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The tangible cost implications of a hospital outbreak of multiply-resistant salmonella

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SUMMARY

A hospital outbreak of multiply-resistant *Salmonella heidelberg* infection, which affected 17 patients and 2 staff, is described. The tangible cost of the outbreak was estimated at £21 151, £17 989 (85·1 %) of which was borne by the hospital. The cost to the Microbiology Department was £3596 (17·0 % of the total). A detailed analysis of the costs and implications for staffing disruption is given and a comparison is made with the costs of preventive activities. Ways of containing expenses in the event of an outbreak and the economic implications for clinical budgeting and privatization of the laboratory service are considered.

INTRODUCTION

An average of 20 outbreaks of salmonella infection in hospitals are recorded each year in England and Wales, varying from 12 in 1981 to 62 in 1974 (Public Health Laboratory Service (PHLS), Communicable Disease Surveillance Centre (CDSC), unpublished). Although the outbreak of *Salmonella typhimurium* infection at Stanley Royd Hospital in Wakefield in 1984 (1) affected large numbers of patients and made national headlines, the average number of patients and staff affected in hospital outbreaks is 8 (2). However, the implications of these outbreaks, in terms of morbidity and mortality, disruption of normal activities, and the financial costs, are probably underestimated.

An outbreak of multiply-antibiotic resistant *S. heidelberg* occurred in St Bartholomew's Hospital during October and November 1987. A total of 19 patients and staff were affected and a detailed analysis of the costs involved for this relatively small outbreak is presented below. The methods used to examine the economic implications are described and may be adapted for similar costing exercises by others. The implications for the control of such outbreaks and their funding are also considered.

THE OUTBREAK

The first two cases infected by *S. heidelberg* were diagnosed on 3 October 1987 on separate wards, and full epidemiological and microbiological investigations were initiated. A case search was carried out amongst staff and patients in the affected wards and amongst staff in the catering department. Information on recent gastrointestinal illnesses was requested and faecal specimens or rectal swabs were screened for salmonellae. Presumptive identification of the organism in specimens was made by serology, biochemistry and antibiogram, and isolates were sent to the Division of Enteric Pathogens, Central Public Health Laboratory for confirmation. Infected patients and staff were questioned about meals eaten in the hospital between 28 September and 10 October and medical, nursing, physiotherapy and domestic staff movements between wards were investigated.

The kitchens were inspected and environmental specimens and swabs were obtained from food preparation areas, refrigerators, mops and drains. Samples of patient meals from the weeks 23 September to 7 October were tested for salmonellae.

S. heidelberg was identified in 17 patients and 2 members of staff on 9 wards in three blocks between 2 and 29 October. Seven patients and one member of staff had symptoms between 2 and 26 October. One nurse became ill after caring for an infected patient. One member of the catering staff, a cook, had a positive stool specimen but was asymptomatic.

The results of the epidemiological investigation suggested a continuing common source outbreak within the hospital. Although it is possible that some later cases may have been caused in two wards by person-to-person spread, it is unlikely that this mode of spread was a significant factor in this outbreak. No common foods were identified in the meals eaten by three symptomatic and five asymptomatic individuals who were interviewed. No pathogenic bacteria were isolated from stored food samples, nor was the outbreak strain of *S. heidelberg* found on testing uncooked chicken, a known vehicle of *S. heidelberg* infection.

The kitchens prepare 3500 meals daily. On 1 October, the hospital changed to a new meat and poultry supplier who delivered frozen meat. Once defrosted this meat was stored on the lower shelves of a walk-in refrigerator where cooked food was also stored on the higher shelves. Staff had been instructed to wash their hands between handling raw and cooked foods. There were no complaints about the water supply or sewage disposal.

Control measures

The Control of Infection Committee held seven special meetings and ensured the following control measures were implemented. Patients with *S. heidelberg* infection were nursed in single rooms or cohort nursed until they had provided three negative stool specimens. Staff with *S. heidelberg* were similarly not allowed to work until they had provided three consecutive negative stool specimens. Affected wards were closed to admissions until screening had been completed.

Although antibiotic therapy of acute salmonella gastroenteritis is not usually recommended, because infection is generally self-limiting (3), it was found that in this outbreak antibiotic therapy with oral ciprofloxacin was indicated to prevent

infection of a joint prosthesis, to eliminate infection in immunosuppressed patients, to enable urgent surgery to be carried out, and for the treatment of septicaemia. Therapy also enabled the cook to return to work after three negative stool samples (at weekly intervals) were obtained.

Two refrigerators were bought for the kitchen to keep cooked and uncooked meats separate. The outbreak also precipitated the purchase and installation of four new bedpan washers for the wards.

Information was provided to all wards by a written statement from the Control of Infection Officer issued via the hospital administration department, and on a day-to-day basis by verbal communication by the Control of Infection Nurse and junior medical staff. The local press were not involved.

METHODS

The tangible opportunity costs of the outbreak were identified and included investigation, treatment, administrative and supplies costs.

Laboratory costs included materials and labour.

Nursing costs were assessed as the extra nurses employed through an agency on the affected wards during the time of the outbreak, namely 36 day shifts of 7·5 h (270 h), 11 night shifts of 10·75 h (118·25 h), handover between shifts (27 h), charged at the agency rates of £8 per hour (which includes all employers costs except National Insurance contributions). The total hours worked were 10 'whole time equivalents' (WTE), that is, the equivalent of employing 10 people for a full week and an additional element of £106 was included for the 10 WTE National Insurance contributions.

The work of the cook, who was excluded from work, was done by another cook and the cost was calculated as 6 weeks overtime on his pay.

Medication costs included the costs of the antimicrobials prescribed, and additional supportive and symptomatic therapy such as intravenous fluids and anti-diarrhoeal agents.

The cost of items such as alcohol hand rub, gloves and aprons was calculated by multiplying the unit cost by the number of patient weeks in isolation by the approximate number of each item required per patient per week.

The outbreak also resulted in the purchase of two new refrigerators for the hospital kitchen.

Administration costs included issuing a statement for distribution within the hospital, a questionnaire distributed to nursing staff on one ward and an estimate of the extra telephone calls.

Only four of those affected were employed at the time; an estimate of their lost productive output was based on the extra time spent in hospital in the case of the patients and on the time off work in the case of the two staff members.

The cost of patient treatment days lost was calculated from daily in-patient costs for the appropriate medical and surgical specialities.

Opportunity costs associated with investigation and control comprised time spent preparing media and examining specimens, attending control of infection meetings, providing education for the staff in the kitchens, and follow-up of patients discharged to the community. The costs were calculated by estimating

Table 1. *Costs associated with the outbreak of* S. heidelberg

	Costs to hospital (£)	Costs to others (£)
Laboratory costs (* see below)		
Human specimens	3202	224
Food and environment	544	—
Medication costs		
Seven courses of ciprofloxacin	178	—
One course of cefuroxime	42	—
Supportive therapy	75	—
Staffing costs		
Extra nursing staff	3428	—
Six weeks overtime to cook	1368	—
Investigation and control costs		
Control of infection meetings	375	605
Taking clinical specimens	432	—
Taking environmental specimens	15	14
Investigation of food and supplies	26	—
Educational visits by EHO	—	42
Follow-up of nursing home patients	—	39
Follow-up of discharged patients	—	41
Hospital administration and supplies costs		
Supplies († see below)	548	—
Two new refrigerators	500	—
Administration costs	60	—
Extra laundry	163	—
Lost patient treatment		
48 days	5574	—
Lost productive output		
Two staff (56 days)	1459	—
Two patients (47 days)	—	2197
Total	17989	3162

* Laboratory costs	Cost (£)
106 faeces	636
(16 isolates sent to Reference Laboratory	224)
376 screening specimens	2256
16 urines	80
8 blood cultures	80
39 food samples	234
45 environmental samples	270
4 chicken samples	40
10 extra haematology tests	50
20 extra biochemistry tests	100
† Supplies	
222 bottles alcohol rub	151
131 boxes disposable gloves	194
18·5 rolls disposable aprons	204

the hours spent in these activities and multiplying them by the appropriate hourly rate of pay.

The costs were further broken down by cost to the hospital and to other parties. Where employment costs were considered an additional 18% employers contribution was included.

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Table 2. *Staff disruption resulting from outbreak of* S. heidelberg

'Other duties' and type of staff involved	Total time spent on 'other duties'
Attending Control of Infection Meetings	
Senior medical	6 h
Junior medical	7 h
Nursing	5 h
Administrative	10·5 h
Catering	5 h
Occupational health	3 h
MOEH and EHO	21 h*
CDSC	15 h*
Taking clinical and environmental specimens	
Senior medical	1 h
Junior medical	20 h
Nursing	20 h
EHO	1 h
Examination of specimens	
Technical	22 days
Investigation of food sources	
Junior medical	2 h
Follow-up of discharged patients	
MOEH	2 h
GP	2·5 h
Hospital supplies, staffing and administration	
Administrative duties	3 h
Installation of bedpan washers (works department)	48 h
Patient treatment days lost through ward closures	48 days
Staff absence:	
Cook	42 days
Nursing staff	14 days

* Includes time spent travelling to attend meetings.

RESULTS

The total cost of the outbreak was £21 151 of which £17 989 (85·1 %) was borne by the hospital and £3162 by other parties (Table 1). The cost to the Microbiology Department was £3596, that is, 17·0 % of the total and 20·0 % of the cost to the hospital (1117 food, faeces, screening and other human specimens were generated by the outbreak in October and November 1987, representing a 100 % increase in workload over the period). The other large items were patient treatment days lost, nursing costs and loss of productive output (26·3 %, 16·2 % and 17·3 % of total, respectively).

The staff disruption caused by the outbreak (Table 2) included 167 man hours attending control of infection meetings, 42 h taking specimens, 4·5 h following-up discharged patients, 2 h investigating food sources, and 3 h in administrative duties. In addition 56 working days were lost by staff and 48 patient treatment days were lost through ward closures.

DISCUSSION

The costing of the outbreak was of great interest. The outbreak itself was relatively ordinary, involving only 19 persons, 11 of whom were asymptomatic, with no deaths, yet the costs amounted to at least £21151, at a conservative estimate. The cost of each of the items taken into consideration could be easily ascertained and the figures given are a reliable representation of the tangible costs of the outbreak. Intangible costs have been excluded because of the major uncertainties in their estimation, but would increase the total further.

The cost per case was £1113 and could have been much higher but for the low number of those involved being in employment. However, the costs are comparable to those of two studies carried out in recent years to assess the economic implications of salmonella outbreaks. Sockett and Stanwell-Smith (4) determined the health care cost per patient to be approximately £400, but they studied all cases in five health districts in Birmingham, both in-patient and out-patient, and they found that in-patient care was the largest item of the bill, accounting for approximately 80% of the total. In the second study (5) involving an outbreak in a geriatric hospital affecting 242 patients and staff, with three patients deaths, the cost per patient was between £825 and £3655. However, the authors themselves considered their patients to be atypical because firstly they were long-stay patients and their stay in hospital and consequent hotel costs were unlikely to be affected, and secondly the patients were more vulnerable.

Of the total cost £17989 fell to the hospital to fund. In these times of strict budgetary control, an outbreak of this nature can cause serious overspending of the allocation, affecting most obviously laboratory and clinical departments, but also laundry, nursing, supplies and cleaning budgets. The analysis of the activities involved also gives an indication of the number of hours and disruption involved in investigating and controlling the outbreak. What it does not indicate is the extra visits and consequent costs both financially and emotionally to the families of the affected patients.

How do the costs compare to the costs of preventing such an outbreak? Ideally, the regular input of the Environmental Health Officer (EHO) and training and refresher courses for the kitchen staff should prevent such outbreaks completely. There had been environmental health input for many years and it was felt that in this instance there was a temporary breakdown in food hygiene. Because of the age of the buildings and the current construction of the new catering block, a few changes were instituted, at small cost. Two refrigerators were ordered for the kitchen to keep cooked and uncooked meats separate (£500). Chicken was obtained from a different supplier and delivered defrosted to the hospital (at no extra cost). The microbiologically based policy for sampling all hot foods in the kitchen was extended to cover all foods, including salads. Food hygiene courses remain unchanged. Catering staff receive 2 days full time training on employment and a half-day refresher course yearly; portering and domestic staff receive two 1 h talks on food storage and hygiene, from an EHO. The costs of these activities to the hospital can be estimated at £1227 and to the EHO at £173 per year. Thus, at today's prices a single ordinary outbreak costs the same as approximately 15 years preventive activities.

Although members of the Control of Infection Team were employed, with control of such an outbreak in their job descriptions, the opportunity costs resulting from the outbreak were included in the total to reflect the extra time involved in investigating the outbreak over and above the normal working day.

A number of measures can be taken to limit the costs if an outbreak occurs. The major expenses are likely to be nursing costs, laboratory costs, patient treatment days lost, and lost productivity of patients and staff in employment. Laboratory costs are difficult to contain, because they are clinically initiated or are required to assess the extent of the outbreak. Similarly nursing costs are difficult to reduce, when patients require nursing in isolation, particularly in an outbreak of this nature involving patients on numerous wards with very different clinical needs. Patient treatment days lost were kept to a minimum by discharge of patients to the community where possible and the nursing of patients in isolation or cohorts, and could not have been further reduced. The lost productivity of patients and staff is possibly more amenable to control; with the availability of an effective oral antimicrobial agent in ciprofloxacin, the time to elimination of the organism, convalescence and return to work may be considerably reduced and there is a financial case to be made for treatment of cases at risk of septicaemia.

Ciprofloxacin is expensive when compared with oral ampicillin or chloramphenicol: £21 *vs.* £3–6 for a 7-day course. However, the use of even a relatively expensive antibiotic may be cost effective if it prevents the stay of patients in side rooms and enables them to return to work more rapidly.

Microbiologists and epidemiologists have a vital role to play in the prevention and control of infection. The benefit may not previously have been as well-defined as that resulting from diagnostic services to patients, but the data presented here demonstrate that the potential savings from their work, in terms of morbidity and mortality, finance and disruption to staff, can be enormous.

With the imminent introduction of clinical budgeting and the threat of privatization of pathology laboratories, a number of important resource implications have to be addressed. Who would pay for the extra laboratory-initiated screening specimens when clinical budgeting is introduced? Indeed, who would pay for Reference Laboratory confirmation of the isolates, an essential element in salmonella surveillance and outbreak investigation, if privatization of hospital laboratories is considered? Who would pay for the burden on support departments, including nursing services? If and when laboratories are privatized allowance must be made for outbreaks of this nature both when specifications for tendering are drawn up and when the tenders are assessed.

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