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Original Research Article

Outbreak of enteric fever: a fact finding mission

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ABSTRACT

Background: In September 2019, a large number of fever cases among troops and families in a military station in Maharashtra were admitted to the local Military Hospital. Detailed epidemiological investigations revealed the cause to be an outbreak of enteric fever due to sewage contamination of drinking water.
Methods: A detailed site survey was undertaken; and a descriptive epidemiological study was carried out. Routine haemogram, blood culture, antibiotic sensitivity test besides serotyping of the isolates were carried out.
Results: In all 28 cases who fulfilled the case definition criteria were admitted in the month of September 2019. Out of these 21 (75%) were confirmed by blood culture, while the remaining were probable cases. Bacteriological examination reports of water samples taken from various source as well as consumer end points both prior to beginning of the outbreak and during the outbreak revealed a high presumptive coliform count. Spatial and temporal clustering of cases was suggestive of common source outbreak. On 16 September 2019 exploration by digging was carried out undertaken which revealed massive leakage of water in close proximity to the overflowing manholes. The outbreak was promptly controlled after detection of this pipeline and provision of alternative source of water supply to the affected area.
Conclusions: *Salmonella enterica serovar typhi* has been implicated in many outbreaks through history. The present outbreak was a common source focal outbreak due to sewage contamination of drinking water in a few areas in the station.

Keywords: Enteric fever, Outbreak, Sewage contamination

INTRODUCTION

A steady rise in the incidence of enteric fever in the Indian Armed Forces has been reported towards the later part of the previous century. The incidence has increased from a rate of 0.13 per 1000 in 1989 to 0.78 per 1000 in 1999 in the Army; during the same period the incidence in the Navy has increased from 0.15 per 1000 to 0.80 per 1000 and in the Air Force from 0.07 to 0.52.[1] In September 2019, a large number of fever cases among troops and families in a military station in Maharashtra were admitted to the local military hospital. Detailed epidemiological investigations revealed the cause to be an outbreak of enteric fever due to sewage contamination of drinking water. In this paper, we describe the details of the outbreak. The objective of the workers is to describe the clinic epidemiological aspects of an outbreak of Enteric fever in the station.

METHODS

The study design used was a cross sectional descriptive study. The study was carried out in the month of September 2019 in a mid-sized city of India. The workers obtained detailed information from each reported case, date of onset of symptoms, date of admission, movement history during the incubation period, history of having worked as food handler in the cook house, personal hygiene and other relevant data. The workers also carried out active case finding by surveys during the period of the outbreak.

All the cases which were admitted to the local military hospital were reviewed by the study team. This included eliciting a detailed clinical and epidemiological history. Stepladder pattern of fever, headache, truncal rose spots, malaise, loss of appetite with gastrointestinal symptoms of more than one week duration and having two or more of the following symptoms/signs; toxic look, relative bradycardia, splenomegaly or non-productive cough constituted the clinical case definition of typhoid fever.[2-4] Any case fulfilling the above criteria was taken as suspect case. A case compatible with clinical description with Widal test titre≥1:80 or exposure to a confirmed case/carrier/staying in the incriminated barrack/house during the last three weeks was taken as a probable case. A suspected/probable case that was confirmed by positive blood culture for *Salmonella enterica serovar typhi* was taken as a confirmed case. The outbreak was studied and analysed in terms of Time, place and person distribution of the cases. The workers also conducted a detailed survey of the site. Blood and serum samples collected from all the cases were subjected to haemogram, blood cultures and Widal test. The antibiotic sensitivity test was carried out by disc diffusion method and minimum inhibitory concentration (MIC). Water samples were taken for bacteriological examination from various source as well as consumer end points. Repeat samples from the same sites were collected again on 25th September 2019 after repair of pipelines. Ethical clearance from the institutional ethical committee was obtained prior to collection of data.

Standard statistical tools like calculating Relative Risk and Chi Square were utilized for data analysis.

RESULTS

In all 28 cases who fulfilled the case definition criteria were admitted in the month of September 2019. Out of these 21 (75%) were confirmed by blood culture, while the remaining were probable cases. At the time of admission 26 (92.85%) cases presented with moderate to high grade fever (mean temperature 101.8°F), few had relative bradycardia, 15 (53.57%) had pain abdomen, 20 (71.42%) loose motions, 18 (64.28%) headache and 17 (60.71%) cough. Rose spots were observed in 10 (35.71%) cases. Poor personal hygiene was observed in 16 (57.14%) cases, while 6 (21.42%) gave history of having worked as food handler in the cook house in the recent past. The first case reported on 08 September 2019, followed by a sudden increase in number of cases. The weekly epidemic curve is depicted in Figure 1. The median incubation period was approximately two weeks. On in depth analysis it was observed that the epidemic curve displayed a sudden peak followed by an abrupt fall. This is strongly suggestive of a common point source outbreak. This curve does not suggest person-to-person spread. Person distribution of typhoid cases is shown in Table 1.

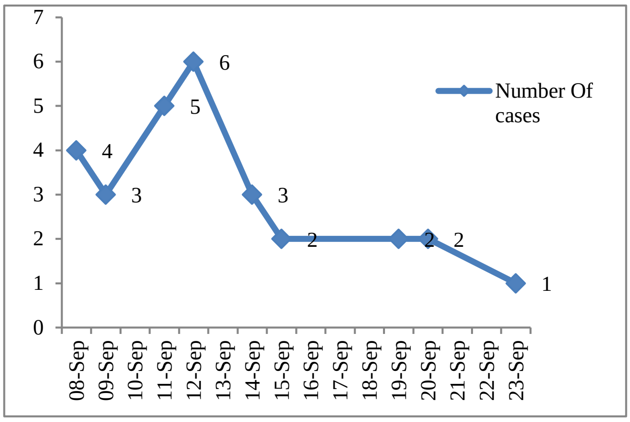

Figure 1: Epidemic curve.

Table 1: Person wise distribution of cases.

Category	Number of cases(%)
Serving personnel	09 (32.14)
Families	19 (67.86)
Total	28 (100)

22 (78.57%) of cases were from two pockets of married accommodation, which were in very close proximity to each other. The remaining six cases were scattered in three different pockets in the station. This spatial and temporal clustering suggests common source outbreak. The location of the affected area, with the pipeline leak adjacent to overflowing manholes is shown in Figure 2.

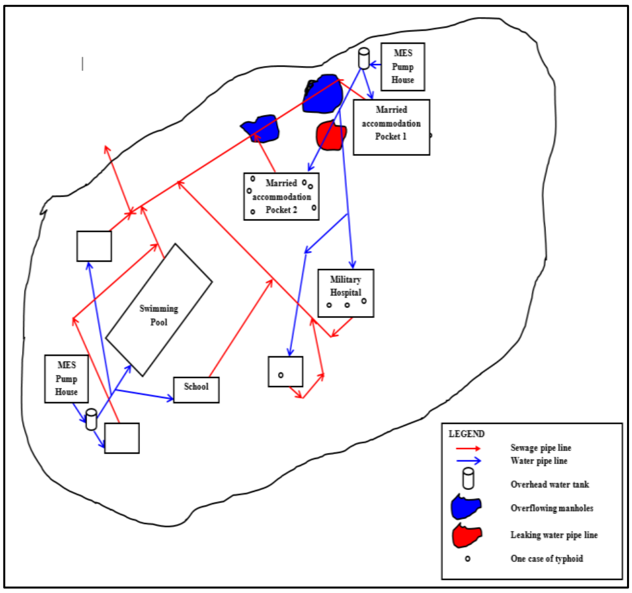

Figure 2: Spot map.

Age distribution of the cases is shown in Table 2. Sex distribution of the cases is shown in Table 3. Bacteriological examination reports of water samples taken from various source as well as consumer end points both prior to beginning of the outbreak and during the outbreak revealed a high presumptive coliform count. Report of repeat samples taken after repair of the pipeline were satisfactory.

Table 2: Age distribution of cases.

Age group (in years)	Number of cases (%)
<10	09 (32.14)
11-15	04 (14.28)
15-19	01 (03.57)
20-24	04 (14.28)
25-29	04 (14.28)
30-34	04 (14.28)
>35	02 (07.14)
Total	28 (100)

Table 3: Sex distribution of cases.

Sex	Number of cases (%)
Male	17 (60.71)
Female	11 (39.29)
Total	28 (100)

The attack rate for cases dependent on the MES Pump House from where the bacteriological examination reports were unsatisfactory was 0.73% as compared to about 0.15% for the remaining areas of the station. No cases gave history of movement in the past one month outside unit line or outside the station, thus ruling out outside exposure. None of the cases had received typhoid vaccination.

Table 4: Attack rates in population exposed to the leaking water pipeline as compared to those not exposed to the leaking water pipeline.

Source of water	No. affected (%)	No. not affected (%)	Total (%)
Leaking water pipeline	22 (0.73)	2978 (99.26)	3000 (100.00)
Normal pipeline	06 (0.15)	3994 (99.85)	4000 (100.00)
Total	28 (0.4)	6972 (99.6)	7000 (100.00)

RR=4.88 (95% CI of 3.97<RR<5.78), Chi Square (Yates Corrected)=14.47, Df=1, p<0.0001.

Table 4 shows attack rates in the population which was leaking pipelines compared to those not exposed. The relative risk for those exposed against those non-exposed was 4.88 (95% Cl of RR 3.97, 5.78). The difference in attack rates between the two groups was statistically significant (p<0.0001).

Sewage pipeline was blocked and manholes were overflowing close to the MES pump house (Figure 2). On 16 Sep 2019 exploration by digging was carried out undertaken which revealed massive leakage of water in close proximity to the overflowing manholes. The water pipeline was totally corroded and leaking. The outbreak was promptly controlled after detection of this pipeline and provision of alternative source of water supply to the affected area.

On laboratory investigations, there was no leucopenia or relative lymphocytosis in any case. The mean total leucocyte count was 7533/mm^3, while the mean lymphocyte count was 33%. In all the 21 cases which were positive on blood culture, the organism was confirmed as *S typhi*. Widal test was positive in 28 (100%) cases. The antibiotic sensitivity test revealed multidrug resistant strains of *S. typhi* with a similar antobiogram in respect of all isolates. Resistance was observed against commonly used antibiotics viz, ampicillin chloramphenicol, and cotrimoxazole. The disc diffusion and MIC tests showed the organisms to be sensitive to the drug in vitro (MIC<2 µg/ml). However, the patients did not show good clinical response to ciprofloxacin. The organism was also found to be sensitive to ceftazidime (MIC<3 µg/ml). The best clinical response was obtained with ceftazidime. All the isolates showed high degree of resistance to chloramphenicol (MIC>128 µg/ml), ampicillin (MIC>128 µg/ml), trimethoprim (MIC>32 µg/ml) and sulphamethoxazole (MIC>128 µg/ml).

No further serotyping of the samples was done given the limited resources available locally.

DISCUSSION

Enteric fever is a major cause of morbidity and mortality in tropical areas worldwide.[5,6] Typhoid fever (TF), caused by *S typhi*, is the most common cause of enteric fever, responsible for an estimated 129,000 deaths and more than 11 million cases annually.[7]

S. typhi has been implicated in many outbreaks through history. The current burden of disease is estimated at 11-18 million infections annually, with the majority of infections located in Africa and South Asia.[8] Kim et al reported 180940 cases in 303 identified outbreaks caused by infection with *S. typhi* and *Salmonella enterica serovar paratyphi* A or B (*S. paratyphi*). The size of the outbreaks ranged from 1 to 42564. Fifty-one percent of outbreaks occurred in Asia, 15% in Africa, 14% in Oceania, and the rest in other regions. Forty-six percent of outbreaks specified confirmation by blood culture, and 82 outbreaks reported drug susceptibility, of which 54% had multidrug-resistant pathogens.[9] Another focal outbreak was reported by Grizhebovskii et al, in the Chechen Republic in the year 2000, due to contamination of drinking water from irrigation ditches.[10] Adriani and Marineli et al also reported several outbreaks of typhoid fever, from an asymptomatic healthy carrier of *S. typhi* who was nicknamed "Typhoid Mary".[11,12]

Sorrell et al reported a total of 205 cases of *S. typhi* among active duty United States military personnel from 1998 to 2011 giving an incidence of 1.09 per 100,000 person-years.[13] In 2001, Michel et al reported twenty-four clinical cases of typhoid fever occurred among the members of the French Armed Forces. All had received a typhoid vaccination as per the immunization in a retrospective cohort study conducted on 94 personnel.[14]

In May 2000 an outbreak of typhoid fever was reported from All India Institute of Medical Sciences (AIIMS), which on investigation was found to be a common source outbreak.[15] Anand reported two hundred and forty two patients of enteric fever at command hospital (EC) Calcutta, during the period 1989-90.[16] Banerjee et al reported ninety five cases enteric fever among military recruits from a regimental training centre at Maharastra in the year 2003 due to sewage contamination of drinking water.[17] The attack rate for the affected population in this previous study was 12.57% which is much higher than the attack rate of 0.73% in present study. However, the antibiogram profile of the isolates in present study to the work carried out by Anand and Banerjee et al.[16,17] Multi drug resistant typhoid fever has been reported both in India and abroad by Chang et al, Wang et al, Fjaerli et al, Kambal et al, Rasaily et al, Saha et al, Iperepolu et al.[18-24]

The present outbreak was a common source focal outbreak due to sewage contamination of drinking water in a few areas in the station. Prompt action was initiated to control the outbreak. Alternate water supply was established for the affected areas. Extensive health education of all troops and families on the subject was carried out. Thus the outbreak was controlled in time, before it reached disastrous proportions.

Outbreaks of typhoid fever due to contamination of drinking water have also been reported by been reported by Banerjee et al, Ceylan et al, Farooqui et al and Swaddiwudhipong et al.[17,25-27]

CONCLUSION

Present study depicts how despite several massive outbreaks having occurred in the past both in India and abroad as complacency does set in regarding water quality monitoring and education of all concerned regarding water borne diseases. The above study thus highlights the necessity of strict water quality monitoring by all authorities concerned in the country to prevent morbidity and mortality due to enteric fever and other water borne diseases.

Recommendations

Prevention of outbreaks of typhoid fever is of prime importance. In most cantonments, the water and sewage pipelines are of very old vintage, which further compounds the problem. Strict monitoring of the presence of free chlorine in water at all source and consumer ends must be carried out by all public health specialists and medical officers alike. The absence of free chlorine from any consumer end should arouse immediate suspicion of sewage contamination of water supply enroute unless proved otherwise. Joint survey of all water supply and sewage pipelines should be carried out by the public health authorities and the military engineering services regularly to identify any leakages and possible contamination. Replacement of the water and sewage pipelines which have lived their life should be carried out on top priority. Typhoid vaccine should be procured and administered to all as per the extant policy on the subject.

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