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Epidemiological features of an outbreak of gastroenteritis/cholera in Katsina, Northern Nigeria

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SUMMARY

In April 1982, Katsina, in Northern Nigeria, was affected by an outbreak of gastroenteritis associated with *Vibrio cholerae* serotype 'Ogawa' and 662 patients were admitted to the Katsina General Hospital during a 16-week period. The outbreak affected all ages and both sexes and all parts of the town and its immediate surroundings except the Government Residential Area (GRA). The overall case fatality rate was 7·7 %. Male specific case fatality and female specific case fatality rates were 9·7 and 6·2 % respectively. 'Adults' and those in the 11–20 and 21–30 age groups accounted for most of the cases. The epidemic curve was of a propagated and protracted nature. About 51·7 % of all the patients spent between 2 and 5 days in the hospital. A similar pattern was observed for all age groups regardless of sex. *Cholera vibrio 'Ogawa'*, *Shigella* spp., *Salmonella* spp., *Proteus* spp. and *Escherichia coli* were isolated from 16 patients. All well-water samples obtained from the compounds of the cases were contaminated with MPN/100 ml index ranging from 540 to greater than 2400. All samples were positive for faecal coliforms. *Salmonella* spp., *Shigella* spp., *Proteus* spp. and non-O, group 1 (non-O 1) *V. cholerae* were isolated. Water sellers probably facilitated the spread of the outbreak.

INTRODUCTION

Cholera is endemic in the coastal areas of Nigeria and tends to be sporadic in the northern part of the country. With rapid urbanization and population growth coupled with inadequate sanitation, inadequate water supply and poor sewage disposal, most towns in Nigeria are at risk of cholera outbreaks. Frequent electric power failures affect the availability of pipeborne water. A lot of people in the North depend on well water from poorly constructed wells generally without casing. In compounds where both a well and a pit latrine exist, the risk of contamination of the well water is often high.

Contaminated water is an important vehicle for spread of cholera. Human faeces are the main source of contamination and cholera outbreaks are typically associated with situations in which two factors are present: the water supply is unsafe or exposed to a high risk of contamination, and defaecation habits and excreta-disposal installations are such that they favour, rather than control, the spread of contamination (De Araoz & Subrahmanyam, 1970). Transmission is maintained in a cycle involving the vibrio excretor, and the environment and the source of water play an important role (Mosley, 1970).

Individuals of low socioeconomic groups are at high risk of being affected by cholera (Mosley, 1970). Funeral habits have been incriminated in the spread of cholera (Mandara & Mhalu, 1980/81). In Katsina, a large proportion of the population was non-immune to cholera since no outbreak has been reported for at least 7 years and only individuals who were planning to travel overseas were vaccinated. The sanitary conditions were such that would favour the spread of cholera.

The paper reports the epidemiologic findings in an outbreak of gastroenteritis cholera in Katsina, in Northern Nigeria.

MATERIALS AND METHODS

Katsina and its population. Katsina, with a population of approximately 126600 (Registrar of Births and Deaths, Local Government) is a traditional town situated in the Sahel Savannah Zone of Nigeria. The town is divided into four wards called 'Wakilins' – Wakilin Arewa, Wakilin Kudu, Wakilin Yamma and Wakilin Gabas which includes the Government Residential Area (GRA). In each Wakilin, there are modern cement-built compounds but a large proportion of the population lives in mud-built compounds. These compounds are no longer as spacious as they used to be because of rapid population growth in the town. Each compound has a latrine and a source of water which is either a dug well, or pipeborne water or both, but most compounds have dug wells. There is no proper sewage disposal system. There are public wells and taps for pipeborne water and people who fetch water from the public wells and taps for sale. The streets are narrow and are lined with open gullies.

The rainy season is May to September with an average annual rainfall of about 700 mm. In 1982, the first rainfall was on 25 May, and the mean temperatures were 35·6 °C, 39·0 °C and 38·2 °C for March, April and May respectively. The population consists predominantly of farmers, artisans and traders. The town has one general hospital. However there are a few drug stores where anybody can buy drugs, including antibiotics, without prescription.

There is a government health office in the same premises as the general hospital. A team from the health office usually visits the hospital wards daily to check for possible outbreak of communicable diseases. It was during such visits that the outbreak of gastroenteritis was detected and later proven to be cholera.

The outbreak. About the middle of April 1982, a team from the health office, Katsina, detected an increased number of patients with gastroenteritis characterized by abdominal cramps, vomiting and watery diarrhoea. The numbers of cases were increasing daily. Faecal samples were sent to the laboratory in the hospital for culture.

Case finding. For the purposes of this investigation, a case was defined as an illness consisting of abdominal cramps, nausea, vomiting and diarrhoea. By studying the records in the hospital, 662 cases were identified during a 16-week period. Cases occurred in all age groups and both sexes were affected.

Contact tracing. Because there are no street names in all parts of the town, accurate addresses cannot be obtained. The patients or their relatives were asked to name their area (ward), and four households (compounds) in their immediate vicinity, to facilitate tracing possible contacts. Contact-tracing often consisted of a team from the health office visiting the administrative offices of each Wakilin. A messenger who was known to the people in that Wakilin was then sent to accompany and direct the health-office team to the compounds of case(s). Possible contacts were then vaccinated against cholera.

Laboratory investigation. Rectal swab specimens obtained from 16 patients were placed in selenite F broth for salmonella–shigella growth and in alkaline peptone water (APW) for vibrio culture.

Compounds of some of the cases were visited; all had dug wells. Water samples were taken from the wells for microbiological analysis. For coliform count, 100 ml of freshly drawn well water was put into a sterile 200 ml bottle and ice cooled until used. Approximately 5·0 ml of the water was added to 10·0 ml of selenite F broth for salmonella–shigella detection and 5·0 ml of the water was added to 10·0 ml of alkaline peptone water (APW) for vibrio culture.

Samples from pipeborne water were taken by the Principal Water Chemist and submitted to the Kaduna State Water Board Chemistry Laboratory for microbiological analysis and analysis for chlorine levels.

Salmonella–shigella detection. All samples enriched in selenite F broth were incubated overnight at 42 °C and then inoculated on brilliant green agar (BGA), salmonella–shigella agar (SS) and MacConkey agar. All identifications were carried out according to standard methods (Cowan & Steel, 1965).

Vibrio detection. After an overnight incubation at 37 °C, APW inoculated with either the rectal swabs or well-water samples was inoculated heavily on thiosulphate citrate–bile–salt–sucrose agar (TCBS). Samples showing typical 2 mm diameter yellow colonies after overnight incubation were further identified as recommended by Furniss (1979). Slide agglutination tests using the polyvalent and *V. cholera* (Ogawa) antisera were performed on typical colonies on TCBS. All isolates that failed to agglutinate either sera were termed non-O 1 *V. cholerae*.

Determination of most probable number (MPN) for coliforms. Tests to determine MPN index for coliforms in the well-water samples were performed as described in standard methods (Rand, Greenberg & Taras, 1975). Faecal coliform was detected in EC medium with a multiple-tube procedure as described by Rand, Greenberg & Taras, (1975) with a slight modification. A loopful of inoculum of all positive brilliant green bile broth during the confirmed test was added to EC tubes and incubated at $44{\cdot}5 + 0{\cdot}2$ °C for 24 h. Growth and gas production was taken as positive. Additionally, cultures from positive EC tubes were made on eosin methylene blue (EMB) agar and incubated overnight at 37 °C.

Data analysis. Patients were divided into 10-year age groups up to 50 years and the data analysed as rates. The category 'adult' included all those entered as such in the hospital record and usually means individuals more than 20 years of age.

Table 1. *A comparison of admissions to Katsina General Hospital during the first half of* 1981 *and* 1982

	1981			1982		
Month	Ward 1*	Ward 6†	Total	Ward 1	Ward 6	Total
January	176	92	268	171	126	297
February	146	103	249	188	92	280
March	161	113	274	166	99	265
April	201	122	323	190	165	355
May	135	93	228	353	249	602
June	166	122	288	183	212	395
Total	985	645	1630	1251	943	2194

* Ward 1 = Male Medical Ward.
† Ward 6 = Female Medical Ward

RESULTS

The outbreak. During the period in which this investigation was carried out, 662 patients from Katsina and its immediate surroundings were admitted to the General Hospital, Katsina. This was the first serious outbreak in more than 7 years. There was an increase in the number of admissions in both the male and the female medical wards (1 and 6) with the peak in May (Table 1) when the cases of gastroenteritis also peaked.

Patients. Epidemiological analysis was performed on information obtained from all 662 patients admitted to the hospital by 21 June 1982. The overall case-fatality rate was 7·7 % which tended to decrease as the outbreak progressed.

Distribution of cases by age and sex. Table 2 shows the distribution of cases by age and sex and the associated case-fatality rates. Age-specific and sex-specific attack rates could not be calculated because of lack of information on the distribution of the population by age and sex. Male specific case-fatality rate was 9·7 % while female specific case-fatality rate was 7·7 %. The 11 to 20-year male age group had the highest number of cases but the case-fatality rate was highest (20 %) in the 31 to 40-year age group. When the ages were stated, females in the 21 to 30-year age group had the highest number of cases, otherwise females in the group 'adult' had the highest number of cases. The case fatality rate was highest (36·4 %) in females whose age was not stated. Where the ages were known, female patients in the 41 to 50-year age group had the highest case fatality rate (7·7 %). In general, where ages were stated, patients in the 31 to 40-year age group and those older than 50 years had the highest case-fatality rates (11·1 % and 11·8 % respectively).

Cases by week of admission to the hospital. Epidemic curves (i.e. number of cases by week of admission) are shown in Figs 1 and 2. In general, the outbreak peaked during the fourth week but mortality was highest during the fifth week. The peak for males was the third week and for females the fourth week. The epidemic curves seem to indicate protracted pattern of spread as the epidemic has occurred for 16 weeks and was continuing.

Fig. 3 shows Wakilin specific distribution of cases by week of admission. There is an indication that the outbreak started in Wakilin Gabas, Wakilin Arewa, and

Table 2. *Age and sex distribution of cases of cholera and deaths during the outbreak in Katsina, Nigeria*

	Age (years)								
Sex	0–10	11–20	21–30	31–40	41–50	> 50	Adult	Not stated	All ages combined
Male	30 (2)* 6·7†	69 (5) 7·2	35 (3) 8·6	20 (4) 20·0	26 (1) 3·9	13 (1) 7·7	82 (8) 9·8	15 (4) 26·7	290 (28) 9·7
Female	35 (2) 5·7	39 (2) 5·1	75 (2) 2·7	43 (3) 7·0	26 (2) 7·7	4 (0) 0·0	139 (8) 5·8	11 (4) 36·4	372 (23) 6·2
Total	65 (4) 6·2	108 (7) 6·5	110 (5) 4·6	63 (7) 11·1	52 (3) 5·8	17 (2) 11·8	221 (16) 7·2	26 (8) 30·8	662 (51) 7·7

* Number of deaths in parentheses.
† Age-specific case-fatality rate percent.

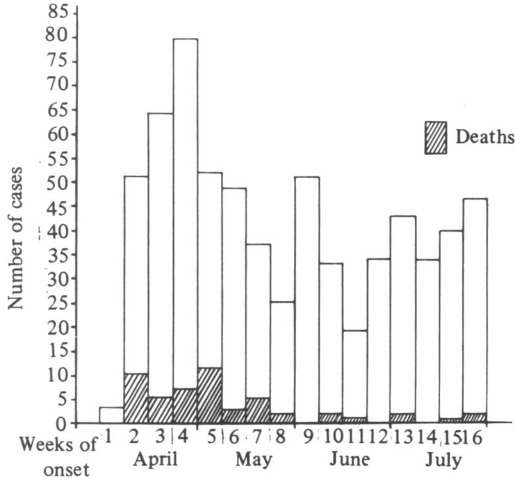

Fig. 1. Distribution of cases of cholera admitted to General Hospital, Katsina, during the course of the cholera outbreak.

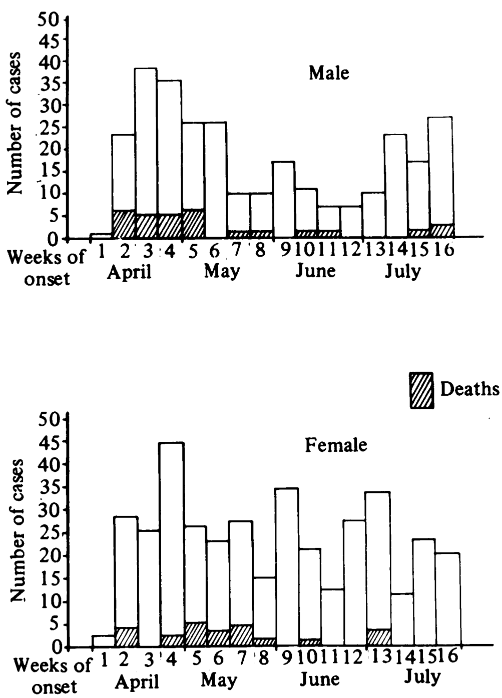

Fig. 2. Sex distribution of cases of cholera admitted to General Hospital, Katsina during the course of the cholera outbreak.

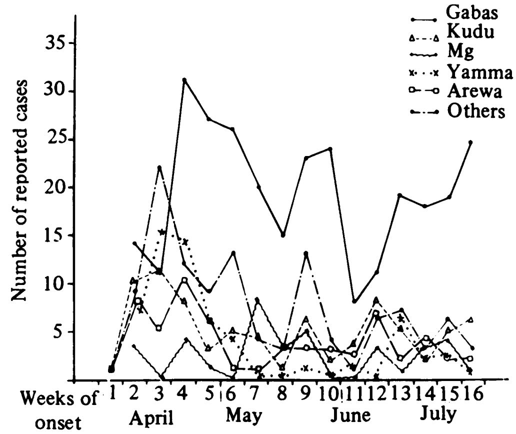

Fig. 3. Time course of the reported cases of cholera in different parts of Katsina and its surroundings.

Wakilin Kudu within the same week. It then spread to Wakilin Yamma and other parts of Katsina and the surrounding area by the following week; the GRA was spared. The outbreak peaked in Wakilin Arewa and areas surrounding Katsina but not under the Magajin Gari during the fourth week. The curves show various modes though some are small involving only a few cases.

Duration of hospital stay by patients. This is shown in Tables 3 and 4. About 11·3 % of the patients stayed for 2 days, 18·3 % for 3 days, 13·8 % for 4 days and 8·3 % for 5 days. Only 22 patients (3·3 %) stayed for more than 8 days in the hospital before discharge. Except for two patients, information was lacking on the length of stay prior to death. Nor could information on the length of stay be obtained for 28 % of the patients because they either absconded or were treated and discharged as outpatients. In general, 51·7 % of the patients spent 2–5 days in the hospital before discharge. Tables 3 and 4 show the distribution of hospital stay by age and sex.

Bacterial isolation. Bacterial isolation was attempted on faecal samples from 16 patients. *Shigella* spp. was isolated in eight cases, *Salmonella* spp. in four, *E. coli* in three, *Proteus* spp. in one, *V. cholerae* (Ogawa) in 10 and non-O 1 *V. cholerae* in two.

All the nine well-water samples taken from homes of cases indicated evidence of contamination. *Shigella* spp. alone was isolated in two samples, *Salmonella* spp. alone in one, *Shigella* spp. and *Vibrio* spp. in two, *Salmonella* spp. and *Vibrio* spp. in one, *Shigella* spp., *Proteus* spp. and *Vibrio* spp. in two, and *Proteus* spp., *Vibrio* spp. and *Salmonella* spp. in one.

Vibrio spp. isolated in water samples were serotyped and found to be non-O 1 *V. cholerae*. Six of the nine wells had had MPN/100 ml index of greater than 2400, two had MPN/100 ml index of 920 and one had MPN/100 ml index of 540. All of them were positive for faecal coliforms. Only one of the four samples of pipeborne water had an MPN of 6. All the pipeborne water samples had a chlorine content of 0·1 p.p.m.

Table 3. *The age-specific frequency distribution of length of hospital stay for male patients during the outbreak of cholera in Katsina, Nigeria*

Age (years)	Duration of hospital stay (days) 1	2	3	4	5	6	7	8	> 8	Dead*	Not stated
0–10	1	3	4	3	3	0	2	0	1	2	11
11–20	0	6	17	11	2	2	1	2	0	5	23
21–30	0	3	10	7	1	2	0	0	2	3	7
31–40	1	0	3	3	1	1	3	0	0	4	55
41–50	0	2	5	4	4	4	3	0	1	1	2
> 50	0	1	1	0	1	0	0	0	1	1	88
Adult	0	9	8	7	4	3	1	1	4	8	38
Not stated	0	0	3	0	0	0	0	0	0	4	8
All ages	2 (0·7)†	24 (8·3)	51 (17·6)	35 (12·1)	16 (5·5)	12 (4·1)	9 (3·1)	3 (1·0)	9 (3·1)	28 (9·7)	102 (35·2)

* When six patients were reported dead, the duration of stay in the hospital was not recorded except for one patient.
† Percentage of all 290 male patients

Table 4. *The age-specific frequency distribution of length of hospital stay for female patients during the outbreak of cholera in Katsina, Nigeria*

Age (years)	Duration of hospital stay (days) 1	2	3	4	5	6	7	8	> 8	Dead*	Not stated
0–10	0	4	9	4	3	1	0	0	1	2	11
11–20	0	6	3	7	5	1	2	1	2	2	10
21–30	0	15	14	11	5	6	3	2	4	2	14
31–40	0	7	10	4	4	3	0	0	1	3	11
41–50	0	2	5	4	1	3	1	2	1	2	5
> 50	0	0	0	2	1	0	0	0	0	0	1
Adults	0	16	28	23	20	3	5	4	3	8	29
Not stated	0	1	1	1	0	0	1	0	1	4	2
All ages	0 (0·0)†	51 (13·7)	70 (18·8)	56 (15·1)	39 (10·5)	17 (4·6)	12 (3·2)	9 (2·4)	13 (3·5)	23 (6·2)	83 (22·3)

* When the patient was reported dead the duration of stay in the hospital was not recorded except for one patient.
† Percentage of all the 372 female patients.

DISCUSSION

This outbreak of gastroenteritis was considered due to *V. cholerae* serotype Ogawa since symptoms indicative of cholera predominated. Other pathogens, notably *Shigella* spp., *Salmonella* spp. and *E. coli* probably merely exacerbated the condition. A few days prior to this outbreak, there was an acute water shortage in Katsina. It was hot and dry. (The mean maximum temperature for April 1982 was 39·0 °C.) The inhabitants had to open up abandoned private wells. Water sellers in many areas moved from house to house and through market stalls selling water which they obtained from public wells.

It has been observed by Adesiyun *et al.* (1983), that the distances from pit latrines to dug wells in all the compounds surveyed in Katsina ranged from 1·8 to 16·5 m and that some wells were usually left open and that the wells were only slightly raised above the ground level. The wells have uncemented walls and the possibility of seepage of bacteria from the pit latrines to the wells is high. The depth of the latrines were not assessed, but they are generally very deep since they are designed to serve the household for many years. The possibility exists that the bottom of the latrines are very close to the water-table.

This outbreak started in three areas of the town simultaneously. The common denominators are the use of well water by all patients interviewed, and the presence of pit latrines and wells in the compounds. Areas in which there are no wells and pit latrines, e.g. GRAs, were spared the outbreak. It has been recommended that latrines should be at a lower level than the nearest wells, the bottom of latrines must be at least 1·5 m above the ground-water table and the distance between latrine and any water source should be as large as possible, but never less than 30 m (De Araoz & Subrahmanyan, 1970).

During the study of conditions in the compound of the index case, it was observed that the compound was located at a low elevation and that bordering the compound was a large open gully filled with stagnant sewage from many houses in the area. Water obtained from the well in that compound was brownish in colour and had MPN/100 ml index of greater than 2400 and faecal coliforms. Non-O 1 *V. cholerae*, *Proteus* spp. and *Salmonella* spp. were isolated. There were three cases of gastroenteritis with one death in that compound.

Where there are no street names and numbers, tracing of the compounds where there were cases could be difficult, but the method used for tracing in this outbreak proved very effective. All compounds with cases were traced. The public health team from the government health centre in Katsina vaccinated contacts and advised regarding the use of well water for drinking, for preparation of food or for washing kitchen utensils. The method used here indicates the importance of involving local government health agencies and traditional rulers in disease outbreak investigation and control, since they are familiar with the people and the prevailing condition of their areas. Both males and females seem to have been exposed at the same time. However, since females usually stay at home, especially with the traditional 'purdah' system, they are more likely to be exposed to contaminated well water than males. This probably accounts for the difference in the number of cases between males and females. However, the difference could also be a reflexion of the population distribution by sex in the area. It is probable that continuous low level exposure is more likely in females than males. This produces subclinical infections and immune responses which could account for the lower case-fatality rate in females.

Death due to cholera may be dose-related and may depend on nutritional status, immune status and the level of gastric acid in the stomach. In a normal person, a very high dose is required to produce clinical disease (Mackay, 1979). Failure to seek medical care in time probably accounted for the high case-fatality rates in the initial stages of the outbreak. A campaign was then instituted to inform people of the need to report to the hospital as soon as they noticed any signs of gastroenteritis. In addition to antibiotics, all patients were given intravenous fluid immediately on admission to the hospital; no oral rehydration strategy was used during this outbreak. Timely replacement of water and salts lost in diarrhoea and vomitus of cholera can correct dehydration and ensure survival in virtually all cases (Nalin, 1972).

The source of the outbreak could not be pinpointed since the outbreak occurred in the different parts of the town at about the same time and later spread to the surrounding rural areas. Vaccination of school children and contacts and health education were the measures taken in an attempt to control the outbreak in the town. However, the amount of vaccine available was not sufficient for the vaccination of a large proportion of the population.

Though *V. cholerae* serotype *Ogawa* was isolated from the rectal swabs of 62·5 % and non-O 1 *V. cholerae* from 12·5 % of the patients that were investigated bacteriologically, only non-O 1 *V. cholerae* was isolated from 67 % of the well-water sample obtained from compounds of cases. These have been incriminated in outbreaks of gastroenteritis characterized by nausea, vomiting, watery diarrhoea and fever (McIntyre *et al.* 1965; Aldová *et al.* 1968; World Health Organization, 1969; Dakin *et al.* 1974; Wilson *et al.* 1981). Contaminated well water has been implicated as a vehicle of transmission of non-O 1 *V. cholerae* responsible for an outbreak of gastroenteritis (World Health Organization, 1969).

E. coli isolated from faecal samples of 3 of the 16 patients investigated bacteriologically were not checked for enterotoxigenicity. The possibility of enterotoxigenic *E. coli* being responsible, at least in part, for the clinical picture in this outbreak exists, as these have been isolated from patients with severe cholera-like disease elsewhere (Sack *et al.* 1971, 1975). However, the isolation of *V. cholerae* (Ogawa) from 10 of 16 tested faecal samples combined with the clinical manifestations, particularly vomiting, suggest that *V. cholerae* might be the primary causative agent.

In this outbreak, asymptomatic carriers probably brought the cholera vibrios to Katsina town and shed the bacteria into pit latrines, as there were two outbreaks of cholera in the state at about the same time. Seepage from the pit latrines then contaminated the wells and the ground water. Many people were therefore exposed to low doses of *V. cholerae* and this may have resulted in a large number of asymptomatic carriers who in turn shed the bacteria. Because of shortage of pipeborne water, people resorted to using well water for drinking and washing and the risk of exposure increased and the outbreak occurred. Water sellers probably facilitated the spread. The 662 cases seen is probably a small proportion of the individuals infected. It is known that most individuals infected with *V. cholerae* have no symptoms or only mild diarrhoea. The ratio of severe cases (requiring hospitalization) to mild or inapparent infections has been shown to be 1:5 to 1:10 in classical cholera (Mosley, 1970).

The provision of a safe water supply which will curtail the dependence on unsafe well water might prevent a recurrence of this type of outbreak in Katsina.

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