The cost of renal dialysis in a UK setting—a multicentre study

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Abstract

Background. The UK National Health Service (NHS) will fund renal services using Payment by Results (PbR), from 2009. Central to the success of PbR will be the creation of tariffs that reflect the true cost of medical services. We have therefore estimated the cost of different dialysis modalities in the Cardiff and Vale NHS Trust and six other hospitals in the UK.

Methods. We used semi-structured interviews with nephrologists, head nurses and business managers to identify the steps involved in delivering the different dialysis modalities. We assigned costs to these using published figures or suppliers’ published price lists. The study used mixed costing methods. Dialysis costs were estimated by a combination of microcosting and a top-down approach. Where we did not have access to detailed accounts, we applied values for Cardiff.

Results. The most efficient modalities were automated peritoneal dialysis (APD) and continuous ambulatory peritoneal dialysis (CAPD), the mean annual costs of which were £21 655 and £15 570, respectively. Hospital-based haemodialysis (HD) cost £35 023 per annum and satellite-unit-based HD cost £32 669. The cost of home-based HD was £20 764 per year (based on data from only one unit). The main cost drivers for PD were the costs of solutions and management of anaemia. For HD they were costs of disposables, nursing, the overheads associated with running the unit and management of anaemia.

Conclusions. Renal tariffs for PbR need to reflect the true cost of dialysis provision if choices about modalities are not to be influenced by erroneous estimates of cost. Knowledge of the true costs of modalities will also maximize the number of established renal failure patients treated by dialysis within the limited funds available from the NHS.

Keywords: cost; haemodialysis; health economics; peritoneal dialysis; renal failure

Introduction

In 2005, 41 776 adult patients received renal replacement therapy (RRT) in the UK. The number of prevalent cases is rising by 5% per annum [1]. Of those patients receiving RRT in the UK, 45% have a transplant, with the remainder receiving dialysis [1]. The management of renal failure is disproportionately costly in comparison to other medical conditions. The total cost to the UK National Health Service (NHS) of treating people with established renal failure (ERF) amounts to ~1–2% of the total NHS budget, even though individuals with ERF represent only 0.05% of the general population [2]. With the increase in number of patients requiring RRT it is imperative to identify both clinical and cost-effective therapies to meet the projected demand.

Like most other European health systems, the NHS provides haemodialysis (HD) in hospitals or satellite units, or to patients in their own homes (HHD). Peritoneal dialysis (PD) is delivered at home by continuous ambulatory peritoneal dialysis (CAPD) or automated peritoneal dialysis (APD). Both PD and HD are clinically effective RRTs, suitable for a wide range of patients [1,3–5]. Overall, PD and HD have similar long-term survival rates in various patient categories, as demonstrated by the various registries [1,6].

A direct comparison of patient survival is complicated by the underlying differences observed between patients receiving HD or PD [7]. Recent studies have indicated that PD may offer an initial survival advantage, particularly in non-diabetic and younger diabetic patients [7,8]. However, this benefit has been seen to reduce over time, with outcomes in the longer term becoming similar for both modalities [9].

However, it has been suggested that clinical factors alone do not account for modality choice; indeed in typical European systems, there is evidence that the method and magnitude of reimbursement influence the choice of dialysis modality [10]. Reimbursement for healthcare services in the UK is being changed to a system known as Payment by Results (PbR) for healthcare resource groups (HRGs). HRGs are similar to diagnosis-related groups (DRGs) that are used in some European countries. Provision of renal services will be reimbursed using PbR from 2009. For this new system to achieve its potential, it is important to...
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determine the true costs of all elements of RRT. A clearer understanding of these costs may help identify potential areas for efficiencies in the patient management pathway.

Recent health economics studies investigating renal dialysis in the UK either have been preliminary or have not compared all the different modalities that are available [11–13]. We therefore undertook a comprehensive study to determine the cost to the NHS of providing different types of dialysis services.

The objective of this study was to compare the direct costs of providing APD, CAPD, hospital-based HD, satellite-centre-based HD (SHD) and HHD, and to identify both the potential differences in costs between the different forms of dialysis provision and those elements that are key determinants of cost for each form of provision (i.e. the ‘cost drivers’). The intention was to determine all the elements that contribute to the dialysis patient’s treatment pathway. In addition we sought to include the cost of each of these in the overall assessment in order to highlight the true cost of the different treatment modalities and to emphasize that the proposed indicative tariffs for dialysis treatments in 2009 should reflect the true cost of service delivery.

Methods

Study design

This multicentre study was carried out in two phases. Phase I comprised a detailed cost analysis carried out in the Cardiff and Vale NHS Trust. In Phase II we used the insights gathered from the Phase I exercise to extend our analysis of the costs of dialysis provision to six further hospitals, four of which were teaching hospitals.

We conducted semi-structured interviews with nephrologists and head nurses from each of the renal units in order to determine the treatment pathways for the different forms of dialysis and the resources used for each of these forms of treatment. We also asked business managers about the costs of the resources used for each of the dialysis modalities. The questionnaire was checked against clinical practice guidelines [14,15], and tested, modified and validated in Phase I; this validated version was used in Phase II.

From the interviews we constructed comprehensive clinical management pathways (typical pathways for CAPD initiation and PD maintenance in Cardiff are presented in Appendices A and B). These pathways, which describe either initiation or maintenance phases, included lists of all the medical activities undertaken during the whole process of dialysis treatment. The initiation phase started directly after access surgery and included all activities before routine dialysis was started. We also identified the activities and collected data during routine maintenance therapy. Subsequently we listed all the disposables and human resources used during routine actions together with the potential range of patient-specific variability in the frequencies of activities, quantities and drug dosages. We used these pathways as the basis for our estimates of consumables and labour costs, achieved by identifying and recording the annual costs of all the identifiable elements that contributed to the total costs of providing HD, CAPD and APD. These elements included direct nursing, other nursing activities, disposables and solutions, physicians’ supervision, machine maintenance, anaemia therapy, hospital transport and general hospital overheads. Due to problems in obtaining overhead costs calculated in a methodologically consistent way, costs are presented with and without overheads.

Costing

All costs, including laboratory costs, were estimated from the service provider’s perspective. We included direct costs plus the costs of transport and medication usage. The costs associated with access surgery and managing dialysis complications were excluded because the PbR renal tariff is intended to consider maintenance dialysis only, with separate tariffs for access surgery and complications. The building capital costs were not included as a separate item in the costing analysis since these data were not available for most centres. Water treatment costs (applicable to HD and HHD) are not explicitly presented in the results (for reference costs see [12]). Although we calculated costs for the initiation phase (excluding access costs) and maintenance phases separately for each unit, we decided not to present these as individual items. This is because units differed in the ways they determined their overhead costs. Consequently the proportions of these costs that the different units allocated to overhead costs differed. Our approach (not using the individual data) was therefore intended to avoid the possibility of double counting. The costs are expressed as average cost per typical patient per year.

In most instances, we applied the costs from reported sources or publicly available hospital suppliers’ price lists. The only exception was the cost of laboratory investigations and transportation costs. Since there was a paucity of data on such costs in the literature, business managers were asked to provide the unit costs of laboratory tests. Not all the centres were able to provide these costs; where data were missing, cost profiles from Cardiff were assumed. The same basis was used for costing elements of treatment in both phases of the study. For the purpose of this study we applied mixed costing methods [16]. For direct nursing, medical supervision, dialysis disposables and solutions, and anaemia treatment, we used a microcosting approach. Nursing activities not directly related to the provision of dialysis, machines and maintenance costs, hospital transport costs and hospital overheads were incorporated via a top-down approach.

Costs for constructing a new satellite unit in the UK varied significantly and ranged from £12 800 to £80 000 per dialysis station (£47 890 on average) in 2006 [17]. Costs varied due to the differences in size, property costs and potential for expansion. Moreover, average costs per patient depended on the level of utilization at each unit. Assuming average utilization per patient reported in the investigated centres and assuming a depreciation period of 20 years gives an additional cost of £800 per patient per year for HD patients treated at satellite units. Whether such costs were included in the overhead costs depended on how each unit calculated overhead costs. To avoid possible double counting, this cost is not included in the final results.
Overheads were calculated using a top-down approach. In Cardiff, as we had an access to hospital finance data, a thorough analysis of overheads and attribution on the basis of the unit’s revenues (e.g. administration) or square footage (e.g. heating, electricity) was possible. However, for the other centres we used the overhead-cost data provided by the centres without being able to analyse the data in detail. Although it is likely that the different centres used different methods to apportion overhead costs, the method of apportioning such costs was almost certainly consistent within any one of the hospitals in the study.

The annual cost of providing HD machines is £720 per patient per year, assuming a 10-year lifespan [12]. The APD costs, assuming a 10-year lifespan and list prices, were £924 per patient per year.

The dialysis machine maintenance costs for HD were calculated as either dialysis technicians’ labour costs per patient (for those centres that employed in-house technicians) or as a contracted cost divided by the number of HD patients in the centre (for those centres that outsourced the maintenance service). For APD the calculation of maintenance cost was not possible, as all the units in the study used APD machines that were owned and maintained by the PD-solution suppliers. We attempted to contact the suppliers but were unable to obtain true costs from them because of confidentiality issues. Therefore, values for the cost of maintaining APD machines were assumed to be the same as those for HD machines. There may be a potential issue with the way we have costed HD and APD machines and their maintenance. Some HD machines are owned by hospitals (we believe ~70%) and are maintained by in-house technicians, while nearly all APD machines are owned and maintained by PD-solution suppliers. Consequently costs of disposables and solutions for APD tend to include machine and maintenance costs, whereas HD costs of disposables only sometimes include machine and maintenance costs. It is likely that in the case of APD, this led to an overestimate of total costs by ~£1600 since the majority of suppliers include these costs in their disposables and solutions costs. For HD, there was an element of overestimation that we estimate to have been ~£1000, assuming that 70% of hospitals own their HD machines.

### Staff costs

To assess costs of nursing, technicians and administration officers to an employer, costs of all statutory allowances were added to the net salary [18]. To estimate the cost per hour, the number of hours per year was assessed assuming a 37.5-h working week, 8 days of national holidays, 29 days of paid leaves [18] and 10 days of sick leaves per year [19].

The average labour costs for the different units were based on staff bandings (a system adopted in the UK based on qualifications and experience to determine where each nurse is placed on the seniority ladder). As we did not have information on staff experience, we used salaries at the mid-point of the salary scales for each band as published in the UK literature [18,19]. Wages were corrected for the number of unsocial hours worked, calculated from information on opening hours and staff rotas. An appropriate multiplier from a pay system in operation in the NHS [18] was applied. For staff-grade doctors and dieticians, costs were extracted from unit costs of healthcare tables [19] and indexed for inflation.

Direct nursing costs presented in Table 1 were obtained using a microcosting approach. Other nursing activities are the differences between a microcosting estimate and a top-down approach. Costs of physicians’ supervision, including outpatient visits together with the costs of laboratory tests, are listed in Table 1 as medical supervision.

### Disposables and solution costs

We prepared lists of all disposables and solutions used in treatment. Because dialysis patients differ in their comorbidities, access type and drug needs, even within one dialysis modality, we averaged the disposable use over all
patients in each modality. To assess the costs of disposables, we obtained the unit prices wherever possible from the British National Formulary [20], or otherwise using on-line services from dialysis- and hospital-equipment suppliers. The proportion of patients receiving various dialysis solutions was analysed in detail using data from the Cardiff and Vale NHS Trust, which enabled a weighted average to be calculated. We applied the same weighting to data from the other centres in order to arrive at a per-patient cost for solutions.

Results

The number of patients managed by each unit ranged from 205 to 765 and the renal dialysis units in this study were each supervising 1–5 satellite units. The number of patients undergoing HD ranged from 158 to 364 per centre and those undergoing PD from 46 to 139 per centre.

The mean total annual cost of delivering APD or CAPD was substantially lower than that for HD. The annual maintenance costs for patients undergoing APD and CAPD were £21 655 and £15 570, respectively, compared with £35 023 and £32 669 for hospital-based HD and SHD, respectively (Table 1). The cost of HHD for three sessions a week was £20 764 per year, which appears to be significantly cheaper than hospital-based HD. The mean annual per-patient costs of providing APD or CAPD were ∼38% and 56% less, respectively, than the cost of providing hospital-based HD. This pattern was echoed in all the hospitals evaluated; the cost of APD was ∼28–45% lower than the cost of hospital-based HD, and for CAPD it was 47–61% lower.

Our results are broadly consistent with previous analyses of the cost of dialysis. However, due to differences in the methodologies used, the number of renal centres included in the analyses, different years and the variety of countries in which the analyses were carried out, direct comparisons may not be particularly informative. Nevertheless, a review of 20 publications reporting 25 studies in Europe in the 1990s [21] showed that CAPD was the least expensive modality, although the authors pointed out that variations in the way data were collected and evaluated made it difficult to make comparisons. They added that more detailed disclosure of the details of costing methods is needed.

Our methodology, although not perfect, did allow us to collect more detailed costing information than many previous studies. In another review that used data from national registries and unpublished data from local hospital records or private healthcare providers in Belgium, Canada, France, Germany, Italy, Japan, Netherlands, Spain, Sweden, Switzerland, UK and USA [22], CAPD was again found to be a more efficient way of providing dialysis than HD. In some countries two patients could be treated by CAPD
for the same cost as one patient could be treated by HD. It should also be recognized that a major cost driver for modality costs was erythropoietin for the treatment of anaemia. It could be implied that patient variability may also be a cost driver in that patients with extensive comorbidity will be directed to HD and may therefore require more erythropoietin. Additionally, erythropoietin costs may be driven not only by patient comorbidity but also by blood loss, anticoagulation and loss of residual renal function. To evaluate this more fully would require a large, prospective, multicentre study to match these heterogeneous patients within each modality.

The differences in the costs of HD between the different units were mainly due to marked differences in the costs of overheads because centres used different methods to apportion overhead costs and different accounting methods. Building costs for satellite units, for example, may or may not be subsumed into overhead costs depending on the accounting process for each hospital. Although accounting methods are likely to vary between hospitals, any one hospital uses the same accounting process from one year to another.

The main problem of using the top-down approach used with current costing models is that it does not allow accurate costing of elements such as overheads, which tend to have a disproportionately large impact on total cost in the area of healthcare services. The model we have used corrects for some of these deficiencies, providing a more realistic assessment of these elements. A further advantage of our approach is that it not only allows comparison of different modalities, but also enables groups to identify inefficiencies within their own centres by comparing the details of their costs with those of other centres, highlighting differences in their treatment pathways at which cost savings could be made.

However, as complete application of microcosting was not possible in our study due to confidentiality of financial data, a top-down method to estimate the overheads was applied. The different accounting procedures used by the different units also prevented us from applying a homogenous methodology. The values for overheads may therefore not fully reflect the true overhead costs. Our microcosting approach may have underestimated costs, e.g. by omitting minor procedures. Also, the estimates of the times taken to complete the different procedures were based on interviews and therefore a subjective bias may exist. By applying list prices to disposables and solutions (because individual hospital data were not available), we may have overestimated this element of the total costs since hospitals normally receive some level of discount from these list prices. The use of list prices also complicated the costing of HHD in which the only centre reporting HHD costs outsourced HHD delivery to a commercial organization using locally negotiated prices. For consistency in methodology, we assumed that HHD consumables and machine costs were similar to HD, and that staffing support, overheads and transport were similar to APD. These assumptions are likely to underestimate the actual cost of HHD. Despite these shortcomings, we believe that the results of our analysis give a good indication of the magnitude of true costs.

PbR represents a complete change to NHS funding and aims to standardize care in the NHS and improve financial management. The current process relies on three government bodies working together to provide the base data needed to calculate the tariff. NHS Connecting for Health produces the systems that allow medical notes to be coded, capturing diagnoses and interventions. The NHS Information Centre develops resource groupings (the HRGs) and the Department of Health (DoH) collects reference costs and calculates the final tariff. HRGs are similar to the activity-based tariffs provided by DRGs that are increasingly being used across Europe; HRGs classify patient activity according to case mix and the resources used. PbR hinges on good information about activities and costs. Poor data quality has serious financial implications for purchasers and providers since their funding will rely on the tariffs set by the DoH [23]. There are published indicative tariffs for admitted patient care, outpatients, renal dialysis and transplantation, and there is a tariff for each of the different dialysis modalities. However, renal replacement care is an extremely complex therapy area and it is not clear at this stage which cost elements will be included in the final tariff. Current information indicates that high-cost drugs such as erythropoietin may be excluded. Transparency and accuracy of the renal tariff will therefore be a key to ensuring that PbR achieves the twin aims of creating value for money within the NHS and driving efficiency. There is no clear distinction
between PD and HD in terms of survival benefit [1,4,6]. There is, however, evidence that comorbidity-adjusted survival is better in the early stages in patients treated by PD than in those undergoing HD [4,6]. In addition, PD is more convenient to patients because it is home based and the exposure to hospital-acquired infections is reduced compared with HD [24–26]. There is evidence that the risk of complications associated with PD is no worse than or lower than with HD [26–28].

Despite the benefits listed above and the cost advantage identified in this study, the proportion of renal dialysis patients treated by PD in the UK has fallen from ~50% in the early 1990s to ~22% in 2005 [29,30]. While increased HD capacity may partially account for this finding, the dramatic reduction in PD therapies is still surprising given the evidence from publications looking at an ‘ideal’ PD–HD split. In a questionnaire-based study in 2002, Jassal et al. reported that in an ‘ideal’ dialysis system, PD would account for 38% of patients (19% on CAPD, 16% on APD and 3% on intermittent PD), with 62% on HD (27% on hospital-based HD, 24% managed through satellite units and 11% on HHD) [30].

The demand for renal replacement services in the UK, as indicated by the number of new patients accepted for RRT, increased by 7.3% per annum between 2000 and 2005; this increase can be expected to continue [31]. Given the shortage of kidneys for transplantation and the unsuitability of some patients for transplantation, the increase in demand for RRT will have to be met by dialysis. Of the dialysis modalities that are currently in use, HD places the highest demand on specially trained nursing staff. A key limiting factor on the use of HD is therefore any shortfall in the availability of such staff. PD, on the other hand, is less nurse-intensive, which in turn means that the availability of trained nurses has less impact on the ability of renal units to deliver dialysis care by PD.

The expected increase in RRT patient numbers in the UK will present a capacity problem for the NHS. While this need could be met by increasing satellite units or HD units, this will incur significant additional cost and will require the training and recruitment of additional nursing staff. Changes in dialysis delivery could lead to a more efficient use of resources. Since the cost per patient is lower, increased utilization of PD would mean that, from the point of view of healthcare purchasers, either more patients could be treated within a fixed budget or the same number of patients could be treated at a lower cost.

Such a move towards PD would also be in line with the UK government’s strategy to increase patient choice and encourage self-care at home. However, it is important that the tariffs for renal dialysis services reflect the true cost of such services. This is necessary to ensure that there is no unjustified financial incentive for providers to use one particular dialysis modality.

A strength of the study is that the seven centres we investigated provide a good overview of renal service provision in the UK, since the hospitals differed in size and were located in different parts of the country.

There is evidence that the major non-medical determinants of dialysis modality choice are financial and reimbursement issues. Lameire et al. stated in 2006 that, “...medical factors alone cannot explain why the wide differences in PD utilisation are still present and why PD is even declining in some European countries. ... We believe that above all, financial and reimbursement issues are the most important non-medical determinants of the choice of dialysis modalities. [10]”

Similarly, Barnum et al. wrote, ‘The mode of payment creates powerful incentives affecting provider behaviour and the efficacy, equity and quality outcomes of health finance reforms’ [32]. In order to eliminate perverse financial incentives to renal providers to influence modality selection, we conclude that UK renal tariffs need to be set at levels that reflect the true cost of dialysis services. Our study found that the annual maintenance costs for the different modalities were £21 655 for APD, £15 570 for CAPD, £35 023 for HD and £32 669 for SHD, and although our estimates of these costs may not be completely accurate, we believe they are a good indicator of the up-to-date costs of providing dialysis. Knowledge of the true cost of the different forms of modalities will allow appropriate auditing of dialysis services and could ensure that the number of individuals with ERF that can be treated is maximized within the constraints of the limited, fixed resource available from the NHS.

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Appendix A. Management pathway for the initiation phase of continuous ambulatory peritoneal dialysis (CAPD) at the reference hospital

OP: outpatient; PD: peritoneal dialysis; PET: peritoneal equilibration test.
Appendix B. Management pathway for maintenance phase of peritoneal dialysis (PD) at the reference hospital

OP: outpatient; PET: peritoneal equilibration test.

References


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