SECOND CARNEGIE INQUIRY INTO POVERTY

AND DEVELOPMENT IN SOUTHERN AFRICA

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An Investigation of a Cholera outbreak at the Umvoti Mission Reserve, Natal. A Non-Water borne Epidemic?

by

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1) BACKGROUND

1.1 THE CHOLERA[1] EPIDEMIC IN SOUTH AFRICA AT THE TIME OF THE SURVEY

At that time epidemic cholera in South Africa had spread to many black rural and periurban areas.[2),3)]

1.2 THE CHOLERA EPIDEMIC IN THE VICINITY OF THE RESERVE

The area under investigation, Umvoti Mission Reserve, is situated immediately south of Stanger, 75km north of Durban. A cholera outbreak at the Reserve was first recognized by the Department of Health and Welfare on 19th November 1981[4)] but rumours suggested that the first cases could be traced back to the 12 November 1981, when a family from the Reserve had come back ill after visiting friends in a cholera affected area further north. (Refer to Fig.1 Centre page).

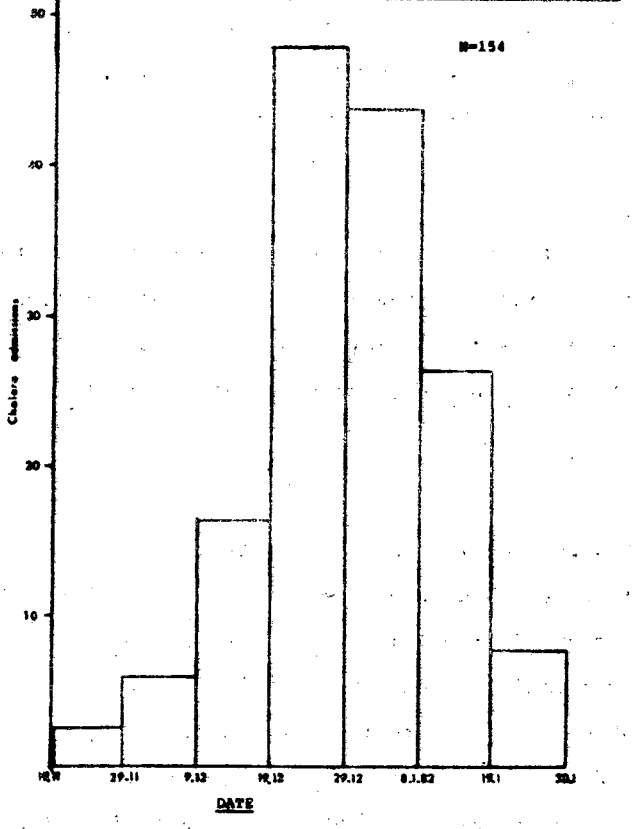
In the Reserve's vicinity the epidemic began in November 1981 and lasted until April 1982. Besides the Reserve, areas such as Etete, Shakaskraal, Maphumulo and other districts were affected. It is assumed that all patients from the Reserve received treatment at Stanger Hospital in that it is the nearest one available.

The intake procedure at the hospital was as follows:
For each person admitted with cholera-like symptoms a "suspect" cholera investigation form was completed by the Department of Health and Welfare.[5)] Faecal samples were obtained from each patient and only records of laboratory

confirmed cases were kept. Indications are that 30% of patients with the above symptoms were not confirmed by laboratory tests[6]. Their investigation forms were therefore discarded. Consecutive data of cholera patients from the Reserve were kept from 19 November 1981 until the end of January 1982, after which the magnitude of patients admitted for treatment made record-keeping difficult.

Figure 2 shows the number of laboratory confirmed cholera cases from the Reserve between 19 November 1981 and 31 January 1982. During this period a total of 155 cases was recorded, 154 of which could be traced to their settlement types (shown in Fig.1) using the relevant information listed in the cholera investigation forms. The information gathered from these 154 cases forms the basis of this study.

FIG 2 LABORATORY DIAGNOSED CHOLERA ADMISSIONS FROM THE HINTERLAND OVER THE PERIOD STUDIED (17.11.1981-30.1.1982)



2. INTRODUCTION

2.1 The Umvoti Mission Reserve

The Reserve has a population of about 20 300 people all of whom are black.

Using historical and social descriptions[7),8)] data on land-ownership, permanence of housing, water facilities (see below) and informal interviews conducted by the author, the Reserve can be divided into two class categories of rich and poor.

Category 1

This comprises the landowners and local entrepreneurs who reside in settlement types 1 to 5. Some of the landowners grow sugarcane, whereas many find it more profitable to sow people on their land, who pay a yearly or monthly rental to them.

Category 2

This category comprises mainly squatters who have been moving into this area since the 1930's in the hope of finding accommodation and work in the sugarcane fields and urban industrial centres. These comprise settlement types 7 & 8, which are characterised by overcrowded primitive shelters made of a variety of scrap materials. In some instances overcrowding excludes the possibility of building toilets[9)]. Furthermore, there is a general reluctance to build any permanent shelters for fear of eviction [10)].

There is a general reluctance[11] to build any permanent structures since the entire population is destined to be resettled into KwaZulu.. The future of the Reserve is to this date uncertain.

2.2 SETTLEMENT TYPES

Demographic surveys of the area have been conducted by the Natal Town & Regional Planning Commission[12] during 1981 and 1982 based on permanence of housing materials, permanence of water supply and permanence of ablution facilities. Although in some cases the observations are unsuited for health analysis they are the only data available on the area to date.

Table 1 shows the criteria used to classify houses, ablution facilities and water source into permanent and non-permanent categories.

TABLE 1

Criterion 1 BUILDING MATERIALS	Criterion 2 ABLUTION FACILITIES	Criterion 3 SOURCES OF WATER
PERMANENT	PERMANENT	PERMANENT
Brick and mortar - iron asbestos and tilings. Wood and iron - iron, asbestos	Pit latrines, septic tanks, water borne sewage or sewage removal.	Private rain tanks public tanks, tankers, boreholes towns or townships, mains.
NON-PERMANENT	NON-PERMANENT	NON-PERMANENT
Packing cases, wood iron-plastic, iron asbestos, thatching Wattle & daub, daub & cartons - iron asbestos, thatching plastic sheeting.	No facilities or veld Buckets and combination of no facilities and pit latrines.	Rivers, springs, dams combinations, rivers and private tanks or springs and private tanks.

The settlements were then divided into 8 types according to the permanence of the above criteria as shown in Table 2.

TABLE 2 - SETTLEMENT TYPES

Settlement Type	Criteria 1 - 3		
	1. Building Materials	2. Ablution facilities	3. Sources of Water
1.	Permanent	Permanent	Permanent
2.	Permanent	Impermanent	Permanent
3.	Permanent	Permanent	Impermanent
4.	Permanent	Impermanent	Impermanent
5.	Impermanent	Permanent	Permanent
6.	Impermanent	Impermanent	Permanent
7.	Impermanent	Permanent	Impermanent
8.	Impermanent	Impermanent	Impermanent

The average population/settlement is 7 members per household[13].

TABLE 3 - DISTRIBUTION OF POPULATION ACCORDING TO SETTLEMENT TYPE

Settlement type	Population	%
1.	987	4,9
2.	-	-
3.	182	0,9
4.	252	1,2
5.	5971	29,3
6.	-	-
7.	12614	62,0
8.	350	1,7
TOTAL	20356	100,0

Of 8 settlement types, 6 are present in the Reserve (see table 3). The bulk are made up of group 7, 62%, which are mainly wattle and daub or cardboard and tin shacks built in the periphery of the Groutville Village and type 5 settlements, 29,3%, comprising the Groutville village (No. 49), Lloyds (No. 2) and part of N'Choweni (No. 2).

2.3 WATER SOURCE

The source of water in the settlement types varies consider-

ably from raw river water to chlorinated piped mains. A tanker system operated by 4 trucks owned by the Department of Cooperation and Development is responsible for distributing water into 2 000 litre tanks placed in various settlements. The water costs 1c/25 litres. The supply is generally unreliable because of mechanical breakdowns of the trucks. There are some boreholes in the area but as the water is salty people avoid drinking it. Most people in groups 7 and 8 rely on rivers or springs for their water requirements and only 22,67% have access to a water tank or tanker (table 4).

The data at hand do not show the quantity of water used, but in most cases people use 20-251 plastic or metal containers for water transport and storage.

TABLE 4 - DISTRIBUTION OF THE POPULATION ACCORDING TO WATER USE AND SETTLEMENT TYPE

	Impure - - - >			<- - - - - - - - - - - - Pure - - - - - - - - - - - - >						
Settlement Type	River	Spring	Borehole	Tanker	Private Tank	Public Tank	Company piped	Mains piped	Town piped	TOTAL
1.				122	610			255		987
3.	182									182
4.	252									252
5.			805	1708	2513		210	525	210	5971
7.	6934	2762		638	1867	423				12624
8.	319	32								351
Total	7687	2794	805	2468	4990	423	210	780	210	20367*

* Note: The final figure is higher than the given population figure due to the rounding off of numbers. In some cases settlements use a variety of sources and to draw up this table the population was divided equally according to the number of water sources it used.

2.4 ABLUTION FACILITIES

It is difficult to draw any conclusions about ablution facilities in that the only well built toilets are settlement type 1, the other types have pit privies constructed of tins, boxes, wattle, daub or other impermanent materials.

3) METHOD

The addresses of 154 consecutive cholera patients admitted at Stanger hospital between 19 November 1981 and 31 January 1982 were traced on a map of the Reserve supplied by the Natal Town & Regional Planning Commission which was compiled out of the results of extensive surveys of the area **.

The tracing of the patients was done using the data on the cholera investigation forms and with the assistance of members of the Reserve who were familiar with the area.

Great care was practiced in tracing households in area where more than one settlement type was present.

Once traced, the following analyses were made:

3.1 The age and sex distribution of patients
3.2 Simple analysis of the results was undertaken and the data were further analysed using the X^2 test* to check for the following associations between cholera incidence and:
3.3 Socioeconomic condition **
3.4 Water quality **
3.5 Permanence of housing

* The X^2 test employed here uses the Bonferroni correction. Furthermore this test is based on the assumption that "Healthy"= Total pop in group - "Ill". (Cholera admission).
** See introduction

3.6 Permanence of ablution facilities and
3.7 Association between socioeconomic condition and water source
3.8 Furthermore, the patients were sorted according to date of admission to Stanger hospital. Using this list records were sorted for:
   a) Patients who were related to each other (Intrafamial Transmissions)
   b) Patients who were next-door neighbours (Neigbourhood Transmission)
   c) Patients where it was suspected they were related, the inconsistencies being spelling or omissions of a certain minor piece of evidence (Suspect Intrafamial Transmission)
3.9 The number of days lapsed between the index and secondary cases was recorded
3.10 Their sex recorded
3.11 Ages of the above sorted according to "adult" (over 15 years) and "child" (under 15 years)
3.12 The settlement type of the intrafamilial cases recorded and finally
3.13 The geographical distribution of the epidemic was analysed over time (Time/space study) bearing in mind the flow of the rivers and streams in the Reserve.

4.0 RESULTS

The results of the study are presented in Fig.3 and tables 5-15 below

FIG. 3 AGE-SEX DISTRIBUTION OF CHOLERA PATIENTS

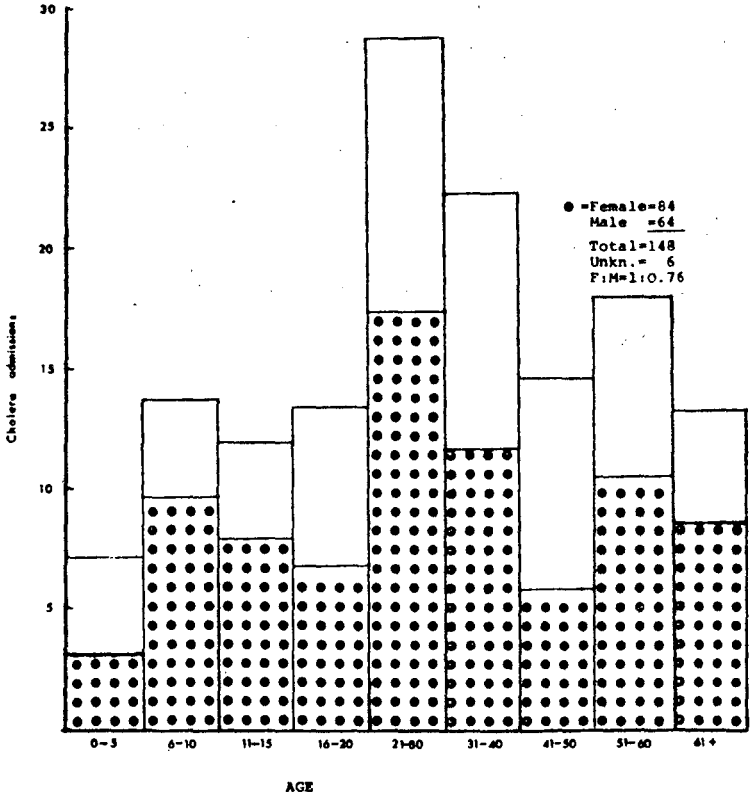


TABLE 5 - INCIDENCE OR LABORATORY DIAGNOSED CHOLERA ACCORDING TO SETTLEMENT TYPE			
Settlement Type (a)	Cases	Population	Incidence/1000
1.	1	987	1,0
3.	2	182	11,0
4.	0	252	0
5.	16	5971	2,7
7.	139	12614	10,4
8.	6	350	17,1
TOTAL	154	20356	$\bar{X}$ 7,6

(a) Settlement types 2 and 6 do not exist in the area under study.

TABLE 6 - ASSOCIATION BETWEEN CHOLERA INCIDENCE AND SOCIOECONOMIC CONDITION			
	Cholera Admissions	Total Population	Incidence/ 1000
Richer Settlements 1-5	19	7392	2,6
Poorer Settlements 7-8	135	12964	10,4
DF=1 X^2=42,4 p<<0,002 Sign at the 0,05 level			

TABLE 7 - ASSOCIATION BETWEEN CHOLERA INCIDENCE AND WATER PURITY			
	Cholera Admissions	Total Population	Incidence/ 1000
Pure water users	51	9886	5,2
Impure water users	103	10481	9,8
DF=1 X^2=13,8 p< 0,002 Sign at the 0,05 level			

TABLE 8 - ASSOCIATION BETWEEN CHOLERA INCIDENCE AND HOUSING PERMANENCE			
	Cholera Admissions	Total Population	Incidence/ 1000
Permanent Housing	3	1421	2,1
Impermanent Housing	151	18935	7,98
DF=1 X^2=6,13 p<0,1 Not sign at the 0,05 level			

TABLE 9 - ASSOCIATION BETWEEN CHOLERA INCIDENCE AND ABLUTION FACILITIES

	Cholera Admissions	Total Population	Incidence/ 1000
Permanent	148	19754	7,5
Impermanent	6	602	9,97
DF=01 X^2=0,51	p<0,1	Not sign at the 0,05 level	

TABLE 10 - ASSOCIATION BETWEEN SOCIOECONOMIC CONDITION AND WATER QUALITY

	Pop. using pure water	% of total a or b	Pop.using impure water	% of total a or b	TOTAL POP.
a. Richer settlements	6958	94,1	434	5,9	7392
b. Poorer settlements	2928	22,6	10047	77,4	12975
DF=01 X^2=8458	p<<0,0005	Sign at the 0,05 level			

TABLE 11 - ANALYSIS OF INTRAMILIAL/NEIGHBOURHOOD TRANSMISSION AT THE RESERVE

	No. of Incidents	No. of people Involved
a. Intrafamilial	22	47
b. Neighbourhood	4	9
c. Suspect	1	2
TOTAL	27	56

TABLE 12 - TIME LAPSED BETWEEN INDEX AND SECONDARY CASES

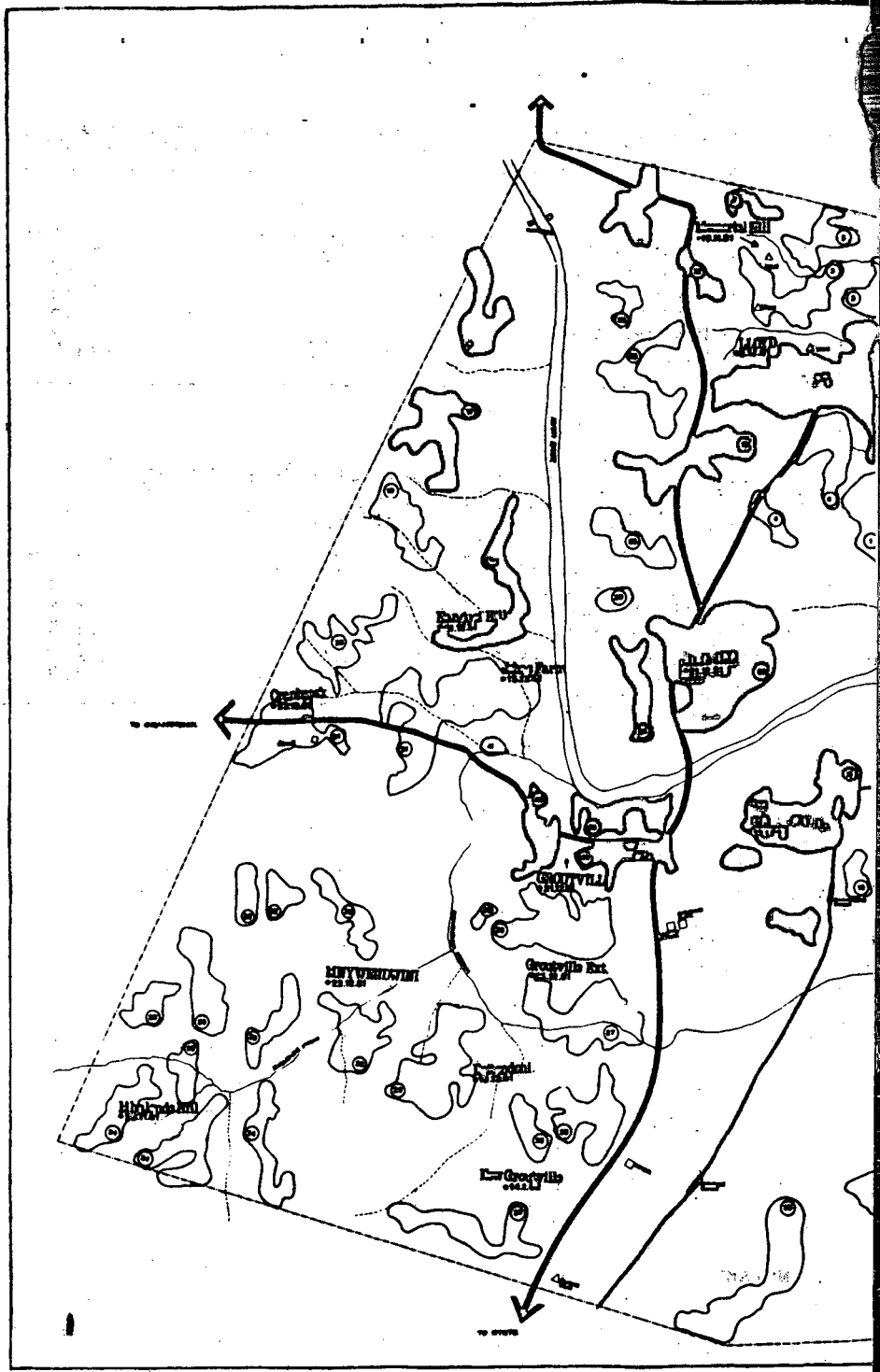
No. of days between Index & Secondadry	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
No. of incidents	10	5	4	3	0	1	1	0	1	0	0	0	1	0	1

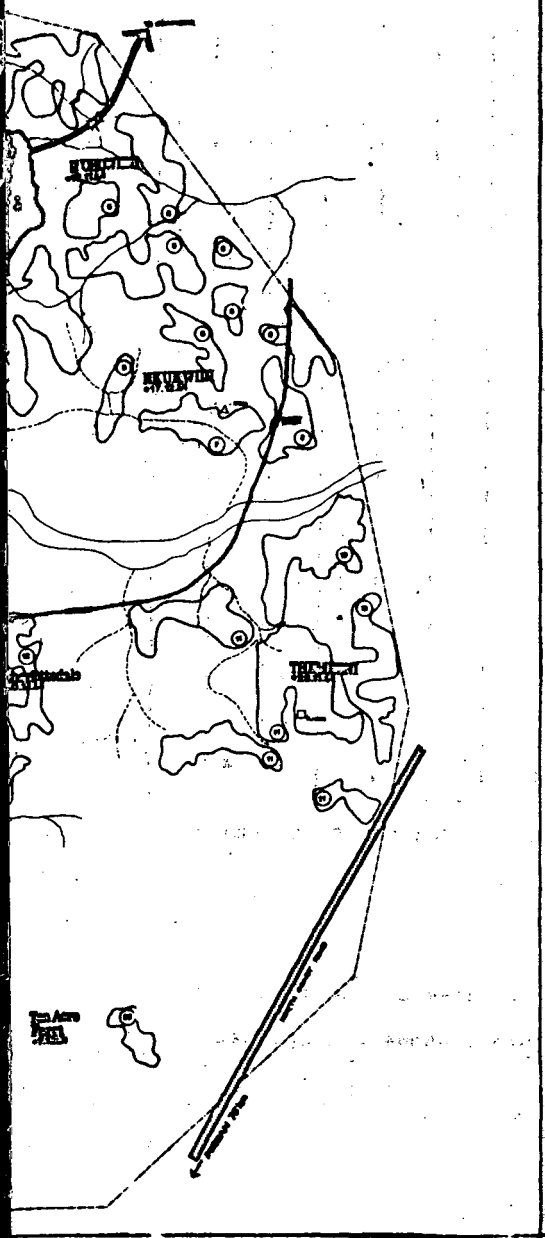
TOTAL = 27

WS1AEJ

TABLE 13 - ANALYSIS OF TRANSMISSION INCIDENTS ACCORDING TO AGE		
Transmission among:	Incidents	%
Adult Peers	14	52,0
Adult to Child	6	22,2
Child to Adult	3	11,1
Children Peers	2	7,4
Unknown Age	2	7,4
TOTAL	27	100

TABLE 14 - ANALYSIS OF TRANSMISSION INCIDENTS ACCORDING TO SEX		
Transmission among:	Incidents	%
Female to Female	10	37,0
Male to Female	6	22,2
Male to Male	5	18,5
Female to Male	5	18,5
Female to Unknown	1	3,7
TOTAL	27	99,9





LEGEND

- Healthy areas
- Poor areas
- Date of outbreak

SCALE

SETTLEMENT NUMBER	POPULATION	WATER SOURCE	SETTLEMENT TYPE
1)	671	River/Public Tank	7
2)	3416	Private Tank/ Town	5
3)	903	Spring/Pubs Pvte.Tank	7
4)	266	Spring/Pubs Pvte.Tank	7
5)	2261	River/Spring	7
6)	399	River	7
7)	287	River	8
8)	153	River	7
9)	98	River	7
10)	479	River/Pvte Tank	7
11)	1008	River/Spring	7
12)	224	River	7
13)	224	River	7
14)	342	Pvte.Tank/ Tanker	1
15)	84	Pvte.Tank/ Tanker	1
16)	203	Pvte.Tank/ Town	1
17)	254	River	4
18)	142	River	7
19)	182	River	3
20)	105	River	7
21)	966	River/Spring	7
22)	63	River/Spring	7
23)	238	River/Tanker	7
24)	238	River/Pvte. Tank	7
25)	644	River	7
26)	63	River	8
27)	357	River/Tanker	7
28)	189	River/Pvte Tank	7
29)	98	Spring/Pvte& Publ.Tank	7
30)	671	River/Pvte Tank	7
31)	114	River/Pvte Tank	7
32)	126	River/Pvte Tank	7
33)	525	Mains	5
34)	420	Town/Company	5
35)	224	River	7
36)	294	River	7
37)	168	Mains	1
38)	144	Pvte.Tank/ River	7
39)	161	River	7
40)	1410	Pvte.Tank/Bore hole	5
41)	35	River	7

FIG 1

UMVOTI MISSION RESERVE Settlement Patterns and distribution of Cholera

TABLE 15 - DATES OF FIRST CHOLERA NOTIFICATION AND NUMBERS INVOLVED

AREA	Date of first Notification	0	10	20	30	40	50	60	70	Days
N'Choweni	12.11.81	(a)				2	1	2	1	
Memorial	19.11.81		1		1					
Mhalende	28.11.81		1				1			
Thembeni	28.11.81		2	1	9	17	4	3	3	
Lloyds	3.12.81			2	1	1		1	1	
10 Acre	7.12.81			1		3				
C/dale	10.12.81			2		5	2	2		
Grout.Ext.	15.12.81				2	5	1	3	1	
Jobas Farm	15.12.81				1	5	1	1	1	
Nkukwini	17.12.81				1	1				
Ezitendeni	18.12.81				1		11	5		
Hangusi	21.12.81					2				
Melville	21.12.81					1		2		
Groutville	21.12.81					3	6			
Mnywendwini	22.12.81					1	3	2		
Cranbrook	23.12.81					6	4	1	1	
Glebelands	13.1.82						2			
New Grout.	14.1.82						6	4		

(a): See p1 (Background). Department of Health (Pers.Comm.)

5.2 DISCUSSION

5.2(a) Sex Distribution

The results show that there were 84 females and 64 males affected (Ratio F:M = 1:0,76). Figure 3 shows the age-sex

distribution of 148 patients. The age groups most affected are between 21 and 40 years in both sexes. This compares well with the data of Seedat[14] who found a ratio of F:M adults being 1:0,88. According to him the reasons for the higher incidence among females is that "women are engaged in domestic chores and are in contact with infected water in rivers and dams."

However, at many of the afflicted areas in the Reserve there are a number of single-sex shacks, inhabited by male squatters who have left their families behind in the rural areas. (Generalisations, however, cannot be made because demographic data for the area are not yet available.)

5.2(b) Age Distribution

The data presented compare well with Seedat's data [15] according to which, in his study, 48% belong to the 21-40 year age groups. This group contained the majority of cases at the Reserve as well, i.e. 36%.

5.3 INCIDENCE OF CHOLERA AND SETTLEMENT TYPE:

From the results presented in Table 5 there are distinct differences in incidence between the various settlement types. The highest incidence appears in the type 8 settlements followed closely by settlement types 3 and 7. With the exception of settlement type 3, all the other settlements are characterised by the poorest sections of the

population of the Reserve.

As shown in table 6 the incidence rate in the poorer settlements is about 4 times higher than the richer settlements. The high incidence at Hangusi Hill could be attributed to the fact that there is a mixture of landlords and tenants of mixed socioeconomic status living there. Furthermore the 2 cases occurring there are related.

An interesting point to be made here is that the incidence rate reflects the social stratification of the settlements in the Reserve. The members in settlement type 1 with the least incidence comprises people who are in close association with the church which includes retired ministers, elders and respected members of the congregation and their families. It is likely that they experience the least contact with the squatter population. Settlement type 5, however, comprising the local enterpreneurial class is, due to the nature of their position, in more contact with the squatters, hence the higher incidence. Feachem[16] proposes that infection could take place primarily among "persons with close social interactions ... (and) others become infected in proportion to their social distance from the index case."

There are frequent citations in Feachem where Snow, writing in the nineteenth century, emphasises that the spread of cholera is promoted by poverty, overcrowding, water

scarcity, poor food hygiene and poor awareness of the infectiousness of the disease, placing the disease in a socioeconomic context.

References are made by Feachem to countries like India the Phillipines and Sri Lanka[18], where cholera is associated with poor socioeconomic conditions, unhygienic living conditions and overcrowding. The situation described in these accounts are strongly echoed in the Reserve, where the settlement types that have the highest incidence are those of the poor. It becomes apparent that the "rich" settlements have access to better housing and are least crowded. A similar conclusion can be reached in this study in that although impure water users, as shown in table 7, have a cholera attack rate 1,8 times higher than pure water users, table 10 shows that the bulk of the poor 77,4% do not have access to pure water. It is therefore impossible to separate the 3 elements in this discussion.

5.5 INCIDENCE OF CHOLERA AND WATER SOURCE

It is often cited in the literature that the consumption of impure water is associated with cholera and a review of this is given by Feachem[19].

Briscoe[20] makes mention of the "large amount of literature on the empirical relationships between water supply and health ... have been plagued by the existence of high multicollinearity of 'independent' variables. For example,

income and nutritional status are usually highly correlated with quality of water supply".

To illustrate the confusing evidence in the study even further, Settlement type 4 (No. 17) although relying on river water did not get any cholera cases whereas with the exception of Hangusi Hill (Type 3) which was discussed above, all the other richer settlements did have some cases of cholera despite their access to a purer water supply. Furthermore, the river in Settlement type 4 dries up and people are often forced to dig in the dry river bed for their water. Also there is no explanation why thousands of people among the poorer settlements (7 & 8), using river water do not get sick.

Although others [21] in South Africa have shown that cholera is associated with the consumption of polluted river water, secondary infections were excluded from the study. It is probable that primary infection was acquired by consuming polluted water but secondary infection could have taken place by direct person to person contact. Furthermore, had the questions asked been related to food sharing, crowding, going to the shebeen etc they may have yielded a picture whereby person to person transmission would have also been implicated.

5.6 INTRAFAMILIAL TRANSMISSION OF CHOLERA

Although the results show an intrafamilial and neighbourhood

incidence rate of 34% it is highly likely that this figure is an underestimate. This may be because antibiotics were distributed to household contacts which had a cholera case. A high percentage of people may not have taken these because of the high percentage of secondary cases being admitted two days after the index case. (Presumably after the visit from the inspectors.)

As regards the concept of neighbourhood transmission, only households which were next door to one another (e.g. house No. 234 and 235) were recorded. The problem here lies with the fact that neighbours need not be socially close. Conversely, the social interaction patterns in a community are complex and were not elucidated.

Although studies in Bangladesh[22] and the Philippines[23] show that "cholera did not spread readily, if at all, among families in a neighbourhood" others have shown in Calcutta[24] that infection is highest among family contacts, second highest among patrilinearly related families and lowest among neighbourhood contacts.

The issue is unclear in this study but well worth examining in more detail.

According to Feachem[25] "Infections among family contacts are of especial interest in documenting possible person to person transmission" (my emphasis). Although in 55% of the cases the time interval between index and secondary case is

less than 2 days and according to Feachem (ibid) "should be excluded from the study as coprimaries of the index case" one is still left with 45% of incidents where the secondary cases are affected within 3-14 days of the index case. In many other countries intrafamilial contact constitutes a large proportion of the cholera cases, namely 35-80% [26].

In the case of the El Tor biotype, Feachem concludes that "up to one quarter of family contacts may develop cholera diarrhoea and at least a further quarter may have asymptomatic infections" [27].

Given the above, and also the fact that the bulk of transmissions take place within 0-4 days of the index case, during which time the index case is recovering in hospital, the role of the healthy carrier needs to be further examined.

5.7 INTRAFAMILIAL TRANSMISSION ACCORDING TO AGE AND SEX

Given that demographic data are not yet available it is difficult to reach any real conclusions over the relative importance of age sex regarding intrafamilial transmission of cholera.

Tables 13 and 14 however, show that transmission is highest among adult peers (52%) and among females (37%). Adult to child transmissions is also an important parameter (22,2%).

5.8 INTRAFAMILIAL TRANSMISSION AND WATER SOURCE

It is difficult to assume that water is the common source of the transmission incidents in that there were only 2 incidents involving 3 family members, the rest involving two members.

5.9 THE EPIDEMIC CURVE AT THE RESERVE

The bulk of the intrafamilial/neighbourhood infections took place during the Christmas period when most contract workers have returned home and are on leave until the New Year. This has significance in two ways:

Firstly, the population in the area increases. The extent to which this happens is not known. Secondly, there is a general hive of activity during this period, quite different from the normal day to day activity that takes place during the rest of the year. This involves a fair amount of gathering, drinking at the local shebeens[a],[b] church services and other meetings to discuss issues held up until the migrants' return.

(a) The "beer" that is commonly drunk is either commercially available sorghum beer, home made sorghum beer or bread and sugar mixed with water and yeast and allowed to ferment overnight.

(b) An employee of the sugarmill inside the Reserve made an interesting observation that among the labourers in the fields the people who contracted the most cholera were those who frequently visited the shebeens. This observation was unfortunately not followed up at all.

A similar conclusion was reached by Dodin and Felix in Mali where cholera was "promoted by crowding, gathering and various behaviours associated with sickness and death" [28] The same observation was postulated by Merson et al (1980) in North Cameroons and Chad[29] .

5.10 TIME SPACE ANALYSIS OF THE EPIDEMIC

With the exception of one case (from Ezitendeni, 18.12.81, to Mnywendwini, 22.12.81) the distribution of the outbreak is scattered in a pattern which is inconsistent with the downstream flow of the water in the Reserve. If the cholera epidemic was "water borne" in the classical sense then one would expect that the disease would spread in an explosive manner downstream, in that many more people who drink river water would have been affected.

CONCLUSION

Given the contradictory evidence as regards consumption of impure water and cholera attack rates, the non-explosive, scattered nature of the outbreak and the small minority of intrafamilial infections involving more than 2 people suggests that cholera is not waterborne in the classical sense but a highly complex fecal-oral disease which was introduced into the Reserve on several occasions. The results indicate that the role of "crowding, gathering and feasts, especially over the Christmas period, is likely to be an important parameter facilitating the spread of cholera at the Reserve in a non-water borne fashion.

This may be possible in two ways: Firstly, directly by infected migrants returning to the Reserve or, secondly, the presence of extra members into a household, especially in the poor settlements may create more overcrowded conditions triggering off or facilitating transmission. The data, however limited, shows that adults bring cholera into the household and spread it to other adults and children in the home. This is possible directly via the fecal-oral route or indirectly due to the lack of plentiful water, rendering households and utensils, especially among the poor, unhygienic.

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