APPLICATION OF HAZARD ANALYSIS CRITICAL CONTROL POINT SYSTEM : ANALYSIS OF A FOOD POISONING OUTBREAK

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ABSTRACT

The World Health Organization as well as several experts have recently recommended the use of hazard analysis critical control point system for prevention of food-borne illnesses. The present study proceeded to identify the hazardous operations and their critical control points by investigating, through a case-control design, an outbreak of food poisoning. The predominant presenting symptoms were watery diarrhoea and abdominal cramps. The cumulative incidence during this episode was 28.6 per cent, with a median incubation of 13 hours. Evaluation of food histories indicated a very high and significant odds ratio for mutton dish (OR = 6.45; $p < 0.001$), which persisted even after adjusting for the consumption of other food items through stratified analysis using the Mantel-Haenszel procedure. Environmental assessment revealed a strong possibility of contamination of raw mutton at the source with animal excreta and prolonged storage at room temperature of cooked mutton dish. Based on these findings, hazardous operations were identified and critical control points and monitoring criteria for prevention of food poisoning have been suggested.

MJAFI 1996; 52 : 100-104

KEY WORDS : Food poisoning; Epidemiologic methods; Hazard analysis critical control point (HACCP).

Introduction

The Indian Armed Forces have always laid stress on prevention of food borne illnesses though various procedures like regular health inspection of food handlers, inspection of messes, and provision of sanitary facilities in eating establishments. However, presently the consensus among experts [1], as well as the WHO [2,3], is that the above mentioned steps may not really be very effective in obtaining the desired goal. The recent recommendations lay stress on the education of food handlers and application of hazard analysis critical control point (HACCP) system [2].

The HACCP approach was initially suggested by Bryan in 1992 and is now strongly recommended by WHO for preventing food borne illnesses [1,2]. The system works by, firstly, identifying those hazardous operations in the preparation and serving of food items during which contamination can occur or perpetuate and, secondly, by determining practical critical control points (CCP) at which the identified hazard can be

controlled. Once the CCP have been identified, criteria which would indicate whether an operation is under control at a given CCP are defined and monitored. The resultant advantage is that the Public Health practitioner as well as the administrator can keep a check at a few relevant points and effectively prevent food borne illnesses rather than going through a lengthy and often impractically long list of inspection details of cook houses and food handlers at frequent intervals.

One of the methods of identifying hazardous operations and establishing CCP for the same is by investigating outbreaks of food poisoning, thus identifying the reasons for contamination of a given food item, a step which was undertaken in the present study.

Material and Methods

The study was an observational, analytic, case-control design for investigating an outbreak of food poisoning which occurred in an Armed Forces unit located in a semi-permanent camp in a hot, arid, semi-desert terrain, in western India. The

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contaminated dinner was consumed by 126 personnel of whom 36 developed the illness. The total sample of 36 cases was studied while a sample of 51 controls was drawn, by systematic random sampling, from those persons who did not develop the illness. Active search was made in the study population to identify any mild or missed cases using rapid epidemiological assessment techniques, through standardized case definitions. Information was recorded on a predesigned questionnaire based on standard texts [4,5]. Laboratory samples were taken as per laid down guidelines [4,6]. However, in the absence of locally available adequate microbiological facilities, as well as the non-availability of food samples, the investigations were mainly based on clinical, epidemiological, circumstantial and environmental evidence. The last two aspects included a detailed public health inspection of the entire food chain in respect of each food item and the water supply.

Results

General : The suspected meal was cooked between 5 p.m. and 7 p.m. and consumed between 8 p.m. and 11.30 p.m. by 126 persons, of whom 36 developed the illness. The cumulative incidence (attack rate) was 28.6 per cent.

Clinico-epidemiological profile : It was observed that watery loose motions and abdominal cramps were universal findings (Table 1). Vomiting, fever, blood in stools and dehydration were conspicuous by their absence. The disease took an uneventful course and all cases recovered within 24 hours.

Epidemic curve : The epidemic curve pattern was classically that of a single exposure epidemic due to a common vehicle, with a quick rise and fall, and a sharp peak (Fig 1). The median incuba-

tion period, as evident from the curve, was 13 hours with a range of 11 to 19 hours.

The findings from the clinico-epidemiological profile and the epidemic curve strongly suggested that the episode was due to *Clostridium perfringens*, or, possibly, due to *Bacillus cereus* (long incubation type) toxin [5, 7-9]. Absence of fever ruled out salmonellosis. *Staphylococci* or *B. cereus* (short incubation type) were ruled out as the causative organism by the absence of vomiting, while shigellosis was excluded by the absence of blood in stools. Absence of nausea or vomiting helped in ruling out chemical poisoning. In the absence of adequate microbiological diagnostic facilities the identification of the etiologic agent was based mainly on clinical parameters.

Epidemiological analysis of exposure histories to various food items : The details are presented in Table 2. It was observed that the highest odd ratios (undefined statistically) were for chapatti and rice. However, this was a statistical fallacy, since everybody (excepting for one subject) had consumed these items. Similar fallacious situations have been described in standard texts also [7].

It was observed that out of the other three dishes, the highest risk-estimate was for mutton (OR = 6.45; $p < 0.001$). Though consumption of peas also carried a fairly high risk (OR = 5.6 ; $p < 0.001$), this effect was because of confounding due to eating mutton. Stratified analysis showed that the risk due to peas became very low and statistically non-significant when adjustment for eating mutton was done using Mantel-Haenszel technique (Mantel-Haenszel OR = 2.1, $p = 0.58$).

Final incrimination : Mutton versus rice : While the risk due to eating rice was possibly a statistical fallacy as explained above, however,

TABLE 1

Clinico - epidemiological profile of food poisoning outbreak

	Symptoms/signs						
	Loose motions	Nausea	Vomiting	Fever	Blood in stools	Abdominal cramps	Dehydration
Proportion of cases with the symptoms	100%	3%	nil	nil	nil	100%	nil
**Severity	++	+	—	—	—	++ to +++	—

** Legend : — = absent; + = mild; ++ = moderate; +++ = severe

Fig. 1: Epidemic curve

TABLE 2

Food histories of cases and controls

Food item	Cases (n=36)		Controls (n=51)		Odds ratio (95% CL)	p value
	eaten	not eaten	eaten	not eaten		
Mutton curry	31	5	25	26	6.45 ## (1.96 - 22.5)	< 0.001
Peas in gravy	32	4	30	21	5.60 # (1.56 - 21.9)	< 0.001
Moong dal (Green gram)	18	18	45	6	0.13 (0.04 - 0.43)	< 0.001
Rice	36	0	50	1	undefined*	1.00**
Chapati (Bread)	36	0	50	1	undefined*	1.00**

* Statistical fallacy without much epidemiology relevance [3]; ** p value (two tailed) by Fisher's exact method = 1.00, indicating a completely non-significant result; ## Mantel - Haenszel Odds Ratio (OR) for mutton adjusted for eating peas = 4.22, $p = 0.08$ (Fisher's exact two-tailed); # Mantel - Haenszel Odds Ratio (OR) for peas, adjusted for eating mutton = 2.11, $p = 0.58$.

since *Bacillus cereus* (which has a predilection for rice as a vehicle) was being considered as a possibility, further analysis was undertaken to assess the risk associated with eating rice. The findings are presented in Table 3.

It was observed that the risk due to eating rice alone was negligible as compared to when both mutton and rice were eaten (OR = 0.15; $p < 0.01$). Thus, the risk was apparently due to mutton and not due to rice. Since mutton is a well documented vehicle for *Clostridium perfringens* food poisoning [5, 7-9] the suspicion regarding the present episode

TABLE 3

Risk due to eating only rice as compared to eating both mutton and rice

Food history	Cases	Controls	Total
Ate rice but not mutton	5	26	31
Ate both rice and mutton	31	24	55
Total	36	50#	86#

: one control had eaten neither rice nor mutton, hence total is less by 1);

Odds ratio (OR) = 0.15; 95% CL = 0.04 - 0.43

Chi square (Yates) = 11.59; df = 1; $p < 0.001$

being due to *Clostridium perfringens* was further strengthened.

Although chapatti had been eaten by all 36 patients, it was unlikely that it was the vehicle and the statistical fallacy has been explained above. Moreover, chapatti being a freshly baked wheat-flour bread, it is not at all a known vehicle for either *C. perfringens* or *B. cereus* toxins. Chapatti was therefore excluded on both grounds [5, 7-9].

Environmental and circumstantial evidence :
The salient findings were :-

(a) Cooked food items had been stored at room temperature (38°C ambient) for approximately 4 to 5 hours before consumption providing ample time for germination of spores. There was no re-heating of food items before consumption.

(b) Mutton was obtained through a civilian butchery. The hygienic conditions at this butchery were far from satisfactory and provided enough opportunity for contamination of raw mutton with excreta of slaughtered animals.

(c) Food handlers were found to be free of septic foci. Water surveillance (free residual chlorine and bacteriological tests) showed satisfactory results.

Discussion

The sequence of events leading to the present episode can be tentatively summarized :- "cross-contamination of raw mutton with *Clostridium perfringens* spores occurred at the civilian butchery due to exposure to excreta of slaughtered animals. Storage of this mutton for 4 to 5 hours at around 38°C ambient temperature, after cooking, provided the ideal time and temperature for the surviving heat-shocked spores to germinate into vegetative forms. These vegetative forms continued to survive as there was no adequate reheating before serving, and after being consumed they produced toxin in vivo leading to the outbreak". This hypothesis is adequately explained by the findings of this study and it is also biologically plausible [5,7-9].

Against the backdrop of the above sequence of events the recommended HACCP system is submitted as per Table 4. The overall HACCP approach has already been evaluated in the Armed Forces and has been found to be feasible [10]. The

TABLE 4

Suggested HACCP system for prevention of food poisoning

Hazardous operation	Storage of cooked mutton dish at room temperature for more than 4 hours
Critical control point	All meat dishes to be consumed within 4 hours of cooking
Criteria for adequate control	i. Cooking of all meat dishes will start after 6 p.m. Monitoring responsibility : NCO i/c mess ii. Serving of the meat dish will commence at 7.30 p.m. and finish by 9.30 p.m. Monitoring responsibility : NCO i/c mess iii. Any meat dish remaining after 9.30 p.m. will be discarded Monitoring responsibility : Senior JCO iv. Completion report regarding (i), (ii), and (iii) above to be recorded Monitoring responsibility : Duty officer

recommendations of the present study may be considered as a simple, practical and effective method of preventing food poisoning in Armed Forces messes. This HACCP-based system is likely to benefit those who are actually concerned at the grass-root level in identifying and preventing food borne illnesses. Such key personnel (viz., Regimental Medical Officers as well as other officers, Junior Commissioned Officers, and non-Commissioned Officers who are in-charge of the cook houses in the Armed Forces) can use the check-list (Table 4) as a rapid epidemiological assessment technique for identifying the hazardous areas and critical points that are crucial for public health activities in eating establishments. In addition, the present study has also highlighted the importance of a case-control method in investigating outbreaks of food poisoning as compared to the conventional retrospective cohort approach, thus reinforcing the findings of earlier studies carried out in the Indian Armed Forces [11].

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