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A cost benefit study of milk-borne salmonellosis

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SUMMARY

An estimate of the benefits which would result from a ban on the sale of non-pasteurized milk in Scotland has been assessed by costing a recent outbreak of milk-borne salmonellosis in the Grampian Region.

The cost of such a ban would not exceed the benefits under any but the most severe assumptions about the values attached to intangible benefits.

INTRODUCTION

Milk-borne transmission of salmonellosis has been a particular problem in Scotland in recent times with a total of 29 outbreaks affecting over 2400 persons reported to the Communicable Diseases (Scotland) Unit during the period 1970–9 (Sharp, Paterson & Forbes, 1980) and a further 10 outbreaks identified up to the end of 1981 (Reilly *et al.*, 1983). Numerous outbreaks have also been recorded in England and Wales (Galbraith, Forbes & Clifford, 1982) although on a considerably smaller scale to that experienced in Scotland.

In August 1983, legislation will come into force requiring the compulsory heat-treatment of virtually all milk produced for retail-sale in Scotland (Hansard, 1980), which it is anticipated will prevent the future occurrence of community outbreaks involving hundreds of consumers (Sharp *et al.* 1980). The introduction of such legislation, however, will not prohibit the supply of untreated milk to farm workers and their families, nor its continued availability elsewhere in the United Kingdom.

In the autumn of 1981, an extensive outbreak of milk-borne salmonellosis, due to *Salmonella typhimurium* phage type 204, affected over 600 persons in the town of Keith and district in West Grampian. The outbreak was traced to contaminated non-pasteurized milk from a local producer-retailer dairy farm. As there is no evidence in the literature of a cost-benefit study of salmonellosis or other food-borne infections having previously been undertaken in the United Kingdom, the opportunity was taken to examine the costs resulting from the outbreak, and the benefits which would accrue from the prohibition of the sale of non-pasteurized milk.

Altogether there were 654 reported cases, 448 of which were laboratory confirmed. These included two deaths which were associated with the outbreak. As the symptoms of salmonellosis may, in many cases be so mild as not to be reported, a costing based on reported cases underestimates the true total cost of the outbreak.

The total costs of the outbreak are the sum of all costs arising from it, regardless of who bears them. These costs represent the value of all losses, some of which are readily measured in monetary terms (the 'tangible' losses) and some of which are not (the 'intangible' losses). Though there is disagreement about how best to value the intangibles, the need to take account of them is universally agreed by economists (see Drummond, 1980; or Mishan, 1978), and is consistent with WHO recommendations on the costing of communicable diseases (WHO, 1981).

MATERIALS AND METHODS

A questionnaire seeking information on various effects of the outbreak (length of illness, absence from work/school and disruption of daily routine) was sent to all individuals whose illness was laboratory confirmed. (Response rate = 93%). In addition personal contact was made with all hospitalized patients, or the parents of hospitalized children, to determine how they were brought to hospital, and the travel patterns of visitors. Information on the number and type of investigations, as well as the amount and type of drugs consumed by the hospitalized patients, was obtained from the patients' hospital records. A more detailed description of how these costs were derived is given elsewhere (Cohen, 1982).

Table 1 shows the costs associated with the tangible losses which resulted from the outbreak. The list of costed items exceeds that used in previous studies on the economic impact of salmonellosis (Cohen *et al.* 1978; Levy, 1974) as well as those given by other sources proposing methods of costing salmonellosis outbreaks (Bryan, 1978; Cvjetanovic, 1979). Items (1)–(6) are those costs incurred directly in the investigation, control and treatment aspects of the outbreak, while items (7) and (8) are costs which arose indirectly as a result of the outbreak.

Twenty three people (3·5% of those affected) were admitted to hospital with salmonellosis with an average in-patient stay of 12 days. Costs associated with these hospital stays consist of (*a*) the cost of transporting the patients to hospital, (*b*) the cost of investigations undertaken, (*c*) the cost of drugs prescribed, (*d*) the cost of medical and nursing time and (*e*) the hotel and other costs.

Hospitalized patients were brought to Aberdeen either by ambulance at a cost of 81 pence per mile (SHHD, 1981) or by private car at a cost of 16 pence per mile (the Grampian Health Board's rate of reimbursement at that time).

The cost per day of nursing and junior medical staff for the relevant ward, as well as 'hotel' costs are in all cases average costs although, strictly, marginal costs (the extra costs imposed by the outbreak) are more appropriate. Marginal costs, however, are difficult to measure, and as wards approach full occupancy, as was the case in the Infection Unit, City Hospital, where most patients were treated the divergence between marginal and average costs is narrowed (Cullis & West, 1979).

The cost of general practitioner involvement was calculated on the basis of the

Table 1. *Tangible costs of the outbreak* (£)

I. Direct costs			
(1) medical			
(*a*) Hospitalization	21138		
(*b*) General practitioners	2529		
(*c*) Field work nurses	6195		
(*d*) Senior medical/nursing staff	2000		
(*e*) Administrative and clerical	1360		
(*f*) Others	516		
Total		33738	
(2) Laboratory investigations (human)		2112	
(3) Laboratory investigations (milk)		27	
(4) Phage typing		1490	
(5) Veterinary		910	
(6) Environmental health surveillance		6075	
Total direct costs			44352
II. Indirect tangible costs			
(7) Travel to visit hospital patients		2873	
(8) Lost productive output		36864	
Total indirect tangible costs			39737
Total tangible costs			84089

number of relevant visits, multiplied by the cost per visit as determined in an earlier study in Grampian Region (Mooney, 1978). For community nursing and other personnel, the time spent directly in dealing with the outbreak was recorded, and multiplied by the relevant cost per hour. Administrative and other costs were estimated by the relevant personnel.

On this basis, the total cost of treating those who became ill was £33738 (Table 1). Adding the costs of all laboratory investigations as well as veterinary and environmental health surveillance brings the total direct tangible costs of the outbreak to £44352.

The indirect tangible costs consisted of the travel costs of friends and relatives of the hospitalised patients and the lost output of people who were kept off work. There were a total of 1357 working days lost as a result of the outbreak. The value of the output lost due to this absence is estimated by the gross cost of employing that labour (Morgan & Davies, 1981). Financial transfers, such as compensation for lost wages, involve no net drain on resources and are not included in the figure for this item.

The total tangible cost of the outbreak was £84089 as shown in Table 1.

Intangible costs

In addition to the costs of the outbreak which represent financial losses, there are several 'intangible' costs which, though not readily measurable in monetary terms are no less real. To ignore them is to suggest that no value would be attached to their avoidance, and consequently that society would be unwilling to pay anything for their reduction. How 'best' to value intangible losses is inevitably a contentious issue. Rather than defend any single method, a range of values for these losses is shown in Table 2.

By far the widest range is that given for loss of life. Several methods of valuing

Table 2. *Total costs* (£) *of the outbreak under various assumptions*

Intangible costs	Minimum	Mid	Maximum
Loss of housewives' output	9222	18444	36888
Pain, grief and suffering	33450	66900	100350
Loss of time	240	480	720
Loss of life	109000	1554500	3000000
Total intangible costs	151912	1640324	3137958
Tangible costs	84089	84089	84089
Total cost of the outbreak	236001	1724413	3222047
Number of reported cases	654	654	654
Cost per case	361	2637	4927

life have been used in economic appraisals (see Mooney, 1977). That which gives the lowest value is the 'human capital approach', which is based on an individual's expected future production. The most recent adaptation of this approach puts a mean value of £109000 on human life (Morgan & Davies, 1981). In contrast the 'willingness to pay approach', based on the amount that an individual would be prepared to pay to reduce a particular risk of dying by some small amount, gives a value for a human life as high as £3 million (Jones-Lee, 1976). These two extremes are here taken as the minimum and maximum values of the range for the value of lost life with the mid-range value arbitrarily taken as the mid point between them.

Since salmonellosis is not normally fatal, it would be inappropriate to equate a salmonellosis related death with the loss of a 'typical' life (i.e. the mean value of life). If the pre-infection condition of the individual was such that he/she had an X % chance of normal life expectancy then the cost of a salmonellosis related death could be assessed at X % of the value of a normal life. On this basis the cost of the two salmonellosis associated deaths in the Grampian outbreak have been taken as 10 % of the value of a normal life in the case of the elderly man who was in poor health before infection and 90 % in the case of the otherwise healthy 6 year old girl who developed colitis. Thus the loss of these two lives is roughly equivalent to the loss of a single 'typical' life.

The value of housewives' non-marketed output has been valued at the equivalent of the wage of a working woman of similar age (Department of Transport, 1981). In this study we prefer to use the gross cost of employing a home help as this most closely resembles the 'replacement' cost. Though this later method gives a total cost of £36888 for the 464 reported days lost by housewives, it is most unlikely that no work at all was done during this period. This figure is thus taken as the maximum value for lost non-marketed output with the minimum taken as 25 % of this (£9222).

The costs of 'pain, grief and suffering', and of 'loss of time' to visitors of hospitalized patients are based on the methodology used by the Department of Transport (1981) in its calculation of the cost of road accidents. Since both estimates are crude they have been taken as mid-range values, with figures of plus and minus 50 % of these used as the extremes.

Table 2 shows the total intangible costs of the outbreak to be between £151912 and £3137958. The total cost is thus between £236001 and £3222047 depending

Table 3. *Outbreaks of milk-borne salmonellosis in Scotland 1970–81*

	Farm		General		Total	
Year	No. of outbreaks	No. of reported cases	No. of outbreaks	No. of reported cases	No. of outbreaks	Total no. of reported cases
1970–75	4	61	8	1146	12	1207
1976–81	10	107	17	1942	27	2049
Annual average (1970–81)	1·2	14·0	2·1	257·3	3·2	271·3

on the value of the intangibles. As will be shown, however, the higher values of this range are of no importance to the cost-benefit analysis. Of more relevance is the fact that the cost per case is at least £361 and will be higher if anything other than minimum values for the intangibles are used.

The benefits of a reduction in milk-borne infections

In this study the benefits of a ban on the sale of non-pasteurized milk in Scotland are measured only in terms of reduced salmonellosis, although other pathogens, notably *Campylobacter sp.* are also killed by the pasteurisation process (Waterman, 1982).

Table 3 shows the reported number of outbreaks of milk-borne salmonellosis in Scotland for the period 1970–81. Those outbreaks under the heading 'Farm' were confined to farm workers and their families, while those under 'General' refer to outbreaks in the general community. There were 11 deaths associated with these outbreaks. Over the past 12 years there has been no decline in the number of reported cases and it can be assumed that this existing pattern would continue in the absence of legislation requiring the heat treatment of milk for human consumption.

As the ban is expected to eliminate future general community outbreaks it will generate benefits from the avoided costs of two general community outbreaks per year affecting on average 257 people with approximately one death per year. On the basis of the cost per case in the Keith outbreak, the annual benefits of the ban will be at least £92777. The high proportion of total cost attributable to the value of lost life shows these results to be sensitive to variations in the number of deaths. However the types of cases arising in the Keith outbreak are considered to be fairly typical of those which would arise in future in the absence of any ban (Sharp *et al.* 1980).

The costs of the ban

The main sources of non-pasteurized milk in Scotland are producer-retailer dairy farmers who sell the output of their own herds directly or through a retail outlet. Of 260 current producer-retailers, 37 (mainly larger ones) already have on-farm pasteurizers. A ban on the sale of non-pasteurized milk will leave the remaining 223 with the choice of having all output collected by the Milk Marketing Board for central pasteurization, or of purchasing pasteurization equipment. It has been estimated that costs in the former case will be negligible while those in the latter will be approximately £2297 per year, per producer-retailer, which includes the

costs of purchase, heat treatment, and maintenance (Cohen, 1982). Though a government grant of 22½% is available this is only a financial transfer and does not affect total cost. It may, however, influence the number choosing this option.

As it is not possible to predict how many producer-retailers will choose the latter option, it is not possible to predict the total cost of the ban. Clearly the more who choose this option, the greater will be the total cost of the ban. The minimum total annual benefits from the ban (£92777) will exceed the cost if up to 40 producer-retailers choose to purchase new equipment (£2297 × 40 = £91880). Any greater number would require some higher than minimum value for the intangible benefits. However, the mid-value benefits are sufficient to exceed the costs even if all producer-retailers chose this option.

In reality this number will be far less, as witnessed by the fact that there are currently less than 1/7th the number of producer-retailers in Scotland than there were in 1955 and the rate of decline has been increasing since 1965 (U.K. Dairy Facts and Figures, various years). Clearly producer-retailing, particularly on a small scale is a relatively inefficient way of getting milk from producer to consumer. The ban is likely to act as a catalyst to the further reduction in the number of producer-retailers and consequently the number choosing to continue retailing using on-farm pasteurizers is likely to be small. Thus the lower estimate range of the benefits of reduced salmonellosis, and probably the minimum estimate, is likely to justify the ban on cost-benefit grounds.

Discussion

This study has estimated the benefits of pending legislation requiring the compulsory heat treatment of milk produced for retail sale in terms of the avoidable costs of milk-borne salmonellosis. This underestimates the true total benefits. First it is based on reported cases only. Second, certain intangible costs, such as the value of lost schooling, have been omitted. Third, and, perhaps of greatest importance, the accompanying reductions in other milk-borne infections have not been considered. The benefit figures here derived ought, therefore, to be regarded as minima. Even so, this study has shown that such benefits will exceed the costs arising from the legislation under all but the most severe assumptions about the values attached to intangible benefits, coupled with unlikely behaviour on the part of current suppliers of non-pasteurized milk to consumers.

Milk-borne salmonellosis represents only a small part of total human salmonella infections in Scotland (Sharp & Collier, 1981). The estimated cost per case as derived in this study suggests that the costs and benefits of implementing available control measures for minimising the spread of other forms of food-borne salmonellosis should be investigated.

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