A simulation model to estimate the cost and effectiveness of alternative dialysis initiation strategies

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Record Status
This is a critical abstract of an economic evaluation that meets the criteria for inclusion on NHS EED. Each abstract contains a brief summary of the methods, the results and conclusions followed by a detailed critical assessment on the reliability of the study and the conclusions drawn.

Health technology
The study compared four alternative dialysis initiation strategies.

Strategy 1 was current practice. The authors reported that there was no compact representation of current practice and, as such, analysed data from the United States Renal Data System (USRDS). Given these data, the authors assumed that patients would receive dialysis 3 times per week, with men receiving 3.75 hours of dialysis in each session and women receiving 3.5 hours.

Strategy 2 was early initiation. Patients with chronic kidney disease (CKD) initiate dialysis when their estimated glomerular filtration rate (eGFR) drops below 15 mL/minute per 1.73 m². Duration and frequency of dialysis as in current practice.

Strategy 3 was late initiation. Patients with CKD initiate dialysis when their eGFR drops below 6 mL/minute per 1.73 m². Duration and frequency of dialysis as in current practice.

Strategy 4 was no dialysis. Patients would not be dialysed. Waiting for a transplant was the only option.

Type of intervention
Treatment.

Economic study type
Cost-utility analysis and cost-effectiveness analysis.

Study population
The study population comprised three key populations of kidney disease:

178,086 CKD patients alive at the end of 2000, which formed part of the USRDS prevalent population;

53,837 CKD patients who were either new enrolees in the USRDS or had a first transplant in 2000, which formed part of the USRDS incident population;

8,458 advanced CKD patients (eGFR > 15 mL/minute per 1.73 m²), which formed part of Kaiser Permanente Northern California.

Setting
The setting was primary care. The economic study was carried out in the USA.

Dates to which data relate
The effectiveness data were derived from studies published between 1984 and 2004. The price year was 2001.
Source of effectiveness data
The effectiveness data were derived from the USRDS, Kaiser Permanente Northern California and the San Francisco Department of Public Health, and were supplemented with data from a review of the literature.

Modelling
The authors developed a simulation model comprising two parts, a patient generation model and a patient simulation model. The patient generation model generated hypothetical patient cohorts for simulation, while the patient simulation model was a patient-by-patient simulator of disease progression. The model took, as its inputs, a cohort of patients with a series of initial attributes (i.e. demographics, co-morbid conditions, disease markers and clinical flags) along with a predefined dialysis policy. It then started simulating the clinical events, which modified the patient’s attributes.

Outcomes assessed in the review
Using data from the different primary data sources, the authors developed a regression model and derived regression coefficients for hospital admissions, mortality, transplant arrivals and graft failures. Quality of life data (i.e. utility values) were also assessed in the review.

Study designs and other criteria for inclusion in the review
Not reported.

Sources searched to identify primary studies
Not reported.

Criteria used to ensure the validity of primary studies
Not reported.

Methods used to judge relevance and validity, and for extracting data
Not reported.

Number of primary studies included
Fourteen primary studies were included in the review. In addition, effectiveness data were derived from three other unpublished sources (the USRDS, Kaiser Permanente Northern California and the San Francisco Department of Public Health).

Methods of combining primary studies
Not reported.

Investigation of differences between primary studies
Differences between the primary studies were not investigated.

Results of the review
The authors reported estimates for the regression coefficients in the hazards model for:

- hospitals admissions (in months),
the hazards model for on-waitlist mortality (in months),
the hazards model for on-transplant mortality (in days),
the hazards model for transplant arrival (in days), and
the hazards model for graft failure (in days).

There were too many regression coefficients to report in this abstract.

**Measure of benefits used in the economic analysis**
The measures of benefit used were the life-years gained (LYG) and the quality-adjusted life-years (QALYs) gained. The utility values were derived from a published study. Discounting was relevant, as the QALYs could be incurred over the lifetime of the patient, therefore all future QALYs were appropriately discounted at a rate of 3% per annum. The LYG were left unadjusted (i.e. they were not discounted).

**Direct costs**
The direct costs included in the analyses were those of the health care system. These included the costs incurred for dialysis, hospitalisation, graft failure and transplantation. The cost estimates for transplantation were obtained from the published literature. All other costs were derived from 2001 Medicare claims data. Discounting was relevant, as the costs could be incurred over the lifetime of the patient, therefore all future costs were discounted at an annual rate of 3%. The study reported the average costs per patient. The price year was 2001.

**Statistical analysis of costs**
The data were treated deterministically (i.e. the data were treated as point estimates).

**Indirect Costs**
The indirect costs were not included.

**Currency**
US dollars ($).

**Sensitivity analysis**
The authors performed a sensitivity analysis by examining how the relative rankings of the interventions' cost-effectiveness ratios (calculated on the basis of a simulated sample of 1 million patients) were affected by variations in hazard rates (+/- 20%), costs (+/- 20%), quality of life scores (+/- 20%), dose response model parameters for both hospitalisation and mortality (+/- 20%), and discount rate (+/- 50%).

**Estimated benefits used in the economic analysis**
The unadjusted LYG with each strategy were 3.78 with no dialysis, 5.81 with late initiation, 6.38 with current practice and 6.51 with early initiation.

The QALYs gained with each strategy were 2.1 with no dialysis, 2.85 with late initiation, 3.08 with current practice and 3.12 with early initiation.

**Cost results**
The average cost incurred by patients was $185,000 for no dialysis, $274,000 for late initiation, $313,000 for current
practice and $323,000 for early initiation.

**Synthesis of costs and benefits**
The costs and benefits were combined using an incremental cost-utility ratio (i.e. the additional cost per QALY gained).

Compared with no dialysis, the incremental cost-utility ratio was $106 for late initiation, $120 for current practice and $124 for early initiation. Compared with current practice, the incremental cost-utility ratio was $120 for no dialysis, $170 for late initiation and $250 for early initiation.

The results of the sensitivity analysis showed that the cost-effectiveness ratios were modestly affected by perturbations. Perturbations in the dose response parameter and the eGFR deterioration rate were the two most important drivers behind the cost-effectiveness of the various initiation strategies.

**Authors’ conclusions**
The model produced reliable results and was robust. The authors also concluded that their model enabled the cost-effectiveness analysis of dialysis strategies.

**CRD COMMENTARY - Selection of comparators**
The authors evaluated and compared four different initiation strategies for dialysis since the optimal timing of dialysis initiation, in terms of the cost-effectiveness, had not been established. You should decide if the interventions compared are current practice in your own setting.

**Validity of estimate of measure of effectiveness**
The authors did not report that a systematic review of the literature was undertaken to identify relevant research and minimise bias. However, they used a wide range of sources, including published data, existing databases and newly derived data, when calibrating the various sub-models. The authors provided only limited details of the literature search and of the studies included in the review. For example, they did not report whether data from the primary studies were combined or if differences between the primary studies were investigated.

**Validity of estimate of measure of benefit**
The measure of benefit was derived from a simulation model, which was appropriate for the study question. Further, the authors validated the model by comparing simulated outcomes with historical data published by the USRDS. As the outcomes were incurred over the lifetime of the patient, they were appropriately discounted.

**Validity of estimate of costs**
The authors did not explicitly report the perspective adopted in the economic analysis, but it would appear that the perspective of a health care system was used. Under this perspective, all the relevant cost categories and costs were included. The costs and the quantities were not reported separately, which will limit the generalisability of the authors' results. The costs were derived from published sources. Appropriate sensitivity analyses of the costs were undertaken, using ranges that appear to have been appropriate and wide. As the costs were incurred over the lifetime of a patient, all future costs were appropriately discounted. The authors used Medicare claims to proxy costs, which may not reflect the true cost of performing a health care intervention or service. The price year was reported, which will aid any possible future inflation exercises.

**Other issues**
The authors did not compare their results with those from other published studies, probably because no other economic evaluation had evaluated the cost-effectiveness of alternative dialysis initiation strategies. The issue of generalisability to other settings was appropriately addressed in the validation of the model and the sensitivity analysis. The authors do
not appear to have reported their results selectively and their conclusions reflected the scope of the analysis. The authors reported a number of further limitations to their study. In particular, the use of modelling studies with inherent assumptions and model structures rather than data from RCTs (which did not exist).

**Implications of the study**
The authors reported that data generated from RCTs, including an upcoming trial of more frequent dialysis, could inform the next iteration of the simulation model.

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**Other publications of related interest**
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**Indexing Status**
Subject indexing assigned by NLM

**MeSH**
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