DIARRHOEAL DISEASES IN GLASGOW

BY

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Interest in diarrhoeal disease was intensified following the appointment of a subcommittee on enteritis in infancy by the Preventive Medicine Committee of the Medical Research Council. I am indebted to Dr. A. S. M. Macgregor, a member of the committee, for the suggestion to compile this review of the prevalence of the diarrhoeal diseases in Glasgow, with special reference to non-specific enteritis. The incidence of these diseases is indicated in the following list, which shows the average number of deaths or cases registered annually:

Diarrhoea and enteritis (all ages), 1919-38	..	..	..	422 deaths
Bacillary dysenteries, 1919-38	..	..	..	90 cases
Typhoid, 1925-38	..	..	..	41
Paratyphoid, 1925-38	..	..	..	63

The specific infections in the above order have shown an average primary fatality of 5, 15, and 5% respectively. As regards the fatality of non-specific diarrhoea, Cooper (1937), studying 300 cases of acute (mild and severe) and chronic gastro-enteritis in a Glasgow children's hospital, recorded a case mortality of 47%. A measure of the morbidity from non-specific enteritis is thus provided; because on an annual average 70% of the deaths from enteritis in patients under 2 years of age occur in hospital.

Age and Sex Distribution

The average age distribution in the non-specific group has been as follows:

	-1	-5	5+	Total
Deaths ..	298	60	64	422
Percentage ..	71	14	15	100

Infants are therefore mainly involved. In the specific groups infections of infants are few. Of 908 dysentery patients registered during the past four years, 412 (45%) were under 15 years of age, but only thirty (3.3%) were under 1 year. Similarly, only 2% of paratyphoid and less than 1% of typhoid patients are under 1 year old.

The distribution of the sexes also varies in the different groups. For dysentery it is approximately equal. Among enteric cases, especially paratyphoid, females exceed males—a reversal of sex incidence in years preceding 1914 that has been chiefly attributed to extensive wartime inoculation of males. Infantile digestive diseases, on the other hand, kill 140 males for every 100 females. However, the proportion of infantile mortality in each sex due to digestive disease is approximately the same for males and females—namely, 14 to 15%.

Annual Incidence

The "residual" numbers of the specific infections are occasionally multiplied through agencies which may or may not be recognized. Thus in 1935 forty-one pilgrims imported typhoid; in 1936 paratyphoid notifications numbered 195; and during the period 1935-8 the annual dysentery notifications averaged 227, of which 101 were notifications of infections contracted annually in institutions. Deaths from non-specific diarrhoea show relatively smaller fluctuations. During the past twenty years these have ranged between 279 and 536, excepting 1921, when they numbered 702.

The annual fluctuations in the several diarrhoeal diseases seem mutually unrelated. Between 1919 and 1938 there was increased annual prevalence of one or more of these diseases on thirteen occasions. In eight of these

years one or another of the diseases was increased alone; on the remaining five occasions varied associations between the diseases were recorded.

The average of 422 deaths, constituting a death rate of 0.374 per 1,000 living, represents a definite but disappointingly moderate improvement on the rates of 0.843 for the period 1891-1900 and 0.681 for the period 1901-10. Indeed, as long ago as 1909 and 1910 the corresponding rates were 0.130 and 0.161 respectively. On the other hand, the enteric death rate, which was 0.215 in 1891-1900, has now fallen to the low level of 0.010. As annual causes of infantile mortality, digestive diseases continue to be exceeded only by immaturity and respiratory diseases; infrequently infectious disease rises from fourth to third place.

Seasonal Incidence

The following table shows the seasonal incidence of deaths under 1 year from diarrhoea and of their quarterly peak during the decennium 1928-37:

	Quarter				Total
	1st	2nd	3rd	4th	
Deaths ..	573	603	915	941	3,032
Quarterly peak ..	..	..	7	3	10

Enteric infections, especially typhoid, and non-institutional dysentery also tend to reach a peak in the third quarter, the warmest of the four quarters; but the non-specific group alone reveals the regular occurrence in another quarter of an alternative seasonal peak. Cooper recorded that half his patients had been ill for only a week or less. The high incidence of non-specific diarrhoea in the fourth quarter is therefore not altogether due to the termination in that quarter of illnesses previously contracted.

Graham (in 1936) held that the incidence of infantile mortality from diarrhoea now tended to show a winter instead of a summer peak owing to respiratory infections. The researches of otologists in other parts of the country into the association between otitis and gastro-enteritis lend support to this view, as also to their injunction to mothers to shield their infants from adults suffering from colds or influenza. In Glasgow, too, as described below, an institutional outbreak of presumably virus origin, which caused 7 neonatal deaths among 9 cases during the early part of 1938, was marked by: rhinitis at onset, although the terminal phases consisted of enteritis. Nevertheless the seasonal behaviour of the non-specific group can still be described as generally "diarrhoeal" rather than "respiratory" in character. As indicated by the monthly mean shade temperatures, the warmest month of the year is usually July, less frequently August, and deaths from infantile diarrhoea continue to reach their monthly peak, as they did in years preceding 1914, during August or, somewhat less often, in September. Moreover, Macgregor (1933) has pointed out that while broncho-pneumonia has an irregular seasonal incidence lobar pneumonia regularly maintains high prevalence during the first four months of the year. As shown above, infantile mortality from diarrhoea is relatively low during the early months of the year. Similarly, Stirk Adams (1937) reported that paracentesis operations for otitis media in a children's out-patient department in Birmingham showed a winter crest and a September trough; whereas, as we have seen, September is a month of high incidence of gastro-enteritis.

Housing Accommodation and Fatal Enteritis

As enteritis is not a notifiable disease epidemiological information regarding cases is generally meagre. During the years 1926-32, however, information regarding size

of house and number of inmates was noted in connexion with the registration of 2,163 deaths from diarrhoea in children under 2 years of age. The opportunity has been taken to compare the housing accommodation of these children with the size of house noted in connexion with a series of births:

	Apartments				Total
	1	2	3	4+	
Births	12	37	29	22	100%
Diarrhoeal deaths under 2 years	36	52	10	2	100%

A disproportionate incidence of diarrhoea among the children in the smaller houses is apparent. This analysis also revealed, incidentally, that the housing distribution of births was very similar to the size distribution of all Glasgow houses. In the following table, therefore, one may reasonably compare the percentage of various sizes of houses known to be overcrowded in Glasgow with the percentage of overcrowded houses among the homes of the 2,163 fatal diarrhoea cases:

	Apartments				All Houses
	1	2	3	4+	
Percentage of houses overcrowded : Housing Act survey	52	43	18	4	31
Percentage of houses overcrowded : Diarrhoeal deaths under 2 years	94	80	47	23	82

A striking degree of overcrowding among the diarrhoea cases is seen when compared with overcrowding existing generally in the city.

To corroborate this finding an effort was made to ascertain the degree of overcrowding among births. Such information is available from health visitors' records regarding midwives' births—i.e., births at which there is no medical attendance. The housing conditions in a series of these births were as shown:

	Apartments				All Houses
	1	2	3	4+	
Midwives' births : size of house	37	47	12	4	100%
Midwives' births : percentage over- crowded	66	47	33	21	51

A close resemblance is seen between the size distribution of these poor houses and the size distribution, previously tabulated, of the houses of the fatal diarrhoea cases. It is therefore noteworthy that the overcrowding even among the poor homes of the midwives' births falls short of the overcrowding, previously tabulated, in the homes of the diarrhoea cases. The apparent effect of overcrowding is not due, as in the incidence of the infectious fevers, to the frequent occurrence of multiple cases in the same house; for such association of cases, which mainly concerned twins, was very uncommon.

Prevention of Enteritis

In discussing prevention practically all the authorities stress the importance of breast feeding. Still (1933) recorded that 96% of his fatal cases of infantile diarrhoea had occurred among artificially fed children. Graham laid emphasis on breast feeding, hygienic environment, and the maintenance of weight; and ascribed to children in Glasgow under 70% of their normal weight a diarrhoea mortality more than twice as high as among children of normal weight. Cruickshank (1937) specified as the important adverse factors artificial feeding, infancy, unhygienic surroundings, and raised internal or external temperatures. It is of interest to note that Ebbs (1937) also stressed the importance of breast feeding in his dis-

cussion of post-mortem examination of 880 children, 80% of whom had died under 2 years of age from all types of medical and surgical conditions. Of these children under 2 years old 238 had suffered from gastro-enteritic symptoms, and 193 of these had had otitis media, while purulent ear material had been found post mortem in 52% of the entire group studied. Only a negligible number of all these children had been breast-fed. On the whole it is accepted that breast feeding (or suitable and careful artificial feeding) and hygienic surroundings are important factors in the prevention of gastro-enteritis as of other infantile diseases. Apart from illness due to any pathogenic bacteria in prepared foods as sold, unsuitable food could obviously result in digestive disorder, while careless feeding could act by conveying infection. In Glasgow, as described above, enteritis deaths are associated with the two unhygienic environmental factors of small size of house and overcrowding of house, and such factors could presumably operate either by impairing vital functions or by facilitating the spread of infections.

Infective Enteritis

Thus both infection and physiological upset appear to play a part among the non-specific diarrhoeas. When cases occur acutely in groups infection is naturally suggested; in other instances digestive derangement seems sufficient explanation. A link between the two types of cases is provided by the work of Blacklock, Guthrie, and Macpherson (1937). They found a sequence of events in infantile gastro-enteritis consisting of impaired gastric secretion, interference with normal acidity, and ascent of coliform organisms to the upper part of the small bowel; and held that these events could be initiated by fever due to an infection as well as by unsuitable feeding, even on occasion by feeding with cows' milk.

Outbreaks of non-specific enteritis outside institutions have not attracted attention in Glasgow. In 1929 one such outbreak was discovered through its association with an epidemic of dysentery. The dysentery epidemic was regarded as comprising 51 persons, although positive specimens were obtained from 35 only. In the non-specific outbreak specimens were examined from 93 persons. At the same time as these two outbreaks were proceeding side by side a morbidity inquiry was being conducted in a neighbouring district, and no cases of infectious diarrhoea were discovered there.

The limited extent of the prevalence of the specific diarrhoeas among even infective cases of diarrhoea thus illustrated increases the importance of the non-specific group and of its study. In a few localities hospital arrangements have been made which diminish possible spread of infection within the institution and at the same time facilitate investigation. For these arrangements the energetic co-operation of the hospital administration is necessary.

Hospital Arrangements

Mitman (1937) and Joe (1937) described their arrangements for the segregation in special wards planned on the "cell" system of all cases of non-specific enteritis, primary or secondary to infectious disease, occurring in two L.C.C. fever hospitals. Special attention was devoted in these wards to the handling of food and to the prevention of cross-infections, whether respiratory or enteral.

The segregation of cases of non-specific enteritis admitted to or sickening in general institutions would also be a valuable procedure. Although open wards, preferably small, might have to be used in some instances, cubicles or compartments are desirable, since a variety of infections may be concerned. The possession of a training qualification in fever by the nursing staff attending

these cases would obviously be an advantage. Epidemiological, clinical, pathological, and therapeutic studies would be facilitated by special wards. Any grouping of cases could be recognized by noting the ward or address of sickening of the cases. The incidence and nature of parenteral complications could be recorded. Cooper, for example, found that 40% of his 300 cases had parenteral affections; of these 122 cases 78 had otitis media, 11 pyuria, and 9 bronchopneumonia. Routine examination of ears, such as was reported by Maizels and Smith (1934), could also be performed, and that preferably by an otologist owing to the difficulties in diagnosis and treatment of ear disease in young children. Chemical and dietetic treatment are aspects attracting investigation even in the present state of knowledge regarding the aetiology of the disease. Chemotherapeutic successes have not yet been reported; but the work of Anderson (1939) on the treatment of measles by sulphanilamide suggested that the latter might have some value in prophylaxis against secondary gastro-enteritis.

Enteritis and Otitis

Reference has already been made to the association between enteritis and otitis recorded by Cooper and, to a more striking extent, by Ebbs. Blacklock, Guthrie, and Macpherson found that the purulent exudate seen post mortem in 90% of their gastro-enteritis cases sometimes contained coliform organisms which had presumably spread from vomited material in the nasopharynx. As they also commented, however, other workers continue to submit that otitis may be primary to gastro-enteritis, and, in any case, otitis media figures prominently among parenteral conditions reported to be associated with gastro-enteritis.

The practical implications of this association may cause difficulty to administrators as well as to clinicians. Maizels and Smith reported case mortalities of 31%, 80%, and 50% respectively among their small groups of enteritis cases without ear disease, enteritis cases with surgically untreated ear disease, and enteritis cases treated surgically for ear disease. Such evidence implies that for the routine treatment of infantile gastro-enteritis outdoor medical services would require to be supported by specialist services or ample hospital accommodation.

Since streptococci and pneumococci are said to account for almost two-thirds and one-third respectively of middle-ear infections, Cleminson (1939) suggested the use of sulphapyridine on the first appearance of ear symptoms or signs of otitis in school children. The routine application to infants, however, of even such a chemotherapeutic measure will present a problem in proportion to the difficulty of recognizing the indications for treatment.

A Fatal Neonatal Outbreak

Some points mentioned above are illustrated by a series of related illnesses with terminal enteritis which occurred early in 1938 among the newborn children in the maternity unit of a Glasgow municipal hospital. Although the cases were afebrile infection was obviously at work. Seven of the 9 cases sickened during the first three days of the year, and the remaining 2 within forty-eight hours of each other towards the end of February. The ages at onset were 3 to 7 days. The recurrence of what was apparently the same infection took place despite the closure of the ward to admissions from early in January till mid-February and despite the introduction, on reopening with different nursing attendants, of linen masks for use during the handling of infants. Arrangements had also been made for the sterilization of infants' towels and clothes and for the use of an infant's towel once only.

The infection was obviously respiratory, for the resident medical officers reported that the onset had been marked by rhinitis with clear or purulent discharge. They took nasal swabs from 7 cases and, in connexion with the first group of cases, nose or throat swabs from 28 contacts, including mothers, nurses, and all infant contacts. The following findings were reported:

Cases: *Staph. aureus*, 2; *Staph. aureus* and diphtheroids, 1; *Staph. albus* and *Strep. viridans*, 1; staphylococci and coliforms, 1. Last two cases: diphtheroids, 1; staphylococci and *M. catarrhalis*, 1.

18 adult contacts: *Staph. aureus*, 4; *Staph. albus*, 2; staphylococci and streptococci, 11; haemolytic streptococcus, 1.

10 infant contacts: *Staph. aureus*, 4; staphylococci with streptococci and other organisms, 6.

One of the two cases which recovered was also one of the two cases whose nasal swab had yielded *Staph. aureus* in pure culture. Blood culture was attempted in one case, with negative result. One child, born of a syphilitic mother, showed purulent ophthalmia which yielded a staphylococcus, probably *aureus*. Associated infections in the ward were as follows: One case of maternal sepsis in mid-December and another early in January, a case of maternal mastitis early in January, two cases of infantile pemphigus in the second week of December, and an attack of *Staph. aureus* mastitis in an infant a fortnight after his recovery from the outbreak infection.

The terminal phase consisted of enteritis with loose or green stools and, in two instances, the appearance of blood and mucus. Death occurred on the second to the seventh day of illness and the enteritis had appeared one to four days after the onset. Stools were reported negative for staphylococci and streptococci as well as for dysentery and enteric. Similar cases occurring sporadically under different circumstances could understandably present themselves as clinical cases of acute primary enteritis. In the early group the only clinical features reported besides rhinitis and enteritis were loss of weight and, in one case, cyanosis. The last two cases were both fatal. One of these showed oedema of the face and scalp; the other showed hard swelling of the face and scalp, ophthalmia, and attacks of cyanosis with shallow respirations.

The infective agent was not identified nor was its source recognized. Necropsies were performed, however, in 4 of the 7 fatal cases, including the last 2, by the pathologist of Stobhill Hospital, Dr. F. E. Reynolds, and the deaths were ascribed to infection by a virus. Signs of severe toxæmia or of septicaemia were found post mortem. At one necropsy the findings included acute encephalitis and lateral ventricular haemorrhages; at two others haemorrhages of considerable size in various situations, including the peritoneal cavity, were recorded. In the remaining necropsy (Case No. 8) the diagnosis of virus infection was largely based on the clinical history and the epidemic context. Abstracts from the pathologist's reports are given hereunder.

Case No. 5.—No congenital abnormalities; peritoneum covering the structures in upper part of abdomen smeared with blood; lungs deeply congested; about the middle of small intestine, over a distance of 10 cm., mucous membrane haemorrhagic with haemorrhage into lumen, and below this flakes of blood clot mixed with the mucus-like contents of bowel; haemorrhage of some size into right adrenal gland; other organs, including brain, congested. Diagnosis: acute and severe toxæmia. Microscopical examination confirmed the above data.

Case No. 6.—No congenital abnormalities; blood vessels on the surface of the brain and those within its substance engorged; considerable subdural haemorrhage; lateral ventricles filled with dark blood clot; thoracic and abdominal organs deeply congested; Peyer's patches dark red in colour; distal 20 cm. of ileum deeply engorged and a certain amount

of blood in the lumen. Diagnosis: acute encephalitis with consequent haemorrhage into subdural space and into lateral ventricles. Microscopical examination confirmed the diagnosis of acute encephalitis.

Case No. 8.—Well-developed child without congenital abnormalities. Clear dark straw-coloured fluid in pleural cavities and pericardium. Much oedema and many petechial haemorrhages in scalp over vertex and occiput. Pial vessels congested and many petechial haemorrhages in brain substance, including cerebellum. Petechial haemorrhages below visceral pleura on each side and one below visceral pericardium. Several considerable haemorrhages into substance of each kidney. Congestion of lungs, especially bases, and of liver and spleen. Diagnosis: acute septicaemia.

Case No. 9.—Small child, born after 7½ months' pregnancy of mother with a positive blood Wassermann. Considerable haemorrhage into pericardium and into peritoneum. Patches of intense pulmonary congestion into which quite massive haemorrhages had occurred. Liver and spleen almost black from congestion but of average size. Congestion of kidneys, bladder, alimentary tract, and adrenal glands. Considerable oedema of scalp. Leptomeninges and brain intensely congested and some haemorrhage into leptomeninges. Microscopical examination: Brain—vessels congested but no cellular infiltration of perivascular sheaths; occasional small haemorrhages. Liver—blood sinusoids greatly congested. Lungs—in portions examined, alveoli and small bronchi filled with blood.

Summary

The notifiable diarrhoeal diseases have occasions of increased prevalence but "residual" average dimensions. Non-specific diarrhoea results in considerable relatively constant annual mortality, mainly among infants. Specific diarrhoea cases and enteritis deaths are usually highest in the third quarter. Enteritis deaths are regularly frequent also in the fourth quarter. In a Glasgow series of enteritis deaths nearly nine-tenths of the homes were small and four-fifths were overcrowded. The aetiological significance of these seasonal and environmental factors is discussed. Reference is also made to the advantage of segregating hospital cases of non-specific gastro-enteritis and to the practical implications of the recognized frequency of association in infants between enteritis and otitis.

In a winter outbreak of neonatal infections in a Glasgow institution 7 of 9 cases ended fatally after an afebrile illness characterized by rhinitis at onset, loss of weight, and terminal enteritis. The bacteriological findings in the noses or throats of cases and infant and adult contacts are reported. Four cases went to necropsy, and infection was ascribed to an unidentified virus. Abstracts of the pathologist's reports are given.

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O. M. Stout and R. J. Kositchek (*Arch. Derm. Syph.*, 1940, 42, 803) report their observations on fifty-eight patients in whom pruritus was an outstanding symptom and who were treated at first with subcutaneous and later intravenous injections of 50 c.cm. of a 50% solution of dextrose. They found that the injections were of value in treatment of serum sickness, of temporary but often prolonged value in certain kinds of pruritus, and useless for pruritus in dermatitis venenata, senile pruritus, and infectious eczematoid dermatitis.

THE PROPHYLAXIS OF THROAT INFECTION

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At this time of the year there is always a sharp rise in the incidence of infections of the upper respiratory tract. This winter the conditions of overcrowding and poor ventilation which prevail in public air-raid shelters will undoubtedly prove to be another important factor in the aetiology of these diseases. Various remedies to solve the shelter problem, such as the use of aerosols to diminish air-borne bacteria, are being investigated, but it is unlikely that these will be in operation before the winter is far advanced. In the meantime some simple method of prophylaxis which can be easily applied to large numbers of people is urgently required.

The Case for Nasopharyngeal Hygiene

The throat and nasopharynx form a natural reservoir and breeding ground for many varieties of pathogenic organisms, their dissemination into the atmosphere taking place by means of the buccal spray. A recent Ministry of Health memorandum (Straker, Hill, and Lovell, 1939) on the bacteria of the nasopharynx has shown that the carrier rate of throat-borne infections is astonishingly high, up to 20% of throat swabs yielding cultures of *Strept. haemolyticus* and 20 to 60% yielding pneumococci. *Haemophilus influenzae* showed a constant carrier rate in the nasopharynx of 60 to 65%. It has also been proved that during most of the large influenza epidemics of recent years the causal virus could be isolated from throat garglings.

Local treatment of the throat and nasopharynx has been regarded with a great deal of reserve since the last war, due largely to the conflicting results obtained in attempts to eliminate the meningococcus carrier. But in view of the pathogens which inhabit the throat in both health and disease there must still be a place in prophylaxis and therapeutics for one method of local treatment—the antiseptic throat spray. For whereas the limit of effective action of the gargle is somewhere between the pillars of the fauces, the throat spray, which projects droplets of fluid direct into the throat, brings the antiseptic into contact with the pharyngeal mucosa.

The following investigation was carried out in a large naval training establishment during the 1939-40 epidemic of influenzal nasopharyngo-tracheitis with the object of estimating the prophylactic value of the antiseptic throat spray. A solution of sodium hypochlorite (15 to 20%) was chosen as the antiseptic because it combines a powerful bactericidal action with a strong oxidizing and deodorant quality.

Procedure

Two groups each of fifty naval ratings were selected from those joining the establishment for the first time. Care was taken to ensure that these two groups should live under identical conditions in the same part of the establishment and that they should perform similar duties. From the day of joining the establishment one of these groups was subjected to a daily prophylactic routine, this being omitted in the case of the other group. The routine adopted was as follows: Each morning at 6.45, immediately after assembly, the group chosen for treatment was subjected to a throat spray of 15 to 20% sodium hypochlorite solution. The instrument used for producing the spray was a portable pressure atomizer. This consists of a hand-pressure pump fitted with a spray nozzle and