What is the cost of getting the price wrong?
E. J. Beck, J. Beecham, S. Mandalia, R. Griffith, M. D. S. Walters, M. Boulton and D. L. Miller

Abstract

Background The objective of this study was to compare differences in cost estimates for paediatric HIV hospital service provision based on hospital prices with cost estimates obtained through a research-based service-specific costing exercise.

Methods Activity data on the use of hospital services of children by stage of HIV infection were collected from case-notes for 118 HIV antibody positive children, managed at St Mary’s Hospital NHS Trust, London, 1 January 1986–31 December 1994. Hospital unit prices were obtained from the Hospital Trust Finance Department; unit cost estimates were obtained from relevant hospital departments through a research-based service-specific costing exercise. Financial data related to the 1993–1994 financial year, and were indexed to 1995–1996 prices. The main outcome measures were cost estimates per patient-year by stage of HIV infection. Three cost scenarios were calculated: first by linking activity data with hospital prices (Trust Prices); second by linking activity data with routinely available hospital prices plus units costs from the costing exercise where no relevant hospital prices existed (Supplemented Trust Prices); third, by linking activity data exclusively with unit costs from the hospital-specific costing exercise (Unit Costs).

Results There were substantial differences between unit cost estimates per patient-year based on Trust Prices and Supplemented Trust Prices compared with those based on Unit Costs. Differences increased with more intense use of services. The deficit based on Trust Prices compared with Unit Costs ranged from £432 per patient-year for HIV negative children, £574 for asymptomatic HIV-infected children, £1288 for indeterminate children, £1814 for children with symptomatic non-AIDS to £7418 per patient-year for children with AIDS.

Conclusions In this hospital, reliance on generic hospital prices to derive cost estimates for paediatric HIV services produced considerable underestimates of the cost of service provision compared with data derived through the costing exercise. If this occurs across all or most areas of service provision, this can lead to substantial financial deficits, which in turn may mean that the needs of specific client populations may not be met.

Keywords: costing studies, hospital prices, specialist services, paediatric HIV infection

Introduction

As resources available for health care provision are limited, the efficiency as well as the effectiveness of interventions needs to be assessed and compared with that of existing or alternative interventions. If we want to deploy health services ‘in such a way as to maximize their effectiveness or their success, or to distribute them in accordance with agreed criteria of fairness or justice, then we need to take a careful look at the cost implications of policy designs and practice decisions. Allocating resources in one way immediately implies the rejection of an alternative allocation, and this is the key to understanding the meaning of cost and its measurement.1

The costs of a particular health care activity include those directly attributable to that programme (direct costs), those that embrace the wider economic consequences of the intervention on the individual or society (indirect costs) or may refer to the intangible costs resulting from the illness or treatment.2 It has long been recognized that prices – the monetary value attributed to particular tests or activities as used within the health care sector – may not necessarily be synonymous with costs.3 In this study direct costs for hospital service provision for children with HIV infection were estimated. Estimates of the total cost of treating children by stage of HIV infection based on hospital prices were compared with cost estimates obtained through a research-based service-specific costing exercise. This activity was part of a wider study to determine the use and costs of hospital services for HIV-infected children by stage of infection.4

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Methods

Health care professionals at St Mary’s NHS Trust, London, have been treating HIV-infected children since 1986. By December 1994, the Department had managed 44 (31 per cent) of the 142 reported paediatric AIDS cases and 44 (36 per cent) of the 124 HIV-infected children reported but who had not yet developed AIDS in England.5 A special Paediatric HIV Unit was established at St Mary’s in 1990, which provides a family-centred, multidisciplinary service for the management of HIV infection. During the study period, in-patient care was provided mainly on the infectious diseases ward or in the paediatric intensive care unit if the children were very ill. Some neonates were treated in the neonatal unit. The Paediatric Outpatient Department provided scheduled appointments, an open-access clinic and specialist clinics. No day-ward facilities were available at the time. The 119 children who attended for HIV-related care during the study period (1 January 1986–31 December 1994) made up the study population. The notes of one child could not be located, so 118 children were included in the study.

Hospital activity data were abstracted from the clinic case-notes of each child from entry to the study until the child died or ceased to attend St Mary’s, or the end of the study period. The data abstracted included demographic information and information on each in-patient episode and out-patient visit. Each child was assigned a clinical category on each occasion that they used hospital services. The classification system used was based on the CDC classification for HIV infection in children under 13 years of age.6,7 Five stages of HIV infection were defined:

- **Indeterminate**: when the child had anti-HIV antibodies but it was unclear whether these were only maternal antibodies or whether the child was actively infected;
- **Asymptomatic**: when the child was actively infected with HIV but remained asymptomatic;
- **Symptomatic non-AIDS**: when the child had developed symptomatic disease that was not an AIDS-defining condition;
- **AIDS**: when the child had been diagnosed with an AIDS-defining condition;
- **HIV-negative**: an indeterminate child who was subsequently found to be not infected with HIV.

The data were analysed using SAS.8 Items of service use for each child were aggregated to produce a mean number of items used per patient-year. One ‘patient-year’ is defined as a period of follow-up at St Mary’s Hospital for 365 days for a particular stage of HIV infection. Prescribed drugs were summed in the same way as other items of service utilization. A ‘drug-day’ constituted one day on which one drug was prescribed. Prescriptions for multiple drugs for the same patient were aggregated and therefore the mean number of drug-days per patient-year could exceed 365.

As the resource utilization data were dependent, only mean values could be calculated.9,10 These mean values were linked to unit costs so that total costs could be calculated for each stage of HIV infection. Costing studies can be extremely complex and time consuming to perform.11,12 Often the main obstacles are scarcity of resources to perform the costing exercise and the lack or inaccessibility of data.13,14 The focus for cost studies should also be specified.11,12 Here it was the services used by HIV-infected children at St Mary’s and activity data were obtained from case-notes.15 Unit costs were estimated from finance and activity information provided by the Hospital Trust Finance Department and each of the departments involved in paediatric HIV services. Thus we were able to compare cost estimates based on specific service utilization data with routinely available hospital prices.

Unit cost data related to the 1993–1994 financial year and were indexed to 1995–1996 prices.16 For hospital services, average unit costs were calculated for each in-patient day, out-patient visit, each test and procedure performed and each drug prescribed. Where possible specific overheads and capital equipment costs were attributed to the relevant departments and included in the unit costs estimated for that department.15,17 Overhead costs and capital equipment that could not be allocated to specific service components were included in the general overhead costs of an in-patient day or out-patient visit.

Our unit cost estimates were underpinned by the concept of opportunity costs, which represent the value of resources in their next best use. In estimating opportunity costs the conventions used in previous health and social care studies were adopted in which short-run (current) average revenue costs, plus the costs of capital (buildings and equipment) and relevant overheads are regarded as sufficiently close to long-run marginal opportunity costs for most evaluative purposes.1,15,18–21 In this study long- rather than short-term marginal costs were considered important, as services will probably need to expand to meet future demands from an increasing number of HIV-infected children.22 Our costs, therefore, include the resource implications of expanding the current level of services.

All costs were calculated using information made available by the Hospital Finance Department. Data consisted of the itemized budget statements devolved to each department and the financial statements recording the allocation of central hospital overhead costs to each department. This information plus activity data from the relevant departments allowed calculation of HIV-specific costs per in-patient day, per out-patient visit, for tests and procedures, and for drugs prescribed. All prices obtained from the Hospital Trust Finance Department were generic prices used for all disease categories, whereas the calculated costs were HIV specific. The first step of the costing exercise involved identifying the services for which the hospital had prices and which items of expenditure had been included in estimating these prices. Once this was established components of the service that had not been costed were identified and the missing costs were added.
In-patient day and out-patient visit

To calculate an average cost for an HIV-specific in-patient day and an HIV-specific out-patient visit, the 1993–1994 costs of the paediatric wards and out-patient department were obtained from the Hospital Finance Department. HIV-related staff and overhead costs were allocated to in-patient day and out-patient visit costs, based on the ratio of in-patient to out-patient workload as specified by each relevant HIV-staff member. Face-to-face interviews with each professional allowed calculation of time disbursement between HIV-related and other work. Salary information was obtained from the finance departments of the hospital and the medical school. General staff and miscellaneous expenditure, overheads, central support services (which included central hospital services such as the finance and chief executive), and infection control costs were all included in the unit cost calculations. These costs were aggregated and the sum was divided by the total number of out-patient visits or in-patient days generated by HIV-infected children. Thus an average cost was calculated for each of these service components and total unit cost per in-patient day and out-patient visit could be estimated.

Average unit costs per test

To calculate the unit costs per test, internal recharges, or the sum of money notionally transferred between devolved budget heads for each test, were obtained during an interview with the business manager of each directorate. The business managers were asked to specify which items of expenditure had been included in calculating these internal charges. Additional items of expenditure that had not been included were identified from departmental accounts provided by the Hospital Finance Department. General departmental costs, departmental overheads, central support services and infection control were the main components omitted. These additional items of expenditure were divided by the number of tests performed within each department during 1993–1994 to give an additional cost per test, which was added to the internal recharge to give an overall unit cost per test.

Procedures

Various procedures were performed on children with HIV infection, including lumbar punctures, bronchoalveolar lavages, electrocardiograms, electroencephalograms and surgery. No internal recharges were available for these particular paediatric procedures. To estimate a unit cost for these surgical procedures the cost per operating hour (including relevant overhead costs) was combined with information on the duration of particular procedures. The cost per hour was derived from expenditure statements of the surgical theatres and Theatre Sterile Supply Unit obtained from the Hospital Finance Department. Information about the duration of paediatric procedures was provided by the surgical theatre database system. Unit costs were not estimated for those procedures performed on the ward, as their costs were already included in ward expenditure and staff costs.

Drug costs

All the costs associated with the dispensing and administration of the drugs were incorporated into the in-patient day and out-patient visit costs. The prices of all drugs used by children with HIV infection were obtained from the Paediatric Pharmacy HIV expenditure records and the British National Formulary.

No significant price differences were found between the two sources of information, so no adjustment had to be made for differences between market prices and those paid by the hospital. For all drugs the cost of an average daily dose was calculated. At the analysis stage, adjustments were made to the per-diem dose where they varied by the child’s weight, surface area or whether it was a prophylactic or a treatment dose. Further details of how units costs were calculated have been documented elsewhere.

Three cost scenarios will be presented. The first set of cost estimates (Trust Prices) was calculated by linking activity data with hospital prices from the Hospital Trust Finance Department. As not all service components of hospital care had prices attached, a second estimate (Supplemented Trust Prices) linked activity data to available hospital prices supplemented by unit costs, derived by the study’s costing exercise, for those items of service delivery for which no hospital prices existed. The third set of cost estimates (Unit Costs) was calculated by linking activity data with unit costs calculated as part of the service-specific costing exercise.

Results

A major difference between Trust Prices and Unit Costs related to the cost of an in-patient day, out-patient visit and the costs of tests and procedures. For instance, whereas the Unit Cost of an HIV-specific in-patient day on the infectious disease ward was estimated to be £432 per day, the Trust Price for an in-patient day amounted to £358. Similarly, an HIV-specific Unit Cost for a day in the paediatric intensive care unit was estimated at £1888, whereas the Trust Price amounted to £1462 per day. Furthermore, whereas the Unit Cost of an HIV-specific out-patient day was estimated at £86 per visit, the Trust Price was £60. Although differences between Trust Prices and Unit Costs were less marked for most of the tests, at the time of the study a number of the procedures, including surgical procedures, had not been priced and Unit Costs had to be calculated.

For the three scenarios, different total cost estimates per patient-year were produced for each stage of HIV infection. Total cost estimates were lower for all stages of HIV infection when using Trust or Supplemented Trust Prices compared with estimates based on Unit Costs. The extent of the underestimate is evident when Trust Prices are presented as a percentage of the
**Table 1** Cost estimates per patient-year by stage of HIV infection based on Trust Prices, Supplemented Trust Prices and Unit Costs for the period 1986–1994 (1995–1996 prices)

<table>
<thead>
<tr>
<th>Types of hospital services used</th>
<th>Mean use of services per patient-year</th>
<th>Types of hospital services costed</th>
<th>Cost estimates based on Trust Prices*</th>
<th>Cost estimates based on Supplemented Trust Prices†</th>
<th>Cost estimates based on Unit Costs‡</th>
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<tr>
<td><strong>Indeterminate (n = 45)</strong></td>
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<tr>
<td>In-patient days</td>
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<td>In-patient and out-patient care</td>
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<td>271</td>
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<td></td>
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<td>In-patient days</td>
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<td>In-patient and out-patient care</td>
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<td>In-patient days</td>
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<td>In-patient and out-patient care</td>
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<td>Tests or procedures</td>
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<td><strong>HIV-negative (n = 30)</strong></td>
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<td>In-patient days</td>
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<td>In-patient and out-patient care</td>
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<td>1097</td>
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<td>Tests or procedures</td>
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<td>221</td>
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<td></td>
<td>£1289</td>
<td>£1289</td>
<td>£1653</td>
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*Trust Prices cost estimates based on linking activity data with hospital prices from the Hospital Trust Finance Department.
†Supplemented Trust Prices cost estimates based on linking activity data with available hospital prices plus units costs obtained through the study’s costing exercise for items of service delivery for which no hospital prices existed.
‡Unit Costs cost estimates based on linking activity data with unit costs calculated as part of the service-specific costing exercise.
cost estimates based on Unit Costs. The size of this deficit varied according to stage of HIV infection but generally reflected the intensity of resource use in the management of the different clinical stages. The percentages ranged from 69 per cent for asymptomatic HIV-infected children, 78 per cent for HIV-negative children, 81 per cent for children with symptomatic non-AIDS or AIDS to 88 per cent for indeterminate children. The monetary differences ranged from £364 per patient-year for HIV-negative children, £464 for asymptomatic, £1251 for indeterminate, £1740 for children with symptomatic non-AIDS to £7330 per AIDS patient-year.

Estimates of total costs based on Supplemented Trust Prices were closer to estimates based on Unit Costs, but there were still substantial differences, especially with increasing use of services as observed among children with HIV disease. Total cost estimates for indeterminate and negative children based on Supplemented Trust Prices remained at 88 per cent and 78 per cent, respectively, of the costs based on Unit Costs. For the asymptomatic HIV-infected children the ratio improved by 10 per cent from 69 per cent to 79 per cent, whereas for children with symptomatic non-AIDS or AIDS it improved slightly from 81 per cent to 85 per cent. The monetary differences ranged from £317 per patient-year for asymptomatic children, £364 for HIV-negative children, £1251 for indeterminate, £1400 for children with symptomatic non-AIDS to £5783 per AIDS patient-year.

Discussion

The reliance on Trust Prices for HIV-related children’s services leads to considerable underestimates of the actual costs involved in HIV-service delivery. Trust Prices underestimated the cost of certain services, for example, cost per in-patient day. In addition, the cost implications of some components of care, especially procedures, were excluded from the Trust Prices. Similar disparities between prices and costs have been observed previously in fee-for-service health care systems but also exist in other areas of the National Health Service in England.

Such a disparity can have serious consequences for hospital revenues. As our sample included all but one of the children managed for their HIV infection during the study period, the total revenue potentially lost by the hospital can be estimated. For the total study period this would have amounted to £503 970, and for 1994 alone this amounted to £269 010. Moreover, in the light of policy requirements to assess population needs and provide a responsive clinical service, this study suggests that purchasers and providers of services should be aware of the cost implications of treating children at different stages of illness; treating more severely ill children increased the disparity between the prices charged by the hospital and the actual costs incurred. For example, this disparity amounted to £6888 for treating the asymptomatic children during the study period whereas for the children with AIDS the disparity between Trust Prices and Unit Costs amounted to £326 392.

Of course, a ‘bottom-up’ approach to costing services, such as undertaken to estimate the research-based unit costs, is time consuming and expensive to undertake. It requires the collection of relevant resource inputs at the individual level as well as detailed consideration of service-specific financial and activity data for each of the components of care that comprise treatment for the population under study. Prices, however, are commonly estimated using the more easily administered ‘top-down’ approach, where total known costs are allocated to specific service provider units and ‘average’ activity and service use data are considered. Although the top-down approach is less time consuming and less expensive to perform, the results of this study suggest that if trusts do not invest resources in the estimation of more accurate prices, funding shortfalls may continue.

Good quality cost data, which provide an accurate reflection of the resources required to provide certain services, are vital to improving resource allocation within and between hospital trusts, as well as informing pricing strategies. For example, the large deficits generated through providing treatment for children with HIV infection may have been cross-subsidized by other elements of hospital care, perhaps from a surplus made through overestimated prices in other parts of the hospital service or through a reduction in the level of care provided to other patient populations. However, if this level of cost underestimation is endemic throughout the hospital it could lead to a considerable deficit in the hospital’s financial situation. It was recently reported that this particular hospital had a financial deficit of £5.9 million for the financial year 1997–1998, an overspend which in part may have been avoided had prices been more accurately estimated. Cuts in service provision were anticipated as a result of this deficit. The problem is not unique to this hospital. It was anticipated that the overall financial deficit for English hospital trusts at the end of the 1997–1998 financial year would amount to £108 million. This again raises the question of what the ultimate aim of financial management in English hospitals should be: should hospitals break-even, generate profits, or be allowed to run financial deficits and be reimbursed for their deficits because they are considered to be a public utility?

A bottom-up approach to costing care is the preferred method for assessing the cost-effectiveness of existing and new interventions, but more pertinent to the purpose of this paper is that it generates more accurate costs and allows greater flexibility in relating use of services to costs and patient characteristics. A less accurate costing strategy is likely to underestimate the true costs of providing services to particular patient groups and could potentially lead to commissioning activities that will under-fund services, which in turn may mean that the needs for specific populations cannot be met.
Acknowledgement
This study was funded by the Department of Health, England and Wales.

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*Accepted on 30 March 1999*