

Costing of a hospital-based outbreak of poultry-borne salmonellosis

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SUMMARY

Poultry-borne salmonellosis is the most common form of foodborne infection in Scotland for which the vehicle can be identified, yet little is known about the costs imposed on society by this disease, or the costs of preventing it. The present study identifies and values the costs of a hospital based outbreak of poultry-borne salmonellosis. Account is taken of costs falling on individuals, the health services and society as a whole. Depending on assumptions made about the value of 'intangibles', the cost of the outbreak is estimated to be between £200 000 and £900 000.

INTRODUCTION

Prior to 1983 contaminated raw milk was the main cause of salmonellosis in Scotland, but with the introduction of compulsory pasteurization in that year the position has changed and poultry is now the most important food vehicle (Sharp *et al.* 1986). Outbreaks of foodborne salmonellosis in hospitals are not uncommon and are frequently associated with the consumption of poultry (Collier *et al.* 1986).

Salmonellosis is a preventable disease. However, in order to evaluate the economic efficiency of preventive measures, the costs imposed on society by this disease must be known. The costs of food poisoning have not been studied in any detail in Scotland; the only previous work referred to community outbreaks of salmonellosis, in one of which the food vehicle was milk (Cohen *et al.* 1983) and in the other unknown (Neilson, 1984).

As part of the national surveillance programme undertaken by the Communicable Diseases (Scotland) Unit, plans were made in 1985 to cost the next poultry-borne outbreak of salmonellosis so this could be compared with the known costs of previous outbreaks. This information could then be used in the evaluation of measures to prevent poultry-borne salmonellosis.

On 18 December 1985 Christmas lunches were served in an Edinburgh hospital which accommodated at that time 209 patients, of whom 169 were elderly and 40 were young physically handicapped persons. Traditionally the meal was shared by patients and staff and consisted of soup or fruit juice, turkey with the usual

trimmings and Christmas pudding. It was consumed by approximately 280 persons. On 20 December the staff of the Blood Transfusion Centre based at the hospital, who had not eaten the meal on 18 December, ate Christmas lunch which also included turkey.

Individuals who ate either of the meals became ill and 161 persons were confirmed bacteriologically to have suffered from salmonellosis (*Salmonella thompson* and *S. infantis*). Of these, 60 were patients, 88 were hospital staff, and 9 were Blood Transfusion Service staff, while 4 other people who were home contacts of index cases were also infected. In addition a further 50 patients and 31 staff reporting symptoms were found to be bacteriologically negative. The total number of persons affected was 242. Three deaths were associated with the outbreak and one patient suffered severe complications (deep venous thrombosis and pulmonary embolism) resulting in chronic ill-health.

Turkey was incriminated on the epidemiological evidence as the responsible food vehicle. Eighty of 83 infected hospital and Blood Transfusion Service staff who had given a clear food history admitted to having eaten turkey at one or other of the meals, and 3 (catering staff) did not; of 41 staff who ate Christmas lunch and remained well, 28 had eaten turkey and 13 had not. The difference in the incidence of illness between those who consumed turkey and those who did not is statistically significant (Fisher's 'Exact' test, $P < 0.001$).

The occurrence of this incident enabled detailed costing of a hospital-based outbreak of poultry-borne salmonellosis and assisted in comparing it with costs which had already been established for community outbreaks of salmonellosis. With the information obtained a study of the costs and benefits of irradiation to prevent poultry-borne salmonellosis has been undertaken (Yule *et al.* 1986).

MATERIALS AND METHODS

Following the principles of economic appraisal, we sought to identify the 'marginal social opportunity costs' of the outbreak (Drummond, 1980). This phrase highlights three aspects of the relevant costs. First, they are *opportunity costs*: they represent the value of benefits forgone because resources were diverted from other uses as a consequence of the outbreak. These need not correspond to financial outlays. For example, use of GPs' surgery time by salmonella victims does not result in extra payments to GPs, but imposes an opportunity cost because GPs' time is scarce and is diverted from other patients. Secondly, it is the *marginal* (or extra) costs imposed by the episode which are of interest. The normal costs of hospital stay for previously hospitalized patients, for instance, could not be attributed to the outbreak. Thirdly, all costs to *society* are relevant, irrespective of the parties bearing them. Thus costs falling on individuals and society as a whole were included, as well as those borne by the health services.

Since the outbreak was identified at an early stage as being suitable for a costing exercise, detailed and accurate records of hospital resources used and absence from work of infected staff were readily available. A questionnaire was prepared and distributed to affected staff in order to ascertain their use of GP services, as well as work absences of friends and relatives arising from the incident.

Costs are classified as tangible or intangible according to whether or not they are

easily measured in money terms, and direct or indirect according to whether they are borne by the health services or other parties. Where major uncertainties exist about the magnitude of costs the technique of sensitivity analysis is used, i.e. a range of costs is taken so that the sensitivity of the results to alternative values can be judged.

Economic losses due to absence from work are proxied by gross employment costs (Morgan & Davies, 1981). This method may be criticized on the grounds that, in times of unemployment, workers can be replaced from the pool of unemployed at zero opportunity cost to society (Williams, 1985). However, this argument is less persuasive in the case of absences due to salmonellosis, which are typically of short duration: appropriate labour may not be immediately available, and the process of finding and hiring replacements is itself a costly activity.

The valuation of 'intangible' costs, such as loss of life or the 'pain, grief and suffering' associated with illness, is always problematic in economic appraisal. It does not follow that such valuation is impossible; indeed values are currently being placed on 'intangibles' (usually implicitly) in many areas of public policy-making (Hurst & Mooney, 1983). The approach here is to make use of existing work on the monetary valuation of intangibles, but bearing in mind that such estimates are inevitably crude, using sensitivity analysis to give a range of estimates under different assumptions.

RESULTS

The results of the costing study are shown in Table 1.

Tangible direct costs

(a) Hospital costs

As a direct consequence of the outbreak, additional resources were used on existing hospital patients. Extra expenditures on drugs, disposables and administration amounted to £6201.

In addition two victims of the outbreak were admitted to hospital for treatment. The marginal cost to the hospital of treating these patients is difficult to estimate, but may be considerably less than the average cost per patient (Henderson, McGuire & Parkin, 1984). To approximate marginal costs we have deflated average costs per in-patient day for the hospital (SHHD, 1986) by factors of 25, 50 and 75%. (Greater refinement was felt not to be justified since it was clear that this component of hospital costs would be small relative to total costs in the study.) The resulting range of costs for patients admitted to hospital is £235–£704. Follow-up out-patient visits were costed at the average cost per out-patient attendance (SHHD, 1986), giving a cost of £42. This puts the total hospital cost of the outbreak at £6478–£6947.

(b) General practitioner services

Numbers of surgery and domiciliary visits were obtained from the questionnaire responses. Adjusting for non-responders, 556 visits were attributable to the outbreak.

There is no established methodology for costing GP visits. The cost of each visit

Table 1. *Costs of the outbreak (£, 1985)*

Tangible direct costs	Lower	Mid	Upper
(a) Hospital costs	6478	6713	6947
(b) GP services	2569	2677	2785
(c) Laboratory tests	—	16812	—
(d) Senior nursing and medical staff	—	4681	—
(e) Environmental health department	—	1537	—
(f) Central administration	—	2192	—
Tangible indirect costs			
(g) Loss of productive output	—	79240	—
Total tangible costs	£ 113509	113852	114194
Intangible indirect costs			
(h) Pain, grief and suffering	23850	47700	71550
(i) Loss of life	62220	380610	699000
Total intangible costs	£ 86070	428310	770550
Total cost of the outbreak	£ 199579	542162	884744
Cost per reported case	£ 825	2240	3655

will depend on the value of the GP's time used, plus the cost of any drugs prescribed. As a proxy for the former, total expenditure on GPs in Scotland (SHHD, 1986) was divided by the estimated number of GP visits in Scotland (OHE, 1984). If society is prepared to pay £119.90 million (M) for 25.96 M visits, the implied minimum value of a visit is £4.62 ($119.9 \text{ M} \div 25.96 \text{ M}$). This would put a low estimate of the value of GP services used, excluding drugs, at £2569.

Details were unfortunately not generally available on the nature of treatment, mostly anti-diarrhoeals, prescribed by GPs. Two common anti-diarrhoeals 'Kaolin and Morphine Mixture' and 'Lomotil' tablets, were priced at £0.12 per 100 ml and £9.80 per 100 tablets respectively in 1985. If each of the 110 patients who visited their GP received a typical prescription for 'Lomotil' (20 tablets), the cost of drugs would have been £216. This is an upper estimate: some patients will not have been prescribed any drugs by their GP, and some will have received cheaper preparations. Therefore an upper estimate of the cost of GP services, including drugs, is £2785.

(c) *Laboratory tests*

A total of 1707 faecal specimens were examined at the Central Microbiological Laboratories in Edinburgh at a standing NHS cost of £6 per specimen, amounting to £10242. Additional costs were incurred in further identification of the salmonella isolated (£3310) and from additional hospital visits by the Consultant Microbiologist, extra technician time and clerical costs (£1900). Serotyping of salmonella isolates carried out at the Scottish Salmonella Reference Laboratory in Glasgow cost a further £1360. The resulting total cost of laboratory tests was £16812.

(d) *Senior nursing and medical staff*

Senior nursing, community medicine and hospital medical staff involved in investigating and controlling the outbreak incurred costs of £4681 based on their time and travel expenses.

(e) *Environmental health department*

The time and travel costs of the environmental health officers involved, plus administrative costs amounted to £1537.

(f) *Central administration*

The cost of clerical time, extra postage and telephone charges incurred by the health board as a result of the outbreak was estimated at £2192.

Tangible indirect costs

(g) *Loss of productive output*

A clearance standard of three negative stool cultures was agreed for hospital staff. Employees who were ill were typically either not replaced (in which case their output was lost), or they were replaced by employees from other hospitals (in which case output was forgone at these hospitals). Over 3000 working days were lost at a cost of £69576 based on the grades and hourly earnings of the staff involved. Where agency nurses were used to replace sick nursing staff the marginal cost incurred thereby (£1350) was included.

In addition to ill hospital employees, nine relatives or flatmates of members of staff were excluded from work in what were regarded as being high-risk areas (e.g. neonatal intensive care, foodhandling), and four relatives lost working days caring for ill staff. The number of working days lost and occupations of these individuals was obtained from the questionnaire and costed using earnings data from the New Earnings Survey (Department of Employment, 1986). The resulting estimated loss was £8314. Adding this to the output losses of ill staff gives a total value of output lost of £79240.

The total tangible cost of the outbreak is between £113509 and £114194 (Table 1). No account has been taken here of the possibility of litigation, and resulting resource costs of the legal process, which are increasingly a feature of foodborne outbreaks of disease. (Note that any compensation awarded should *not* be included as this would 'double count' the intangible indirect costs estimated below.)

Intangible indirect costs

(h) *Pain, grief and suffering*

Illness imposes losses over and above medical care costs and the loss of marketed output; for example victims are likely to be less able to enjoy their normal leisure activities. In an attempt to capture these subjective costs we follow Cohen *et al.* (1983) who use the methodology applied by the UK Department of Transport in costing road accidents. This derives an estimate of the minimum amount society is prepared to pay to prevent the death of any of its members, irrespective of their productive capacities. This is then scaled down in the case of non-fatal injuries or diseases (Morgan & Davies, 1981). Updating to 1985 prices, the subjective cost placed on each salmonella case is around £300. Applying this to the 159 non-fatal laboratory confirmed cases gives a value for 'pain, grief and suffering' of £47700. In order to test the sensitivity of the results to the cost per case used, values $\pm 50\%$ of £300 were also taken, giving a lower estimate for 'pain, grief and suffering' of £23850 and an upper estimate of £71550.

(i) Loss of life

Three elderly persons died during the outbreak. Two frail hospital patients died of pulmonary embolism and broncho-pneumonia respectively, with salmonellosis playing a minor contributory role. The third fatal case, resident outside the hospital, was a 76-year-old man whose cause of death was cerebral thrombosis with salmonellosis a major contributory factor.

There is no single, universally agreed, method of valuing human life. We have used the approach of Cohen *et al.* (1983) whereby a 'human capital' estimate is used as the lower bound (Morgan & Davies, 1981) and a 'willingness-to-pay' estimate as the upper bound (Jones-Lee, Hammerton & Philips, 1985). This places the mean value of human life between £207400 and £2330000 in 1985 prices. Given the age of the individuals involved, the lives lost cannot be considered to be 'average' lives. Assuming a life expectancy of '10% of normal' would reduce the range to £20740–£233000, or £62220–£699000 for three lives lost.

The estimated total value of intangibles is between £86070 and £770550 (Table 1). This gives an estimated total cost for the outbreak of £199579–£884744, or an average cost per reported case of £825–£3655.

DISCUSSION

The outbreak under study is atypical of outbreaks of poultry-borne salmonellosis in the community generally, and of those occurring in acute hospitals, in several features. Many of the victims (45%) were geriatric hospital patients for whom losses of productive output and use of acute medical services were considerably less than might have been the case in a general community ('non-institutional') outbreak. In a geriatric hospital, the lengths of stay of those infected and hence hotel costs are unaffected, unlike the situation in an acute hospital. Conversely the vulnerability of the frail elderly to the effects of salmonellosis will more frequently result in more serious illness and death. Similarly the costs arising from extensive control measures implemented to protect vulnerable geriatric patients are greater than the costs of measures which would be applied for less vulnerable types of patients. Bacteriological clearance standards of three consecutively negative stool samples were applied by the health board before permitting staff who continued to excrete salmonella organisms, although symptom-free, to return to duty.

The range of average costs per case, £825–£3655 (Table 1), is within that found by Cohen *et al.* (1983) in a general community outbreak of milk-borne salmonellosis at Keith in North-East Scotland in 1981, namely £451–£6215 (at 1985 prices). The latter range is wider because of the higher value attached to lives lost in the community outbreak, in which an otherwise healthy 6-year-old girl died.

When fatalities are excluded the average cost per case in the Edinburgh outbreak (£568–£768) is substantially higher than in the earlier Keith outbreak (£245–£430). There are two main reasons: the relatively low proportion of employed victims in the Keith incident, and the relatively high management costs in the Edinburgh outbreak where a vulnerable population of geriatric patients

required care. The proportion of employed victims at Keith (31%) was low by international standards, and few of these were required to remain off work for public health reasons (Cohen *et al.* 1983). By contrast, in the present study 55% of those affected were NHS staff who were excluded from work until bacteriologically clear of infection. The importance of bacteriological clearance standards in determining the resource implications of an outbreak of salmonellosis is highlighted by the results.

During the 6-year period 1980–5, 224 household and general outbreaks of poultry-borne salmonellosis were recorded by the Communicable Diseases (Scotland) Unit, affecting a total of 2245 persons, 12 of whom died, giving an annual average of 372 non-fatal cases with 2 deaths. If we apply the estimated cost per non-fatal case, and values of life from this study, to these numbers of non-fatal and fatal cases this yields an estimated annual cost of £252 776–£751 696 in Scotland.

International studies suggest that perhaps only 1% of all salmonella cases are identified and reported (Aserkoff, Schroeder & Brachman, 1970). Whilst the costs of the present outbreak may be considered 'above average', the estimate of the total cost of poultry-borne salmonellosis in Scotland is undoubtedly an underestimate. There are on average 115 outbreaks of salmonellosis reported in Scotland each year for which the food vehicle is not identified, along with an unknown number of sporadic cases, many of which on the epidemiological evidence available are almost certainly due to poultry-borne infection.

The costs imposed on society by outbreaks of poultry-borne salmonellosis are clearly substantial. The results from this study provide one source of information which can be used to project the benefits obtained from control measures in the prevention of poultry-borne salmonellosis (Yule *et al.* 1986).

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