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ORIGINAL ARTICLES
Economic Evaluation

High-Dose Hemodialysis versus Conventional In-Center Hemodialysis: A Cost-Utility Analysis from a UK Payer Perspective

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ABSTRACT

Objective: To investigate the cost-effectiveness of high-dose hemodialysis (HD) versus conventional in-center HD (ICHD), over a lifetime time horizon from the UK payer's perspective. **Methods:** We used a Markov modeling approach to compare high-dose HD (in-center or at home) with conventional ICHD using current and hypothetical home HD reimbursement tariffs in England. Sensitivity analyses tested the robustness of the results. The main outcome measure was the incremental cost-effectiveness ratio (ICER) expressed as a cost per quality-adjusted life-year (QALY). **Results:** Over a lifetime, high-dose HD in-center (5 sessions/wk) is associated with higher per-patient costs and QALYs (increases of £108,713 and 0.862, respectively) versus conventional ICHD. The corresponding ICER (£126,106/QALY) indicates that high-dose HD in-center is not cost-effective versus conventional ICHD at a UK willingness-to-pay threshold of £20,000 to £30,000. High-dose HD at home is associated with lower total costs (£522 less per patient) and a per-patient QALY increase of 1.273 compared with ICHD under the current Payment-by Results reimbursement tariff (£456/wk). At an increased home HD tariff (£575/wk), the ICER for high-dose HD at home versus conventional ICHD is £17,404/QALY. High-dose HD at home had a 62% to 84% probability of being cost-effective at a willingness-to-pay threshold of £20,000 to £30,000/QALY. **Conclusions:** Although high-dose HD has the potential to offer improved clinical and quality-of-life outcomes over conventional ICHD, under the current UK Payment-by Results reimbursement scheme, it would be considered cost-effective from a UK payer perspective only if conducted at home.

Keywords: cost-effectiveness analysis, cost-utility analysis, end-stage renal disease, high-dose hemodialysis, in-center hemodialysis.

Introduction

End-stage renal disease (ESRD) is an irreversible decline in kidney function that, without dialysis or kidney transplantation (renal replacement therapy [RRT]), is fatal. In the United Kingdom and globally, ESRD poses a substantial health and economic burden. In 2009-2010, the England National Health Service (NHS) spent an estimated £1.45 billion (~1.3% of all NHS spending) on chronic kidney disease. Half this amount was spent providing RRT to patients with ESRD even though patients receiving RRT represent only 2% of the population with chronic kidney disease [1].

The two main dialysis modalities are hemodialysis (HD) and peritoneal dialysis (PD). HD is generally performed in a hospital or satellite unit but can be performed at home in suitable patients (home hemodialysis [home HD]). In the United Kingdom, 80% of prevalent dialysis patients receive conventional HD, usually 3 sessions/wk and 3 to 5 hours a session [2]. Evidence suggests, however, that clinical and quality-of-life (QOL) outcomes can be improved with higher doses of HD by increasing the frequency and/or duration of treatment via short-daily, quotidian or nocturnal HD. Three randomized controlled trials reported that frequent nocturnal HD and six times weekly in-center HD (ICHD) were

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associated with clinically significant improvements in selected clinical and QOL measures versus conventional, thrice-weekly HD [3–5]. Several observational and retrospective studies reported 36% to 61% reductions in mortality in patients receiving high-dose HD versus conventional HD [6–8]. Home HD has further benefits: patients have greater control over their dialysis schedule, fewer travel requirements, and are less exposed to hospital pathogens [9].

Previously published cost-effectiveness analyses of high-dose HD versus conventional ICHD are based on earlier evidence. Recent clinical and humanistic evidence warrants a reevaluation of the cost-effectiveness of high-dose HD. Although an earlier NHS analysis showed that home HD was associated with lower costs and better outcomes than was ICHD, increased dialysis frequency, duration, or both were not included in its main evaluation [10]. A 2003 National Institute for Health and Care Excellence (NICE) appraisal of home HD considered the cost-effectiveness of short-daily and nocturnal home HD, but only in sensitivity analysis [9]. The current analysis assesses the cost-effectiveness of high-dose HD (in-center or at home) versus conventional ICHD over a lifetime time horizon from a UK payer perspective. Given the average age of the home HD population in the United Kingdom (47–48 years old), a time horizon of 40 years is used and believed to be equivalent to a lifetime time horizon for patients with ESRD.

Methods

We constructed a Markov model to assess the cost-effectiveness of high-dose HD performed in-center or at home compared with thrice-weekly, conventional ICHD by simulating a hypothetical adult ESRD population requiring RRT. Model structure and data inputs were informed by a review of literature and renal registry reports.

Model Structure

The model comprises a number of discrete health states between which patients can move (Fig. 1) and adopts 28-day cycles to ensure consistency in calculations. Short cycles are preferable in ESRD because of their sensitivity to likely changes in health states [10,11]. From one cycle to the next, the patients may stay on their current modality, change modality, undergo a kidney transplant, or die (in any health state). To reflect clinical practice, patients may move to PD or kidney transplant during the model time horizon.

Model Inputs

Model inputs were sourced from published articles, UK Renal Registry annual reports, NHS Payment-by-Results (PbR) tariffs, and the European Renal Association-European Renal Dialysis and Transplant Association (ERA-EDTA) registry report.

Quality of Life

Patients' QOL has been shown to vary between dialysis modalities. A systematic review by Liem et al. [12] provides the main source of utilities for the model with adjustments to account for the improved QOL in patients receiving high-dose HD and for the home setting (Table 1). Culleton et al. [4] is the only randomized controlled trial to have considered the effect of dialysis dose on patient utility, demonstrating a 17.6% increase in utility from baseline in patients changing from conventional ICHD to high-dose HD at home. We assumed that half this benefit comes from the change to high-dose HD and half from the move to the home setting; consequently, in the model, patients receiving high-dose HD have utility values 8.8% higher than the utility values of those receiving conventional HD. Considering that the assumption is based on one small study, we varied the percentages of benefit in sensitivity analysis. De Wit et al. [13] reported 22.7% higher QOL values for patients on limited care HD than for patients on ICHD (0.81 vs. 0.66). The ratio of these values was applied to the utility assigned to patients on ICHD (from Liem et al. [12]) to derive the utility for patients receiving conventional home HD, assuming that the QOL of patients receiving limited care HD in the De Wit et al. study is comparable to that of conventional home HD patients.

Survival

Survival of patients receiving conventional HD in the model is estimated using survival data for European incident patients on HD published in the ERA-EDTA 2009 Annual Report [14]. Use of ERA-EDTA data requires us to assume that these patients are representative of those in the United Kingdom (in the ERA-EDTA 2009 Annual Report, UK patients represent 20% of all incident patient counts). Parametric survival models were fitted to 5-year survival data to extrapolate beyond 5 years [15]. An exponential distribution provided the best fit for HD survival data based on a comparison of Akaike information criterion values (the model with the smallest Akaike information criterion value is preferred).

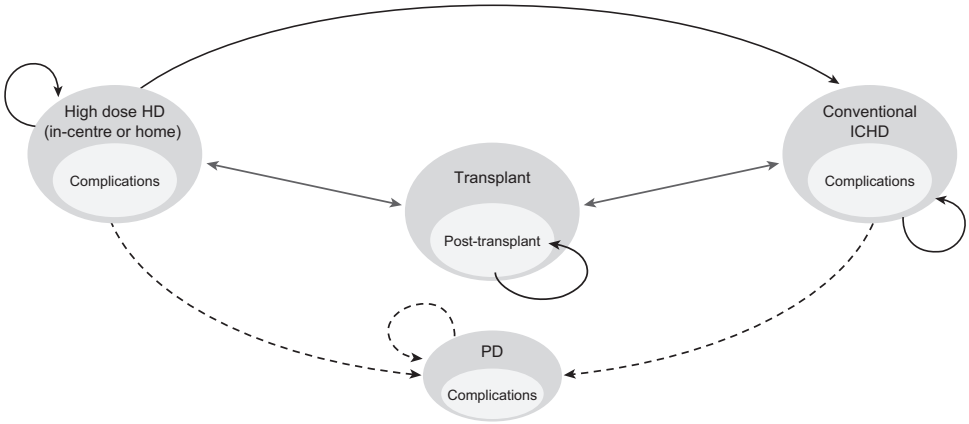

Fig. 1 – Model flow diagram. Each dialysis modality is shown as a separate health state in the model as follows: conventional in-center hemodialysis (ICHD) includes hospital or satellite; high-dose HD, in-center or at home; peritoneal dialysis (PD); transplant; posttransplant. Patients can die from any of the health states in the model. Although the emphasis of the analysis is the comparison of costs and outcomes between patients on high-dose and conventional HD, to reflect clinical practice some patients may move to PD during the model time horizon.