MEDICAL PRACTICE

Contemporary Themes

How far does prophylaxis against infection in total joint replacement offset its cost?

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Abstract

Selection of a cost effective method of prophylaxis against infection for patients undergoing total joint replacement was shown to depend on the number of arthroplasties performed each year at individual hospitals. When 100 arthroplasties were performed each year the prophylactic use of systemic antibiotics minimised the total costs of the department—that is, the combined costs of prophylaxis and reoperation for deep sepsis. Some departments also used local antibiotic prophylaxis in the form of polymethylmethacrylate cement impregnated with gentamicin or a combination of systemic and local prophylaxis at almost as low a total cost and with comparable effect.

Selection of a method of prophylaxis should not be determined solely on the basis of reducing costs. When a value was assigned to the effects of loss of health an economic optimum was established that allowed selection of a more costly method of prophylaxis together with further reductions in the incidence of infection and the need for reoperation.

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Introduction

In 1984 more than 7000 total hip arthroplasties and about 1300 total knee arthroplasties were performed in Sweden.[1,2] Patients who have these operations may develop prosthetic infections and consequently require reoperation; this is costly and not without risk or stress to the patient.[3,4] Thus prophylaxis against infection is a primary concern for patients having arthroplasties.

Among the prophylactic methods used in western Europe for patients undergoing total joint replacement are parenterally and locally administered antibiotics, the latter sometimes in the form of polymethylmethacrylate cement impregnated with gentamicin. In addition, arthroplasty may be performed with an ultraclean air system (surgical enclosure) and the surgical team may wear exhaust ventilated suits to reduce the risk of infection. These methods are costly, but if deep sepsis can be prevented the cost of prophylaxis may be offset by a reduced need for reoperation. We aimed to calculate the costs of these four methods of prophylaxis used either alone or in combination in patients undergoing total joint replacement and to determine the point at which the costs were offset by a reduction in the incidence of deep infection and the consequent need for reoperation.

Methods

CALCULATION OF THE COST OF PROPHYLAXIS

To find out the cost of prophylaxis when systemic antibiotics were given we carried out a telephone survey of all Swedish orthopaedic departments.[1] Prices are those current in 1984 and are in Swedish Kr unless otherwise stated. £1 was then worth about Kr 11. Information was recorded on the antibiotics given, the dosages, and the duration of treatment. The prices of antibiotics were supplied by the National Corporation of Swedish

Pharmacies and included the pharmacies' handling costs. The average cost for the initial operation was Kr 209.

The cost of locally administered antibiotic prophylaxis was determined by calculating the difference between the costs of standard bone cement and of polymethylmethacrylate cement impregnated with gentamicin. Assuming that three packages of cement weighing 40 g each were used at each operation, the average cost for the initial operation rose to Kr 563 when polymethylmethacrylate cement impregnated with gentamicin was used.

Calculating the average cost of the initial operation when an ultraclean air system was used required that the cost of buying and installing the equipment as well as the length of its useful life be considered. For the Charnley-Howorth surgical enclosure allowing 10 years of use, the average cost of buying and installing the machine was Kr 414 000. The yearly cost was calculated by treating the investment as a 10 year annuity with a yearly cash outflow of Kr 66 717 and by adding a yearly cost of Kr 9857 for filters and electricity. In all our calculations of expenditure we assessed the real cost of capital at 6% a year and allowed no terminal residual value for the equipment. Thus the estimated cost each year of using the enclosure was Kr 76 574; the average cost for the initial operation depended on the number of operations performed in that enclosure each year. When 100 operations were performed each year this method of prophylaxis cost about Kr 766 for each initial operation.

To calculate the average cost of exhaust ventilated suits for each initial operation the investment of Kr 96 052 for a blower, tubes, and other equipment was treated as an annuity. Assuming that the equipment had 10 years of useful life and that 100 initial operations were performed each year, the average cost for each initial operation for the initial investment was Kr 131. In addition costs of buying and laundering the exhaust ventilated suits were considered. Each new suit cost Kr 2469. Assuming that the surgical team used four suits for each operation, and that a suit had a useful life of 300 operations, the average cost for each initial operation was Kr 33. Laundry costs for each initial operation for four suits were Kr 220. This estimate was based on work studies made by the Swedish Planning and Rationalisation Institute of the Health and Social Services and included not only laundry but also the transportation, inspection, sterilisation, folding, and packing of the laundry[5]; the 1980 figures were increased by 10% a year to approximate 1984 prices. Accordingly when 100 operations were performed each year the average cost for the initial operation for four exhaust ventilated suits and other equipment was Kr 384.

*Average cost in 1984 of prophylaxis of initial arthroplasty depending on method of prophylaxis and number of operations performed each year. Figures are Swedish Kr**

	No of arthroplasties performed a year				
Method of prophylaxis	50	100	150	200	250
Systemic antibiotics	209	209	209	209	209
Polymethylmethacrylate cement impregnated with gentamicin	563	563	563	563	563
Charnley enclosure	1531	766	510	383	306
Exhaust ventilated suits	514	384	340	318	305

*£≈Kr 11 in 1984.

The table shows how the costs of prophylaxis varied for each prophylactic method and for the number of initial operations performed each year.

CALCULATION OF THE RATES OF REOPERATION

The incidences of deep infections associated with various prophylactic measures after total joint replacement were based on the findings of Lidwell and Josefsson *et al*[6-8] and on unpublished observations of L A and U P Lidwell's studies (fig 1) comprised 6781 patients who underwent total hip arthroplasty and 1274 who underwent total knee arthroplasty.[6,7] Josefsson *et al* investigated the incidence of deep sepsis in 1633 patients who underwent total hip arthroplasty and found that the prophylactic effect of polymethylmethacrylate cement impregnated with gentamicin was comparable with that of systemic antibiotics.[8] In our continuing study (unpublished observations) all initial total hip arthroplasties performed in Sweden since 1967 and all reoperations performed since 1978 because of deep sepsis, have been recorded; 90% of all the infections were diagnosed and reoperation performed within four years of the initial operation. Assuming that routine prophylactic measures were taken during the initial operations, we calculated an incidence of infection for the 14 752 primary operations registered. Figures 2, 3 and 4 show the findings of these four studies.

CALCULATION OF THE COST OF REOPERATION

From 1978 to 1983, 1102 initial total hip arthroplasties were performed at Malmö General Hospital; 12 patients required reoperation during this period because of deep sepsis. For nine of these 12 patients (five of whom underwent a one stage and four a two stage operation) it was possible to calculate the costs of reoperation. These included expenditure on the number of bed days in orthopaedic, isolation, and postoperative wards; on anaesthesia, blood, prostheses, x ray examination, and other testing; and on medical treatment and drugs before and after operation. The costs of these items were calculated from the hospital's final accounts and prices estab-

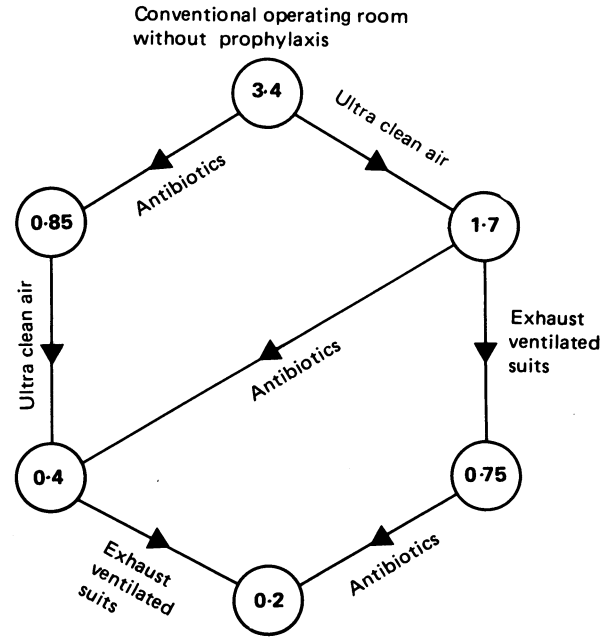

FIG 1—Incidence of deep sepsis within two and a half years of total joint replacement with no prophylaxis and with various combinations of prophylactic methods.[7]

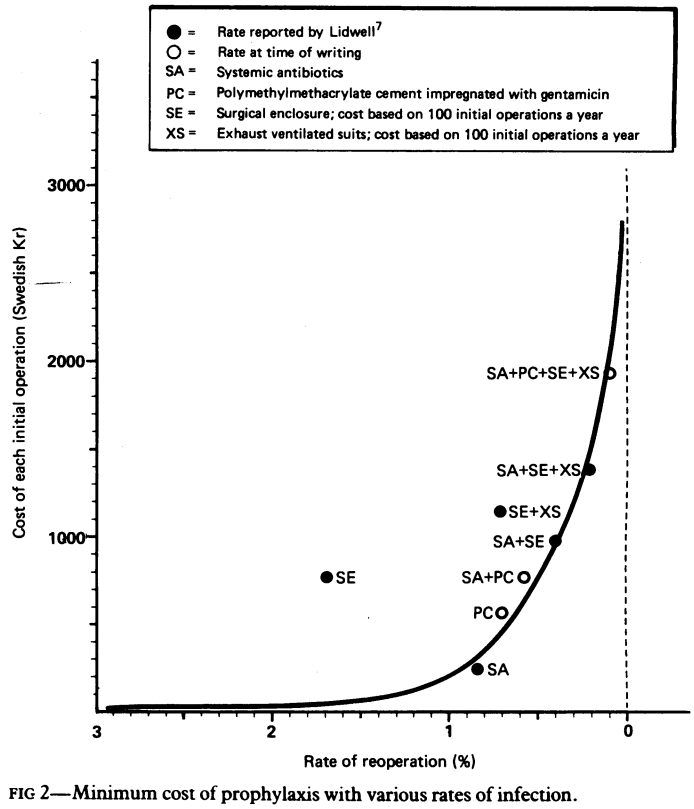

FIG 2—Minimum cost of prophylaxis with various rates of infection.

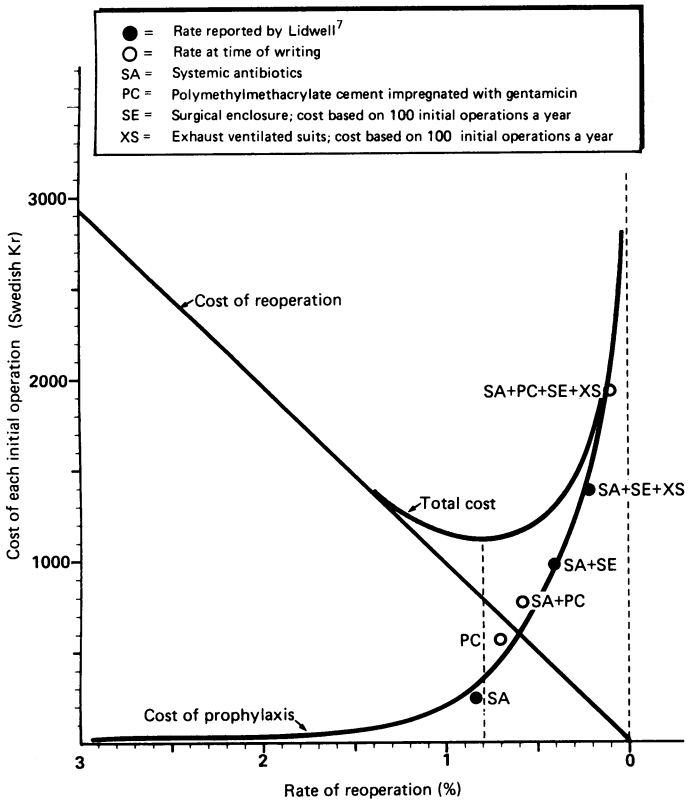

FIG 3—Total cost of deep sepsis with various rates of infection.

lished by the National Corporation of Swedish Pharmacies. Costs of operation and the treatment of postoperative complications then were added on. We have not found (unpublished observations) any pronounced differences in the number of operative complications associated with one or two stage operations. Thus the cost of such complications were assumed to be equal for the two types. It was calculated that the average cost of a one stage operation was Kr 79 000, of a two stage operation Kr 154 000, of removal of a prosthesis Kr 77 000, and of other types of treatment Kr 79 000. Costs incurred from loss of productivity and for services such as transport were not included.

The treatment of deep sepsis entailed a one stage surgical repair in 115 (56%) patients, a two stage surgical repair in 50 (24%) patients, removal of the prosthesis in 38 (18%) patients and other types of treatment in 4 (2%) patients during the period 1978-83.[1] From these figures and the costs calculated at Malmö General Hospital a weighted average of the costs was calculated; the average hospital related cost of reoperation was Kr 97 000.

Results

Figure 2 shows the costs and effectiveness of the four prophylactic methods and combinations of them. To calculate the cost of any combination of the four methods the costs of each method were added together. It can be seen that the more expensive the method of prophylaxis the lower the incidence of deep sepsis and the subsequent rate of reoperation. There were, however, exceptions. For example, the rate of reoperation was nearly the same when an ultraclean air system was used in combination with exhaust ventilated suits and when polymethylmethacrylate cement impregnated with gentamicin was used alone, yet the latter method was the less expensive of the two.

Figure 3 shows the relation between the cost of prophylaxis and the rate of reoperation as a straight line. As the average cost of reoperation was Kr 97 000 a 1% rate of reoperation corresponded to an average cost of Kr 970 for each initial operation. The cost of reoperation decreased continuously and eventually reached zero at the point where the rate of reoperation—that is, the rate of infection—was zero. Furthermore, the total cost (cost of prophylaxis plus cost of reoperation) changed as the rate of reoperation varied. The minimum total cost was reached at a rate of reoperation of about 0·8%. Thus hospital departments that performed 100 primary total joint replacements each year could minimise the total cost for prophylaxis and reoperation simply by giving antibiotics parenterally. These departments could also prescribe local prophylactics in the form of polymethylmethacrylate cement impregnated with gentamicin or a combination of parenteral and local antibiotics at an almost equally low total cost and with comparable prophylactic effect. Although such departments could use more expensive

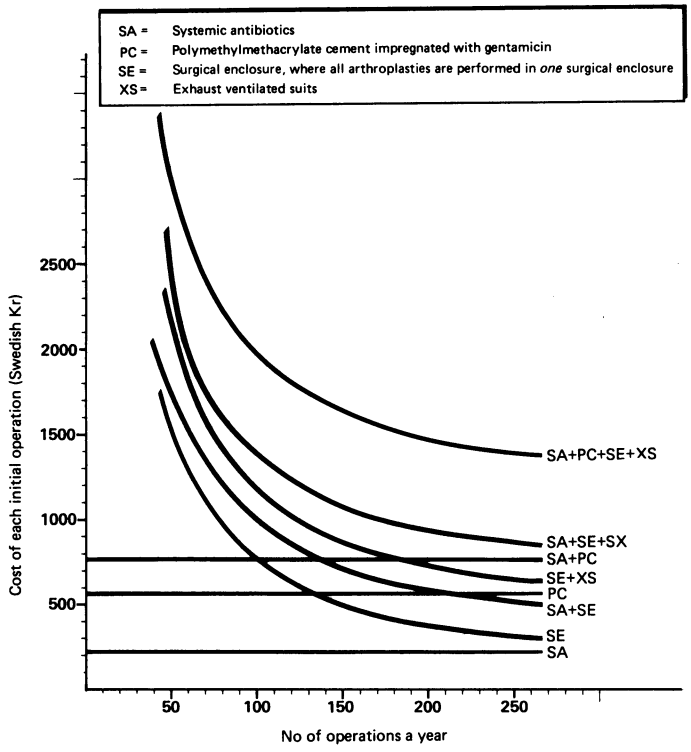

FIG 4—Relation between cost of prophylaxis for each initial operation and number of operations a year.

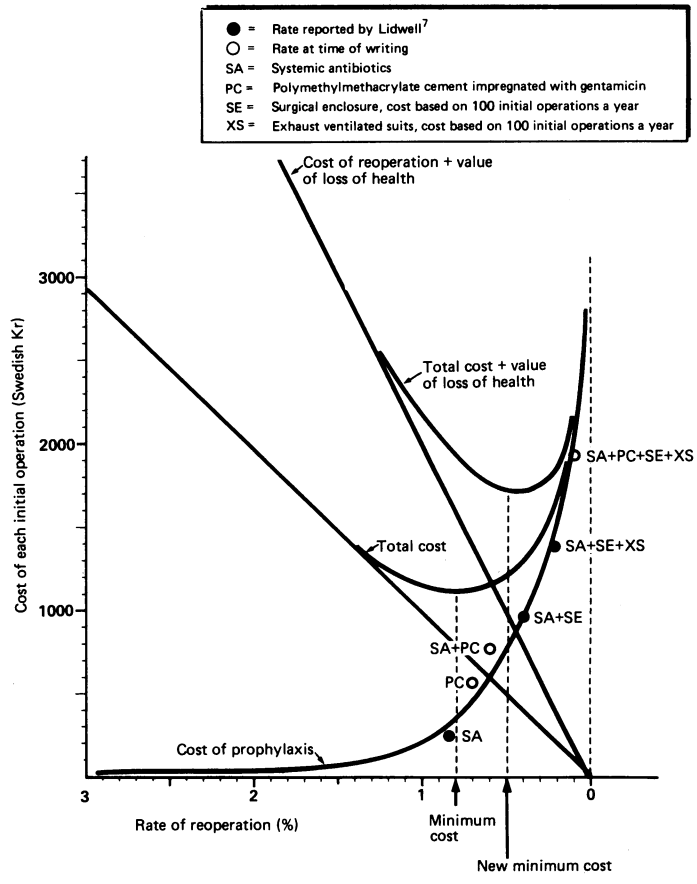

FIG 5—Total cost of deep sepsis with various rates of infection when value assigned to loss of health.

methods of prophylaxis to reduce the rate of reoperation further, total costs would increase overall. For departments that performed more than 100 initial operations a year the cost of reoperation could be reduced to a minimum by using a combination of the surgical enclosure and exhaust ventilated suits.

Figure 4 shows that parenteral antibiotic prophylaxis alone invariably costs less for each initial operation than any other method, regardless of the number of operations performed each year. A combination of the use of parenteral antibiotics and an ultraclean air system was less expensive than a combination of parenteral and local antibiotic prophylaxis, but only when more than 130 operations were performed each year in a department with a single surgical enclosure.

Discussion

As a patient, a citizen, and a tax payer one should demand more from the health services than merely keeping costs to a minimum. The value of health itself should also be considered. Despite this there is still no consensus about the correct value to be placed on health when evaluating health care programmes. In order to indicate the effects of taking this important element into account we simply assumed that the loss of health from deep sepsis incurred a cost of an additional Kr 97 000. This value was not chosen arbitrarily. There are areas other than health care in which decisions are taken that affect people's health, one being traffic planning and investment in roads; the Swedish National Road Administration, for instance, adds Kr 100 000 to the cost of treatment after a typical, serious road accident when calculating the value of preventing that accident.[9]

By assuming a value of health similar to that used in decisions affecting road safety, the total cost of loss of health, prophylaxis, and reoperation is increased and an economic optimum established at a point where the rate of reoperation would be about 0·5% (fig 5). Using a combination of parenteral and local antibiotics would be a cost effective means of reducing infection in departments that performed less than 100 arthroplasties each year. For departments performing 100 or more a combination of parenteral antibiotics and operating in the surgical enclosure would be the most attractive means of prophylaxis from the social point of view.

These results, however, should not be considered to be final, because the value put on health for the purpose of traffic planning may not be directly applicable to the evaluation of prophylaxis for patients undergoing total joint replacement. The value should be adjusted to take account of differences in age and survival rates. Nevertheless, the use of a value explicitly assigned to loss of health implies a willingness to minimise not just the costs of health care but all costs associated with total joint replacement.

The data on the costs of prophylaxis and reoperation used in this study are specific to Sweden. The conclusions to be drawn from the analysis may, therefore, be slightly different for other countries. The model, however, is general and could be used by any hospital department that wanted to calculate the most cost effective method of prophylaxis against infection for patients undergoing total joint replacement. Various local options could be tested by supplying the model with the relevant information. If the relation between the cost of prophylaxis and the cost of reoperation is the same as the one we have calculated the conclusion will be the same as ours. When estimating the economic optimum costs should preferably be based on the total number of arthroplasties, provided that the costs of reoperating on the knee and the hip are the same.

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Everyday Aids and Appliances

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AIDS FOR LOW VISION IN THE ELDERLY

Although visual impairment is not caused by increasing age alone, low vision is common in the elderly. The commonest causes of registration of visual handicap are macular degeneration, glaucoma, cataract, and diabetic retinopathy. Many elderly patients with failing vision fear the progression to total loss of sight, and explanation and appropriate reassurance are most important. Emphasise that the eyes do not "wear out" from overuse and the patient can continue to read without harm. Reassure the patient with macular degeneration that, although the detailed central vision used for reading may be lost, the peripheral vision which is important for mobility is usually retained and independence need not be lost.

Several aids are available from most major hospital eye departments and from some opticians, but all do require effort and application by the patient if they are to give worthwhile benefit.

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Spectacles

It is important that spectacles should be from a recent prescription, and refraction should be checked by an optician about every two years if vision is stable. The power of the reading lenses can be increased to give effective magnification, but as the lenses are strengthened print must be brought closer to the eyes and the positioning of reading matter is critical. The patient must be encouraged to move the print to and fro to find the best distance as print will be out of focus at normal reading distance.