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# SPECIALITY COSTING IN HOSPITALS : A REVIEW

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Contents



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## 1.0 Introduction

This paper provides a review of recent British work in the field of estimating hospital specialty costs. It is divided into five main sections. Section 2.0 briefly looks at why there is a need for this sort of information and how the research developed in Britain. Sections 3.0-5.0 deal with statistical modelling, cost accounting and patient costing approaches to the estimation of these costs respectively, with the final section presenting some conclusions on the subject. The review focuses attention on the derivation of in-patient costs almost exclusively. These form the largest proportion (over 60%) of all hospital costs and have been the main subject studied by researchers in this field. Models dealing more specifically with teaching hospital costs have been excluded from the review; the reader is referred to Foster, M.J. (1982) for coverage of this work. It should also be mentioned at this stage that, again almost without exception, work has concentrated on deriving revenue costs, capital costs being excluded bar one or two attempts to make some allowance for them (e.g. Hurst 1977). Reasons for this include the difficulty of apportioning capital costs over different specialties - particularly when the whole hospital unit is deriving benefits - and of accounting for depreciation of assets.

## 2.0 Background

The need for detailed information on the costs of running Britain's health services has never been more urgent than in recent years. Health service expenditure is no longer assured of a real growth in funding from central government and, as a consequence, regional and district health authorities are having to make decisions which involve closure of hospitals or reducing one service to fund the development of another and are constantly being exhorted to improve efficiency. "The key importance of effective management is the better use of resources", the Secretary of State for Health, Mr. Fowler, told health service administrators recently (The Health Services 1983). Cost information, regarded as something of academic rather than practical use in the early years of the NHS is now given top priority and seen as an essential element in the effort to maintain and adapt health services in their current operating environment. Some of the most pressing questions facing health service managers were outlined by the Financial Information Project (FIP 1979) and include:

(i) How much do current treatments/services cost, and what is this likely to be in the future?

(ii) What effect on levels of service will an increase or decrease in its planned expenditure have?

(iii) What savings or extra costs would be incurred by increasing or decreasing the level of a given service by a specified amount?

(iv) How does cost vary across the different demographic and socio-economic characteristics of patients?

(v) What are the costs or savings accruing from the substitution of one type of care for another? (e.g. community care for geriatrics rather than hospitalisation).

The main problem in attempting to answer these questions remains the availability of the necessary data, both inpatient statistics and cost data. The latter have always been closely allied to the routine financial accounting system which gives rise to several major drawbacks in their value hindering inter-authority comparisons of hospital costs. Again the Financial Information Project (1979) summarised these disadvantages as being

(i) The broad classification of hospital types - the NHS defines 19 categories - which do not account for large case-mix variations between hospitals in the same category.

(ii) Within the hospital the secondary analysis of the hospital accounts does not account for the case-mix variation - particularly a problem when considering the costs of a large multi-specialty acute hospital.

(iii) There is no method of collecting demographic or socio-economic characteristics of patients and thus no way of identifying particular groups of patients based on, say, age or diagnostic type.

(iv) Unit costs are averaged over a year, concealing any differential variations in the cost of resources. Only average cost figures are produced which makes them unsuitable for short term marginal planning especially if there are economies or diseconomies of scale.

(v) How costs are apportioned is not a standardised procedure. Guidance to authorities exists but practices vary over the country thus making inter-authority cost comparisons suspect.

Hospital costs form the largest single sector of expenditure in the NHS

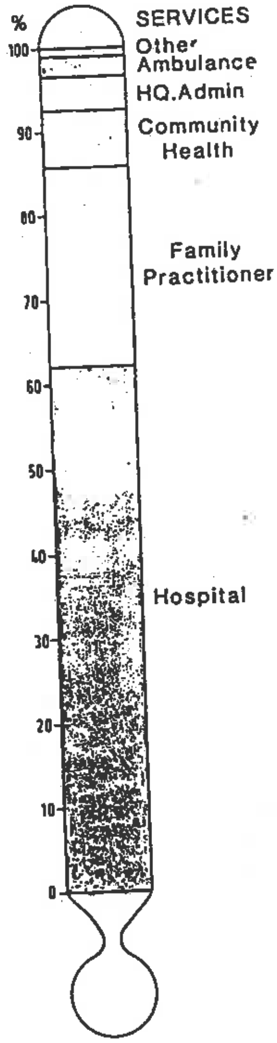
(Figure 1 ) and, at the district level this proportion is even higher - up to 80%. Hence the interest in applying systems to derive hospital costs as a matter of priority.

As the inadequacies of the existing cost system have grown more apparent over the past 10-15 years so a body of research has developed, working both inside and outside the DHSS, into ways of estimating these costs. Much of this work was derived from N. American studies which were undertaken because of the nature of the U.S. health care system. In Britain the research has looked at costs in a variety of ways ranging from comparative studies into the costs of different forms of treatment for a particular condition (Piachaud and Weddell 1972), to attempts to improve the information bases for detailed inter-authority cost comparisons and at a detailed enough level to provide information for short/medium term management decisions (Ashford and Butts 1979, Magee and Osmolski 1978). This review is of methods of deriving specialty costs which have been developed in Britain and it focusses on two main approaches to estimating these costs which have developed over the past 15 years. Within these two basic approaches - statistical modelling and cost accounting - have developed several models and the statistical modelling approach can be further subdivided into two main groups; "economic" or "theoretical" models and "empirical" models (Ashford and Butts 1979). These methods are examined in the next section. The cost accounting approach aimed at identifying detailed specialty costs is more recent and has seen the concurrent, if somewhat slower, development of the patient costing approach which is claimed to be more versatile in its range of applications. These are examined in detail in Sections 4 and 5 of the paper respectively.

### 3.0 The development of the statistical approach

The statistical approach to the estimation of hospital costs has been the subject of research and debate since the 1960s. North America has been the home of many econometric analyses focussing primarily on establishing a relationship between hospital cost and size; looking at returns to scale as evinced by the long run average cost curve and discussing the optimal scale of production of hospital services. There are good reviews of the main work in this field by Mann and Yett (1968), Hefty (1969) and Berki (1972). The work has been characterised by a plethora of different results and explanations and recent work, reports Foster (1982),

Figure 1. Breakdown of NHS expenditure by sector




Source: Health Services Costing Returns 1979/80 DHSS

"... appears to offer no more promise of a definitive solution than did work reported ten years ago." Difficulties abound over how to measure hospital output and the scale of production (hospital capacity) to mention but two of the more intractable technical problems, and there remains the more fundamental question of the applicability of these methods to institutions not operating in the normal economic environment. This has led Evans (1971) to describe the cost/output relationships as "behavioural", indicative of a nature peculiar to the acute hospital industry rather than, say, manufacturing industry.

Notwithstanding the differences between N. American and British health care systems which make difficulties in relating models, results and conclusions from most of this work, econometric models appear to offer little help in obtaining detailed, sub-hospital specialty costs. Feldstein (1967), in a work generally regarded as the first major contribution in this field applied to the British system, demonstrated the need to take the case-mix of a hospital into account. He analysed data based on 177 large, non-teaching hospitals defining "large" as those hospitals with "expenditure exceeding £50,000 per year". Whether this was revenue or capital expenditure was not made clear. The data related to the period 1960/61; by then there were already well over 200 hospitals with an annual revenue expenditure exceeding £100,000 per annum implying a potentially larger data set available for study on those grounds. He assumed that total hospital inpatient costs could be modelled in terms of the numbers of people treated in one of 9 specialty groups (see Appendix I). The model estimated average costs per case by specialty grouping and although only able to account for 27.5% of the inter-hospital variation in average cost per case (varying over individual cost components from 7.6% for medical and surgical supplies and equipment to 37.6% for medical staff costs) the general conclusion was that any attempt to compare hospital costs should take case-mix into account. Evans (1971) and Lave and Lave (1970) did so by means of a "case-mix complexity" variable. In Evans' model this was an index derived from original diagnostic data; Lave and Lave defined it as a vector characterising both diversity and quality of services of a hospital. This still does not permit specialty costs to be derived, however, and it is to more recent statistical models developed in Britain that we now turn our attention. From the mid 1970s onwards the derivation of these costs attracted more researchers working both within the DHSS operations research unit and in universities (particularly Exeter). During this time there has emerged two distinct approaches within the statistical umbrella; the "economic" approach, characterised by models based on classical economic theory with a pre-conceived structure of inpatient costs (developed from econometric analyses), and an "empirical" approach. This holds no a priori assumptions about the inpatient cost structure, allowing regression analysis to determine which cost factors are the most relevant in accounting for variation in total costs (Ashford and Butts 1979). The focus of both of these approaches has been centred on inpatient hospital revenue costs almost exclusively; capital costs being usually omitted from calculations although Hurst (1977) is an exception to this.

### 3.1 The "economic" model

Feldstein (1967) demonstrated the importance of case-mix and despite criticisms over some aspects of the work, such as its small size biased towards large hospitals and the absence of a component in the model representing expenditure not related to the numbers of patients treated, (Ashford and Butts 1979) it remains a seminal work on British hospital costs of the "economic" statistical approach. Succeeding work in this line, Gibbs (1971), (1976) and Hurst (1977), like Feldstein, were not primarily interested in obtaining specialty costs. Gibbs (1976), for example looked at the consequences of using hospital beds more intensively and constructed an elementary cost equation which considered the total revenue cost of a hospital as the sum of three elements; overheads (costs varying with the size of a hospital; eg. heating, lighting), hotel costs (those varying with the number of patient days; eg. catering and laundry), and treatment costs, such as medical staff time, which vary directly with the actual number of patients treated. The results obtained from a rather small sample indicated a breakdown of cost over those elements of 42%, 25% and 33% for overhead, hotel and treatment costs respectively. Armed with these figures Gibbs assessed the cost consequences of different intensities of use of hospital beds; however no allowance was made for the case-mix of a hospital so specialty costs were not obtainable from his model.

Based on Gibbs' and Feldstein"s work, Hurst (1977) produced a paper in which he sought to demonstrate that the use of average costs per day of hospital stay would "substantially over-estimate" the true marginal costs when estimating the savings accruing to expenditure from reduced lengths of stay. In wanting to examine influences other than length of stay on cost he chose case-mix as being "easily the most important" and basing this according to medical specialty he re-examined costs looking first of all at single specialty hospitals, then at mixed specialty hospitals. In the former case only pre-convalescent hospitals displayed enough variation in lengths of stay to permit a regression analysis to be carried out. Using a very small sample of these (22 hospitals in England 1969/70) the following relationship was calculated:

$$C_j = t + m\,S_j + e_j \qquad (1)$$

where

$C_j$ = cost per case in hospital $j$
$t$ = intercept on cost axis
$S_j$ = average length of stay (in days) at hospital $j$
$m$ = marginal cost of stay per day
$e_j$ = error term

In the second case Hurst chose to merge overhead and hotel costs because, being interested in long run costs only, this effectively means that all costs - including those normally regarded as fixed - are variable. The model was also adapted to allow for specialty mix (it was assumed that initial treatment costs would be different for each specialty but that the marginal costs in respect of length of stay would be the same over all specialties) with 12 specialty groups being defined (see Appendix I). Data from 360 type 1, 2 and 3 non-teaching acute hospitals in England (1969/70) was used and it was shown that 75% of the variation in cost per case was accounted for by length of stay and case-mix. (Run without a length of stay component case-mix accounted for 47% of variation, emphasising its importance in the determination of costs). The model assumed that specialties differed in extra treatment and diagnostic costs early in the stay but not in marginal costs with respect to stay. The equation he used was:

$$C_j = m\,S_j + C_1P_{1j} + C_2P_{2j} \;\dots\; C_iP_{ij} + e_j \qquad (2)$$

where

$C_j$ = cost per case in hospital $j$
$m$ = marginal cost of stay per day
$S_j$ = average length of stay (in days) at hospital $j$
$C_{1-i}$ = extra treatment costs per case by specialty group $i$
$P_{1-i}$ = proportions of cases in each specialty group $i$
$C_j$ = error term

Hurst went on to make an allowance for capital costs and to illustrate possible savings from reducing the length of stay.

The unrepresentative nature of the sample is one of the criticisms which has been levelled at Hurst's work; Ashford and Butts (1979) also criticised the fact that no allowance was made for costs not associated with patient treatment (as for Feldstein's model) and that the grouping together of specialties for the analysis would inevitably make the results suspect due to the different treatment patterns and lengths of stay peculiar to each specialty. There was also no attempt to account for any economies of scale.

More recently Coverdale, Gibbs and Nurse (1980) offered another contribution to the "economic" estimation approach. The three basic elements of overhead, hotel and treatment costs were modified by specialty. These were grouped according to their treatment costs rather than on medical characteristics (see Appendix I) and the basic form of the model expressed as:

$$TC_j = oA_j + \sum_i h_i B_{ij} + \sum_i t_i N_{ij} \qquad (3)$$

where

$TC_j$ = total inpatient costs in hospital j
$o$ = overhead cost (per $m^2$)
$h_i$ = hotel cost per patient in specialty i
$t_i$ = treatment cost per case in specialty i
$A_j$ = floor area of hospital j (in $m^2$)
$B_{ij}$ = no. of bed days used by patients of specialty group i in hospital j
$N_{ij}$ = no. of patients in specialty group i in hospital j per annum

Multi-collinearity of some of these terms ($A_j$, $B_{ij}$, $N_{ij}$) required the division through the equation of a scale factor and, in the first instance, the total number of patients was used. This still left $B_{ij}$ and $N_{ij}$ correlated so, at this stage, it was assumed that hotel costs per day were the same over all specialty groups. The original equation was then divided through by the number of occupied bed-days to give:

$$CD_j = o\ A_j/B_j + h + \sum_i t_i\ N_{ij}/B_j \qquad (4)$$

where

$CD_j$ = $TC_j/B_j$ = average cost per day for inpatients in hospital $j$
$B_j$ = $\sum_i B_{ij}$ = total number of occupied bed-days in hospital $j$
$h$ = average hotel cost per day (equal over all specialties)

Using data from 1150 non-psychiatric hospitals in England and Wales a regression analysis based on equation (4) yielded a correlation coefficient of 0.90 and a split over the three cost components of overheads 40%, hotel costs 25% and treatment costs 35%. Various applications of the model were discussed, of particular interest to this review is that relating to the estimation of specialty costs. Knowing the model parameters for a particular hospital it should be possible to use the model directly; however, a problem occurs over the allocation of the floor area of corridors, diagnostic departments, theatres etc. to specialties. Coverdale et al suggest that this could be sidestepped by dropping the overhead term from the cost model. These costs would be absorbed into the hotel and treatment components and enable costs to be calculated on the knowledge of the average length of stay for the specialty. This was regarded as a satisfactory approximation and the DHSS have used the results in their regional resource allocation decisions. As can be seen from the table of results produced this enables a fairly detailed breakdown of specialty costs although note that treatment costs are calculated for the 10 main specialty groups (see Table 1) (Coverdale et al 1980)

This paper provoked a bitter response from Ashford and his colleagues based in Exeter. Under the heading "Is There Still a Place for Independent Research Into Issues of Public Policy in England and Wales in the 1980s?" they wrote a detailed critique of the model by Coverdale et al and compared it to their own statistical model based on the "empirical" approach. (Ashford et al 1981). The title of the paper, however, highlighted the main thrust of their argument. Their anger was directed at the apparent

TABLE 1. Specialty costs determined from the Coverdale, Gibbs and Nurse model. (No overhead cost component included : 1976 figures

| Specialty | Treatment cost (£) | Length of stay | Hotel cost (£) | Estimated cost per case (£) | Number of cases | Estimated inpatient cost of the specialty (£m) |
|---|---|---|---|---|---|---|
| Rehabilitation | 22 | 30.8 | 410 | 432 | 11,753 | 5.1 |
| Preconvalescent | 22 | 18.9 | 251 | 273 | 50,772 | 13.9 |
| Convalescent | 22 | 14.5 | 193 | 215 | 18,823 | 4.0 |
| Staff wards | 22 | 5.6 | 74 | 96 | 5811 | 0.6 |
| General medicine | 179 | 12.2 | 162 | 341 | 751,442 | 256.2 |
| Infectious diseases | 179 | 11.3 | 150 | 329 | 36,113 | 11.8 |
| Chest diseases | 179 | 21.4 | 285 | 464 | 77,283 | 35.9 |
| Dermatology | 179 | 21.7 | 289 | 468 | 20,117 | 9.3 |
| Sexually transmitted diseases | 179 | 12.0 | 160 | 339 | 274 | — |
| Rheumatology | 179 | 23.8 | 317 | 496 | 15,707 | 7.8 |
| Other specialist units | 179 | 11.2 | 149 | 328 | 73,823 | 24.2 |
| Gynaecology | 89 | 5.6 | 74 | 163 | 476,614 | 77.9 |
| Paediatrics | 128 | 6.1 | 81 | 209 | 246,038 | 51.4 |
| Obstetrics | 128 | 7.1 | 94 | 222 | 578,539 | 128.4 |
| Special care baby units | 128 | 8.2 | 109 | 237 | 101,687 | 24.0 |
| GP maternity | 128 | 5.0 | 67 | 195 | 118,942 | 23.2 |
| General surgery | 132 | 8.6 | 114 | 246 | 970,580 | 238.8 |
| Ear, nose and throat | 132 | 4.3 | 57 | 189 | 244,645 | 46.2 |
| Ophthalmology | 132 | 7.4 | 98 | 230 | 120,169 | 27.6 |
| Dental surgery | 132 | 2.7 | 36 | 168 | 64,054 | 10.8 |
| Orthodontics | 132 | 8.2 | 109 | 241 | 628 | 0.2 |
| GP Dental | 132 | 1.7 | 23 | 155 | 841 | 0.1 |
| Traumatic & orthopaedic | 223 | 14.0 | 186 | 409 | 432,060 | 176.7 |
| Radiotherapy | 223 | 12.1 | 161 | 384 | 52,239 | 20.1 |
| rology | 223 | 8.3 | 110 | 333 | 90,649 | 30.2 |
| lastic surgery | 223 | 9.6 | 128 | 351 | 45,378 | 15.9 |
| eurology | 491 | 14.7 | 196 | 687 | 36,181 | 24.9 |
| ardiology | 491 | 10.6 | 141 | 632 | 31,089 | 19.6 |
| horacic surgery | 491 | 13.0 | 173 | 664 | 38,105 | 25.3 |
| eurosurgery | 491 | 13.5 | 180 | 671 | 29,400 | 19.7 |
| eriatrics | 137 | 84.9 | 1129 | 1266 | 220,963 | 279.7 |
| nits for the younger disabled | 137 | 210.4 | 2865 | 3002 | 2,261 | 6.3 |
| P Other | 65 | 18.3 | 243 | 308 | 91,093 | 28.2 |
| sychiatry children* | 319 | 114.0 | 1516 | 1835 | 1,542 | 2.8 |
| ental handicap* | 319 | 1041.9 | 13,857 | 14,176 | 17,107 | 142.5 |
| ental illness* | 319 | 169.4 | 2253 | 2572 | 178,843 | 460.0 |
| dolescent psychiatry units* | 319 | 130.4 | 1734 | 2053 | 823 | 1.7 |

* These are poor estimates as purely psychiatric hospitals were omitted from the regression sample.

attitude of the DHSS towards independent researchers which appeared to be one of ignoring them. Coverdale et al were working within the DHSS OR unit and their model was incorporated by the DHSS into RAWP calculations without taking note of any of the technical criticisms levelled against it. Ashford et al warned that independent researchers were having to work in "a climate which is becoming increasingly hostile to their activities and indeed to their very existence""and they thought that if this was indicative of future DHSS policy - or indeed of any government department - it was a disturbing trend. The technical criticms levelled by Ashford et al will be taken up later; for the moment attention is turned to the "empirical" statistical approach.

3.2 The "empirical" model

From the outset this method has been primarily used in estimating specialty costs and Ferster and Butts (1977a) developed a model based on 186 hospitals in a single region to investigate these more thoroughly. There were two stages in their procedure. The first consisted of carrying out a regression analysis between the total inpatient hospital cost (of all hospitals) and the number of available beds in each of six specialty groups (see appendix I). The second stage embodied these derived regression coefficients in a model to establish the breakdown of an individual hospital's expenditure by specialty group with additional cost factors represented by outpatients and day cases also included.

The model is set out below in its original form. It is, unfortunately, marred by some poor specification and inconsistency in handling subscripts and superscripts.

$$\begin{aligned} C_{AH} &= ({}^{b}AH^{r}A \,/\, \Sigma^{b}iH^{r}i) \times IC_{H} \quad \text{(inpatient component)} \\ &+ ({}^{d}AH \,/\, \Sigma^{d}iH) \times DC_{H} \quad \text{(day case component)} \\ &+ ({}^{O}AH \,/\, \Sigma^{O}iH) \times OC_{H} \quad \text{(outpatient component)} \end{aligned} \tag{5}$$

where

CAH = revenue expenditure of specialty A in hospital H
dAH = number of day cases, specialty A, hospital H
DCH = total day case expenditure, hospital H
OAH = number of outpatients in specialty A, hospital H
OCH = total outpatient expenditure in hospital H

The results of this analysis gave an explanation of variation in costs of 99%, with the coefficients for each specialty conforming to expectations (eg. surgical specialties were the dearest; psychiatric care the least expensive). Such a high explanation of variation was achieved, they reasoned, through the adoption of beds per specialty rather than discharges per specialty in the equation because expenditure was tied more to the resources provided (largely dependent on the number of beds) than the number of patients actually treated. The results of applying the model to a particular large acute hospital were presented (see Table 2) and a later paper (Ferster and Butts 1977b) looked at applications to estimating revenue expenditure by specialty at a regional level.

TABLE 2. Specialty costs derived from the Ferster and Butts model

| Specialty | In Patient | | | | Out Patient | | | Day Case | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Beds | Cost £* | Cost/Bed | Cost/Pat | Pats | Cost £ | Cost/Pat | Pats | Cost | Cost/Pat | Cost £ |
| General Medicine | 54 | 165853 | 3094 | 120 | 4612 | 16826 | 3.6 | 0 | 0 | 0 | 191378 |
| Paediatrics | 19 | 58482 | 3094 | 87 | 5204 | 18986 | 3.6 | 1 | 54 | 54 | 80589 |
| Dermatology | 1 | 3094 | 3094 | 344 | 0 | 0 | 0 | 0 | 0 | 0 | 3257 |
| Geriatrics | 33 | 72332 | 2205 | 470 | 1966 | 7173 | 3.6 | 0 | 0 | 0 | 84343 |
| General Surgery | 43 | 223642 | 5153 | 159 | 4064 | 14827 | 3.6 | 279 | 15141 | 54 | 277722 |
| ENT | 8 | 41224 | 5153 | 61 | 0 | 0 | 0 | 1 | 54 | 54 | 45723 |
| Trauma & Ortho | 16 | 80387 | 5153 | 194 | 2416 | 8814 | 3.6 | 87 | 4721 | 54 | 102590 |
| Gynaecology | 43 | 220550 | 4124 | 157 | 3616 | 13192 | 3.6 | 60 | 3256 | 54 | 206135 |
| Obstetrics | 64 | 265151 | 4124 | 158 | 11398 | 41584 | 3.6 | 0 | 0 | 0 | 326557 |
| Special Care Babies | 20 | 82473 | 4124 | 229 | 504 | 1839 | 3.6 | 0 | 0 | 0 | 90477 |
| Mental Illness | 66 | 123862 | 1877 | 233 | 2240 | 8172 | 3.6 | 0 | 0 | 0 | 131354 |
| GP Maternity | 22 | 91545 | 4124 | 111 | 1262 | 4604 | 3.6 | 0 | 0 | 0 | 48243 |
| OSU | 0 | 0 | 0 | 0 | 1197 | 4367 | 3.6 | 0 | 0 | 0 | 4367 |
| Unclassified | 2 | 4457 | 2229 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3931 |
| TOTAL | 391 | 1433052 | 3665** | 162** | 38479 | 140384 | 3.6** | 428 | 23226 | 54** | 1596672 |

*For purposes of this analysis notional costs or costs are synonymous with revenue expenditure.
**Denotes average cost among specialties.

Ashford and Butts (1979) provided a brief review of previous hospital cost research and clarified the differences between the economic and empirical approaches. In presenting their own model they favoured bed numbers for a better explanation of most cost components although they acknowledged that some costs - chiefly direct treatment costs - are patient dependent. To avoid the redundancy in the model which would be caused by including both numbers of beds and numbers of patients treated, they used the number of "excess" patients (ie. the difference between the expected number of patients treated and the actual number treated). Patients were grouped into one of 6 groups (see appendix I). Also included in the model was a term to represent economies of scale:

$$TC_j = \sum_i (r_i V_{ij} + s_i V_{ij}^2) + pX_j + e_j \qquad (6)$$

where

$TC_j$ = total annual inpatient cost, hospital $j$

$V_{ij}$ = available beds in specialty $i$, hospital $j$

$X_j$ = number of "excess" acute patients annually in hospital $j$ where "excess" is calculated as the difference between the actual number treated in acute specialties minus the expected number based on the average throughput of the whole sample and the number of acute beds at the hospital concerned

$r_i$ = cost of providing a bed in specialty $i$

$S_i$ = economies of scale

$p$ = cost associated with each excess acute patient

$e_j$ = random error associated with a particular hospital

The model was applied to data for the Thames RHAs, with adjustments made for London weightings, and the results showed a 94-95% explanation of variation in costs. One of the uses claimed for the model was its ability to estimate individual specialty costs. Despite the high degree of explanation offered, however, the results show high degrees of error with each parameter. This was attributed to the wide variations in size and case-mix of the hospitals in the original data. The results also showed significant diseconomies of scale in the medical specialties of regions immediately outside the London zone (defined as the area in which London weightings were paid on salaries) in contrast to the earlier work by Ferster and Butts (1977b) which reported no significant economies of scale in the analysis for a single region.

The differences between the economic and empirical approaches were again spelled out in a paper by Ashford, Butts and Bailey (1980). Using the same model as before, this time for a much larger data set consisting of over

2000 non-teaching hospitals in England and Wales (excluding those in the four Thames regions), a similarly high explanation of cost . variance was achieved; 97-98%. Once again significant diseconomies of scale manifested themselves in the medical specialties of many of the RHAs. It was concluded that this was the result of a more expensive case-mix occurring in larger hospital units. This paper also reported preliminary analysis on costing individual cost components which were shown to have the same form of cost structure as that applying to total costs and dominated by costs relating to beds rather than patients.

The paper by Ashford, Butts and Bailey (1981), in which the viability of independent research in the face of the attitude taken by the DHSS was questi contained a detailed assessment of the two statistical model approaches and compared the performance of the model by Coverdale et al. with that of the Exeter researchers on the same data set (1365 hospitals in England and Wales excluding the Thames RHAs). The fit of the model developed by Ashford and Butts was claimed to be substantially better, returning a correlation coefficient of the observed and expected values of total cost of 0.98 as opposed to 0.92 from the model of Coverdale et al. although using weighted regression analysis with the latter model uprated the correlation coefficient to 0.97. Without using a weighted regression procedure the random error in that model was demonstrated as being non-homoscedastic, a feature which calls into question the validity of the parameter estimates. The two models were presented on a comparable basis and the point made that the empirical model did not have a cost component which was not allied to resources consumed by particular specialties. The models were compared on a number of other points as well as including their ability to estimate specialty costs. For some specialties the figures were shown to be "in close agreement" but for others, for example general medicine, estimated costs differed by almost 25% (see Table

TABLE 3. Table comparing estimates of specialty costs per case from the Coverc *et al* model (CGN) and Ashford and Butts model (AB). 1976/77 costs

| Specialty | Model C-G-N | Model A-B |
|---|---|---|
| General medicine | 340 | 275 |
| General surgery | 250 | 260 |
| ENT | 190 | 230 |
| Gynaecology | 165 | 230 |
| Obstetrics | 220 | 215 |
| GP maternity | 195 | 165 |
| SCBU | 235 | 205 |
| Paediatrics | 210 | 250 |
| Traumatic and orthopaedic | 410 | 320 |
| Neurology | 685 | 665 |
| Cardiology | 630 | 500 |
| Geriatrics | 1265 | 1130 |
| Mental illness | 2570 | 970 |

In another application the models were compared on their respective abilities to account for the costs of marginal changes in resource provision. On the whole it was concluded that the Ashford and Butts model was superior in both its range of applications and in how it fitted the data. The apparent disregard of the DHSS to the evidence presented gave rise to the acrimonious comment which concluded the paper.

### 3.3 The component model

The most recent contribution to the empirical statistical approach has been by Bailey and Ashford (1982) who developed the ideas for a component model first mentioned in Ashford, Butts and Bailey (1981). This was seen as something of a reconciliation between the two main statistical approaches and embodied a set of models relating inpatient costs to the resources and activity within specialities. Total costs were divided into 12 sub-groups for each of which a model was derived from a set of 1505 English hospitals. This was where the merging of the two approaches occurs, because one third of the cost component expenditures reflected patient dependency while the remainder were linked with resource provision. Case-mix variations between hospitals were expressed in terms of 7 specialty groups (see appendix I and the whole equation was disaggregated by specialty because the parameters were thought likely to vary between groups of patients and between the size of particular care units within the hospital.

$$TC_j = TD_j + R\sigma_j + Fa_j + e_j \tag{7}$$

where

$TC_j$ = total inpatient cost at hospital $j$
$TD_j$ = treatment costs per discharge in hospital $j$
$R\sigma_j$ = residential (hotel) costs per occupied bed day in $j$
$Fa_j$ = overhead costs per available beds in $j$
$e_j$ = random error associated with a particular hospital

Disaggregation by specialty is possible for parameters T, R and F, in addition R and F may vary with the size of the particular care unit in the hospital. The model could then be written:

$$TC_j = \sum_g (T_i d_{ij} + R_i\sigma_{ij} + SR_i\sigma^2_{ij} + F_i a_{ij} + SP_i a^2_{ij}) + e_j \tag{8}$$

where

$T_i$ = treatment cost specialty i
$R_i$ = hotel cost specialty i
$F_i$ = overhead cost specialty i
$SR_i$ = economies of scale (hotel costs) specialty i
$SF_i$ = economies of scale (overhead costs) specialty i

Strong correlation between the numbers discharged and available beds for a given specialty and between overhead costs and the number of beds in a specialty require further changes to the structure of the model.
The authors noted that in previous models that in getting around these difficulties total cost remained treated as a single entity; they chose, however, to model each component of cost separately and aggregating the results to produce a figure for total costs. In overcoming these multicollinearity problems they also improved upon the level of detail of the analysis of individual cost components by specialty. By adopting a two-stage Aitken estimation procedure to estimate the models simultaneously, the new problem that the approach presented - that the model for any one cost component should not be estimated without taking the models for other components into account - was overcome. This procedure replaced the single equation standard least squares estimation. The final version of the model was given as:

$$TC_j = \sum_k TC_{kj}$$

where $TC_{kj}$ = set of cost components k for hospital j

and $TC_{kj} = \sum_i (F_{ik}a_{ij} + SF_{ik}a^2_{ij} + T'_{ik}d_{ij}) + e'_{kj}$,

or $TC_{ki} = \sum_i (R_{ik}\sigma_{ij} + SR_{ik}\sigma^2_{ij} + T_{ik}d_{ij}) + e_{kj}$ .

The explanation of variation differed over cost components, ranging from 85% for diagnostic departments to over 90% for all others and the costs figure accounted for 98% of variation. This was noted as being an improvement on estimations from previous models due to the fact that not all cost components have the same cost structure so by estimating them separately accuracy was improved. A wide range of the model's potential application was offered: Comparisons between actual and expected costs in hospitals of the same type within or between authorities and for management control purposes; the cost consequences of particular changes in resource provision or patient throughput rates; and long term strategic planning assistance.

### 3.4 Pros and cons of statistical models

Looking at the statistical modelling approach as a whole, a number of general advantages and disadvantages can be associated with it. The advantages lie in relative ease of obtaining data for the model - the usual sources have been the SH3 inpatient statistics and the health costing returns.

The models themselves - despite the fundamental differences between the economic and empirical modellers - are similar in form and relatively straightforward to use. The applications claimed are widespread aimed primarily at assisting strategic planning decisions by indicating cost consequences of various policy options and highlighting areas of expenditure which appear abnormal so they can be investigated in more detail.

In practice, however, there are problems in using models based on regression analysis, a major one of which has been the need to group specialties prior to analysis - thus losing detail which might be quite important for some plans. There are technical criticisms which can be levelled against some work too such as the adoption of a small or biased sample or insufficient attention paid to the distribution of error. The differences between the empirical and economic models have already been discussed; depending on the approach adopted there can be significant differences in cost estimates produced. Beresford and Elliot (1982) recently reported on the use of the Ashford and Butts model in a health district, comparing it with a cost accounting exercise carried out at the same time, and concluded that for local level management control purposes regression gave "valuable insight" into the structure and behaviour of hospital costs and was useful for "broad planning purposes"; but for management control purposes at a local level was of limited value. It was found that estimates for geriatric and psychiatric units in particular were poor and that the aggregation of specialties into groups was also a hindrance. To be fair it is appreciated by those in the modelling field that the results are not perfect and cannot provide a very accurate estimation of marginal costs at an individual or even group specialty level. It is hoped, however, that further developments, eg. the cost component model outlined by Bailey and Butts (1982) will improve the sensitivity of this form of analysis and enable it to become more widely accepted, especially given the availability of the data inputs required and its speed of operation relative to the cost accounting methods. This has led to a computer package, designed for use in health authorities, by the Exeter researchers based on their methods for example.

## 4.0 The cost accounting approach

The cost accounting method is the main alternative approach to deriving specialty costs. Basically it involves the setting up of detailed cost accounting exercises at individual hospitals running over several months or more. Cost centres, to which expenditure may be directly of indirectly allocated, are identified and the outcome is an analysis of costs in terms of high and low level costs of different areas of activity in the hospital and a breakdown by specialty.

The main research project in this field was funded by the DHSS for a 3 year period (1976-79) and involved a detailed examination of costs at Bridgend General Hospital in S.Wales (Magee and Osmolski 1979). The brief set out by the DHSS was to develop a low cost procedure for obtaining specialty costs which could be incorporated into the existing day-to-day financial recording system of a hospital simply and efficiently. From the outset it was decided to exclude teaching and special hospitals on account of their extra complexity in cost terms although it was noted that once a method had been established for other hospitals attention could then be turned to adaptations for teaching and special hospitals. Bridgend General was considered to be a "typical" example of its type (although "typical" was not defined) and the initial costing exercise was based there.

Attention was focussed on average costs from the outset. In an earlier paper (Magee 1974) it was argued that most marginal costs in a hospital were medium rather than short term and that a direct cost saving to a hospital woul not be made by the reduction in length of stay of an individual patient (apart from some obvious "short-term" marginal items such as food and drugs). Savings would come about through an increase in the rate of admissions, which reduces the average cost per patient, or through longer term changes in establishment levels with a re-allocation of resources. It was on this basis that costs were gathered and compared over the 3 years for Bridgend (with estimated annual inflation for wages and salaries and for "other expenses" allowed for).

The basic method of cost accounting consists of establishing cost centres to which expenditure can be allocated or apportioned (see Table 4). It is worth noting that medical and nursing staff costs alone account for some 80% of direct treatment services. To each of these centres expenditure was allocated directly, if possible, or apportioned on the basis of the number of inpatient days of each specialty on a ward. Any undistributed costs were accumulated as inpatient or outpatient residuals respectively and presented as such in the final returns for each year. Treatment costs were found to account for the majority of costs (53%) but it was considered that to limit specialty costing just to these cost variables would inhibit valid inter-hospital comparisons and that account would also have to be taken of diagnosti department (radiography, patholoty) and general service expenditure. This wa despite doubts expressed by NHS finance officers consulted about the validity

TABLE 4. FUNCTIONAL HEADINGS EMPLOYED (by Magee and Osmolski)

| | |
|---|---|
| Direct Treatment Services: | Medical staff<br>Dental staff<br>Nursing staff<br>Medical and surgical supplies and equipment: (a) supplies<br>(b) pharmacy<br>(c) CSSD<br>Operating theatre |
| Medical and Paramedical Supporting Services: | Radiography<br>Pathology: (a) Microbiology<br>(b) Histopathology<br>(c) Haematology<br>(d) Chemical Pathology<br>EEG<br>EEC<br>Physiotherapy and Remedial, Gymnastics<br>Dietitians<br>Miscellaneous |
| General Services: | Administration<br>Medical Records<br>Catering<br>Domestics<br>Laundry<br>Linen |

Source: Bridgend Cost Statement - March 1979 of incorporating some of the general service items which were more dependent on hospital age, size and location than patient throughput. Administration, medical records, catering, domestic, laundry and linen services were regarded, however, as bearing at least some relationship to throughput. A detailed manual of procedures for specialty costing was prepared and the reader is referred to it for the finer details of how allocations and apportionments were made by cost centre (Magee and Osmolski 1979). Some results of the exercise are reproduced here with figures taken from the costing statement for the year ended 31st March, 1979. The graph in Figure 2 relates to the proportions of expenditure in that year that went to direct treatment, general service and other categories per inpatient day by specialty and appendix II illustrates an example of a specialty cost statement for general medicine which compares the expenditure over three years (Magee and Osmolski 1979). Despite a detailed examination of expenditure there remained a sizeable proportion of unapportioned - ie. unexplained - expenditure for each year. The accounting system could locate the general cost centre of virtually all of this (the teaching element of nursing staff costs was 10%, administration 16%, portering 10%, estate management 58% in 1979, for example) but this could not be satisfactorily apportioned over specialties. Instead an "approximate apportionment" of some 7% was made to out-patient and accident and emergency services and the remainder - which amounted to 28% of the total inpatient expenditure in 1979 was expressed as a cost per inpatient day and applied equally to all specialties.

The Bridgend study devised a general method for cost accounting, but of course the results were specific to that hospital. This is one of the main drawbacks of the method; there are general principles which can be fine tuned to the particular characteristics of a hospital, but the problem of validating the inter-hospital comparisons remains. For an individual hospital it is possible to pinpoint high and low level expense activities but there is not enough information to ascertain if the cost is higher than it should be. The aim should be, therefore, to produce "national average" cost figures for each specialty based on hospitals in different parts of the country and use those as a surrogate for standard costs against which an individual hospital's specialty costs might be compared (Magee 1981). Following the Bridgend project the DHSS set up further trials using the Magee manual in six health districts round the country ranging from Teeside to Basingstoke and at the S.Glamorgan area health authority. These were official for two years but appear to have been continued by their responsible health authorities. Nothing official appears to have been published on the outcomes but it is known that the scheme in the Harrogate health district has been deemed successful and that work on its applications and potential for the district is still under assessment (Harrogate Health Authority 1983). Throughout the trial period there was plenty of contact with the other participating authorities and evidently they, too, have continued their projects. Apart from actual specialty costs themselves there have been other benefits of a local nature; ranging from an improved information from a computerisation of the pharmacy to a better two way flow of information with the clinicians and, importantly, their support.

4.1 Clinical accounting

Although the work by Magee and Osmolski has been the principal contribution in the cost accounting approach to obtaining specialty costs it has not been the only one. Of particular note is the Clinical Accountability, Service Planning and Evaluation (CASPE) project being undertaken at the King's Fund in London which has been working on methods of provi ing individual clinicians and their respective medical teams with information on the way resources are used in response to their clinical management decisions. By focussing on activities directly under the control of the doctors and presenting them with the resource consequences of their actions the aim of CASPE has been to develop a situation where clinicians and administrators plan future service and expenditure plans jointly. This has been tried out using PACT (Planning Agreement with Clinical Teams) and the effects of this method of planning resources was shown to have definite improvements in resource use. In trials undertaken at the Westminster Hospital, London, there were marginal improvements in throughput rates and reattendance rates dropped slightly, but the most significant effects were in the use of medical resources. One team is reported as having reduced its use of mobile Xray equipment by 66%, another reduced its costs of immunological investigations by 67% (Wickings 1977). This "clinical budgetting" approach is regarded by its authors as quite different from the Magee approach which they label as "clinical costing" (Wickings et al. 1983). The CASPE methodology is held up as prospective; actively encouraging forward planning for efficiency through involving the clinicians. The costing approach is seen as retrospective; forward action being taken on the basis of historic data and, by not involving the close cooperation of the resource users, being less readily acceptable or slower to be implemented. The advantages of CASPE, particularly in the wider sense of imbuing a sense of the necessity in accounting for the cost of resources by the major users themselves should not be underestimated but in concentrating only on clinician-controlled costs other costs only indirectly or totally outside their control are overlooked and this, as Magee has pointed out, may inhibit valid inter-hospital cost comparisons.

4.2 The pros and cons of the cost accounting approach

At a more general level there are both advantages and disadvantages with the cost accounting approach. This depends in part on the attitude adopted towards the concept of "standard costs", the method proposed by Magee to enable inter-hospital comparisons. In fact the notion is not a new one; in a report on a costing system for the NHS the Nuffield Provincial Hospitals Trust (1952) recommended standard costs to be established and the DHSS use a form of standardised costs in calculating the SIFT (Service Increment For Teaching) allowance for health authorities with teaching functions. However, not all commentators agree with this concept, as has been outlined before (Wickings et al 1983), and the question of the valid use of standardised costs for comparative purposes remains a source of debate.

Notwithstanding this, the approach does offer advantages over regression modelling especially in terms of the number of specialties which can be considered (unlike the aggregation of specialties necessary in regression studies). The information resulting is of a better quality for management purposes than the existing costing system and the method of obtaining the costs is relatively straightforward to apply. There is, however, the disadvantage of the time needed and the initial set up costs which have to be incurred and, whereas the system may work very well for an individual hospital, there remains the problem of its wider applicability. Magee (1978) did not see this as posing any major difficulties - indeed one of specifications of the project was to make it a general approach. However Coverdale et al (1982) are not so assured on the case of this in practice and also question the arbitrary nature of the allocation of costs where this has to be done over more than one cost centre. There is, too, the question of what constitutes a "typical" hospital or group of hospitals to be used to establish standard costs and the fact that within particular specialties there may exist quite wide variations in cost. Magee recognised this last point and suggested it might be overcome by focussing on smaller patient groups within a given specialty. Other researchers, eg. Prowle (1981) in recent years still regard this as not being the complete answer and propose instead a patient costing approach arguing that it offers a more flexible approach to establishing costs. This approach, developed from cost accounting is discussed below in Section 5.

5.0 Patient costing

By examining costs at the level of the individual patient the advocates of the patient costing approach argue that the potential of the system for presenting both inpatient statistics and cost information is enhanced and made more flexible. Thus costs could be examined by patient groups not only along specialty lines; demographic or socio-economic classifications could be adopted for example. Greater flexibility in the system would be produced by getting down to the smallest unit - the patient - which would mean that as information requirements change over time so different aggregations of these basic units could be made in a way that simple specialty costing could not. These points were outlined in a report on a project of this type undertaken at the Queen Elizabeth hospital in Birmingham (School of Business and Management, Wolverhampton, and Birmingham AHA 1981). This system works by setting up an information system which records for each patient a cost factor related to an "event" performed for that patient. Examples of events include pharmacy (drugs consumed by the patient), pathology (tests performed on the patient) and catering (meals consumed by the patient). For each of these a set charge needs to be determined and, as the patient stays in hospital, events are recorded against him and a cumulative cost picture built up. The differences between fixed and marginal depending on the circumstances (eg. an extra patient on a ward necessitating an extra member of staff only if, say, his condition warranted it) are also discussed. Cost components are assigned to those categories from the outset. No firm conclusions are drawn in this report; techniques were tested on a sample of only 30 patients in two specialties over a 3 month period. Preliminary findings indicate however the generally held belief that costs can vary considerably within specialties (Table 5).

Patient costing studies are not new and there have been 3 other major studies in the UK prior to the work at Birmingham. Two were more specialised in their approach, however, concentrating attention on the costs of treating particular diagnoses. Thus Babson (1973) examined costs associated with the treatment of appendicitis and inguinal hernias, while Piachand and Waddell (1972) looked at the costs of alternative forms of treatment for varicose veins. The third, undertaken by Russell (1969) in an acute surgical ward in Aberdeen had more general aims, however, similar to those of Prowle, ie. the design of a simple costing method that could be generally applicable. In a 6 month period some 1205 patients were followed through

Hospital, Birmingham.

PATIENT COSTS : CARDIOLOGY

| No. | Stay (Days) | COSTS (£) | | | | | | Total | Cost per Day |
|---|---|---|---|---|---|---|---|---|---|
| | | Ward | Theatre | ITU/CCU | Drugs | Tests | Overheads | | |
| CD 1 | 8 | 140 | - | - | 20 | 75 | 146 | 381 | 48 |
| CD 2 | 13 | 227 | - | - | 44 | 183 | 237 | 691 | 53 |
| CD 3 | 6 | 105 | - | 78 | - | 28 | 109 | 320 | 53 |
| CD 4 | 2 | 35 | - | - | 4 | 127 | 36 | 202 | 101 |
| CD 5 | 5 | 87 | - | - | 28 | 151 | 91 | 357 | 71 |
| CD 6 | 19 | 332 | 124 | 86 | 86 | 351 | 346 | 1325 | 70 |
| CD 7 | 4 | 70 | - | - | 19 | 148 | 73 | 310 | 78 |
| CD 8 | 2 | 29 | - | - | 27 | 111 | 36 | 203 | 102 |
| CD 9 | 9 | 157 | - | - | 13 | 30 | 164 | 359 | 41 |
| CD 10 | 2 | 35 | - | - | 20 | 130 | 36 | 221 | 111 |

NOTE: Excludes medical staff costs.

with the aim of devising standard units of resources used to which costs could be assigned as a second step. Costs were classified as direct and indirect; the latter being either indirect costs associated with a department (ie. costs related to a resource area in proportion to its size) or with the whole hospital (ie. resource areas or services serving the the whole hospital and used by patients irrespective of their location within it). There w ere two methods Russell used to cost resources to a patient. Method "A" charged both departmental and general overheads as a fixed amount per inpatient day. This assumed that these items were consumed equally by all patients throughout their stay. Method "B" charged departmental overheads to each patient in proportion to that individual's use, while still charging general overheads on a duration of stay basis. The units were priced historically, being based on half the amount of expenditure recorded in that year. This is quite different from the approach taken at Birmingham where the charge for cost units was predetermined as the budgeted cost for a particular cost centre, such as an operating theatre, divided by the budgeted workload. This form of costing would need periodic revision because actual and budgeted costs and workloads rarely coincide exactly in practice.

It is difficult to compare the various patient costing approaches tried out so far because of different assumptions made especially with regard to cost apportionment and the measurement of activity units. All the studies considered medical and nursing pay as individual costs for example, but there were substantial differences in the calculation of operating theatre costs. Babson based his on work-study measurements; Piachaud and Weddell used a figure based on the unit cost per hour taken from the routine hospital cost statement plus an allowance for the anaethetist's time; and Russell regarded one minute of theatre time as a "theatre unit" and obtained unit costs on the salaries involved and the resources used. There is also the paucity of studies undertaken; apart from the Birmingham project there does not appear to be any similar study under way at present. Indeed nothing was done on the development of a general patient costing scheme throughout most of the 1970s. The Aberdeen results were presented again by Harper (1979) who reiterated the potential advantages of the introduction of such a system. Patient costing as a method is not without its critics, however. Despite the advantages it is claimed to have over specialty costing it still has some of that method's drawbacks over the basis on which apportionments between cost centres should be made and the difficulties and expense of setting up the necessary information systems - the patient costing approach being an even more varacious consumer of cost and case data at a fine level of resolution. Magee (1974) has criticised the attempt at individual patient costing on the grounds that individual items of cost are incurred for a group of patients rather than any one individual, thus making attempts at individual costing irrelevant. Further trials along the lines of those done for the Magee specialty costing method would serve to clarify some of these issues and develop the potential of the approach which remains difficult to assess on the basis of the existing evidence.

## 6.0 Conclusions

This review highlights the complexities inherent in the NHS as a system of interest. Not only are there problems associated with the scale and nature of its operations and the lack of useful and reliable data, but there are also different ways of analysing the structure of inpatient costs which, in turn, give rise to different results (vide the differences between the "economic" and "empirical" statistical methods). Despite these difficulties, however, the increasing sense of urgency in the need to have this information has led to the development of more sophisticated models and trials of other costing techniques. This is likely to continue given the attitutde of the current govenment and its concern over costs (DHSS, 1983, DHSS Steering Group on Health Services Information 1983). Both of the two main approaches to costing - statistical modelling and cost accounting - have their respective advantages and disadvantages. Statistical models use existing data sources and can provide information more quickly than accounting methods but at the expense of detail in the information. Individual specialties are usually grouped togehter on medical or cost criteria and the results only give broad indications of the costs of particular groups of specialties in a hospital - requiring a more detailed follow-up investigation to take place. This problem is overcome to a certain extent by cost-accounti methods, more so by individual patient cost accounting, but the results take much longer to produce and, particularly with patient costing, require considerably more data than is currently readily available. It is argued that once established a cost accounting system would be straightforward to operate and adapt to local circumstances; however, at this stage it is still largely under trial. Unless there are major changes in data collectior in the NHS costing at the specialty level rather than patient costing - despi its perceived advantages of flexibility in presenting information - is likely to become the more widely adopted of the accounting methods.

The indications are that it will be the "marketing" of a costing technique rather than any obvious major advantage of one approach over another which will be responsible for improvements in specialty costing. Once a particular system is embarked upon by a district authority the chances are that money and manpower will act as major constraints on any radical changes. The trial authorities for the cost accounting system developed at Bridgend General hospital, for example, have continued to apply and develop that system for their own districts. The use of interactive computer programs employing statistical methods is likely to accelerate as they are developed and become more widely available. There are still many authorities which do no more than produce the cost accounts they are statutorily required to do. The scope for improving their financial information systems is enormous but unless this is coordinated to some extent at a regional, if not national, level there is a danger that accurate inter-authority cost comparisons will remain elusive as different districts employ different costing systems.

## APPENDIX I

### Specialty groupings

SH3 statistics are routinely collected in hospitals and provide basic information on beds, discharges and lengths of stay by specialty. This is the main source of data used in regression models of cost but the 40 different specialties identified in the statistics have to be reduced for technical reasons (some are too small; others are strongly inter-correlated). The number of groups selected for study ranges from 7-12, with the majority of them classifying the groups on clinical grounds. The main exception to this is in Coverdale et al. (1980) where specialties were grouped on the basis of similar treatment costs (Table 6).

TABLE 6. Number of specialty groups used in different models

| Study | Criteria of grouping: Clinical | Other |
|---|---|---|
| Feldstein (1967 | 9 | - |
| Hurst (1977) | 12 | - |
| Ferster and Butts (1977) | 6 | - |
| Ashford and Butts (1979) | 6 | - |
| Coverdale, Gibbs and Nurse (1980) | - | 10 |
| Bailey and Ashford (1982) | 12 | - |

Ashford and Butts (1979) reported testing their model using different specialty groups but concluded that more complex grouping was "unproductive" in terms of providing a better explanation of the variation in total costs.

Tables 7-9 show examples of which specialties were classified into what groups in different studies.

TABLE 7. Ferster and Butts (1977)

| Medical (X1) | Geriatrics and Convalescent (X2) | Surgical (X3) | Maternity (X4) | Psychiatric (X5) | Others (X6) |
|---|---|---|---|---|---|
| General Medicine<br>Paediatrics<br>Infectious Diseases<br>Chest Diseases<br>Dermatology<br>Neurology<br>Cardiology<br>Physical Medicine<br>VD<br>Rheumatology | Geriatrics<br>Units for Younger Disabled<br>Pre-Convalescent<br>Convalescent | General Surgery<br>ENT<br>Trauma & Orthopaedic<br>Ophthalmology<br>Radiotherapy<br>Urology<br>Plastic Surgery<br>Thoracic Surgery<br>Dental Surgery<br>Neurosurgery<br>Gynaecology | Obstetrics<br>Special Care Baby Unit<br>GP Maternity | Child Psychiatry<br>Mental Handicap<br>Mental Illness<br>Adolescent Psychiatry | GP Dental<br>GP Other<br>Staff Wards<br>Other Surgical Units |

*Notes*

*This grouping of specialties corresponds to that provided by DHSS on SH3 returns up to 1971 except for "others" and pre-convalescent and convalescent which they did not classify under any heading.
The X's correspond to the variables used in the regression analysis.

TABLE 8. Ashford and Butts (1979)

| ACUTE | | | | LONG-STAY | |
|---|---|---|---|---|---|
| Medical | Surgical | Regional Specialties | Maternity | Geriatrics Convalescent & G.P. | Psychiatric |
| General Medicine<br>Paediatrics<br>Infectious Diseases<br>STD - Special Clinics | General Surgery<br>ENT<br>Trauma & Ortho.<br>Opthalmology<br>Plastic Surgery<br>Dental Surgery<br>Orthodontics<br>Gynaecology<br>OSU - Other Specialist Unit | Neurology<br>Cardiology<br>Radiotherapy<br>Urology<br>Thoracic Surgery<br>Neurosurgery | Obstetrics<br>SCBU<br>G.P. Maternity | Chest Diseases<br>Rehabilitation<br>Rheumatology<br>Geriatrics<br>Younger Disabled<br>GP Other<br>Pre-convalescent<br>Convalescent<br>Staff Wards | Child Psychiatry<br>Mental Handicap<br>Mental Illness<br>Adolescent Psychiatry |

TABLE 9. Coverdale, Gibbs and Nurse (1980)

| Group | |
|---|---|
| 1 | Rehabilitation<br>Preconvalescent<br>Convalescent<br>Staff wards |
| 2 | General medicine<br>Infectious diseases<br>Chest diseases<br>Dermatology<br>Sexually transmitted diseases<br>Rheumatology<br>Other specialist units |
| 3 | Gynaecology |
| 4 | Paediatrics<br>Obstetrics<br>Special care baby units<br>GP maternity |
| 5 | General surgery<br>Ear, nose and throat<br>Ophthalmology<br>Dental surgery<br>Orthodontics<br>GP dental |
| 6 | Traumatic and orthopaedic<br>Radiotherapy<br>Urology<br>Plastic surgery |
| 7 | Neurology<br>Cardiology<br>Thoracic surgery<br>Neurosurgery |
| 8 | Geriatrics<br>Units for the younger disabled |
| 9 | GP other |
| 10 | Psychiatry children<br>Mental handicap<br>Mental illness<br>Adolescent psychiatry units |

Specialty ........General Medicine........

| Year Ended 31st March: | 1977 | 1978 | 1979 |
|---|---|---|---|
| No. of in-patient Days | 19,513 | 20,319 | 21,815 |
| No. of Discharges | 2,219 | 2,272 | 2,503 |
| Average length of stay | 8.8 | 8.9 | 8.7 |

| | Total Cost | | | Cost per in-patient day | | | Cost per Case | | |
|---|---|---|---|---|---|---|---|---|---|
| Year Ended 31st March: | 1977 | 1978 | 1979 | 1977 | 1978 | 1979 | 1977 | 1978 | 1979 |
| | £ | £ | £ | £ | £ | £ | £ | £ | £ |
| **Direct Treatment Services** | | | | | | | | | |
| Medical Staff Services | 41,714 | 51,874 | 59,193 | 2.14 | 2.55 | 2.71 | 18.8 | 22.8 | 23.65 |
| Dental Staff Services | 162 | - | - | - | - | - | 0.1 | - | - |
| Nursing Staff Services | 152,477 | 180,135 | 247,464 | 7.81 | 8.87 | 11.34 | 68.7 | 79.3 | 98.87 |
| Medical and Surgical Supplies and Equipment | | | | | | | | | |
| (a) Supplies | 9,240 | 16,265 | 21,940 | 0.47 | 0.80 | 1.01 | 4.2 | 7.2 | 8.77 |
| (b) Pharmacy | 24,946 | 31,090 | 36,224 | 1.29 | 1.53 | 1.66 | 11.2 | 13.7 | 14.47 |
| (c) C.S.S.D. | 10,391 | 8,521 | 12,313 | 0.53 | 0.42 | 0.57 | 4.7 | 3.7 | 4.92 |
| Operating Theatre | - | - | - | - | - | - | - | - | - |
| Sub Total | 238,930 | 287,885 | 377,134 | 12.24 | 14.17 | 17.29 | 107.7 | 126.7 | 150.68 |

APPENDIX II (contd)

**Bridgend General Hospital**

**Specialty Cost Statement**

Specialty ..........General Medicine.................. (Cont'd)

| Year Ended 31st March | Total Cost 1977 £ | Total Cost 1978 £ | Total Cost 1979 £ | Cost per in-patient day 1977 £ | Cost per in-patient day 1978 £ | Cost per in-patient day 1979 £ | Cost per Case 1977 £ | Cost per Case 1978 £ | Cost per Case 1979 £ |
|---|---|---|---|---|---|---|---|---|---|
| **Medical and Para Medical Supporting Services** | | | | | | | | | |
| Diagnostic Departments | | | | | | | | | |
| Radiography | 12,590 | 16,042 | 19,387 | 0.65 | 0.79 | 0.89 | 5.7 | 7.1 | 7.8 |
| Pathology | | | | | | | | | |
| a. Microbiology | 3,380 | 3,025 | 3,216 | 0.17 | 0.15 | 0.15 | 1.5 | 1.3 | 1.3 |
| b. Histopathology | 2,605 | 2,082 | 2,708 | 0.13 | 0.10 | 0.12 | 1.2 | 0.9 | 1.1 |
| c. Haematology | 4,702 | 6,486 | 7,331 | 0.24 | 0.32 | 0.34 | 2.1 | 2.9 | 2.9 |
| d. Chem. Pathology | 17,907 | 23,549 | 25,332 | 0.92 | 1.16 | 1.16 | 8.1 | 10.4 | 10.1 |
| E.E.G. | 380 | 426 | 330 | 0.02 | 0.02 | 0.02 | 0.2 | 0.2 | 0.1 |
| E.C.G. | 2,449 | 3,989 | 3,679 | 0.13 | 0.20 | 0.16 | 1.0 | 1.7 | 1.5 |
| Sub Total | 44,013 | 55,599 | 61,983 | 2.26 | 2.74 | 2.84 | 19.8 | 24.5 | 24.8 |
| **Other Medical and Para Medical Supporting Services** | | | | | | | | | |
| Physiotherapy and Remedial Gymnastics | | | 3,420 | | | 0.16 | | | 1.4 |
| Dietitians | | | 2,980 | | | 0.14 | | | 1.2 |
| Miscellaneous | | | 3,668 | | | 0.16 | | | 1.4 |
| Sub Total | 3,379 | 6,845 | 10,068 | 0.17 | 0.34 | 0.46 | 1.5 | 3.0 | 4.0 |

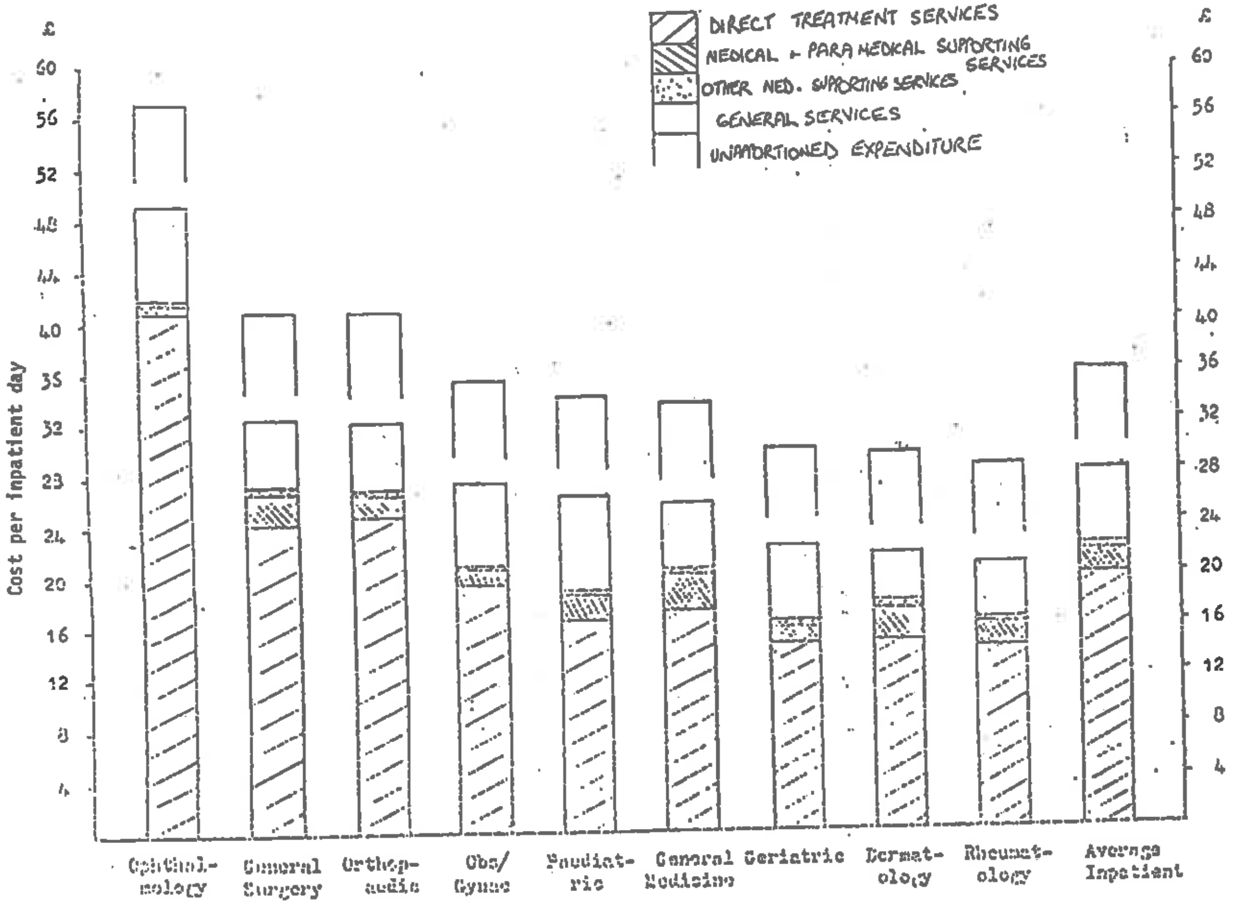
## Specialty Cost Statement

Specialty ....General Medicine............(Cont'd)

| Year Ended 31st March | Total Cost 1977 £ | Total Cost 1978 £ | Total Cost 1979 £ | Cost per in-patient day 1977 £ | Cost per in-patient day 1978 £ | Cost per in-patient day 1979 £ | Cost per Case 1977 £ | Cost per Case 1978 £ | Cost per Case 1979 £ |
|---|---|---|---|---|---|---|---|---|---|
| **General Services** | | | | | | | | | |
| Administration | 3,312 | 6,455 | 4,551 | 0.17 | 0.32 | 0.21 | 1.5 | 2.8 | 1.82 |
| Medical Records | 4,272 | 4,655 | 4,979 | 0.22 | 0.23 | 0.23 | 1.9 | 2.0 | 1.99 |
| Catering | 38,049 | 44,003 | 45,812 | 1.95 | 2.17 | 2.10 | 17.1 | 19.4 | 18.30 |
| Domestics | 27,495 | 36,258 | 37,244 | 1.41 | 1.78 | 1.71 | 12.4 | 15.0 | 14.88 |
| Laundry | 5,479 | 6,712 | 7,202 | 0.28 | 0.33 | 0.33 | 2.5 | 3.0 | 2.88 |
| Linen Services | 7,033 | 7,931 | 8,636 | 0.36 | 0.39 | 0.39 | 3.2 | 3.5 | 3.45 |
| Sub Total | 85,640 | 106,014 | 108,424 | 4.39 | 5.22 | 4.97 | 38.6 | 46.7 | 43.32 |
| Total | 371,962 | 465,343 | 557,609 | 19.06 | 22.47 | 25.56 | 167.6 | 200.9 | 222.78 |

FIGURE 2

Year ending 31st March 1979.



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