THE EPIDEMIOLOGY OF GASTRO-ENTERITIS IN INFANCY: PART II

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ANALYSIS OF FINDINGS

During the course of this analysis it was evident that discrepancies would inevitably arise in various statistical totals, particularly of epidemiological factors, due to wrong addresses given by mistake or with intent, houses found locked with nobody or only small children at home on several revisits, and various other uncontrollable circumstances. Thus, where only children were found at home, information was collected in regard to the premises, environs and what could be observed in the house, but not financial status and similar matters. Percentages in some sections were therefore of the total number of instances where data could be collected and not of the total cases investigated. Much information of interest and general use was discarded in this analysis as being insufficiently pertinent in relation to the problem under review.

A total of 770 children was investigated, of whom 380 presented with gastro-enteritis in terms of the criteria defined and constituted the sample group, and 390 were well babies who formed the control group. The excess number of controls over sample cases was due to loss of contact with children, but there was no reason to exclude any of the controls with whom contact was maintained. Of the 380 sample cases, 135 (35%), randomly selected by the method described, had bacteriological and viral studies completed, and 134 (34%) from the 390 control babies were subject to these laboratory examinations.

Clinical Histories and Examinations

Races and tribes. Only 9 Whites, 6 Coloureds and 1 Asiatic presented with gastro-enteritis corresponding to the defined criteria during the period of the investigation, and a corresponding number of well baby controls were selected in each of these population groups. This analysis therefore primarily refers to Bantu. A detailed breakdown of totals of Bantu infants was made into tribal groups of Zulu, Sotho, Xhosa, Shangaan, Tswana, Pedi, Venda, Baca, Ndebele, Khagtla, Kelanga and others. This was considered important as tribal custom has bearing on infant welfare. For example, the Shangaan mother is far less willing to go out to work and leave her infant to the care of others, and though this tribal group is often socio-economically poorer than others their infant health is often better. Though surmise could be made, no statistically valid deduction was drawn of greater or lesser occurrence in one group than in another because the number of children under 3 years of age in each tribal group was not known.

Age. All sample and control infants were aged 0 - 2 years 11 months in terms of the criteria. Further age analysis of control babies was of course not indicated. An analysis of the sample group with gastro-enteritis is shown in Table V. The greatest number of cases were in the age-group 3 - 17 months and the number thereafter progressively declined to relatively negligible levels in the group 30 - 35 months. The age incidence of the sample appeared to broadly parallel mortality in these age-groups.

TABLE V. AGE ANALYSIS: SAMPLE GROUP OF CHILDREN AGED 0 – 2 YEARS 11 MONTHS WITH GASTRO-ENTERITIS

Age in months	*No. of children*	*Percentage of total*
0–2	39	10·2
3–5	78	20·5
6–8	60	16·0
9–11	63	16·6
12–17	85	22·3
18–23	31	8·1
24–29	18	4·7
30–35	6	1·6
Total	380	100·0

Previous attacks of gastro-enteritis. Many analytical combinations were exercised but were limited by variables such as individual parental, grandparent or older sibling opinion as to what constituted diarrhoea, and ability or desire to recall such occurrence. There is a marked tendency among Bantu, even with interrogators of their own race, to give the answer most calculated to please the questioner, and this must be borne in mind in all questionnaire-based investigations in this community. The interrogator should be, but often is not, attuned to patient and tactful extraction of fact. These are examples of observations constantly recurring in this analysis which may be lost in data-processing by a computer when the resultant statistical conclusions derived from basically invalid data fed to the machine may be grossly misleading.

Within the limitations indicated, there was a history of previous attacks in 45·2% of the total of 770 cases investigated, in 50·8% of the sample group with gastro-enteritis, and 39·7% of the control group of well babies. In the age-group 30 - 35 months 85% of children investigated had a history of previous significant attacks of gastro-enteritis. There were no conclusions regarding the occurrence of other illness during the 2 weeks preceding the existent attack of gastro-enteritis. Of the children with gastro-enteritis, 63% had not been attending the promotive and preventive child health clinics for well babies where, in addition to immunization and examination, supervision, advice and supplementary feeding are given when necessary.

Clinical findings. Of the 380 sample cases with gastro-enteritis, 31 were described as malnourished as against 6 of the 390 controls. There was thus a significantly greater occurrence of malnutrition among the sample cases with gastro-enteritis than among the control of well babies without gastro-enteritis. Surprisingly few of the sample

cases were considered malnourished, but clinical assessment was by experienced medical officers of the clinic services. It might have been an advantage in the older children examined to use an adaptation of the weight/age and height/age growth charts described by Kahn and Freedman[15] in deciding on nutritional status. Possibly in malnourished infants gastro-enteritis becomes sufficiently serious to warrant admission to hospitals and this might have led to a biased view of the extent of malnutrition to be found among infants with gastro-enteritis. In fact it could be a very widespread disease with relatively fewer serious cases in relation to the total occurrence than is generally conceded.

In the 390 well babies of the control group no other abnormal clinical findings were recorded. In the sample group of 380 infants with gastro-enteritis diarrhoea started abruptly in 220 and gradually in 160; in 184 it was profuse, 49 had blood in the stools and 139 had mucus. Vomiting occurred in 190, and was associated with feeds in most instances; in no case was blood present in the vomitus. Most cases had a rectal temperature of 98·6 - 100°F, while 58 had pyrexia over 101°F and the temperature was subnormal in 87. Weight loss could not be properly assessed. Dehydration determined by the signs defined was present in 90 at the time when they presented to the clinic services, suggesting that either 290 had the disease in a less virulent form, or medical aid had been sought quite promptly after onset. Apathy was exhibited by 166, red and excoriated buttocks by 121, and refusal of food by 163, which was of significance because the 210 who did not refuse feeds were children whom mothers could attempt to feed if feeding had to be resumed after a short period of starvation in terms of modern therapeutic concept, provided vomiting permitted reasonable retention. Rapid respiration was observed in 12, intestinal distension in 50, and jaundice in only one. Sclerema was not seen at all. One case of the sample group was known to have died of gastro-enteritis. None of the controls was known to have died of any cause.

Socio-economic and Environmental Investigations

The completed questionnaires showed some lack of initiative in probing potential avenues opened, and these may warrant subsequent investigation.

Household and family. The only interesting fact to emerge from tenure of Bantu premises was considerable unpermitted subtenancy which had no bearing on the problem except that it contributed to overcrowding. In 717 families investigated, 66 consisted of 1 - 4 members, 421 of 5 - 9 members, 212 of 10 - 14 members and 13 of more than 14 members. In only 36 families children were attending nursery schools. Occupation of the father could not be determined in many instances because the child was illegitimate. In 351 instances the father fell into the category of labourer, bricklayer, shop assistant, welder, scrap dealer or the like; in 116 he was a 'white collar' or clerical worker; in 6 a professional; in 38 he had no occupation; and in 3 he had died. In 530 families there were 1 - 2 contributory wage earners, in 154 there were 3 - 4 wage earners, in 14 there were 5 - 6 and in 10 there were none.

In the most important matter of total family income, apparently deduced with relatively facile accuracy in surveys conducted to determine this aspect by other enterprise, this investigation reached deadlock. The clinic services know from long experience the difficulty in determining Bantu family incomes during complex almonizing to calculate, in most instances nominal, fees of 25 cents for attendance at curative and midwifery units based on income and dependants. The same difficulties operative in these circumstances were found in this investigation when many mothers, grandmothers or other children who came with infants, or were present at home during the day when the father was at work, had no concept of the breadwinner's earnings, nor had they the traditional status to convey such information. Many of those who might have known had not divulged factual information. Direct questioning of heads of households when these could be contacted was not necessarily conducive to accuracy.

It is widely accepted from other surveys and observations that the Bantu community has undergone marked socio-economic advancement but that the average income still remains below basically adequate levels. We were unable to draw sufficiently valid conclusions from the data obtained. A total of 81 persons contributed to family incomes by receipt of pensions or grants, but families were inadequately aware of the full extent of facilities available to them in this field. The extent of acquisition of often luxury articles by hire purchase was not anticipated. Of 719 families who could be adequately investigated, 343 were paying hire purchase, and amounts paid by Bantu varied from R1 to R50 per month. It would be unwise to assume that higher wages would necessarily result in improved feeding without intensive health education.

In this latter somewhat intangible science, effectivity of result should not be measured by the amount of talk or demonstration, but by the alteration, and duration of alteration, of previously established habit. Neither in any of the household and family factors discussed, nor in others such as maternal parity, numbers of children under 5 years of age in families, or children attending schools, was any significant variation between sample and control groups found.

Living pattern. Twenty families were found adherent to traditional Bantu tribal custom and living pattern even though resident in a modern urban area. Only 303 could be described as having fully adopted European living patterns, while the remaining families presented mixed patterns with retention of Bantu tradition and customs to greater or lesser degree. In 46·3% of Bantu families the father was the head, in 25·5% the grandfather, in 4·8% the mother and in 6·7% some other person such as an uncle, aunt, brother, sister or foster-parent. In only 19 instances did the head of the family not live in the same house, and 8 of these were foster-mothers. There was no significant difference between sample and control groups.

Illness in the home. Investigation was directed to present illness in families of sample and control groups, illness in the past 2 weeks, and specifically to diarrhoea in the past 2 weeks. Apart from the diarrhoea, a wide

variety of mostly minor concurrent illness had occurred which, however, revealed no consistent relationship to gastro-enteritis. Thirty-two adults and 89 children in the families of sample and control infants had diarrhoea in the 2 weeks preceding selection of these infants. Though not statistically valid, more sample infants came from homes where diarrhoea had occurred than did controls. No index case with several secondary cases in the household or locality was detected.

Premises. In 61% of the families investigated, 6 - 10 persons slept in the same house, in 19% of the families 1 - 5 persons, and in 16% there were 11 - 15 persons. In 2 'houses' in the last remaining slum, now being disestablished, there were 21 - 24 inhabitants. Among 726 families, 613 lived in 3 - 5-roomed houses, 111 in 1 - 2-roomed houses and 2 in houses with more than 5 rooms. If, instead of calculating floor space, overcrowding was considered present when the number of persons living in a house was more than double the number of rooms, then 417 families were overcrowded and 307 were not. Overcrowding had no apparent relationship to sample and control groups and was in fact higher in the homes of the well babies of the control group than in the homes of the sample babies with gastro-enteritis.

Of the homes investigated, 14·1% were classified as poor, 76% fair and 8·5% affluent, and as would be anticipated by those who work in this community, the majority were clean. Neither the state of the premises nor that of the grounds had any particular relation to sample or control groups.

All the homes had water-borne sewerage except for 39 in the slum, and, of these, 21 were homes of sample infants and 18 of control infants. In 60% of the homes no dogs, cats, fowls or any other animal were kept, and their presence or absence, or recent illness among them, had no significance in this analysis. Signs of rodent infestation were found in 43% of homes and cockroaches in 54%, but there was no significant distribution in sample or control groups. Though the study was done in the summer months, no flies at all were found in 66 houses. Nearly twice as many sample cases came from fly-infested homes as did controls.

Water supply. A pure, bacteriologically and chemically monitored water supply from the municipal mains was used by all families. An indoor tap was provided in 23% of the homes and an outdoor tap on the site in 72%, and a communal stand pipe and tap was used by 5% of families. No special relationship to sample or control groups was found.

Milk supply. Many families of both groups used fresh, powdered or tinned milk from time to time. Fresh milk was used by 49% of families; in 22% of these instances the fresh milk was obtained from illegal milk pedlars, who obtained supplies from nefarious sources, and the remaining families obtained milk from properly licensed dairies or cartoned milk from licensed shops. The families who obtained their fresh milk from pedlars included more sample cases (57·5%) than control cases (42·5%). When later assessed in regard to feeding of the infants of the study, fresh milk seemed of importance.

Meat supply. Meat was obtained from licensed butcher shops in 712 instances and from pedlars and other uncontrolled sources by 6 of 718 families. Offal was eaten by 509 of these families, and, unlike meat, the majority of 360 obtained their supplies from uncontrolled pedlars and other illegal outlets. Offal was eaten frequently and formed an important part of the diet. In the total sample and control infants 30% were fed meat, and 60·9% of these were sample infants with gastro-enteritis and 39·1% were well babies of the control series.

Infant feeds. In only 717 of the families were the informants considered sufficiently reliable to permit inclusion in this section of the analysis. Of these sample and control infants 10% were wholly breast fed, 39% received both breast and artificial feeding and 51% were artificially fed. Sample infants constituted 57·8% of the artificially fed children. Of all the infants receiving artificial feeding 13% had fresh milk, 82% powdered milk and 5% condensed tinned milk. It was possibly providential for infants that bottle-fed babies received mostly powdered or tinned milk. Of the infants receiving fresh milk, 78% were sample cases with diarrhoea and 22% were well baby controls.

Of 525 infants fed gruel, 359 had it from a spoon and 166 from a bottle, of whom 58% were sample cases and 42% controls. There was a higher incidence (70%) of gastro-enteritis among children fed solids. Data suggested that gastro-enteritis was more frequent when food was prepared for the whole 24-hour period than when single feeds were individually prepared. Refrigeration was found in 9% of homes.

Reasonable protection from contamination was recorded in 58% of observations. In the remainder, possibly due to awareness of the strong views of medical personnel, no sufficiently accurate information could be obtained regarding 'topping up' and multi-purpose use of feeding bottles to permit any worth-while conclusions. In 528 reliable assessments 400 of the infants had their bottles washed after each feed and 128 once daily, but this showed no significant relation to sample or control groups. Only 134 had boiled feeding bottles. Hypochlorite cleansing was never used. Water alone was used for washing bottles in 16%, water and a brush in 17% and water together with some agent in 67% of cases.

Agents consisted of various soaps, a considerable range of commercial detergents, washing powders for laundry purposes and abrasives, paper, sand, mealie rice, mealies and, in one enterprising instance, toothpaste.

Dummies were only employed in 14% of 701 reliable observations, and supported the frequently-seen use of the feeding bottle as a comforter. This manifestation of widespread demand feeding may be anathema to experts but has a place in certain societies, and may well have a place in so-called developed communities where it is precluded on the grounds of scientific rationalization rather than the truth of social convenience. The habit of 'gum feeling' is high in some sections of this population. None of these factors was shown to have especial relation to sample or control groups.

Medications. Though it was thought unwise to attempt the drawing of valid statistical conclusions in regard to

sample and control groups, some unexpected and accurate information was nevertheless obtained, which might have considerable association with the initiation or exacerbation of gastro-enteritis. Of 721 infants in this series, 18% received different medicines from time to time, derived from various sources, 54% received laxatives at various times and 53% enemata. The precise relationship to the onset of gastro-enteritis in the sample group could not be accurately determined. These procedures were of broadly equal distribution in the sample and control groups. Substances used as laxatives were a variety of proprietary preparations and baby powders, magnesia, castor oil, sweet oil, magnesium sulphate, traditional European folk remedies of this country and Bantu herbal medicaments. In some of these infants milk of magnesia was given 3 times weekly, 4 received Bantu herbs, 1 castor oil twice weekly, a month-old Zulu infant received a laxative once weekly and enemata twice weekly, and another castor oil twice weekly and an enema once a month.

In some instances laxatives and enemata may have initiated significant diarrhoea and they were frequently given when loose stools spontaneously occurred. Substances used as enemata included plain water, soap and water, garlic, 2 drops of Dettol in half a cup of water, vinegar, milk, pepper in warm water, Dettol and salt, mint, and seawater (held in high repute in this area distant from the ocean). Herbal concoctions were often used for enemata given for loose stools and for fever. These various concoctions were of some unidentified herbal powder, thorny aloe boiled in water, unknown leaf extracts, peach leaf extracts, '*Lengona*', and a liquid extract of unidentified herbs grown in the backyards of some premises. Identification of these substances warrants further study. One 3-month-old infant was reputedly given a small soap enema every other day and a 9-month-old child a mint and water enema every other day.

Responsibility for infant care. The mother cared for her own child in 74% of the total of sample and control children in this series, and grandmothers in 16·6%. Young children were 'baby minders' in 3·7%. The others were cared for by adult relatives. In support of an earlier contention in this paper that the Shangaan mother is less willing to relinquish care of her infant was the fact that care by the grandmother fell to 3·1% in predominantly Shangaan areas.

Many other factors were analysed, ranging from napkins to comprehension by those questioned, but proved insufficiently relevant to warrant comment. One unrelated but common observation was how seldom infants of this series were put out of doors, which may have influence on the occurrence of rickets in this sunny climate. As Hansen[2] points out, rickety babies are very prone to gastro-enteritis.

Bacteriological and Viral Isolates

A total of 405 specimens were submitted for laboratory examination, 269 of which were stool specimens and 136 from feeds of sample and control infants randomly selected as previously described. In 133 infants from whom stools were sent, no feeding receptacle content was available or it was found that they were breast fed. All instances in which food specimens were sent had concurrent submission of stool specimens. Of the 269 stools 135 were from infants of the sample group and 134 from the control group. Of the 136 specimens of feeds submitted, 76 were from sample cases and 60 from control infants.

Organisms were not categorized as pathogens or non-pathogens, as it was thought that in some cases of gastro-enteritis virtual commensals attain pathogenicity under certain circumstances.

Isolates are shown in Table VI. All the 136 food specimens yielded isolates singly or in combination. In only 2 instances were the same isolates recovered from the food and stools of an infant, *Staphylococcus aureus* and enteropathogenic *Escherichia coli* B4.0111.

In 10 instances stool specimens were discarded. Specimens yielded isolates singly or in combination. Of 131 stools from sample-group infants with gastro-enteritis, 34 had no significant isolates, and of 128 stools from control infants who were well 43 exhibited significant isolates. Whether these controls could be classified as carriers in the accepted sense of harbouring the infective agent after recovery from the clinical disease, or whether harbouring of the agent was due to an entirely subclinical primary infection, was debatable. This asymptomatic carrier or subclinical infection rate among the well-baby controls for all isolates was 33·6%, for salmonellae 2·3%, shigellae 2·3%, coxsackie virus 9·3% and for enteropathic *Escherichia coli* 15·6%. Poliovirus isolations were probably related to routine live poliovirus oral vaccination in these areas.

Conclusions from the Analysis

Certain more salient points emerged for subsequent consideration.

1. The age of highest incidence among Bantu in the series of sample cases was 3 - 17 months and fell to negligible levels when 3 years was attained.

2. No viral or bacterial organism isolated could be described as a specific aetiological agent in the causation of gastro-enteritis in this area.

3. As in many other conditions such as those due to *Toxoplasma gondii* or TRIC virus, clinical manifestation should not necessarily be attributed to organisms isolated which may be found normally in large numbers of the population without causing clinical disease.

4. Pathogens and potential pathogens were isolated from the stools of infants with gastro-enteritis, but in some instances none were isolated from these cases. On the other hand, similar organisms were isolated from the stools of numbers of infants of the control group who had no apparent illness of any sort.

5. All feeds submitted for laboratory examination yielded isolates, but in only 2 was the same organism found in the food and stool of an infant.

6. While accepting that a sample case with gastro-enteritis might well have been a control if randomly selected after recovery, with weighting of socio-economic and environmental data, and similar argument applied

TABLE VI. ISOLATION OF ORGANISMS FROM STOOLS AND FEEDS OF SAMPLE AND CONTROL INFANTS

Organisms	Total isolations	Isolation from sample group	Isolation from control group	Sample group		Control group	
				Isolation food only	Isolation stool only	Isolation food only	Isolation stool only
Klebsiella aerogenes	65	36	29	36	—	29	—
Klebsiella pneumoniae	69	43	26	43	—	26	—
Streptococcus faecalis	50	31	19	31	—	19	—
Streptococcus viridans	17	9	8	9	—	8	—
Enterobacter cloacae	47	29	18	29	—	18	—
A. anitratus	10	7	3	7	—	3	—
B. subtilis	18	7	11	7	—	11	—
C. freundii	7	4	3	4	—	3	—
B. cereus	3	2	1	2	—	1	—
B. providence	2	2	—	2	—	—	—
Serratia marcescens	3	2	1	2	—	1	—
Aeromonas formicans	1	1	—	1	—	—	—
Aeromonas liquifans	3	2	1	2	—	1	—
E. coli	54	36	18	36	—	18	—
Non-haemolytic streptococcus	8	5	3	5	—	3	—
Staphylococcus albus	9	5	4	5	—	4	—
Staphylococcus aureus	22	12	10	1	11	—	10
Hafnia alvei	1	1	—	1	—	—	—
Alcaligenes faecalis	1	1	—	1	—	—	—
Pseudomonas pyocyanea	8	6	2	6	—	2	—
Pseudomonas species	2	—	2	—	—	2	—
A. Iwoffi	8	3	5	3	—	5	—
Proteus mirabilis	2	1	1	1	—	1	—
Proteus vulgaris	2	1	1	1	—	1	—
Clostridium welchii	2	—	2	—	—	2	—
Alkalescens-Dispar	1	1	—	1	—	—	—
Citrobacter freundii	1	1	—	1	—	—	—
Shigella flexneri	12	11	1	—	11	—	1
Shigella newcastle	7	6	1	—	6	—	1
Shigella sonnei	7	6	1	—	6	—	1
Shigella schmitzi	1	1	—	—	1	—	—
Shigella large sachs	1	1	—	—	1	—	—
Salmonella aberdeen	1	1	—	—	1	—	—
Salmonella johannesburg	1	1	—	—	1	—	—
Salmonella typhimurium	4	3	1	—	3	—	1
Salmonella newport	1	1	—	—	1	—	—
Salmonella lindeberg	1	1	—	—	1	—	—
Salmonella labadia	1	—	1	—	—	—	1
Salmonella heidelberg	1	—	1	—	—	—	1
Enteropath *E. coli* B4.0111	8	5	3	3	2	—	3
E. coli B16.0126	7	4	3	—	4	—	3
E. coli B6.026	2	1	1	—	1	—	1
E. coli B5.055	12	8	4	—	8	—	4
E. coli B14.0119	5	2	3	—	2	—	3
E. coli B8.0127	7	3	4	—	3	—	4
E. coli B15.0125	2	1	1	—	1	—	1
E. coli B7.086	1	—	1	—	—	—	1
Virus group A coxsackie	20	11	9	—	11	—	9
Group B coxsackie	10	7	3	—	7	—	3
Type I polio	3	2	1	—	2	—	1
Type III polio	1	—	1	—	—	—	1
Polio	1	1	—	—	1	—	—

to the pattern of laboratory findings, nevertheless fortuitous selection did not exclude recommending certain factors for further attention which emerged as salient from the plethora of clinical, social and environmental data.

7. Malnutrition, fresh milk, meat and offal supplies, illegal hawking of these commodities, fly control, the abuse of medications and enemata by Bantu, the period of introduction of solids into the infant diet and the importance of hire purchase in lower income groups with maldistribution of income with regard to priority expenditures appeared as target areas against which some of the control measures to interrupt the complex epidemiology of gastro-enteritis will need to be directed.

8. The socio-economic and environmental factors in Bantu which the analysis emphasized are not apparent in communities in which gastro-enteritis of infancy is not a problem.

(To be concluded)