment during the summer months, in particular, the last months of the two years. The two districts where I practised were both in very poor parts of the town (Belmont in the South, and Burlington in the North) where courts and back-to-back houses are numerous, and where many of the poorest huts the two in cellars neither dry nor clean - on the whole, districts most favourable for the occurrence of the malady.

The nomenclature of the diarrhoeal illnesses of children is somewhat involved, but I think Ritchi's term "sensorial" could not well be adverse enough, as applying to the common form
of Swimmer diarrhoea, (Rotch—"Hygiene and Medical Treatment of Children," Boston, p. 280) though it is doubtful whether he is correct in placing this amongst the non-inflammatory intestinal conditions, since it is generally some degree of inflammation of the mucous coat of the bowels, though this may not be an important factor in the disease.

The term "inflammatory" would be better left out in this connection, as it causes direct contradiction between American and English anatomy. For whereas Rotch calls this form non-inflammatory, Ashley speaks of "inflammatory or zymotic diarrhoea" as one disease (Ashley and Wright—"The Diseases of Children," third edition, p. 86).

The term Zymotic seems quite admissible, implying as it does the element of fermentation, and the introduction of a specific worm into the system.

Again, the line between a severe attack of fermental diarrhoea, and an attack
of so-called "Chorea Infantum" is so indefinite, that until some specific organism is found for the latter, distinguishing it from the former, I think the term better discarded, or if used at all it ought to be strictly limited to the exceedingly rare class of cases presenting obvious jar symptoms, chief of which are the wasting evaucations, extremely rapid manifestations, suppression of urine and collapse.

The Etiology of Permanent Dia., which is a large subject, and is best considered under two main headings:
1) As regards General Conditions
2) As in relation to Bacteria

This is a somewhat arbitrary division and the two sets of causes must not be looked upon as entirely distinct, but rather as the second being dependent upon the first.

Before going further I shall briefly point out the chief reasons why this disease is regarded as a bacterial dis- ease.
1. The disease occurs in an epidemic form only when a certain temperature is reached. This temperature being one at which many factors promote an rapid action.

2. The disease is epidemic when other conditions besides that of temperature are favorable for bacterial growth, as in the low lying and distant parts of towns, where a quantity of organic matter is lying about, or where the soil is damp, or kept in an marshy condition by the release of sewage water.

3. Children who are fed from the breast alone, rarely are affected, while those who take from milk alone or in addition, very often suffer.

4. The symptoms of the disease are brain character, temperature above what can be accounted for by the condition of the bowel. Profound nervous symptoms quit not out of proportion to the fever, and with no brain changes sufficient to explain them.
symptoms continuing long after the diarrhoea has subsided.

5. The finding of large numbers of bacteria in the motions, differing in number and variety from those found in natural motions. Also the post-mortem discovery of bacteria in the bowel and in the lesions.

6. The involvement of other organs besides the bowel, as the kidney and spleen, in which the same organisms are found.

7. Bacteria have been found in large numbers in the air, in places where diarrhoea has been epidemic.

8. Experimental evidence - The inoculation of animals with cultures from diarrhoea patients - abundantly proves the bacterial origin.

9. Bocken (Disease of Childhood, Medical n. 46) says: "in many cases uncleanness of diet, often than that commensal with bacterial contamination, can probably or certainly be excluded, and previously healthy and well cared for..."
children frequently suffer and most seldom succumb. It is in the latter class of patients, and unusually when there is a high febrile onset, with vomiting, that a bacterial origin especially forces itself on our notice.

The old idea that this diarrhoea is due to a heart-stroke is largely also disproved by the fact that the high temperature must last some days before the epidemic begins; and that very young children of three months and under, are not attacked as often as older ones; and that the hottest days do not always give the most cases.

General Conditions. There are three great factors in the general causation of infantile diarrhoea: temperature, soil and feeding. Many other conditions, as poverty, bad ventilation, and overcrowding are helpful in spreading the disease, and in diarrhoea; its attacks of it, but unless we have fairly a sufficiently high temperature for the necessary growth and multiplication
of the organisms, then a suitable soil or medium in which they may develop, and lastly a means whereby the poisons generated may reach the child, we cannot have diarrhoea as an epidemic.

Until Dr Ballard made his intensive inquiry into the causes of infant diarrhoea in the years 1850-1851, comparatively little attention had been given to the subject, except in a desultory way. But the summer of 1850 had shown an exceedingly high death rate from diarrhoea, only excelled in 1868 (except in London) since 1837, and public attention was therefor attracted to it, resulting in the Local Government Board requesting Dr Ballard to investigate the matter.

The inquiry was begun at Leicester, which town had unfortunately shown a high diarrhoeal mortality, but it was soon found that the research must be extended far beyond this limit. Dr Ballard was assisted by many able men, and the services of Dr Klein...
and Thorton Cask were ricerca for micro-
scopical and chemical examination of
the blood and tissues, and urine and
faeces of the children affected.

The bacteriological findings were not
of great importance, as the results were
influenced by the fact that some days
elapsed between the procuring of the
specimens, and their examination;
but we shall return to this later.

We shall now consider the conclusions
arrived at by Dr. Ballard upon the
above-named heads, and compare
them with the observations of others who
have heretofore published the causation
of the disease. (Supplement 51st Annual Re-
port to Local Gov. Board 1881-1883)

**Temperature.** Ballard admits at-
mospheric temperature to be an unim-
portant factor, but he denies that this
effect is a more direct one in the case
of diarrhoea than in that of any
other cause of infant mortality.

His contention is that the increased
diarrhoeal mortality does not begin
while the thermometer at a depth of
four feet reaches about 86° F.; regard-
less of what was before registered by the
air thermometer, or that at a depth
of 1 foot below the surface.

He lays even more stress on the simul-
taneous decline of the 4 foot register
and the diarrheal mortality. Naturally
the 4 ft. register does not fall for some
time after the air registers, and Bailey
thus accounts for the constant prevalence
of the malady beyond the months of
greater heat.

"The Etiology of Summer Diarrhoea holds
a slightly different opinion: he
recorded twice daily the earth tempera-
ture at 1 ft. and 4 ft., and he con-
cludes that "not until the earth at
the depth of 1 ft. has reached about 60° F,
or some 4 degrees lower at 4 ft. does
diarrhoea begin to prevail in Leicester.

Coleman (Hygiene and Public Health
- Stevenson and Murphy Vol. 1 "Influence
of Soil on Health") says that almost at
Temperature is by no means an essential factor in producing the disease, since it is never, even in its fatal forms, absent from the population at any period of the year. He says that the epidemical development of diarrhoea does not always correspond with the commencement of summer temperature, especially when the latter is exceptionally early. He quotes Fodor, whose observations in Pinda-cest showed that there may be no apparent connection between the air temperature and the diarrhoea curve, since, while the summer of 1863, which was very warm, was only a few cases, the summer of 1864, a much cooler one, gave many.

Fodor also affirms that the disease usually asserts itself on a sudden, but only after a certain degree of warmth has manifested itself for a longer or shorter period, as if the virus in the soil had had time to ripen.

Again, Coleman says: "The percentage of diarrhoea is not only higher in towns
strain, villages, but in some cities and
in certain parts of cities, the disease is
much more prevalent, though there is no
difference of temperature to account
for. A personal epidemism
therefore, and the atmospheric tempera-
ture by no means invariably correspond,
although the highest point of prevalence
of the disease may occur at a time
when the highest summer temperature
is reached, or a little later. In the
same way it is not possible to trace
any connection between a tendency to
manifestation changes in articles of
foods and drink, such as might in
certain cases be expected to occur
with a high temperature and diarrhea.

Eminent Holt (Cyclopedia of Diseases
of Children - Beirut - Vol III p.67) con-
siders that we are not justified in
saying that the rises in fevers and
mortality of diarrhea in summer is
directly associated with earth tem-
peratures.

Baginsky attempts a close relation be-


earth temperature and diarrhoea, but
regards the atmospheric temperature as
the important one, saying that the
earth temperature depends on this. (Die
Verdunstungs Krankheiten der Kinder. Zürich 1864;
gunted by Hott. of., cit.)

In a paper read before the New York
Academy of Medicine in February 1880,
Dr. Leibni (Med. Record March 24, 68)
demonstrated conclusively that warm,
not hot, weather is necessary for diar-
rhoea to become prevalent. It is
when a minimal daily temperature of
not less than 60 ° F is reached, the
diarrhoea becomes epidemic; and that
the frequency then remains unchanged
whether the maximum reaches 90 °
minimis or falls below 60° F. He also
showed that as long as the mean tem-
perature remains below 70° F, the num-
ber of cases is no larger than in an
ordinary cold winter month. The
inhabitants claim frequency and
mortality of diarrhoea during the July
months. - In July 1867 - to take one occa-
...there were twelve days in which the temperature exceeded 90°F, yet the number of cases was far below the average for July.

I venture to conclude that a comparison of means of monthly temperature during the summer months shows that the frequency of diarrhoea, as also its mortality, is independent of the rise and fall of the air temperature. It does not take any account of earth temperatures, but attributes the frequency of diarrhoea to the milk, which readily decomposes at 60°F. The milk being, from the time it is drawn until it is consumed, exposed to conditions favouring decomposition.

Clark Miller (Med..Records, July 21, 1888) observes this study, says that the milk often encounters a temperature much above 60°F. before it reaches the consumer, or if it is consumed, when the maximum daily register is below 60°F, yet the complaint does not
become epidemic.

There is an apparent discrepancy between the conclusions of the American and English writers, as regards the influence of heat. On the one hand, Bantin (Obst. Journ. 1850) gives the mean temperature of the six summer months, collectively, of different years, and compared these figures with the mortality, the result being that there was no similarity whatever. A comparison of individual months gave the same result.

In Martin's case, Randell (Trans. American Ped. Soc. 1850) gives some points in etiology and treatment of the diarrhoeal troubles of infancy. He reports 131 patients seen in private and dispensary practice. There were marked fluctuations in the temperature at different times, but no corresponding changes of temperature.

On the other hand, Vachet (Brit. Med. Journ. 25th Dec. 1850) "To lessen diarrhoea of children on chilblain or scabies?" princi
a table of summer temperatures for twenty-five years (1860-84) which shows that deaths from diarrhoea every summer quarter are almost always in excess when the temperature is above and below when it is below the average. The average summer temperature in London is 59.6° F, and in very year when the chart not exceeded 3 per 1000 per annum, the average temperature was over 60° F. In all but one of the years in which the mortality was less than 2 per 1000 per annum, the mean temperature was below the summer average of one hundred years.

Thus we see that a hot summer in England gives a large amount of diarrhoea, while a hot summer in America may give fewer cases than a cooler one. But when we remember that the average summer temperature of New York is considerably over 60° F, compared with 59.6° F in London it is clear that these figures,
all go to prove that what is required for the prevention of diarrhoea is a mean of about 60° F. The English summer temperature gives very little margin over the minimum required, whereas the American average is well over the border, and any further mean is of very slight importance. But when once the temperature in America comes down to something like ours, as in October, then a slight mean makes a great difference, as shown by Dr. S. (Dr. S.) stating: on the 2nd and 3rd October (the month of October) the temperature goes down to 55.5° F., but for the next five days none below 60° F., showing an elegant rise of diarrhoea; on 9th and 10th the minimum is below 60° F., giving four mean days: on 20th and 23rd it is higher again, giving a higher mortality.

With regard to monthly comparisons of temperature and frequency of diarrhoea, there may easily arise, as the border promises en-
a considerable fallacy: taking the average birth and mortality for a number of years together, gives the result that in July, the hottest month, there is the greatest mortality, but as has been said, when the months are taken individually, this rule does not hold good. Besides, as Clarke points out, a monthly record is not satisfactory, because there may be two or three weeks of low temperature, giving the month a low mean, and yet enough days of high temperature to give the month a high mortality record; or from a succession of hot days at the end of the month the accumulation of hot storms on the mortality record of the next month with perhaps a low mean temperature.

A study of the bills of mortality of the great cities of Europe and America shows that there is a slight increase in May compared with the winter months, but an enormous increase in June, the mortality in New York in June being seven times as great...
as that in May, whereas there is only a
difference of seven degrees between the
average temperature of the two months.
Again July gives an immense increase
over June, though the difference in tem-
perature is only four degrees, the averages
being 61° and 65° respectively.
How are these disproportionate rises
in mortality and temperature to be
explained? Why should July suffer three
times as great a mortality as June, which
only once a slight difference in heat?
How twice it is explained by saying
that the susceptibility of the children
is less in June, seeing that they have
just come through the healthy spring
season, and are in comparatively
good condition. The question
whether the old idea of heat from
as a cause of diarrhoea is to be
wholly set aside, and he cannot
resist the conclusion that a certain
amount of depression does occur
in the case of young infants when
they are several successive days of
summer heat: this renders the respiration and consequently causes thirst. First may lead to their taking too much food, this being still more likely in the case of hand-fed children when the quality of food is not limited. And heat may depress the nervous system, and thus mitigate its objection.

The first part of this explanation contrasts strangely with a suggestion made by Dr. A. Jacobs (Med. Rec., March 24, 1868) to the effect that the high mortality in July is accounted for by the children having not yet regained their wasted strength after their winter confinement.

Another fact not easy to explain is that their summer tables show a great decline of mortality in August, while the vaccination still remains above the required level. How this is because all these children who were vaccinated in July have been swept away in July?—Sudbury.
says that it is only after a great many deaths have taken place in July, that
the public becomes aroused to the danger and takes steps to have the milk kept
cool.

There is probably a good deal of truth in both these suggestions, and in this
part many children can be taken to the country or sea-side. But it is
natural to suppose also that the action of specific organisms have been
some of their victims.

He shall refer to this part of the subject again, but shall now say a
few words about this soil.

Soil. Ballard in his summary of causation of diarrhoea says that
the essential cause resides ordinarily
in the subepithelial layers of the
esophagus, where it is intimately associ-
ated with the life processes of some
microbe not yet discovered; that
the vital manifestations of this organ-
ism depend chiefly on conditions of
season and on the presence of dead organic matter, which is its nutriment; and that on occasion this organism is capable of getting abroad from its primary habitat, the earth, and having become air-born, obtains opportunity for fastening on non-living organic material and never mind for water and nutriment in undergoing various phases of its life-history.

If this hypothesis be correct, we require to know what kinds of earth are most favourable for the growth of this organism. Ballard says that solid rock gives the lowest mortality, while a loose sandy soil gives the lowest, and that the presence of organic matter tends to raise the mortality, as when towns are built upon made ground, the refuse of towns or market gardens, or when the earth is polluted with excrement. If there be peat-moor or mud with firmness of the rock, this modifies the manner...
By their rock alone would give.

This fact is borne out by the observation (Ofman, p. 366) that in some parts of Devon and Cornwall no serious or fatal cases of diarrhoea may occur for a long series of years; in other localities the dwellings are built on hard impermeable rock. The same writer also says that gravel varies in its relation to diarrhoeal mortality, according as it approaches to sand in firmness or to rock in coarseness — and that organic matter, not necessarily fecal or excremental, favors mortality.

Thus the idea that diarrhoea is essentially connected with filth, and emanations of sewer gas, does not hold good.

Coombe (Op. cit.) says that Lavinia is situated on clay with new red sandstone below, but along the line of the river is found an alluvial bed of sand and gravel.
of varying thickness, with a variable quantity of soil or common mould above. He calls this the 'dirt' level, and emphasizes the fact that not only children, but persons of all ages, stations, and occupations, in this area, are attacked. Out of 14,157 cases in four years, 16,306 were of patients over ten years old, but after death, which numbered 837, 725 were of children less than one year of age.

Here Dr. Sherman asserts another mistaken assumption, that it is only a children's disease. Judging from our own observations, his figures seem scarcely credible. The age at which the patients is generally between six and eighteen months, but it is probable that many of those above seven or eight years of age who are attacked are never brought to the doctor, but are treated at home, and
many adults would not come for treatment until the diarrhoea had either become very severe, or was seriously undermining their strength, from its long duration. But known widely the statistics as age of natives differ, there is no doubt that, for confirming, the above two years of age.

The average age of seven fatal cases extended by me last summer was eight months; all were under eighteen months.

Counthyn made soil cultures from the earth of different farms in Leicestershire, and found that when the earth was taken from the "diarrhoea area" he obtained three to six times as many protozoa as from earth from a higher area; and this was more noticeable when the earth from which the culture was taken was subjected to effluent drainage.

Before 1850 diarrhoea was not
excessively prevalent in Leicester, but there has been a steady increase since.
and the reason assigned by this writer is that since 1850 the soil
especially in the older woods, has
been inundated with organic matter
from sewers, and until very lately
the river has occasionally flooded
this area. Therefore, from the
condition of the soil, and the soil
that we have an ample explanation
for the prevaIlence of existence of
many microbes and their germs.
It seems to me that the case of
Liverpool is parallel to that of
Leicester, and that we might look
of a similar area in the former.
The same explanation clearly
does not hold good in both, but
in both there is a good soil for
the microbes. In Leicester this
soil is the old red sand, in
Liverpool the soil is the accumu-
lations of organic matter which
are so commonly seen in the
...from and low-lying parts of the town.

Dr. E. W. Hope (Lancet Med. Chir. Journal, Jan. 1867) compares the annual mortality from diarrhoea in different wards in Liverpool, showing that the wards lying close by the docks show a very high mortality as compared with those farther away, and he shows that it is in these low-lying wards that the worst part of the population live. Labourers flock to Liverpool from all parts of the country in hopes of finding work, many of whom are totally unprovided for town life, and fall with a dreadful condition of poverty and filth.

In his later in the same journal for July 1865 he says the question of filth in some form is necessary for the antemortem microscopical examination of diarrhoea; but in the later article he lays more stress on the manner of feeding the children.
He also draws attention to the fact that there are more deaths in October than June, though the latter is the latest month, and he points out as possibly being some influence. The fact that the ground water is low in early autumn.

It seems quite probable that this may be of some importance, though by some authors it is entirely denied. According to Parke's (Hygiene and Public Health, 5th Ed. p. 23) this water attains its highest level in February or March, while it is lowest in October or November.

When the soil is wetted by a rise of subsoil water, active anaerobic fermentation will take place in the deeper layers, while the upper layers remaining permeable. The oxygenation process can readily come to the surface whereas, when the wetting of the soil is due chiefly to rainfall, the conditions will be reversed.

Now a month the ground water is
raised by the rainfall, much of which percolates through the soil but in the last months the rain mostly evaporates from the surface, and thus the only dampness the soil has is derived by capillary attraction from the ground water, unless there be an exceptionally heavy rainfall. But a heavy rainfall in summer would cool the ground, that its action would be rather to diminish transpiration in the more superficial layers of the soil; and Ballard states this is the only way rainfall does exert any influence in summer, on the diarrheal mortality. According to Ballard, excessive moisture or dryness of the soil is unfavorable for diarrhoea, and the most favorable condition of dampness is that brought about when the subsoil water in the diarrheal season is near enough to the surface to maintain by capillary attraction...
The degree of moisture caused by previous greater warmth at the surface.

But even if the soil temperature had no connection with its decline, yet the simultaneous decline of diarrhoea (and diarrhoea in turn with the rise of diarrhoea) we must not ascribe to the ground water, for the diseases being so frequent in beröthe, as many children will die in beröthe from diseases contracted earlier. Besides, the injurious element in the disease, which Hope himself in places notes strongly, would help to explain the continued prevalence.

As regards the soil, therefore, we need some organism moist (not necessarily filthy), or a loose sandy loam, within of which, with enough moisture, it warneth will form a good breeding ground for the organisms concerned.

Now, a sandy soil in warm season was most common with other soils, but kept it, heat longer; and it can absorb a large amount of water, as well as these three qualities we can easily see how it lends itself to microbe cultivation.
Similarly, soils containing a large amount of vegetable matter are equally well adapted for this purpose; the colour of dark soils is generally due to organic decomposition. Therefore, the warmest soils are those richest in vegetable matter; the decomposition of decayed organic matter causes heat, and plants grow better in warmer soils; so we have these factors all tending to produce heat in such a soil.

Let us regard 25 the fluctuations in the composition of the soil. Lewis and Cunningham in Calcutta found that changes in the upper layers of the soil followed changes in the atmospheric temperature very regularly. But it requires two or three days, often a succession of warm or cold days, for the temperature at a depth of half a metre to begin to become moderate itself to that of the air. Even a change of twelve to fourteen degrees from one day to the next
may not be followed by a difference of 1°C in the temperature of the soil at a depth of only half a meter below the soil face.

At one meter's depth the changes are smaller, while at two or four meters the soil temperature remains on an average almost in a straight line.

(Thomson and Murray, p. 320)

Now the question is, whether the soil must be heated to a certain degree before an epidemic takes place, or is the heating of the atmosphere the important factor.

William Farr (Diseases of Infancy in Hungary and Childhood, p. 28) believes that "the specific organism is always present in the atmosphere in a comparatively innocuous state, and needs time of four days incuba-
tion at 60°F in order to attain the degree of virulence necessary for the development of an epidemic. Even if this were the true explanation, we must surely look upon the organism
seen as developing primarily in the earth. He knew that countless organisms do develop in the earth, and that such heat as we have in summer would aid their rapid multiplication. There for why should not this organism share in the general growth?

Notin and Fratet (Theory and Practice of Hygiene, p. 450) say that all forms of bacterial life have been found to be present in the soil; and it is the deeper layers of the soil favor the preservation of the forms of halotropic organisms, where they are dormant. The summer heat would cause these forms to grow, and having come to the surface, the bacteria resulting from their growth would easily be detached by any wind, and carried about. But in the country, such a thing could only happen towards the end of summer.

And we do not need to suppose that a largely microbic number of the organisms* (Stev braz in "Manual of Bacteriology," p. 623) say: "organic habitation required for nourishment of these (organisms)." bacteria is not found in the air in any considerable amount.
should come to the surface, as the heat would probably increase in greater degree the number of those already there.

It seems purely arbitrary to fix upon a certain depth of soil, at 1 ft., or 2 ft., as the minimum depth; as until we know for certain the microbe (or microbes) causing the disease, and the exact temperature for its most rapid growth, we cannot say the depth at which these conditions occur.

But if it should be midnight or more, the depth of less than Ballard's 4 ft., is the best because at that depth the organisms are so much more secure than near the surface, and also because, though at the beginning of the diurnal period it takes a considerable number of days of high temperature before any effect is seen, it takes only a very short time for a later rise to take effect, as shown by a sycamore, which required 5 before.
Now we come to the third important factor in the general etiology of feeding. It is in this chiefly that we owe our knowledge as to the influence of the manner of feeding. Ballard says it is a mistake to suppose that diarrhoea in summer is caused by insufficiency of food, but that the cause is rather some extraneous substance in the food, sufficient in itself to cause the disease. Hope (Lancet, Vol. III, page 697) made notes of one thousand cases of fatal diarrhoea in Liverpool, having special attention to the manner in which the children were fed up to the time of illness; and his logical conclusions are of great interest and importance.

To ascertain the nationality of the mother in each case, and found that the English were to the Irish as two to one.

Other things being equal, we should expect to find that the diarrhoea
mortality is in the same proportion, and such is the case, approximately.

But if artificial feeding has any influence in the causation, we should expect to see a higher mortality amongst the English, as this mode of feeding is commoner with the latter than with the Irish.

We do not find this higher mortality because the hygienic surroundings of the Irish are not as good as those of the English, and this counterbalances the good effect of the breast-feeding.

But when the cases of our 1 year old age are examined, we find that the Irish mortality does exceed the English considerably.

Out of 10,000 deaths, only 30 occurred in infants fed from the breast alone; 393 in children who got no milk at all, and 2,57 in those getting artificial diet as well as breast milk.

The importance of this cause is accentuated by the fact that Edward
of fifty per cent of infants up to three months of age are fed from the breast alone, and twenty-five per cent at the age of from three to six months.

From his table Hope draws the distinction that for every infant under three months who dies of diarrhea, having been fed from the breast alone, fifteen die, out of the remaining fifty per cent, who receive other food, instead of, or in addition to, breast milk.

Dr. Langford Lyman (some introductory remarks on the diarrhoea of children, Brit. Med. Journal May 2, 1852) says that the greater number of fatal diarrhoes were due to artificial feeding. He states Dr. Nevin's return in Manchester, which showed 99 per cent to be hand-fed. The same percentage was obtained in America, and in Bavaria.

Thus we see from various sources the same result, i.e., that 99 per cent of the mortality occurs in hand-
Fed children, Ballard was reporting a percentage of 78% (Brit. Med. Journ. Aug. 23, 1833, P. 363) out of 341 cases.

In connection with this, it is an interesting fact that in the European cities, as we go from north to south, we find the death-rate from infant diarrhea decreasing ( read in sup. cit. P. 69) Daurier ascribes this to the more general practice of maternal nursing in the southern cities, and to the open houses and open-air life of the people. It records an occasion on which, in one day all the twenty-two children in a ward of the New York Infan
tary were attacked with diarrhea, the cause being traces in the milk.

I do not see why the diarrhea of the warm months should be considered as having any relation with the diarrhea occurring throughout the year; uncleanable foods of any kind, may cause irritation of the bowel, regard less of the season of the year. A
Feeric plan of estimating: the number of cases in various months, would be to subtract from every month in the year the average number of cases occurring in the cool months, and thus we should get only the excess of the hot months, i.e., a disease only occurring in summer and autumn.

Lewis Smith (Med. Record, Dec. 24, 1859) believes that in the cold months, we have a very different disease from that which prevails as acute gastro- intestinal catarrh in the warm months. As the comma bacillus causes Asiatic cholera by its own irritative qualities on the intestinal tract, so may a certain microorganism in summer diarrhoea.

Similarly, Clarke Miller (Med. Record, May 20, 1860) says infants may at all seasons of the year be affected by diseases having choleraic features, but it is very clear that these troubles, occurring in the cool or cold months, are not at all related histologically,
to theSummer diarrhoea under consideration.

The evidence that diarrhoea is connected with artificial feeding so this seems to be overwhelming (the term artificial applying to all cases in which food of any kind is given in addition to or instead of breast milk. Seeing that organisms flourish as well in milk we naturally turn to this as the important factor in the carrying of the germs and their spread to the children.

Pearman and Moor (Applied Bacteriology, 1877, p. 320) made a study of different examinations of milk as follows:

Friedman examined a sample of cows' milk kept at 15°C. At first, the count was 25,000 organisms per cubic centimeter. After 6 hours, 94,000, and after 24 hours there were over 4 millions. Rowland found an average 500,000
organisms per c.c. in milk from London ships.
Stewart and Buchanan Young of Edinburgh examined 300 samples from 50 dairies: 3 hours after milking, in winter, there was an average of 24,000 bacteria per c.c.; in spring and early summer 44,000; in late summer and autumn 170,000. They found that dairies supplied with milk from the country had an average number of organisms contained 5 hours after milking was 41,000 per c.c., while in those supplied from town dairies the average was 352,000.
Numerous other investigators have published similar results. The same authors, in their "Analysis of Food and Drugs, Part I - Milk and Milk Products," p. 53, say it is practically inevitable that milk as delivered from the cow should usually contain a very large number of bacteria. Many of the organisms
which are capable of causing disease by producing decomposition products from the milk.

The vegetative capacity of these organisms increases greatly with a rise of temperature.
Bacteriology. Such a large num-
ber of investigations have been made
during the last few years on this
subject, that we can only briefly
describe those that seem of particular
merit.

With regard to the Klein's observation
already referred to he examined the
blood taken during life from about
twelve patients; in three of these
he found micrococci. From
cases gave cultures, one of these
showing chains of micrococci.
The blood inoculated with living, in
4 cases with micrococci cultivated,
and in 2 with blood, the results
(on pneumonia, hip and a patent) were
entirely negative.

From kidneys (or c.s.) incommunised
bodies within five hours of death,
and in each obtained an abstract
and cultivation from the kidneys,
and in two, from the spleen and
mesenteric glands.
He also obtained good cultivations from the intestinal contents, but in the state of lack of knowledge of intestinal bacteria at that time, these were of little value. But it is well to note that the growths from the kidneys and intestinal canal lignified gelatine more rapidly than those from the spleen and glands.

He had found that the germs taken from the soil or air of the chamber and lignified gelatine more completely and rapidly than those from other parts of the town.

In the case of all cultivations from the air, soil or body, when the lignification of the gelatine was rapid, with a bad odour, a very small dose sufficed to bring on a sharp attack of diarrhoea, lasting several hours.

To utilise the bacteria from the diarrhoeal district, grow and multiplied almost as well as in the gelatine itself.

Microbes and bacteria were always
Present in the growth, but the bacilli were not seen within it. The growths which quickly digested the gelatine.

Secondary and more cultivations from these without diarrhoea within nine hours after being swallowed.

Thus, Lander laid the victory of a microbe origin to common diarrhoea upon a solid foundation, and it only remained for others to follow out his march, with the same confident methods for bacteriological investigation.

But before we can arrive at any satisfactory results from an examination of intestinal contents of children with diarrhoea, we must know what bacilli, if any, are found in the faeces of healthy children, and even this is not enough, for we ought to know the pathological action of the different varieties both individually, and collect...
... with or in a mixed condition, as the effect of some may be aggravated or changed by the presence of others.

Escherich was the first to thoroughly work out the various forms found in healthy milk. He found that although each case contained a constant number of organisms, there were only two that were constantly present: the Bacillus coli communis and the Bacillus lactis acidogenes. These two are the forms called the obligatory milk. These bacilli, as distinct from the microorganisms which are found in smaller numbers and without regularity in pregnancy (Keatinge, cit. "The Microbic Bacteria of Children", Bost.)

The metastatic properties of these bacilli were found to be similar when injected into the blood of mice. They pass through the kidneys in 24 hours, with symptoms of colic and showing intestinal carcinoma just mention.
The habitability of the effect pointed to a toxic rather than a direct action on the intestinal walls. Twelve varieties of micro-organisms, with fecal bacteria, were isolated by bacteriologists. The micro-organisms were as many as the bacteria, and these were identified with gelatin, as common as the non-liquefying ones. They showed the uniformity of bacterial life in healthy and unhealthy with feces, and its correspondence when the food was given.

Bajmůrký (quoted by Krbábik, 1897) was led to believe that the B. lactis aerogenes, placed under favorable conditions, may prevent the growth of pathogenic organisms. He observed that from the stools of children with diarrhea two varieties of bacteria, both of which liquefy gelatin, one was found constantly in the stools, and this was soon fatal to animals, but when this organism was placed simultaneously on gelatin (with the
addition of milk and sugar) with the B. Lactic
ic organisms, the latter has an active develop-
mint which the former ordinarily did
not grow at all. He concluded
that the acetic acid fermentation
caused by the B. Lactic organism was
a remedy in the infant organism,
protecting the intestinal wall from
pathogenic bacteria; but that when
this fermentation excluded a certain
degree as in abnormal conditions of
the intestine, it destroys the B. Lactic,
and thus opens the way for various
mortal and pathological processes.

Dr. S. Barker ("A Study of some of
the Bacteria Found in the Diapers of
Infants Afflicted with Summer Diarr-
hea," Trans. First Internat. Med. Con-
gress Vol II 1883) isolated forty
varieties of bacteria from the face
of thirty infants with diarrhoea.
The bacteria he found were in
many ways different from those
in healthy milk faces. Not only
was greater variety found in individual cases, but most of the cases contained one or more varieties not found in the others. The actual number of bacteria in these cases was no greater than in normal faces, but in four cases there were as many as eight varieties.

Of the total forty varieties, only one was a microscoccus, and only seven were diphtheroids; therefore they differed largely from Escherich's constancy-healthy faces bacteria; and the culture test failed to identify any one of them with Escherich's constancy ones.

Robertson came to no positive conclusions but made the following observations as bearing on the general tendency of his results:

"The obligatory bacteria do not disappear in the diarrhoeal faces. Paederus coli communes, a variety of the colon group, are found in all cases of diarrhoea, but not in
The objective discharges; and they diminish with the severity of the disease.

B. Lactis Aurum was found in nearly all the cases, and generally in larger numbers than in the healthy milk samples.

No variety of bacillus was found to bear the relation of constant or obligatory bacillus to the diarrheal or dysentery discharges.

Bacilli belonging to the Proteus group were the most frequent, and were limited to the more serious cases of Cholera infantum. Varieties of this group were found in seven out of eleven of the cases of Cholera infantum; Proteus vulgaris in three, and "Bacillus A" in four.

The presence of members of the Proteus group in a large proportion of the most serious cases, with symptoms such as colic, diarrhea, and frequent vomiting and offensive stools, is not without significance.
According to Hansen, the Proteus group of bacteria do not grow in the so-called "normal solution," but seem to and highly organized, especially abuminous compounds. They exert invasion in animal tissues, with the development of a serious poison, and evolution of a stinking gas, and on account of their wide distribution and frequent occurrence belong to the most important and common invasion centers.

Their pathogenic properties, as shown by experiments on animals, are very marked. Milk cultures of Proteus fed to mice and fowls yield were fatal in every case, death occurring in one to eight days. Post-mortem examination showed only some emaciation. The bacillus was found by the culture test in the stomach and intestines of all the animals, and sometimes in other organs, especially the kidney. A small quantity of an eight-day agar culture put into 1 c.c. of sterilized...
water, and half this injected into
the jugular vein of rats gave no result,
therefore it is probable that the pathogenic
properties of Bacillus A reside in its
form of motile organism in some
albuminoid compound.

Diarrhoea, however, was not a prominent
symptom in the animals, only
being well marked in one case.

There were two other bacilli, cultures of
which, when injected into the ear-vein
of rats, caused death. One of these,
apparently identical with Proteus Vul-
garis, gave death in 2 or 20 hours, with
active diarrhoea in a majority of cases.

The other varieties experimented
with showed no decided pathogenic
properties.

The bacteria from diarrhoeal cases
do not multiply in ordinary hydriatic
water, and only remain active a
short time in it. They all
perish and give change in milk.

Burk concedes these observations by
saying that not one of their pure organisms
but many varieties of bacteria are the cause of Summer Diarrhoea, and their action is manifested more in the production of infectious products, and in the alteration of the food and intestinal contents, than in a direct irritation upon the intestinal walls.

During the summers of 1892-1893, Boasen isolated bacteria from the rectum in ninety-two infants suffering from Summer Diarrhoea, and from the organs of thirty-three who died of it. (John Hopkins Hospital Reports, Vol V, 1893, p. 161)

The cultures were made by sterilizing glass tubes, on agar and gelatine plates. We did not try to isolate all the various varieties, but confined our attention to those found in large numbers.

The frequency of occurrence and relative number of micrococcus and of Proteus vulgaris, and the relative
nummular metastasis of B. coli and B. lactis were noted in each case. In most of these cases the symptoms were placed in pyoderma. They died a few minutes after death.

Poutre arranged his cases in four groups, according to the species of bacteria appearing to be of most importance in each, without reference to their clinical features.

Group I consisted of 35 cases in which Proteus Only was important. Clinically the symptoms were nervous and chronic. The lesions were metastatic and showed local phenomena. The stools were sometimes purulent, generally blood, with a foul and offensive, and often neutral or alkaline in reaction.

From the preparation of the faces showed enormous numbers of bacteria, chiefly bacilli. Often there was a long slender family, staining bacillus. The latter did not appear in the cultures.
There were generally some symptoms in these cases, but seldom in large numbers.

In cultures from the rectum Proteus vulgaris predominated in these cases, and was in large numbers in many.

B. lactis aureus was found in all the cases except one; generally in large numbers; in one case it was in equal numbers with B. coli, which is found in all and predominating in twenty-seven.

Group II contained twenty-seven cases in which micrococci seemed of specific importance.

These cases were very serious, and showed a general toxic disturbance. The stools were generally frequent, often green and slimey, and the odors not always offensive.

Conspicuous hemorrhoids, much micrococci in relatively large proportions, and in some cases more
numerous than the bacteria
Culture showed adenoviruses; predominant
ly in three cases, and in larger num-
bros in all except three, but in those
later they appeared in large numbers in
the serum only preparations.
B. coli was present in all, predomin-
antly in stools.
B. lactis was in fourteen; numerous
in some, more rarely in others.
Proteus vulgaris was in large numbers in
four.

Group III consisted in cases in
which were found the more un-
constant varieties of bacteria which
often of significance. The
cases were curious, with loci phrenon-
one in general.
The stools were very frequent in some,
very infrequent in others, and often
had a malodorous odor.
B. coli was numerous in all, and
B. lactis in all but one.
Group IV showed chiefly B. coli and B. lactis, the former predominating in all, and appearing as a pure culture in some. B. lactis was not so common as in other groups.

The cases were of short duration, and necropsy in a few instances the intestines were free from local phenomena. The stools were frequent or not, generally acid, and of varying consistence.

From these results, Bocken drew certain conclusions, or rather considerations, as he declined still to say anything positive, the more important of which are:

1) The conditions for the development of bacteria in the intestines of infants with immune diarrhoea are different from those obtaining in the healthy intestines of milk-fed infants. These conditions are more favourable to a greater variety of bacterial growth,
As a rule growth of the microorganisms and to a more uniform distribution through the intestines of the host constant varieties.

Thus Bocken arrives at a different opinion as to the microconstant varieties from that he held before.

2. In single micro-organisms as the specific cause of the disease, it must be attributed to the activity of many, some of which are not known, of ordinary occurrence and wide distribution, the most important being the Streptococcus and Proteus Bulgaris. The Streptococcus is present so often in the ulcerations of the mucus, and in the cases containing many hexacaryes, that probably it is important in the ulcerative process.

Proteus Bulgar is found in more than half of the serious cases, seldom in the mild. Bouillon cultures of this organism with the venom of rabbits
3. The pathological lessons in the intestine and other organs show that the bacteria are directly injurious to the tissues in some instances— in others the injury is done by soluble poisons.

Borken therefore classifies diarrhœas under three headings. The first being a "Dysenteric diarrhoea", free from inflammation, and having among its bacteria chiefly B. coli, and B. lactis in small numbers;—secondly a "Streptococcus gastro-enteritis", with extensive ulceration of the intestine, and a predominance of Streptococcus; though it is rarely, if ever, a pure streptococcus infection;—and thirdly a "Bacillary gastro-enteritis", with less extensive ulceration in the intestine. As a rule many varieties of bacilli are found in these cases, and some streptococci.
There is every one of Boek's cases, both of those narrated in the "Transactions" and in the Hospital Reports, he found the B. Coli Communis, and this is the only bacillus he did find in every case. Moreover, in his second set of observations, the B. Coli predominated in seventy cases out of a total of ninety-two, and in some of these it was a pure culture.

The appearance of the other varieties is so inconsistent, that, although admitting that different varieties do appear in larger numbers in cases with certain clinical and histological features, we cannot say that any one of them is the specific cause of the disease.

The Proteus vulgaris would certainly seem to be of importance, but the experiments performed with it upon animals seem to negative its supposed properties as a diarrheic disease organism. But the cases in which it was found did not always show much diarrhoea, and since it is so
widely distributed organic substance we are bound to consider it of much importance. And Thibert (Proc. of Paris, 26) says of
Lancé, from the enzymic action of Bact. Bulgarica.
He shall now refer to some further researches into the relationships of the
Bacillus Coli Communici.
It is known that the virulence of an
organism, especially when in a more or less autolysed condition, can be
increased by injecting along with it a
quantity of a culture of another
organism, either in a living or dead
condition e.g., an autolysed staphy-
lococcus culture may be increased in
virulence by being mixed with the
Bacillus Coli (Mair and Ritchie: "Manu-
nal of Bacteriology," p. 431)
Thus the B. Coli has the property of
increasing the virulence of other organisms.
But can the virulence of the B. Coli
itself be increased? It seems to
be no doubt that it can, but what
may be the exact cause of the increased
virulence is not so clear.
Researches on the virulence of the B. coli communi were instituted by Dr. C. J. C. Lemoine in 1893 at Geneva, and his results are given in the International Medical Journal for February 1897.

"A Study on the virulence of the B. coli in dysentery diarrhoea."

Before mentioning his own results, he discusses those of other authors, which are of great interest.

Lemaistre and Racquier say that as soon as a diarrhoea is established, the B. coli acquires a certain virulence, and inoculated in normal doses becomes pathogenic. As they obtained no results with B. coli from a normal stool, but produced a stool in mice from a diarrheal case, they concluded that the B. coli of diarrhoea has acquired a virulence. Therefore in studying this organism we must first ascertain the condition of the intestinal tract.

They examined 49 cases of diarrhoea in children; 36 of these were positive, while 13 gave no results.
therefore there must be cases of diarrhoea in which the normal B. Coli does not possess an excited virulence.

To explain the negative results they thought it necessary to consider the influence of summer, because their negative results were observed in winter, and winter cannot claim to demonstrate the influence of summer best on the virulence of the organism. They had experimented before with normal B. Coli and out of 3 cases in which the normal bacilli killed animals in three 15 days, one was in May and two in August, while the 15 negative cases were eight in winter, and three in summer.

Rokit and Rome found that in the guinea-pig a dose of 1cc. of a bronchitis culture from various sources usually caused death generally after 24 hours. Three writers from one of all the varieties of B. Coli with which they experimented, that
From a survey had the greatest part of the known case to the intensity of the lesions.

Gilbert and Frohle caused experimental cholera in rabbits by injecting a culture of B. coli from the fecal of eight diarrheal patients. They conclude that the choleraic poison of the organism belongs to it when taken from cholera feces, and that it is solely a question of virulence.

Lately, Ross Doria found B. coli pure or nearly so in a large series of cases of common diarrheaa in infants, in the feces and mucus.

Referring to his own observations, Conner says that the first question was to find out if the B. coli were common and other microbes in the feces of children with this diarrhoea. He found the B. coli present in a more constant in some cases; the
streptococci were mixed in small quantities with it in eight cases, and only once preponderated, and yet this patient was well at the end of 11 days. All the cases contained the B. Coli.

The streptococci probably played an accessory part, and disappeared or greatly diminished from the time convalescence began.

Thereupon he concludes that the virulence of the infective power of all the cases was due to Escherich's bacillus, whose virulence in virulence cannot all the other usual elements of the virulence of this other during the first few days; and he says: "it is therefore a fact that in the infantile enteritis diarrhoea, which we had under our eyes the intestinal flora became very poor; one or two kinds alone remained, but increased in their virulence. The other species were obliged to disappear as the more virulent varieties increased the virulence. These are the ordinary"
occurrences of the nitrate, which predominates, and are usually milder.

"The B. coli should be placed in the first rank, and the Streptococcus Pyogenes afterward."

In lieu of the cases the patient might not die; in the eleven other cases they died or greatly according to the virulence of the B. coli at the time of inoculation.

Thus from a study of thirteen cases Connell concludes:

1. That the B. coli appears to be the pathogenic agent in the greatest number of cases in fatal diarrheas.
2. That this organism is often associated with the Streptococcus Pyogenes.
3. That the virulence of the B. coli, more considerable than in the bowl of a healthy child, is almost always in direct relation to the condition of the child at the time the culture is taken.
4. That the virulence of the B. coli found in the blood and other organs is almost
call to that of the organism taken from the intestines of the same individual.

It is remarkable that such a very small variety of organisms was found in this investigation, compared with those found by Brodie, but they do not agree on two points, i.e., as to the constancy of the B. coli and the extreme frequency of the B. typhosus or Peyer's.

There is a difference of opinion as regards the virulence of B. coli from healthy and diarrhoeal stools, as Joffe and Hennick (B. cit. 1. 11) made seven cultures from the stools of eight cases of purulent diarrhoea, and found that they were almost unanimous, since it usually ranged from 2 to 5 c.c. of a broth culture in 15 to 20 minutes symmetrical in rabbits, while one found of the species of the same bac tonic strain from a healthy case was often fatal.
But the weight of evidence is overwhelmingly in favour of
the increased virulence of the organ-
ism, and this is authenticated 
by Dreyfuss ('Text-book of Bacteri-
ology', 2nd ed., p. 49) who found 
a decided difference in the patho-
genic virulence of the B. Coli from
healthy individuals, and from
those with intestinal disorders.

The question as to how this increased virulence is brought about is still
uncertain.

There seems to be no doubt that a
diarrhoea of any kind (e.g. on tou-
chard by Anthony (Ernst, op. cit) can
increase the virulence. But that in
any ordinary diarrhoeas such as we
have in the cool months it is very
questionable whether this virulence is
generally increased or not, whereas in
the hot months it is certainly raised

As the heat usually appears to
raise the virulence, or more
 intimately
some slight constitutional peculiarity? Kenoch (translated from Russ. of Dreams of Children, 4th edn.) says that a disturbed alimentary tract nature indicates the tendency to a fermentation dyspepsia which is always present in young individuals and carries the chance to appear in an exceedingly acute form.

In Hopis cases related already, he found almost constantly that some gastro-intestinal disturbance had preceded the attack of real mucous diarrhoea.

And Brohan (loc. cit.) says that the first attack in the Pathological Process is probably an injury to the stomach from an abnormal or excessive fermentation and secretion in the canal, or in other canals and later than allied relations. In conditions favorable for the acting of varieties which were mostly in normal contingence.
Sotman found again, in a breast attended by the nurse, at the Enfield Children's Hospital, on "The Cause and Treatment of Diarrhea in Children" related how it was affecting the hair sometimes (as already stated) got from cultivations of B. Coli in corn with which gave no effect; yet if the patient missed a carafe of the bowels and then neglected the enema, he got an acute gastric enteritis. (March 20, 1888)

This showed that the child must, prior to, go out of health, for the injection to take effect.

Emmett Holt also lays great emphasis on the theory of the heat, acting as a pre-disposing cause of diarrhoea, by setting up an initial state of dyspepsia, in hand-bed children (healing the cut Vol III) chiefly through their taking an undue amount of food.

Therefore it would seem that heat, together with a certain amount of carriage, are the two
conditions which determine by far
the increased virulence of the B. coli.

But whether these two factors have
a direct action, or this action is the
result of these two factors, plus the
virulence of the streptococcus, giving
a still higher virulence, is still open
to question.

But we must now consider again
the factors taken by milk, or any other
artificial food, in the causation.

For it is beyond a doubt that
milk does take an active share.

Finowick in his lecture referred to
above, said that if the milk be
sterilized, epidemic diarrhoea dis-
appears.

But still must always be those
cases, though very rare, in breast-fed
children, going on regardless of pre-
cautions taken for other children.

In these former, no doubt the origin-
al cancer is not influenced one way or
the other. Probably being
And too often to the breast. This would account for the cases occurring among the better classes of breast-fed children. It appears to me that milk acts in two distinct ways on the causation. Firstly, by the action of the irritant matter contained in it. This may be a catarrhal condition of the bowel set up. This catarrhal condition acting (as shown above) in such a way as to recall the evidence of the B. Coli.

Secondly, owing to the minute amount of poisonous material already manufactured in the milk, there is almost immediately a serious reflex disturbance set up from the direct absorption of this poison. That such a minute poison may be formed has been proved by Vomper (quoted by Beechey, B. M. Journal Sept. 12, 1836) who found a poisonous substance in milk ("Short粲on") which gave
symptoms like those of cholera infantum.

This second class of cases would in which all those in which a sudden acute diarrhoea is set up, existing any premonitory symptoms of dyspepsia in all children fed, partly or wholly, on milk other than that from the breast.

As for children fed on farinaceous foods it is needless to emphasize the frequency, or rather constancy, with which they suffer from dyspepsia.

Thus, as regards bacteriology, I should describe two great groups, in the etiology of infantile common diarrhoea: the first, in which the disease is caused mainly by the action of milk containing poisonous bacterial topical produce, this produce causing a catarrh which serves to make the B. coli a highly virulent organism. The second, in which the poisonous products in the milk are the diseases
inerring cause of the disease.*

There is no doubt that the large amount of preservation material, particularly lactic acid, may have considerably to swell the number of cases of child-warm in summer, in children, but this is scarcely to be included in the scope of this paper.

* It is of interest in this connection to note that Dr. R. Powel (Indian Med. Gazette April 1888 p. 142) speaks of summer diarrhoea as a) Subacute milk infection or 2) an Acute milk infection, otherwise cholera infantum, the latter due to putrefactive or allied organisms and their toxic products.

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