Economic impact of a nationwide outbreak of salmonellosis: cost-benefit of early intervention

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Abstract

The recognition and investigation of an outbreak of food poisoning in 1982 due to chocolate contaminated with *Salmonella napoli* enabled the food that carried the salmonella to be identified and four fifths of the implicated consignment of chocolate to be withdrawn. The economic benefits of prompt intervention in the outbreak have been assessed. The cost of the outbreak was over £0·5m. It is estimated that five deaths were prevented by the intervention and that 185 admissions to hospital and 29 000 cases of *S napoli* enteritis were avoided. This successful investigation yielded a 3·5-fold rate of return to the public sector and a 23·3-fold return to society on an investment in public health surveillance. A methodology is described that can be used to estimate the benefits of early intervention in outbreaks of foodborne illness and topics for further research are suggested.

It is concluded that public health authorities and industry have much to gain by collaborating in the research into the design of cost effective programmes to prevent foodborne infections.

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Introduction

In England and Wales prevention of salmonellosis is the responsibility of medical officers of environmental health, local authority environmental health departments, and health authorities supported nationally by the Public Health Laboratory Service and its Communicable Disease Surveillance Centre and the Department of Health. When a salmonella is isolated in a laboratory it may be sent for serotyping and phage typing by the Public Health Laboratory Service Division of Enteric Pathogens. The Communicable Disease Surveillance Centre collates information on human salmonella isolates from public health and hospital laboratories weekly. This is essential for detecting geographically widespread outbreaks of infection and enabling swift epidemiological investigation. Such investigations may limit an outbreak if the source is continuous and can be identified.

A widespread outbreak of infection with *Salmonella napoli* occurred in the Midlands and south of England between April and August 1982. It was detected by the surveillance of routine laboratory reports of salmonella infections and has been described in detail.[1] Altogether, 245 cases of *S napoli* enteritis were reported by laboratories (fig 1). Fifty one (21%) patients were admitted to hospital, and more than a third (20) of these had serious complications, including 16 with bacteraemia.

Epidemiological and microbiological investigations identified imported Italian chocolate bars as the vehicle of infection. The implicated chocolate was manufactured between September and December 1981. On 23 July 1982 the Department of Health and Social Security issued a public warning about the chocolate; wholesale distribution stopped, and four fifths of the consignment of 3 million chocolate bars were recalled and destroyed. The outbreak, which had been increasing, quickly came to an end (fig 1). Many samples from severel batches were shown to contain *S napoli*,[1] and it is therefore reasonable to assume that the batches were uniformly contaminated and that if all of these chocolate bars had been distributed and eaten the outbreak would have been about five times larger.

Many cases of salmonellosis go undetected. Studies in North America have suggested that between 1/29·5 and 1/145 cases only are reported in the United States.[2,3] This "submerged morbidity" potentially has a considerable economic impact, mainly because of the large numbers of people who are probably affected rather than because of the seriousness of their illness. For this reason in this study we included an estimate of the impact of unreported cases. There is no reliable information about the extent of underreporting of salmonellosis in the United Kingdom, and because in this outbreak more cases may have been reported owing to the publicity at the time the total number of passively ascertained cases was mutiplied by 29·5, the lower figure given in the report from North America.[2] This suggested that the true size of the outbreak—the probable morbidity—was at least 7228 cases (table I). This is not an unreasonable estimate given that 600 000 chocolate bars were not accounted for after the chocolate was recalled, that about two fifths of the chocolate bars tested by laboratories were positive for *S napoli*, and that eating a single bar was sufficient to cause illness (Public Health Laboratory Service Communicable Disease Report, unpublished).[1] Had

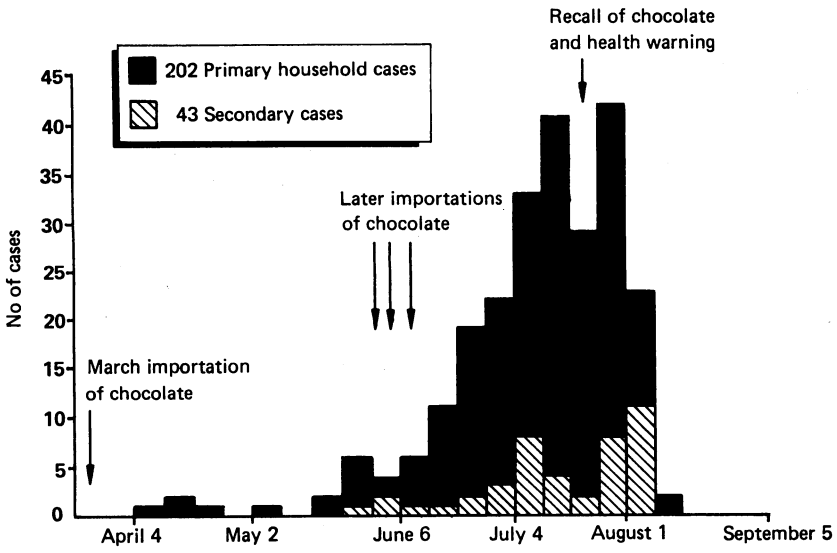

FIG 1—*Number of cases of infection with Salmonella napoli from chocolate during April to August 1982*

all the imported chocolate been eaten it is estimated that about 36 000 cases would have occurred—the total possible morbidity—of which 1200 would have been reported, and 230 people would have been admitted to hospital (table I).

TABLE I—*Ascertained* and potential morbidity in an outbreak of infection with Salmonella napoli in 1982*

	Probable No of cases in community	No of cases reported	No of admissions to hospital	No of deaths
Actual outbreak	7228	245*	51*	-
Potential (uncontrolled) outbreak	36000	1200	230	5

*Ascertained by passive surveillance of laboratory reports to the Communicable Disease Surveillance Centre.

On average there are four deaths associated with salmonellosis for every 1000 reported isolations of salmonella infection in humans in England and Wales,[4] and it is likely that up to five deaths would have occurred had the outbreak continued. It is therefore estimated that the intervention averted at least five deaths, 185 hospital admissions, and 29 000 cases of *S napoli* enteritis (total possible morbidity less probable morbidity; table I).

Method

The study was designed to assess (*a*) the economic impact of the outbreak and (*b*) the potential and actual financial return attributable to preventive activities that reduce the incidence of disease. The purpose of primary prevention is to eliminate the source of infection—for example, milk pasteurisation and water purification. Secondary prevention through surveillance, which leads to outbreaks being recognised and investigated, is aimed at limiting further spread. Tertiary prevention encompasses managing individual cases and limiting the spread of infection by isolating infected people. We carried out an economic evaluation of this intervention in the form of a cost-benefit study.

In estimating the costs attempts were made to approximate to the opportunity cost: the cost which represented the next best alternative use of society's resources. The study was retrospective, however, and it was necessary to compromise and to make various assumptions. When possible a range of estimates was compared with data from other studies. The estimations reported in this study were based on conservative assumptions about the impact of the outbreak, and where either a range of costs or two alternative costs were calculated the average or lowest figure respectively is presented.

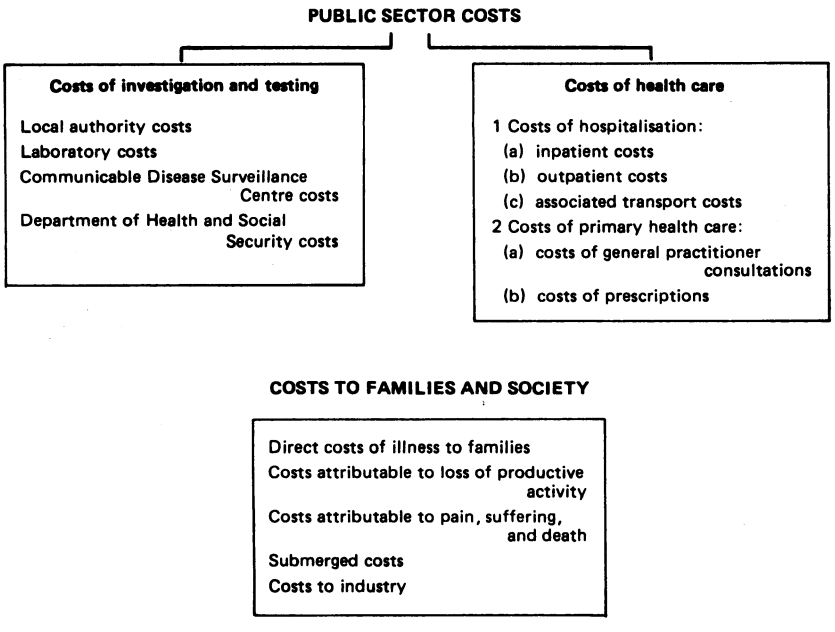

FIG 2—*Types of costs evaluated in this study*

The costs associated with the outbreak were estimated for the investigation and laboratory testing, health care, and costs to families and society (fig 2). The costs of the outbreak were projected to assess the costs that would have been incurred had the outbreak not been contained. The benefits were estimated as: (*a*) the costs that were avoided by the intervention (secondary prevention) and (*b*) the costs that were potentially avoidable if the outbreak had been prevented altogether by primary prevention.

COSTS OF INVESTIGATING AND TESTING

The costs of investigating and testing were divided into costs to local authority environmental health departments, laboratories, the Public Health Laboratory Service (including the Department of Enteric Pathogens, the Food Hygiene Laboratory, and the Communicable Disease Surveillance Centre) and the Department of Health and Social Security. These costs were obtained by the use of questionnaires, time studies, salary scales, and price lists of consumables.

COSTS OF HEALTH CARE

Health care costs consisted of estimates based on costing data for hospital specialties and estimates from other studies[5] that were adjusted for the length of time patients stayed in hospital during this outbreak. Transport costs were estimated using assumptions about the likely use of ambulance services for admitting and discharging patients that were derived from a study by Parkin and Henderson[6] and using data for average costs provided by the ambulance service.

Considerable demands were made on the time of general practitioners and displaced other activities; costs were calculated for consultation at home and at the surgery using estimates based on the work of Mooney[7] and Hurst (J Hurst, personal communication) updated to 1982 costs. Estimates of the payments made by some patients for prescriptions were calculated using data from the Department of Health and Social Security. These were deducted from public sector costs and added to costs to families and society.

COSTS TO FAMILIES AND SOCIETY

The costs to families and society were the most complex aspects of the study. The direct costs to families were calculated; these included costs resulting from hospitalisation, visits to the doctor, and payments for prescriptions. These costs were directly attributable to cases, but when estimating the costs associated with loss of output it was necessary to consider the wider implications of each case. Three fifths of the cases were children, and to take account of the costs associated with caring for them cases were arranged in family groups and the loss of productivity attributable to caring in each family was calculated. As the data that were collected in the original case-control study[1] related to "time off normal activity," adjustments were necessary to convert this into the value of lost production. Adjustments were made to take account of estimated working time lost, wage rates, costs of employment, participation rates in the labour force, part time and full time employment, and gender differences in caring responsibilities.[8] These calculations, based on labour market data, undervalue the worth of the woman's contribution both to caring and to the labour force. Therefore alternative estimations

TABLE II—*Costs of a nationwide outbreak of Salmonella napoli infection and benefits of primary and secondary prevention*

Categories of costs	Costs of the outbreak	Benefits of: Secondary prevention	Primary prevention (£: 1982 base)
Cost to public sector:			
Public health costs (investigations and testing)*:			
Local authority costs	37 272	49 694	62 115
Laboratory costs—human faeces	17 564	70 256	87 820
food	2 345	–	–
Communicable Disease Surveillance Centre	6 758	–	–
Department of Health and Social Security	7 900	–	–
	71 839	119 950	149 935
Health care costs:			
Hospitalisation	29 595	118 380	147 975
Primary care	2 878	11 512	14 390
	32 473	129 892	162 365
Costs to family and society:			
Direct family costs	1 042	4 168	5 210
Loss of productivity	15 356†	61 424†	76 780†
Pain and suffering	125 850	503 400	629 250
Loss of life	–	190 000	190 000
Submerged morbidity	166 248	664 992	831 240
Recalled and destroyed product	92 000	–	92 000
	400 496	1 423 984	1 824 480
Total costs of the outbreak	504 808	1 673 826	2 136 780

Secondary prevention: costs:benefits: 71 839:1 673 826; 1:23·3.
*Not all costs of investigation would have increased or been included if the outbreak had continued. Had no investigation taken place, it is assumed that the Communicable Disease Surveillance Centre and Department of Health costs would have been negligible, and local authority costs resulting from routine follow up of reported cases are estimated at £12 423. It is assumed that testing of faecal specimens would have continued for clinical purposes, but there would have been no sampling of a specific food product. Although no deaths were recorded, had the outbreak continued deaths may have occurred.
†Gender adjusted loss: £26 329, £105 317, £131 646 respectively.

TABLE III—*Rates of return to intervention costs of a nationwide outbreak of Salmonella napoli infection*

Costs of intervention (£71 839)	Benefits of secondary prevention (£: 1982 base)	Cost-benefit ratios
Cost to public sector:		
Public health	119 950	1:1·7
Health care	129 892	1:1·8
Total public sector	249 842	1:3·5
Costs to family and society:		
Direct family costs	4 168	1:0·1
Loss of productivity: (M+F rates)	61 424	1:0·9
Gender adjustment	105 317	1·1:5
Pain and suffering	503 400	1:7·0
Loss of life —implicit	190 000	1:2·6
—human capital	545 000	1:7·6
—willingness to pay	15 000 000	1:209·0
Unreported morbidity costs	664 992	1:9·3

were made removing the gender biases attributable to differential caring and wage rates. These adjustments would have increased the lost productivity cost (see table II).

The opportunity costs to the family are not merely those associated with the loss of productivity. The disease causes discomfort and intrudes on leisure and sleep as well as work, and some allowance for this should be made. Measurements of this aspect are not well developed. To achieve some comparability with the study of Cohen[5] estimates derived from the Ministry of Transport data for assessing injury were used and adjusted according to the proportion of severe, moderately severe, and less severe cases. Marin,[9] however, advocates the use of separate assessments for these effects.

Had the outbreak not been curtailed some deaths would probably have resulted and the value of these lost lives should be included in the evaluation. This is a difficult, highly emotive and sensitive area.[10] Three estimation procedures were used: firstly, implied values, which are based on values derived from decisions that have been made elsewhere in the public sector; secondly, human capital values, which are derived from concepts of lost productivity; thirdly, willingness to pay estimates, which attempt to assess what people would have been willing to pay to avoid death.

There were no epidemiological data or information relating to the severity of illness among the group whose illness was not reported. None the less, we thought that the effects of this illness should be included in the calculation, and we therefore assumed that unreported cases cost 10% of the costs of the known cases excluding the costs associated with hospitalisation.

The value of the chocolate withdrawn from sale in England was calculated, but it was not possible to estimate the costs of interrupting production and international distribution of chocolate and loss of confidence in the firm's product.

Results

The estimated cost of the outbreak was £504 808 (table II). The estimate was particularly sensitive to assumptions about the extent and severity of submerged morbidity and the value placed on pain and suffering.

The cost to the public sector was £104 312, 21% of the estimated total. The investigation accounted for most (£71 839) of these costs, which were mainly due to local authority and laboratory costs. Only one fifth (£14 658) of the total cost was attributable to investigations by the Communicable Disease Surveillance Centre and the Department of Health and Social Security. The costs of health care were due mainly to patients admitted to hospital.

Most (79%) of the costs of the outbreak fell on the family and society. These were largely due to estimates made for costs of submerged morbidity and "pain and suffering" and loss of life (table II). Costs attributable to loss of life were substantial even when the lowest estimates only were used. The impact of the alternative estimations of loss of life are shown in table III. Losses to the manufacturer of £92 000 resulted from the recall and destruction of chocolate stocks in the United Kingdom.

If the outbreak had not been curtailed the additional costs would have been as high as £1·67m because apart from costs directly concerned with the investigation, such as the costs of the Communicable Disease Surveillance Centre, the Department of Health, and some laboratory costs, costs would be expected to increase fivefold (table II).

Had there been no intervention costs other than those resulting from the investigation of the outbreak would have increased in proportion to the estimated numbers of cases. These costs are shown in table II as potential benefits of primary prevention. The rates of return in the form of cost-benefit ratios were calculated for all cost components. This breakdown indicates how possible cost savings or benefits might be distributed as a result of successful preventive policies. There was a 3·5-fold rate of return to the public sector alone and a 23·3-fold return to society (table III). In the difficult area of loss of life there were considerable returns, but these are extremely sensitive to the valuation methods used.

Discussion

The estimated cost of the outbreak up to the point of intervention was £504 808. Had the outbreak continued these costs would have grown by £1·67m. Therefore if it had been possible to prevent the outbreak altogether then some £2 136 780, including £312 300 public sector expenditure, might have been saved.

The rates of return suggested in this study are high despite the estimates being conservative. In addition, it

is likely that the costs of submerged illness were greater than 10% of the reported costs of illness, and the estimates of the value of life in a more litigious society might have approximated more nearly to the values obtained from the willingness to pay than the implied values presented in this paper. Only losses to the chocolate manufacturer resulting from the recall of the two products in the United Kingdom were included. Other costs to the manufacturer associated with the recall of products from other countries, capital costs for plant renovation, cleaning or replacement of equipment, and loss of public confidence in the products were not included in this exploratory study but were likely to have been substantial.[11] The implications of contamination of a wider range of products are not considered because control measures aimed at the two chocolate bars were successful in ending the outbreak; however, in cases of *S napoli* infection recorded in England and Scotland in 1983 and 1984 the people had eaten chocolates (other than the contaminated Rocky or Tommy bars) made by the same manufacturer, which suggests that other products were contaminated (Communicable Disease Surveillance Centre, unpublished; J C M Sharp, Communicable Disease (Scotland) Unit, personal communication).

The return to the Treasury in terms of public sector savings, whether these reduce costs to the health sector or allow other valuable health sector activities to be undertaken, suggest that research and investment in preventive measures are worth while.

This inquiry was exploratory and the information was constrained by its retrospective nature, but we highlighted aspects on which information could be collected cheaply and routinely in subsequent studies. (A mimeographed paper giving a more detailed account of the methods used and background to this study is available from the Health Services Research Unit, Public Health and Policy Department, London School of Hygiene and Tropical Medicine.) As such it has already contributed to the design of other inquiries.[12,13] Moreover topics worthy of further investigation are suggested, such as the impact on local services of large outbreaks, the nature and severity of the submerged morbidity, the impact on the family of an infected member, and the repercussions on industry of the disease. Lastly, research into the profile of costs and benefits associated with different forms of foodborne infection is needed. They may be very different and may have wide ranging implications for designing strategies for prevention.

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MULTICULTURAL MEDICINE

Eye, eye

Norfolk, like other counties, is a predominantly English area, and it is not uncommon in such counties for a junior hospital doctor or vocational trainee general practitioner to complete his or her training without seeing a patient from an ethnic minority. Some trainers fill this gap by inviting outside speakers. One practice of five partners decided to employ an Asian doctor as an assistant. He was a Gujarati (very polite people) and his sympathetic manner was praised by many patients, especially the elderly, who chose to see him. After a while, however, many patients, particularly those with emotional problems, asked to see an English doctor in preference. The receptionist asked some of the patients about their reasons for such a request. A common complaint was that the Asian doctor appeared not to be listening to the patient but kept looking at the wall which happened to have a clock on it. Patients felt insulted and politely ended the consultation. The doctor was startled by this behaviour and did not understand why this was happening so often. The partners became concerned, and sacking him was on the cards. Fortunately, the senior partner, who was a trainer, intervened because he had heard a speaker say that in Eastern cultures (Asian, Chinese, African, and Arab) it is rude to look someone constantly in the eye, and it is a sign of respect to look away during a conversation after initial eye to eye contact and to look intermittently to check that the other person is still there. If a person is angry with someone then he or she looks that person straight in the eye. It is considered an offence if one person stares at another, and it can cause many a fight. Sympathetic constant eye to eye contact is an expression of love, but a bold look is understood as lust. Eastern parents often teach their children not to look them or any older person in the eye. There is a popular Indian song *Akhyun Main Akhyan Dal-ke-na tak*, meaning "Don't look me in the eye (because it is a sensual gesture)." The opposite is true in Western culture. Germans, for example, have a piercing gaze, which can make even an English person shy away. Such social education should be given to all doctors from abroad. On the reverse side of the coin, an English doctor must not look an Eastern woman constantly in the eye, especially if her husband is watching the consultation. It could lead to disaster!

Incidentally, it is said that a man is not complete until he is married and then he is finished. Perhaps it is fair to say that medical training for good patient care is not complete until it includes patients from all ethnic groups.—BASHIR QURESHI, *general practitioner, Hounslow, London*