

Part Three

**Economic Modelling Report:
Modelling the Current and Future Costs
and Benefits of Renal Replacement
Therapy in Queensland**

Acknowledgments

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Disclaimer and citation

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Related documents:

Queensland Government (2007) *Queensland Statewide Renal Health Services Plan, 2008–17, Part One: The Way Forward*, Queensland Government, Brisbane.

Queensland Government (2007) *Queensland Statewide Renal Health Services Plan, 2008–17, Part Two: Current Service Analysis and Future Demand Predictions*. Queensland Government, Brisbane.

Contents

Introduction.....	128
Method.....	130
<i>The Economic Model</i>	130
<i>Sources of estimates</i>	130
<i>Projection of the incidence of End-Stage Kidney Disease 2005 to 2017</i>	130
<i>Health State Utilities</i>	131
<i>Resource use and costs</i>	131
<i>Transition probabilities</i>	133
<i>Calculation methods</i>	133
<i>Prevention of End-Stage Kidney Disease</i>	133
Results.....	134
<i>Health sector costs (in present dollar values) of treating current and new cases of end-stage kidney disease (ESKD) out to 2017</i>	134
<i>Projected annual health sector costs of treating all cases of end-stage kidney disease (ESKD) to 2017</i>	135
<i>Benefits (in life years and quality-adjusted life years) of treating new cases of ESKD (to 2017)</i>	137
<i>Cost effectiveness and cost-utility analysis of changing patterns of RRT modality for all new ESKD patients</i>	139
Appendices.....	142
<i>Appendix A: Details of rationale, methods and results</i>	142
Introduction.....	142
Methods.....	142
The Economic Model.....	146
Results.....	160
<i>Appendix B: Details of unit costs</i>	170
<i>Appendix C: Modelling of prevention of End-Stage Kidney Disease</i>	184
Methods.....	185
Results.....	188
<i>Appendix D: Glossary</i>	190
<i>Appendix E: Acronyms</i>	195
References.....	196

Introduction

Demand for dialysis and kidney transplantation services has significantly increased in Queensland and the rest of Australia over recent decades. An ageing population, increasing diabetes prevalence and the heavy burden of chronic disease among Aboriginal and Torres Strait Islander Australians, particularly in North Queensland, have combined to place renal services under intense demand and capacity pressure. Evidence suggests that renal service planning should take into account the strong likelihood that demand will continue to rise over the next decade.

The Queensland Statewide Renal Health Services Plan (2008–17) has been prepared in response to the increasing pressures and demand on Queensland Health's renal services.

The Plan has three parts.

Part One: The Queensland Statewide Renal Health Services Plan 2008–17: The Way Forward

This part is the 'Plan', an easy-to-read document that discusses the current situation and considers demand forecasts and an economic modelling of current and future costs and benefits associated with changing the service model. The strategies are arranged around five objectives.

Part Two: Current Service Analysis and Future Demand Predictions

This part provides in-depth information on the current incidence and prevalence of end-stage kidney disease as well as service models, and workforce and infrastructure capacity in Queensland. It compares Queensland's performance with other states and territories. Predictions of end-stage kidney disease incidence and prevalence to the year 2017 are also contained in this part.

Part Three: Economic Modelling Report: Modelling the Current and Future Costs and Benefits of Renal Replacement Therapy in Queensland

This Part is a supporting document to the Plan, including the more technical elements of the Plan. Data relating to incidence predictions, workforce and current service capabilities are presented in graphs and tables.

In order to determine the impact on costs and health outcomes, of changes in the clinical management of end-stage kidney disease (ESKD), current costs and benefits must be defined and estimated. A Markov model for treated end-stage kidney disease patients was constructed, upon which the existing patterns of renal replacement therapy (RRT) in Queensland were used to predict the future health care costs and benefits of treating new and existing end-stage kidney disease patients for each year up to and including 2017.

Part Three has taken the perspective of the health care funder and has modelled the health sector costs of providing RRT on the basis of the best available data. These take into account personnel, interventional, pharmaceutical, diagnostic, infrastructure, maintenance and consumable item costs. The costs of comorbidities such as diabetes mellitus, ischemic heart disease and cancer have not been modelled as attribution of the costs incurred by these conditions to end-stage kidney disease or renal replacement therapy is usually not straightforward. Specifically, it is not possible to quantify to what extent these conditions are worsened by RRT and therefore to what extent these costs can be attributed to renal replacement therapy. This, together with the absence of detailed Australian data about

admission rates for specific renal and non-renal causes among the renal replacement therapy population, is a major deficiency in the published literature. It is likely that costs associated with lost earnings and productivity, and other out of pocket costs of patients and families such as the cost of carers, travel, over-the-counter medications as well as other consumables are also very large. Due to a lack of available data, it has not been possible to quantify these costs in this document.

Method

The approach used in this analysis follows a previously developed and reported methodology for the analysis of costs and benefits of renal replacement therapy in Australia.¹ Many of the data limitations identified in this earlier work are also applicable in the Queensland setting. Additional detail of the model, data sources and assumptions are reported in Appendix A.

The Economic Model

A Markov model was constructed as the basis for estimating the costs and benefits of renal replacement therapy (RRT) in Queensland. This model is based upon the general structure (including some assumptions) of an earlier model used to estimate costs and health outcomes of RRT on a national level.

The model follows a cohort of men and women newly treated for end-stage kidney disease, along with existing renal replacement therapy patients. The length of each 'treatment' cycle in the model is one year. The structure of the model is shown in detail in Appendix A. The model is stratified by Aboriginality and age.

Sources of estimates

In the absence of good-quality individual randomised control trials or large prospective observational studies conducted in Australia, this study uses the best available Australian published data to derive estimates for the model parameters. This required a substantial secondary analysis of ANZDATA in order to derive transition probabilities between health states and renal replacement therapy (RRT) modalities. Details of the sources of cost and quality of life data are outlined in the following section. If no published evidence could be found, the opinion of clinical experts was sought.

Projection of the incidence of End-Stage Kidney Disease 2005 to 2017

Future incidence of treated end-stage kidney disease (ESKD) is based on:

- A Poisson model of incidence trends over time (for non-indigenous patients); and
- Two estimates of population projections for indigenous ESKD patients based upon 1) a steady-state and 2) a linear growth model of current increases in the incidence of treated ESKD.

See the related document *Queensland Statewide Renal Health Services Plan 2008-2017, Part Two: Current Service Analysis and Future Demand Predictions* for a detailed description of the modelling of future end-stage kidney disease (ESKD) incidence used in this document.

¹ Agar, J, Knight, RJ, Simmonds, RE, Boddington, JM, Waldron, CM, Sommerville, CA 2005, 'Nocturnal haemodialysis: An Australian cost comparison with conventional satellite haemodialysis.' *Nephrology (Carlton)*, vol. 10, no. 6, pp. 557-70.

2008–17

Health State Utilities

No Australian data existed on utility scores for patients in pre (ie dialysis) and post transplant health states. The health utility scores for dialysis, and post transplant states are summarised in

Table 1.

Table 1 Health utility scores for dialysis and post-transplant states

Assumptions	Value	Source	Justification for source
Renal transplant		Laupacis et al (1996)	Pre and post transplant time trade-off (TTO) utility valuation study conducted on transplant patients and on dialysis patients (pre-transplant)
Time after transplant			
1 month	0.68		
3 month	0.71		
6 month	0.75		
12 months	0.74		
<i>Time weighted average 0-12 months</i>	<i>0.7325</i>		
18 months	0.7		
24 months	0.7		
<i>Time weighted average 12-24 months</i>	<i>0.7</i>		
Dialysis (pre-transplant)	0.55	Laupacis et al (1996)	
Death	0	Convention	

Resource use and costs

Cost data were based on the best available published data that conform to Australian government guidelines for the application of economic evaluation to funding submissions to the Pharmaceutical Benefits Advisory Committee (PBAC) and the Medical Services Advisory Committee (MSAC). Where possible, the most recent (2005-6) Queensland specific NHCDC cost -weights have been used for relevant DRG-based costs. Where 2005-6 data was not available, Queensland specific 2004-5 NHCDC cost weights have been applied. Additional detail is available in Appendix A.

A primary costing study of dialysis modalities or transplantation was not undertaken. Estimates of the cost of each treatment modality were based on the best available published data and were derived from Australian studies. Although a number of costing studies have reportedly been undertaken in various States and Territories, almost none of these studies have been published in peer-reviewed manuscripts or government reports.

Other inpatient resource use by dialysis modality is also partially captured. Data are not available to estimate the total inpatient resource use (renal and non-renal related admissions) for patients on dialysis. Therefore, to capture some of the possible resource use associated with admissions for peritoneal dialysis (PD) patients, an estimate has been generated based upon ANZDATA information on admissions for peritonitis, and for haemodialysis (HD) patients based on ANZDATA information of access revisions. This will likely underestimate true inpatient resource use for both PD and HD patients, although in the absence of other Australian data on patient admissions, this is the only available data.

2008–17

The annual cost of transplant includes surgery and hospitalisation, immunosuppressive therapy, specialist review and consultations and other drugs, as well as donor costs for a transplant. Data sources are discussed in more detail in Appendix A.

The unit costs of renal replacement therapy (RRT) per patient per annum, by treatment modality, are summarised in Table 2 and Table 3 (with further details of the costs of RRT provided in Appendices A and B).

Table 2 Unit cost of dialysis per patient per year by modality (AUD\$2005)

<i>Resource items</i>	<i>Home Haemodialysis \$ unit cost per annum</i>	<i>Satellite Haemodialysis \$ unit cost per annum</i>	<i>PD \$ unit cost per annum</i>	<i>Hospital Haemodialysis \$ unit cost per annum</i>
Dialysis costs (incl fixed costs, salaries and wages, consumables)	35,150	39,373	41,448	76,603
Drugs (incl Epoetin alfa, Darbepoetin alfa, Calcitriol & Iron)	9,707	9,707	9,707	9,707
Hospitalisation due to infection/ other complications / access revisions*	2,395	2,395	5,656	2,395
Specialist consultations and review	490	490	490	490
Work up costs for patients on transplant waiting list	592	592	592	592
TOTAL ANNUAL COST (not including initial access)	\$48,333	\$52,557	\$57,894	\$89,786
Initial access (incl temporary access)	14,914	14,914	10,885	14,914

* NB these costs are estimated from ANZDATA record hospitalisations for peritonitis in peritoneal dialysis (PD) patients and access revisions in haemodialysis (HD) patients and are therefore likely to underestimate the true cost of inpatient resource use for renal and non-renal causes in these patients.

Table 3 Unit cost of kidney transplant per patient per year by modality (AUD\$2005).

<i>Resource items</i>	<i>Live donor Recipient unit cost \$</i>	<i>Live donor Donor unit cost \$</i>	<i>Deceased donor Recipient unit cost \$</i>	<i>Deceased donor Donor unit cost \$</i>
Transplant				
Year 1				
Surgery and hospitalisation	26,958	7,729	26,958	3,000
Regular Immunosuppressive therapy (PBS)	19,445		19,445	
Additional Immunosuppression	2,620		2,620	
Other drugs	9,439		9,439	
Non drug follow-up costs	4,730		4,730	
TOTAL YEAR 1 COST	\$63,192	\$7,729	\$63,192	\$3,000
Year 2 onwards				
Regular Immunosuppressive therapy	9,042		9,042	
Other drugs	954		954	
Non drug follow-up costs	753		753	
TOTAL YEAR 2 ONWARDS COST	\$10,749		\$10,749	

Transition probabilities

The full set of transition probabilities has been reported previously². As discussed earlier, because of comparatively small patient numbers in Queensland (relative to all of Australia), Australian data has been used as they are more robust. The main areas where these probabilities differ from the previous Australia-wide report is the proportions of patients utilizing different dialysis modalities. Queensland specific data have been used to capture current practice, which then forms the basis for examining the costs and health outcomes of alternative patterns of renal replacement therapy modality delivery (See Appendix A).

Calculation methods

Methods of calculating costs and benefits from 2005-2017 are explained in detail in Appendix A. Appendix A also provides details of the methods used for calculating the incremental costs and benefits, and the incremental cost-effectiveness ratio of changing patterns of renal replacement therapy modality.

The specific calculations are:

- the present value of costs and benefits of treating all existing and new cases of ESKD (from 2005 - 2017)
- the additional health care costs and benefits of increasing the proportion of new ESKD patients who receive a kidney transplant
- the additional health care costs (savings) that accrue by changing the proportion of patients that undergo different types of dialysis (hospital haemodialysis, home haemodialysis, continuous ambulatory peritoneal dialysis ,and satellite haemodialysis).

Prevention of End-Stage Kidney Disease

A separate economic model³ was used to estimate the effect on costs and effects of population based strategies to better manage patients with some risk factors for ESKD (diabetes and hypertension), and strategies for early detection of diabetes, hypertension and proteinuria. These analyses assess the total effects in terms of costs and health benefits from these interventions (including the cost-offsets and health benefits related to prevention of end-stage kidney disease (and renal replacement therapy), and other (predominantly cardiovascular) diseases.

Methods and results of these analyses are summarized in Appendix C.

² Cass, A, Chadban, S, Craig, J, Howard, J, McDonald, S, Salkeld, G, White, S 2006, *The Economic Impact of End-Stage Kidney Disease in Australia*, Kidney Health Australia, Melbourne.

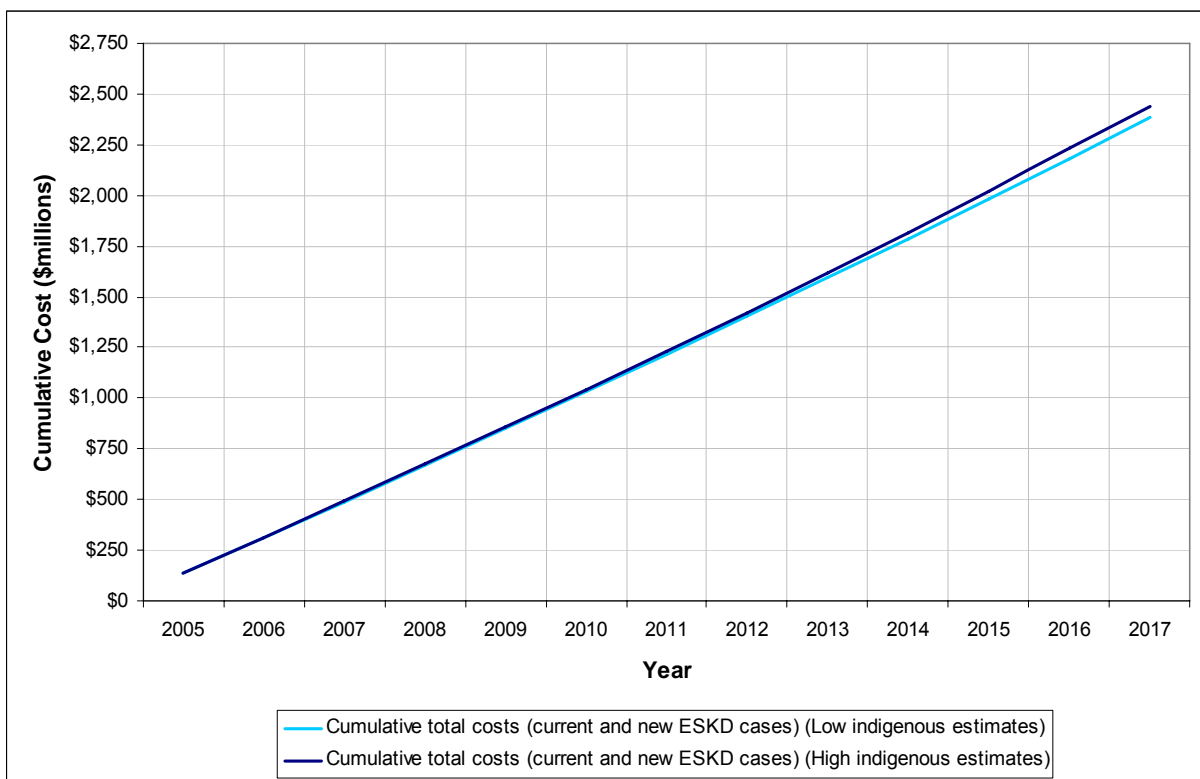
³ Howard, K, Salkeld, G, White, S, Chadban, S, Craig J, McDonald, S, & Cass, A 2006, *The Cost-effectiveness of early detection and intervention to prevent the progression of chronic kidney disease in Australia*, Kidney Health Australia, Melbourne.

Results

Health sector costs (in present dollar values) of treating current and new cases of end-stage kidney disease (ESKD) out to 2017

In today’s dollars the cumulative cost of renal replacement therapy for all current and new cases of end-stage kidney disease treated out to 2017 in Queensland is estimated to fall between \$2.38 billion⁴ and \$2.44 billion⁵ by the end of 2017 (Figure 1). The component costs of new and existing ESKD patients are presented separately in Appendix A.

Figure 1 The cumulative present treatment cost of all new and existing Queensland ESKD patients treated out to 2017



⁴ Based on the steady-state incidence rate in the indigenous population (see *Queensland Statewide Renal Health Services Plan, 2008–17, Part Two: Current Service Analysis and Future Demand Predictions, p 27*).

⁵ Based on the linear growth model of increase in incidence in the indigenous population (see *Queensland Statewide Renal Health Services Plan, 2008–17, Part Two: Current Service Analysis and Future Demand Predictions, p 27*).

Projected annual health sector costs of treating all cases of end-stage kidney disease (ESKD) to 2017

The annual present value cost of renal replacement therapy (RRT) is estimated to rise from \$136 million in 2005 to between \$202 and \$211 million in 2017 (Table 4).

2008–17

Table 4 Total present value projected annual health care costs of treating all cases of ESKD for 2005-2017 (\$ millions)

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Low Indigenous ESKD estimates													
Total annual cost	\$135.8	\$176.1	\$177.9	\$178.7	\$180.2	\$182.2	\$184.5	\$187.2	\$190.2	\$193.3	\$196.4	\$199.4	\$202.3
Cumulative annual total costs	\$135.8	\$311.9	\$489.8	\$668.5	\$848.7	\$1,030.9	\$1,215.4	\$1,402.6	\$1,592.8	\$1,786.1	\$1,982.5	\$2,181.9	\$2,384.2
High Indigenous ESKD estimates													
Total annual cost	\$135.8	\$176.7	\$179.3	\$180.8	\$183.0	\$185.7	\$188.8	\$192.3	\$196.1	\$199.9	\$203.8	\$207.6	\$211.2
Cumulative annual total costs	\$135.8	\$312.5	\$491.8	\$672.6	\$855.6	\$1,041.3	\$1,230.1	\$1,422.4	\$1,618.5	\$1,818.4	\$2,022.2	\$2,229.8	\$2,441.0

Benefits (in life years and quality-adjusted life years⁶) of treating new cases of ESKD (to 2017)

The present value of the benefits of renal replacement therapy (RRT) for all new cases of ESKD out to 2017 will approach 25,000 life years by 2017. The present value of the benefits of RRT for all new cases of ESKD (2005-2017) will be approximately 14,000 quality adjusted life years.

The annual and cumulative present value of total health benefit for treatment of all new cases of ESKD out to 2017 are summarised in Table 5, and are summarised graphically in Appendix A.

⁶ Quality adjusted life years (QALYs) are a multidimensional outcome measure used in health economics. This economic index of outcome combines patient survival in life years with an adjustment for the quality of life, where adjustment is based on interval scale from 0 (worst health) to 1 (full health).

2008–17

Table 5 The present value (annual and cumulative) of health benefit (Life years and quality adjusted life years) for all new ESKD cases out to 2017

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Low Indigenous ESKD estimates													
Total annual life years	423	803	1131	1404	1634	1832	2005	2158	2295	2417	2525	2622	2709
Cumulative life years	423	1225	2356	3760	5394	7226	9231	11389	13684	16101	18626	21248	23957
Total annual quality adjusted life years	234	450	639	798	933	1049	1150	1240	1320	1391	1454	1510	1560
Cumulative quality adjusted life years	234	684	1322	2120	3053	4102	5252	6492	7813	9203	10657	12168	13728
High Indigenous ESKD estimates													
Total annual life years	423	810	1147	1429	1668	1876	2058	2222	2369	2501	2621	2728	2825
Cumulative life years	423	1232	2379	3808	5475	7351	9410	11632	14001	16503	19123	21851	24676
Total annual quality adjusted life years	234	453	647	812	951	1073	1180	1275	1361	1438	1506	1568	1624
Cumulative quality adjusted life years	234	688	1335	2147	3098	4171	5351	6626	7987	9424	10931	12499	14123

Cost effectiveness and cost-utility analysis of changing patterns of RRT modality for all new ESKD patients

A cost-effectiveness and cost-utility analysis was conducted to examine the incremental cost effectiveness ratio (ICER) of increasing transplant rates. Under both models of incidence projection, the incremental cost effectiveness of increasing kidney transplants by 10% is dominant over current practice. That is, increasing the transplant rate is less expensive and more effective than current treatment patterns for ESKD. The incremental cost savings range from \$7.29 million to \$7.38 million out to 2017. Results are shown in Table 6 and Table 7.

Table 6 The present value costs and health benefit (out to 2017) of increasing the current transplant rate in Queensland by 10% by 2010 over current levels

Costs and Benefits to 2017	Total cost (\$billion)	Incremental cost (\$million)	Total Life Years	Incremental life years	ICER	Total QALYs	Incremental QALYs	ICER
Base Case – Low incidence model	\$1.691		23957.09			13727.81		
Increased transplant rate - Low incidence model	\$1.683	-\$7.293	24021.15	64.07	Dominant	13811.12	83.31	Dominant
Base case – High incidence model	\$1.748		24675.93			14123.27		
Increased transplant rate - High incidence model	\$1.741	-\$7.378	24736.34	60.41	Dominant	14204.58	81.31	Dominant

Similarly, under both models of incidence projection, the incremental cost effectiveness of increasing kidney transplants by 50% is also dominant over current practice. That is, increasing the transplant rate is less expensive and more effective than current treatment patterns for end-stage kidney disease. The incremental cost savings range from \$33.94 million to \$34.39 million out to 2017.

2008–17

Table 7 The present value costs and health benefit (out to 2017) of increasing the current transplant rate in Queensland by 50% by 2010 over current levels

Costs and benefits to 2017	Total cost (\$billion)	Incremental cost (\$million)	Total Life Years	Incremental life years	ICER	Total QALYs	Incremental QALYs	ICER
Base Case – Low incidence model	\$1.69		23957			13727.8		
Increased transplant rate - Low incidence model	\$1.66	-\$33.93	24262	304.94	Dominant	14127.6	399.85	Dominant
Base case – High incidence model	\$1.74		24675			14123.2		
Increased transplant rate - High incidence model	\$1.71	-\$34.38	24961	285.64	Dominant	14512.5	389.30	Dominant

The incremental costs and health outcomes of the sensitivity analysis examining switching dialysis modality are summarized in Table 8 to Table 10 below. Increasing the rate of both home haemodialysis (HD) and peritoneal dialysis (PD) utilization (as detailed in Appendix A) will lead to net savings of up to \$145.8 million. Without Australian data on utility-based quality of life on each dialysis modality it is not possible to estimate the incremental benefits of the 'switch modality' scenarios. However, it is reasonable to assume that there would also be a significant improvement in quality of life resulting from these changes.

Table 8 The present value costs and health benefit (out to 2017) of increasing the utilisation of home haemodialysis services in Queensland

Costs and benefits to 2017	Total cost (\$billion)	Incremental cost (\$million)	Total Life Years	Total QALYs
Base Case – Low incidence model	\$1.691		23957.09	13727.81
Increased Home HD utilisation - Low incidence model	\$1.651	-\$40.712	23957.09	13727.81
Base case – High incidence model	\$1.748		24675.93	14123.27
Increased Home HD utilisation - High incidence model	\$1.708	-\$40.712	24675.93	14123.27

2008–17

Table 9 The present value costs and health benefit (out to 2017) of increasing the utilisation of PD services in Queensland

Costs and benefits to 2017	Total cost (\$billion)	Incremental cost (\$million)	Total Years Life	Total QALYs
Base Case – Low incidence model	\$1.691	-\$111.054	23957.09	13727.81
Increased PD utilisation - Low incidence model	\$1.580		23957.09	13727.81
Base case – High incidence model	\$1.748	-\$111.054	24675.93	14123.27
Increased PS utilisation - High incidence model	\$1.637		24675.93	14123.27

Table 10 The present value costs and health benefit (out to 2017) of increasing the utilisation of both Home HD and PD services in Queensland*

Costs and benefits to 2017	Total cost (\$billion)	Incremental cost (\$million)	Total Years Life	Total QALYs
Base Case – Low incidence model	\$1.691	-\$145.813	23957.09	13727.81
Increased Home HD & PD utilisation - Low incidence model	\$1.545		23957.09	13727.81
Base case – High incidence model	\$1.748	-\$145.813	24675.93	14123.27
Increased Home HD & PD utilisation - High incidence model	\$1.602		24675.93	14123.27

* The savings produced through increasing the utilization of both home haemodialysis (HD) and peritoneal dialysis (PD) services in Table 10 are dependent on achieving the targeted levels of modality utilization, as discussed in Part One: The Way Forward.

Appendices

Appendix A: Details of rationale, methods and results

Introduction

In order to determine the impact on costs and health outcomes, of changes in the clinical management of end-stage kidney disease (ESKD), current costs and benefits must be defined and estimated. A Markov model for treated ESKD patients was constructed, upon which the existing patterns of RRT in Queensland were used to predict the future health care costs and benefits of treating new and existing ESKD patients for each year up to and including 2017.

Renal replacement therapy (RRT) programs incur direct costs, which include the cost of all resources necessary to provide RRT, from buildings and equipment to pharmaceuticals to professional services, as well as productivity, or indirect costs. The pain, suffering or fear associated with treatment are regarded as negative benefits in the economic analysis and are captured as changes in quality of life.

This report has taken the perspective of the health care funder, and has modelled the health sector costs of providing RRT on the basis of the best available data. These take into account personnel, interventional, pharmaceutical, diagnostic, infrastructure, maintenance and consumable item costs. The costs of comorbidities such as diabetes mellitus, ischemic heart disease and cancer have not been modelled as attribution of the costs incurred by these conditions to ESKD or RRT is usually not straightforward. Specifically, it is not possible to quantify to what extent these conditions are worsened by RRT and therefore to what extent these costs can be attributed to RRT. This, together with the absence of detailed Australian data about admission rates for specific renal and non-renal causes among the RRT population, is a major deficiency in the published literature. It is likely that costs associated with lost earnings and productivity, and other out of pocket costs of patients and families such as the cost of carers, travel, over-the-counter medications as well as other consumables are also very large. It has not been possible to quantify these costs in this report, due to a lack of available data.

Methods

The approach used in this analysis follows a previously developed and reported methodology for the analysis of costs and benefits of RRT in Australia⁷. Many of the data limitations identified in this earlier work are also applicable in the Queensland setting.

⁷ Cass, A, Chadban, S, Craig, J, Howard, J, McDonald, S, Salkeld, G, White, S 2006, *The Economic Impact of End-Stage Kidney Disease in Australia*. , Kidney Health Australia, Melbourne.

Background data available

The following section describes the data that was available for assessing Australian and Queensland costs and health outcomes of renal replacement therapy (RRT).

Costs

The most readily available information in Australia on the cost of dialysis relates to the price of dialysis modality used to *fund* services. However, the cost of providing a service may be different to the reimbursed amount per service i.e. the funded amount. It is the opportunity cost of resources involved in RRT that should drive an economic model, not State-based funding agreements. Funding of renal dialysis can vary considerably by State and agreed levels of funding do not necessarily reflect the opportunity cost of RRT.

In contrast to many other estimates that report *funding* (rather than actual costs) for dialysis services, in 1999, Bird Cameron Chartered Accountants were commissioned by the Health Department of Western Australia (HDWA) to conduct a cost analysis of the renal dialysis services funded by the HDWA. The authors used 1997-98 financial data from three public hospitals in WA to estimate the *cost of delivering* each dialysis modality and to recommend a benchmark price for HDWA to fund dialysis services. This was a rigorous, bottom up costing, and as such represents some of the best available data on the cost of providing RRT. The results of the study are summarised in Table 1. For this analysis, these data have been inflated to 2005 values using the AIHW Health Price Inflation⁸.

Table 1 1997/98 Costs and pricing by modality for teaching hospitals in Western Australia

Modality	Royal Perth Hospital Costs per patient \$	Sir Charles Gairdner Hospital Costs per patient \$	Fremantle Costs per patient \$	1997/98 Health Dept of Western Australia Price Schedule \$
In Centre HD	58,410	47,981	50,077	57,195
Metropolitan Home HD	20,064	-	-	32,136
Remote Home HD	34,819	-	-	40,872
Training Home HD	27,059	-	-	27,924
Metropolitan Home CAPD	27,564	29,016	30,139	26,473
Remote Home CAPD	32,154	24,413	30,351	29,705
Training Home CAPD	9,831	2,036	2,819	8,030

⁸ AIHW Health Expenditure 2004-5 Table C1 <http://www.aihw.gov.au/publications/index.cfm/title/10350>

You et al (2002)⁹ estimated the hospital costs of Aboriginal and non-Aboriginal patients having haemodialysis in the Northern Territory (NT) of Australia. Based on 1996-7 and 1997-8 fiscal years, all episodes of care for 101 Aboriginal patients and 64 non-Aboriginal patients, grouped by the Diagnosis Related Group Version 3 classification system, were derived for three public hospitals in the NT. The study authors report the number of admissions, days of hospitalisation and costs for all causes as well as the number of dialysis treatments received by patients. In total there were 488 hospital admissions, 4,312 days of hospitalisation at a total cost of \$2,933,917. The data were then used to project future demand (through to 2005) for dialysis treatments in the NT, costing an estimated \$49.8 million.

In 2003/2004, Agar et al conducted a costing analysis of nocturnal home haemodialysis (NHHD) compared to conventional satellite haemodialysis (SHD) within the renal program at the Geelong Hospital in Victoria, Australia¹⁰. The authors selected a low acuity, limited care SHD facility for the cost comparison with NHHD. Only NHHD and SHD patients who had completed an uninterrupted, complete 12-month dialysis program throughout the 2003-2004 financial year were included in the patient-based cost study. The cost of NHHD included i) the costs associated with training and program maintenance and ii) the ongoing costs of dialysis in the home once a patient is 'installed' at home. For both NHHD and SHD, the authors estimated the staff and recurrent (consumables) expenditure as well as capital and other infrastructure costs. The costing did not specifically include erythropoietin (EPO), medical service costs and initial access. The estimated cost per patient per month of treatment for SHD was \$3,023.66 (consisting of wage and recurrent costs \$2,495.67 and fixed and estimated costs of \$527.99) and for NHHD it was \$2,699.31 (consisting of wage and recurrent costs of \$2,336.31 and fixed and estimated costs of \$363). Again, these figures have been inflated to 2005 values using the AIHW Health Price Inflatons.

Utility-based Quality of Life (QoL) on Dialysis

Quality of life is a significant factor when assessing the outcome of RRT from the patients' perspective. The extent to which one treatment modality provides patients with good physical, social and emotional well-being and allows them independence can be measured and valued using a preference based measure of quality of life such as the QALY (quality adjusted life year). This economic index of outcome combines patient survival with an adjustment for the quality of life, where the adjustment is based on an interval scale from 0 (worst health) to 1 (full health). Changes in quality of life that may result from switching RRT modalities, for example from hospital haemodialysis to home haemodialysis or from dialysis to transplant, can be measured on the 0-1 scale and the impact of the change captured in the number of QALYs derived from each treatment modality.

A number of quality of life studies have been undertaken and reported among dialysis and transplant patients. This economic model uses the utility-based quality of life reported in a well designed pre- and post-transplant study by Laupacis et al in 1996¹¹. Laupacis et al conducted an earlier study on 188 haemodialysis patients enrolled in a RCT of the effect of erythropoietin (EPO). The authors used one disease specific measure of QoL, the Kidney Disease Questionnaire and two generic instruments, the Sickness Impact Profile (SIP) and

⁹ You, J, Hoy, W, Zhao, Y, Beaver, C, Eagar, K. 2002, 'End-stage renal disease in the Northern Territory: current and future treatment costs.' *Medical Journal of Australia*, vol. 176, no. 10, pp. 461-5.

¹⁰ Agar, J, Kinght, RJ, Simmonds, RE, Boddington, JM, Waldron, CM, Sommerville, CA 2005, 'Nocturnal haemodialysis: An Australian cost comparison with conventional satellite haemodialysis.' *Nephrology (Carlton)*, vol. 10, no. 6, pp. 557-70.

¹¹ Laupacis, A, Keown, P, Pus, N, et al, 1996, 'A study of the quality of life and cost-utility of renal transplantation', *Kidney International*, vol. 50, no. 1, pp. 235-42.

the utility-based Time Trade-off (TTO) method. The results of the Laupacis study were: for haemodialysis and no EPO (at 6 months) the mean utility score was 0.42, with EPO and maintaining Hb 95-110g/L utility equals 0.51, with EPO and maintaining Hb 110-130g/L utility equals 0.58¹². There is limited and somewhat inconsistent utility based QoL information available on alternative dialysis modalities, and there is no published information available on QoL for Australian patients.

Russell and colleagues (1992) used the TTO method to measure QoL for a group of 27 patients on dialysis who subsequently received a successful kidney transplant¹³. The mean utility score whilst on dialysis was 0.41.

De Wit et al (1998) administered a series of QoL questionnaires alongside a clinical study of dialysis treatments in thirteen Dutch dialysis centres¹⁴. Three instruments were used, the EQ-5D Visual Analogue Scale, the TTO and the standard gamble (SG) technique. The mean utility scores (SG, TTO and EQ-5D) for each type of dialysis were: for hospital haemodialysis (HD) 0.84, 0.87 and 0.58 respectively; for satellite centre HD 0.91, 0.93 and 0.65; for continuous ambulatory peritoneal dialysis (CAPD) 0.81, 0.86 and 0.61 and for continuous cycling peritoneal dialysis (CCPD) 0.74, 0.93, 0.61.

In a subsequent study, de Wit used two health profile (generic) instruments, the EQ-5D and the SF-36 and two utility-based instruments, the SG and TTO, to compare health-related QoL for haemodialysis and peritoneal dialysis health states. A total of 135 dialysis patients participated in the study (69 on HD and 66 on PD). The mean utility scores for HD were 0.86 (SG) and 0.89 (TTO) and for PD 0.82 (SG) and 0.87 (TTO)¹⁵. The SG and TTO scores were higher than previously published data, which lead the authors to speculate that their results reflect adaptation by patients to their current state of health on dialysis.

Wasserfallen used the EQ-5D multi-attribute utility instrument to measure quality of life in Swiss dialysis patients¹⁶. The EQ-5D measures five dimensions of QoL, including mobility, self care, usual activity, pain/discomfort and anxiety/depression. At the time of the survey 419 respondents were receiving HD and 49 PD. The mean utility score for HD was 0.62 and the mean score for PD was 0.58.

Churchill (1987, 1991) has published two studies in which the TTO method was used to derive utility scores for hospital HD (0.43), home HD (0.49) and peritoneal dialysis (0.56).^{17, 18} McFarlane et al (2003) used the SG technique in a survey of 24 patients to value patients' quality of life for home nocturnal haemodialysis (0.77) and in-centre haemodialysis (0.53).¹⁹

¹² Laupacis, A, Wong, C, Churchill, D. 1991, 'The use of generic and specific quality-of-life measures in hemodialysis patients treated with erythropoietin', *Control Clinical Trials*, vol. 12, no. 4 Suppl, pp. 168s-79s.

¹³ Russell, J, Beecroft, ML, Ludwin, D, Churchill, DN. 1992, 'The quality of life in renal transplantation - a prospective study', *Transplantation*, vol. 54, no. 4, pp. 656-60.

¹⁴ de Wit, G, Ramsteijn, PG, de Charro, FT. 1998, 'Economic evaluation of end stage renal disease treatment', *Health Policy*, vol. 44, no. 3, pp. 215-32.

¹⁵ de Wit, G, Merkus, MP, Krediet, RT, de Charro, FT. 2002, 'Health profiles and health preferences of dialysis patients', *Nephrology, Dialysis and Transplant*, vol. 17, no. 1, pp. 86-92.

¹⁶ Wasserfallen, J, Halabi, G, Saudan, P, et al. 2004, 'Quality of life on chronic dialysis: Comparison between haemodialysis and peritoneal dialysis.' *Nephrology, Dialysis and Transplant*, vol. 19, no. 6, pp. 1594-9.

¹⁷ Churchill, D, Torrance, GW, Taylor, DS, et al. 1987, 'Measurement of quality of life in end-stage renal disease: the time-trade-off approach.' *Clin Invest Med*, vol. 10, no. 1, pp. 14-20.

¹⁸ Churchill, D, Wallace, JE, Ludwin, D, Beecroft, ML, Taylor, DW 1991, 'A comparison of evaluative indices of quality of life and cognitive function in hemodialysis patients', *Control Clinical Trials*, vol. 12, no. 4 Suppl, pp. 159s-67s.

¹⁹ McFarlane, P, Pierratos, A, Redelmeier, DA. 2002, 'Cost savings of home nocturnal versus conventional in-centre hemodialysis', *Kidney International*, vol. 62, no. 6, pp. 2216-22.

Utility-based Quality of Life (QoL) with Transplant

The most extensive Quality of Life (QoL) study done on transplant patients was conducted by Laupacis et al (1996). The TTO method was used to measure pre- and post-transplant QoL for 136 patients who were on dialysis when they entered the study.²⁰ In addition to rating their own health status at baseline (on dialysis and pre transplant) at 1 month, 3, 6, 12, 18 and 24 months post transplant, patients were also asked at the same points in time to rate four hypothetical scenarios representing patients who were doing well and poorly on both dialysis and transplantation. The mean utility score pre-transplant was 0.57 (for the whole group) and 0.55 (for those patients on dialysis prior to transplant), and 0.68 (1 month), 0.71 (3 months), 0.75 (6 months), 0.74 (12 months), 0.70 (18 months) and 0.70 at 24 months.

Moons et al (2003) used the EQ-5D to derive utility scores for 350 renal transplant recipients on a tacrolimus-based immunosuppressive regimen. The mean utility score for transplant patients on tacrolimus +/- steroids was 0.80 and 0.73 for those on tacrolimus + steroids + azathioprine.²¹

Girardi et al (2004) used the TTO and SG to estimate the utility associated with return to dialysis after a graft failure. Based on the responses of 166 patients, the mean utility score was 0.59 for the SG and 0.57 for the TTO.²²

As with dialysis, there is no published information available on QoL for Australian transplant recipients.

The Economic Model

A Markov model was constructed as the basis for estimating the costs and benefits of renal replacement therapy (RRT) in Queensland. This model is based upon the general structure (including some assumptions) of an earlier model used to estimate costs and health outcomes of RRT on a national level.

The model follows a cohort of men and women newly treated for ESKD, along with existing RRT patients. The length of each 'treatment' cycle in the model is one year. The structure of the model is shown in detail in Figures 1 and 2. The first diagram represents the pathway for patients undergoing their first year of any type of RRT. The second diagram represents the pathway for patients undergoing any type of RRT in the second and subsequent years. Treatment and outcomes are shown in the elliptical shapes and arrows show the transitions that can occur. The model is stratified by Aboriginality and the following age groups:

- 25-44 years
- 45-64 years
- 65-74 years
- 75 years and older

²⁰ Laupacis, A, Keown, P, Pus, N, Kreuger, H, Ferguson, B, Wong, C, Muirhead, N 1996, 'A study of the quality of life and cost-utility of renal transplantation', *Kidney International*, vol. 50, no. 1, pp. 235-42.

²¹ Moons, P, Vanrenterghem, Y, Van Hooff, JP, et al 2003, 'Health-related quality of life and symptom experience in tacrolimus-based regimens after renal transplantation: A multicentre study.' *Transpl Int*, vol. 16, no. 9, pp. 653-64.

²² Girardi, V, Schaedeli, F, Marti, HP, Frey, FJ, Uehlinger, DE. 2004, 'The willingness of patients to accept an additional mortality risk in order to improve renal graft survival', *Kidney International*, vol. 66, no. 1, pp. 375-82.

2008–17

Figure 1: Markov model for ESKD patients in the first year of treatment

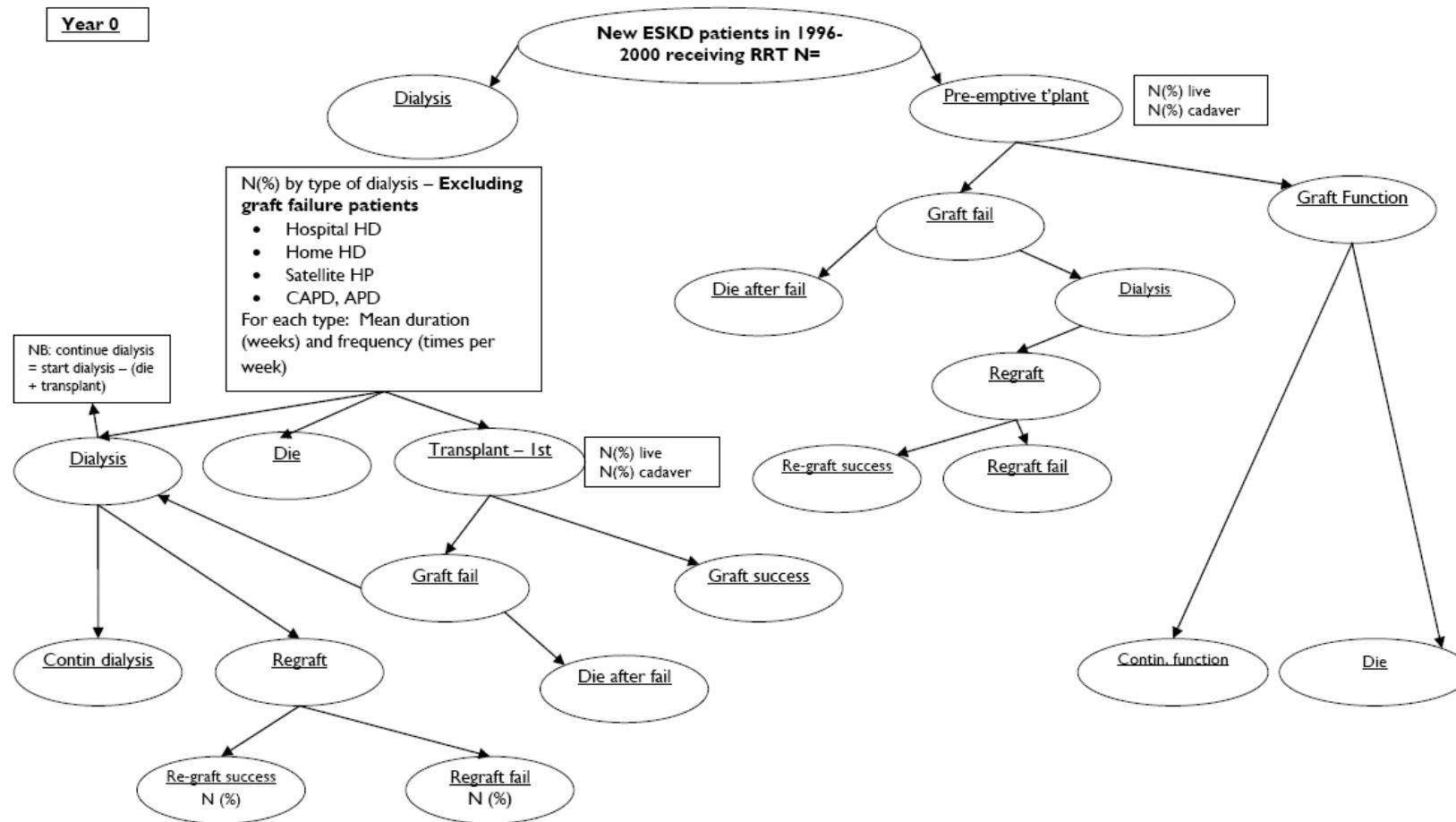
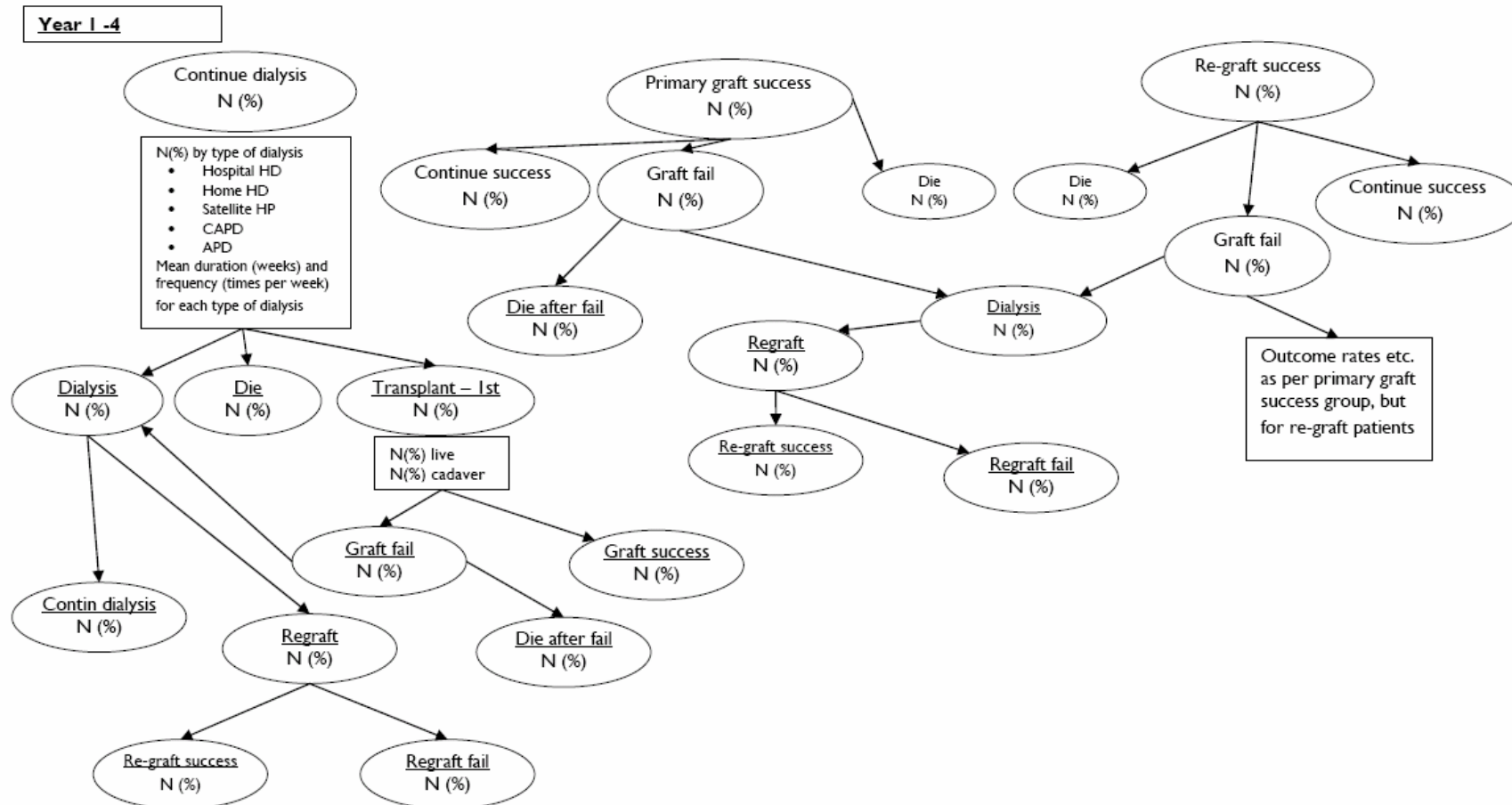


Figure 2 Treatment and outcome in the 2nd and subsequent years



Sources of estimates

In the absence of good-quality individual randomized control trials (RCTs) or large prospective observational studies conducted in Australia, the Queensland economic modelling exercise uses the best available Australian published data to derive estimates for the model parameters. This required a substantial secondary analysis of ANZDATA in order to derive transition probabilities between health states and RRT modalities. Details of the sources of cost and quality of life data are outlined in the following section. If no published evidence could be found, the opinion of clinical experts was sought.

Assumptions used in the model

The assumptions and sources of data for transition probabilities between states, costs, discounting and utilities used in the model are summarised in the text and tables below. Each of these components of the model is discussed in the following sections.

Main overall Assumptions

The health states and pathways are the same for all types of ESKD. The treatment and outcome states in the ESKD model are as follows:

- Dialysis – includes hospital haemodialysis (HD), home HD, satellite HD and PD.
- Functioning kidney transplant – patients may undergo a pre-emptive transplant from a live or deceased donor after diagnosis of ESKD or a first transplant following dialysis.
- Transplant outcomes – graft success or fail. A graft fail may result in a re-graft, a return to dialysis or death.
- Death – may occur whilst on dialysis or after transplant.
- Transition probabilities for year 0 to year 4 are based on the actual treatment and outcome probabilities derived from a cohort of RRT patients (1996-2000) from ANZDATA (for the entire Australian indigenous and non-indigenous cohorts over this time). Because of small numbers, it was not possible to estimate these transition probabilities for a Queensland specific cohort. The Australia-wide data give more robust estimates on which to base estimates of future costs and benefits.
- Transition probabilities from year 4 to year 10 are based on the application of constant year 4 transition probabilities.
- Total resource utilisation and benefits are calculated based on probability transitions at 6 months in each treatment cycle.
- Future incidence of treated ESKD is based on:
 - A Poisson model of incidence trends over time (for non-indigenous patients) and
 - Two estimates of population projections for indigenous ESKD patients based upon 1) a steady-state and 2) a linear growth model of current increases in the incidence of treated ESKD.

Other parameters included in the model are:

- Costs of each treatment modality (based on the best available *published* Australian data).
- Utility weights (quality of life assessments) associated with the outcomes of each treatment modality (based on Laupacis et al 1996, a before and after study of utility based QoL in transplant recipients).
- The present value of all future costs and benefits was used (discounted at 5% per annum).

Transition probabilities

Published Australian data on the probability of an ESKD patient undergoing a particular type of RRT, of switching between treatment modalities and on the outcomes were not available. For that reason, a dedicated secondary data analysis was conducted on the treatment and outcome patterns for a cohort of ESKD patients as recorded in the ANZDATA Registry.

Grouped data on RRT received and treatment outcomes were extracted for all people diagnosed with ESKD in the period 1996 to 2000. The data were grouped by age group (25-44 years, 45-64 years, 65-74 years, and 75 years and older) and Aboriginality. An annual transition probability was estimated for each of the first four years of treatment with the year 4 rate applied as a constant transition probability for years 5 to 10. All transitions between states occur at 6 months (that is, midway through the yearly cycle).

Projection of the incidence of end-stage kidney disease (ESKD) 2005 to 2017

See *Queensland Statewide Renal Services Plan, 2008–17, Part Two: Current Service Analysis and Future Demand Predictions* for a detailed description of the modelling of future ESKD incidence used in this document.

Health State Utilities

Only two studies report utility-based quality of life scores for people with ESKD, pre- and post-transplant^{23,24}. The authors elected to use the Laupacis study because Russell et al had fewer than 30 patients (Laupacis et al had over 150), and was conducted prior to 1992, meaning both dialysis and transplantation treatments may no longer be applicable to current practice. The TTO derived utility scores from Laupacis et al for the pre-transplant dialysis state and the post-transplant state (using a weighted average of QoL score over 0-12 and 12-24 months post transplant) have been used to value outcomes in this study. Other studies have measured dialysis-specific quality of life, but the methods and values vary to such an extent that the measures of utility-based QoL are not comparable between modes of dialysis treatment.

The health utility scores for dialysis, post- transplant states are summarised in Table 12.

²³ Laupacis, A, Keown, P, Pus, N, Kreuger, H, Ferguson, B, Wong, C, Muirhead, N, 1996, 'A study of the quality of life and cost-utility of renal transplantation', *Kidney International*, vol. 50, no. 1, pp. 235-42.

²⁴ Russell, J, Beecroft, ML, Ludwin, D, Churchill, DN. 1992, 'The quality of life in renal transplantation - a prospective study', *Transplantation*, vol. 54, no. 4, pp. 656-60.

Table 2 Health utility scores for dialysis and post-transplant states

<i>Assumptions</i>	<i>Value</i>	<i>Source</i>	<i>Justification for source</i>
Renal transplant		Laupacis et al (1996)	Pre- and post-transplant time trade-off (TTO) utility valuation study conducted on transplant patients and on dialysis patients(pre-transplant)
Time after transplant			
1 month	0.68		
3 month	0.71		
6 month	0.75		
12 months	0.74		
<i>Time weighted average 0-12 months</i>	<i>0.7325</i>		
18 months	0.7		
24 months	0.7		
<i>Time weighted average 12-24 months</i>	<i>0.7</i>		
Dialysis (pre-transplant)	0.55	Laupacis et al (1996)	
Death	0	Convention	

Resource use and costs

Cost data were based on the best available published data that conform to Australian government guidelines for the application of economic evaluation to funding submissions to the Pharmaceutical Benefits Advisory Committee (PBAC) and the Medical Services Advisory Committee (MSAC). Both PBAC and MSAC do not consider the economic impact of productivity changes in their recommendations to the Minister for Health regarding public expenditure on drugs and other health technologies. For that reason, the costs related to productivity changes associated with the treatment for ESKD are not included in this study.

Where possible, the most recent (2005-6) Queensland specific NHCDC cost -weights have been used for relevant DRG-based costs. Where 2005-6 data was not available, Queensland specific 2004-5 NHCDC cost weights have been applied.

Renal Replacement Therapy costs

This document explores health sector costs arising from the provision of RRT services. However, the authors did not undertake a primary costing study of dialysis modalities or transplantation. Estimates of the cost of each treatment modality were based on the best available published data and were derived from Australian studies. Although a number of costing studies have reportedly been undertaken in various States and Territories, almost none of these studies have been published in peer-reviewed manuscripts or government reports. Tables 3 to 5 provide information regarding the data sources used in this report and estimates of unit costs of dialysis and transplant service provision.

The annual cost of renal dialysis includes dialysis equipment, buildings, maintenance, salaries and wages (nursing and allied health), consumables, the cost of initial access, revision of access, drugs (including Epoetin alfa and darbepoietin, Calcitriol and Iron), hospitalisation due to infection/ other complications, specialist consultations and review and work up costs for patients on the transplant waiting list. The data sources used to estimate per annum patient utilisation of each resource item and the valuation source are summarised in Table 3. Other inpatient resource use by dialysis modality is also partially captured. Data are not available to estimate the total inpatient resource use (renal and non-renal related admissions) for patients on dialysis. Therefore to capture some of the possible resource use associated with admissions, for PD patients an estimate has been generated based upon

ANZDATA information on admissions for peritonitis, and for HD patients based on ANZDATA information of access revisions. This will likely underestimate true inpatient resource use for both PD and HD patients, although in the absence of other Australian data on admissions in the patients, this is the only available data.

The annual cost of transplant includes surgery and hospitalisation, immunosuppressive therapy, specialist review and consultations and other drugs. The cost of a kidney transplant for the recipient (both live and deceased donor) was based on Queensland-specific NHCDC Round 10 (2005-6) cost weights for AR-DRG A09A (Renal Transplant + Pancreas with complications and/or comorbidities)/ A09B (Renal Transplant without pancreas transplant, without comorbidities of complications) for a public hospital admission. Fourteen per cent of all transplants are classified as AR-DRG code A09A (12/85) and 86% as AR-DRG code A09B (73/85).

As there is no specific AR-DRG code for donor costs for a kidney transplant, an assumption based upon expert opinion was made to base the cost of a kidney transplant for a live donor on Queensland specific NHCDC Round 9 (2004-5) cost weights for AR-DRG L04A (Kidney, urinary tract and major bladder procedures (no neoplasms) with complications and/or comorbidities) with complications)/ L04C (Kidney, urinary tract and major bladder procedures (no neoplasms) without complications and/or comorbidities) for a public hospital admission. (Queensland specific NHCDC Round 10 cost weights (2005-6) were not available). The cost of organ procurement from a deceased donor was unavailable from any published sources and has been estimated at \$3000 (expert opinion). As with dialysis, there is little available data on renal and non-renal inpatient resource use in patients with a functioning transplant. As such these costs have not been estimated.

The unit costs of RRT per patient per annum, by treatment modality, are summarised in Table 3 and Table 4 (Further details of the costs of RRT are provided in Appendix B).

Productivity costs

Productivity changes have not been included in this analysis as they are not relevant from the pre-specified, health care funders' perspective. In addition, there are no reliable Australian data that can be used to estimate the opportunity cost of lost productivity due to ESKD, therefore the present analysis has not included productivity changes.

2008–17

Table 3 Type of cost, source of data by treatment resource item

Resource items	Data Source Utilisation	Data Source Cost	Reference to further details
Dialysis			
Home / Satellite Haemodialysis Equipment Buildings Maintenance Salaries and wages Consumables	ANZDATA “ “ “ “ “	Agar <i>et al</i> , inflated to 2005 “ “ “ “ “	Appendix B, Tables 2-4 “ “ “ “ “
Hospital Haemodialysis	ANZDATA	Queensland Round 10 (2005-6) NHCDC	“
Peritoneal dialysis	ANZDATA	Health Dept of Western Australia, inflated to 2005	“
Initial access	ANZDATA	Queensland Round 10 (2005-6) NHCDC	“
Revision of access	ANZDATA	Queensland Round 10 (2005-6) NHCDC	“
All dialysis Drugs EPO/Darbepoietin	ANZDATA/Expert opinion	PBS, 2005	“
Calcitriol	Expert opinion	PBS, 2005	“
Iron	Expert opinion	PBS, 2005	“
Hospitalisation due to infection/ other complications	ANZDATA	Queensland Round 10 (2005-6) NHCDC	“
Specialist consultations and review	Expert opinion	MBS, 2005	“
Work up costs for patients on transplant waiting list	Expert opinion	MBS, 2005	“
Transplant			
Inpatient recipient costs	ANZDATA	Queensland Round 10 (2005-6) NHCDC	Appendix B, Tables 5-12
Annual cost of immunosuppression Yr 1	ANZDATA / expert opinion	PBS, 2005	“
Annual cost of non-immunosuppressive related drugs Yr 1	Expert opinion	PBS, 2005	“
Annual cost of non-drug follow-up Yr 1	Expert opinion	MBS, 2005	“
Annual cost of immunosuppression Yr 2 onwards	ANZDATA / expert opinion	PBS, 2005	“
Annual cost of non-immunosuppressive related drugs Yr 2 onwards	Expert opinion	PBS, 2005	“
Annual cost of non-drug follow-up Yr onwards	Expert opinion	MBS, 2005	“
Inpatient donor costs (live donor)	ANZDATA	Assumptions; Queensland Round 10 (2005-6) NHCDC	“
Donor procurement costs (deceased donor)	ANZDATA	Expert Opinion	“

2008–17

Table 4 Unit cost of dialysis per patient per year by modality (AUD\$2005)

Resource items	Home Haemodialysis \$ unit cost per annum	Satellite Haemodialysis \$ unit cost per annum	PD \$ unit cost per annum	Hospital Haemodialysis \$ unit cost per annum
<u>Dialysis</u>				
Haemodialysis & peritoneal dialysis				
Equipment				
Buildings				
Maintenance				
Total	4,727	6,875		
Salaries and wages				
Consumables				
Total	30,423	32,498		
Total (fixed costs, salaries and wages, consumables)	35,150	39,373	41,448	76,603
Drugs(total)	9,707	9,707	9,707	9,707
Epoetin alfa	5,217	5,217	5,217	5,217
Darbepoetin alfa	4,168	4,168	4,168	4,168
Calcitriol	196	196	196	196
Iron	126	126	126	126
Hospitalisation due to infection/ other complications / access revisions*	2,395	2,395	5,656	2,395
Specialist consultations and review	490	490	490	490
Work up costs for patients on transplant waiting list	592	592	592	592
TOTAL ANNUAL COST (not including initial access)	\$48,333	\$52,557	\$57,894	\$89,786
Initial access (incl temporary access)	14,914	14,914	10,885	14,914

* NB these costs are estimated from ANZDATA record hospitalisations for peritonitis in PD patients and access revisions in HD patients and are therefore likely to underestimate the true cost of inpatient resource use for renal and non-renal causes in these patients

Table 5 Unit cost of kidney transplant per patient per year by modality (AUD\$2005)

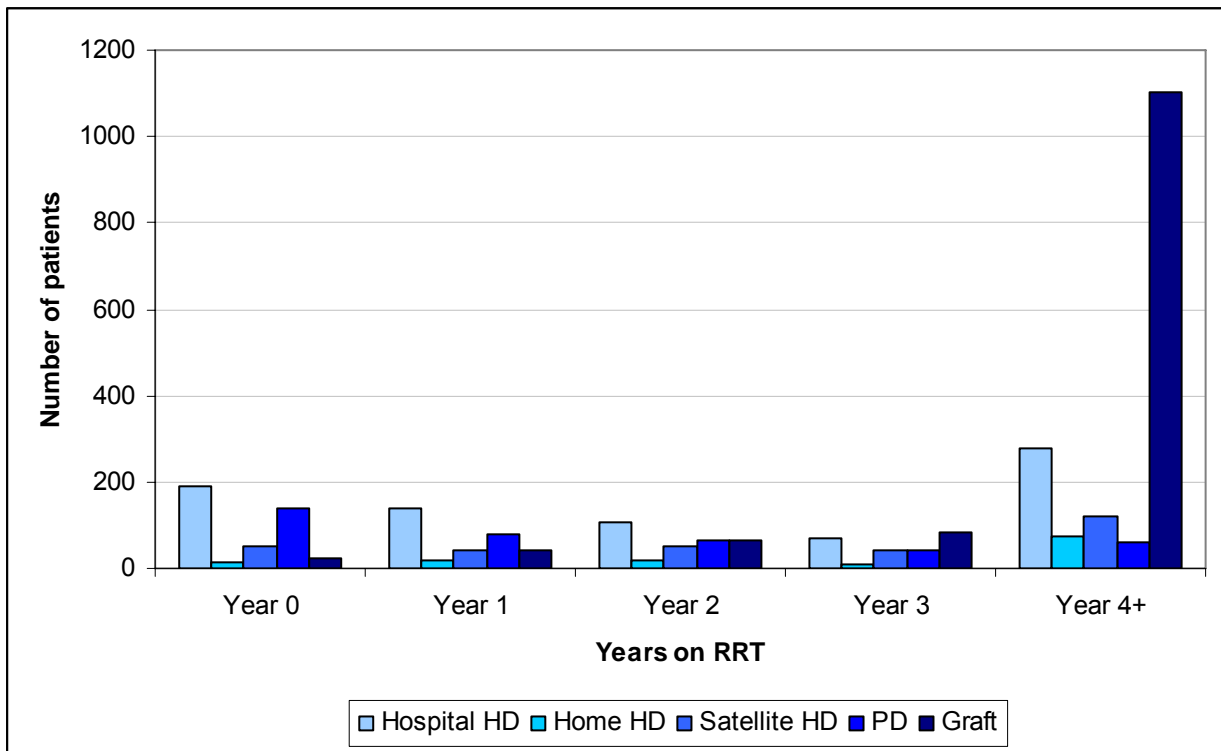
Resource items	Live donor Recipient unit cost \$	Live donor Donor unit cost \$	Deceased donor Recipient unit cost \$	Deceased donor Donor unit cost \$
Transplant				
Year 1				
Surgery and hospitalisation	26,958	7,729	26,958	3,000
Regular Immunosuppressive therapy (PBS)	19,445		19,445	
Additional Immunosuppression	2,620		2,620	
Other drugs	9,439		9,439	
Non drug follow-up costs	4,730		4,730	
TOTAL YEAR 1 COST	\$63,192	\$7,729	\$63,192	\$3,000
Year 2 onwards				
Regular Immunosuppressive therapy	9,042		9,042	
Other drugs	954		954	
Non drug follow-up costs	753		753	
TOTAL YEAR 2 ONWARDS COST	\$10,749		\$10,749	

Transition probabilities

The full set of transition probabilities has been reported previously.²⁵ As discussed earlier, because of comparatively small patient numbers in Queensland (relative to all of Australia), Australian data has been used as they are more robust. The main areas where these probabilities differ from the previous Australia-wide report is the proportions of patients utilizing different dialysis modalities. Queensland specific data have been used to capture current practice, which then forms the basis for examining the costs and health outcomes of alternative patterns of RRT modality delivery. This is important, as patterns in service delivery in Queensland appear to be somewhat different from the rest of Australia, with a higher proportion of dialysis patients receiving hospital-based HD. Figure 3 presents the Queensland patterns of RRT modality usage by years on RRT. These patterns were used to create the annual transition probabilities for each of the first four years of treatment, with the year four rate being applied as a constant transition probability for the remaining years.

²⁵ Cass, A, Chadban, S, Craig, J, Howard, J, McDonald, S, Salkeld, G, White, S 2006, *The Economic Impact of End-Stage Kidney Disease in Australia*. , Kidney Health Australia, Melbourne.

Figure 3 Pattern of RRT modality usage by years on RRT in existing Queensland patients



Calculation methods

Present value of costs and benefits of treating all existing and new cases of ESKD (from 2005 - 2017)

The formula for calculating the present value of the cost of treating current ESKD patients is summarised in equation 1. The prevalent cohort is based on the number of ESKD patients in Queensland, by modality of treatment, as recorded on the ANZDATA registry in 2005. Patients are followed up until the end of 2017.

2008–17

Prevalent Cohort

$$\text{Equation 1 } PVTC_p = \int_t \sum_{n=13}^{2017} (P_{1tp}) [(P_{2tp}) (C_{2p}) + (P_{3tp}) (C_{3p})]$$

where:

$PVTC_p$	=	present value of the total cost of treatment for the ESKD prevalent cohort as at 2005 out to end 2017
P_{1tp}	=	probability of being alive in year t
P_{2tp}	=	probability of having dialysis in that year
C_{2p}	=	present value of the annual cost of dialysis (by modality)
P_{3tp}	=	probability of having a kidney transplant in that year
C_{3p}	=	present value of the annual cost of transplant (by type of transplant)

Incident Cohort

The formula for calculating the present value of the cost of treating new ESKD patients (2006 to 2017) is summarised in equation 2.

$$\text{Equation 2 } PVTC_i = \int_t \sum_{n=13}^{2017} (P_{1ti}) [(P_{2ti}) (C_{2i}) + (P_{3ti}) (C_{3i})]$$

where:

$PVTC_i$	=	present value of the total cost of treatment for the ESKD incident cases out to end 2017
P_{1ti}	=	probability of being alive in year t
P_{2ti}	=	probability of having dialysis in that year
C_{2i}	=	present value of the annual cost of dialysis (by modality)
P_{3ti}	=	probability of having a kidney transplant in that year
C_{3i}	=	present value of the annual cost of transplant (by type of transplant)

Benefits are calculated using a similar formula, where the present value of annual cost of dialysis and transplant in Equation 1 is replaced by the present value of the health outcomes (QALYs) generated by dialysis and transplant. In the Markov model, the number of patients entering each treatment and outcome state is used to estimate the present value of quality adjusted life years (QALYs) based on follow-up to the end of 2017. This highlights the impact of quality of life, by treatment modality, for prevalent and incident patients, based upon the data assumptions discussed earlier.

The total present value of cost and benefits of treating existing and new cases of ESKD in Queensland, projected out to end 2017, is the sum of Equation 1 and 2 ($PVTC_p + PVTC_i$)

These analyses are conducted for all patients combined, and separately for non indigenous patients, and indigenous patients.

2008–17

Change in RRT modality

A number of analyses have also been conducted to examine the effect of changing patterns of RRT modality on costs and health outcomes in Queensland. Specific questions address the effect of increasing transplant rates, the effect of different proportions of patients receiving alternative dialysis modalities.

Additional health care costs and benefits of increasing the proportion of new ESKD patients who receive a kidney transplant

The formula for estimating the incremental cost effectiveness of increasing the number of new ESKD patients who receive a kidney transplant by between 10% and 50% over current levels by 2010 is summarised in equation 3.

Equation 3

$$ICER_{\text{transplant}} = (TC_{\text{low/high increase in transplants}} - TC_{\text{current practice}}) \div (TB_{\text{low/high increase in transplants}} - TB_{\text{current practice}})$$

where:

$TC_{\text{low/high increase in transplants}}$	=	the total cost of treatment for the ESKD incident cohort out to 2017 assuming an increase in the number of transplants by 10% to 50% by 2010 (and concomitant reduction in dialysis rate)
$TC_{\text{current practice}}$	=	the total cost of treatment for the ESKD incident cohort out to 2017 with current transplant rates
$TB_{\text{low/high increase in transplants}}$	=	the total number of quality adjusted life years (QALYs) for the ESKD incident cohort assuming an increase in the number of transplants by 10% to 50% by 2010 (and concomitant reduction in dialysis rate)
$TB_{\text{current practice}}$	=	the total number of quality adjusted life years (QALYs) for the ESKD incident cohort

2008–17

Additional health care costs (savings) that accrue by changing the proportion of patients that undergo different types of dialysis (hospital haemodialysis, home haemodialysis, CAPD and satellite)

The formula for estimating the incremental cost effectiveness of switching the proportion of current ESKD patients who different types of dialysis is summarised in equation 4.

Equation 4.

$$\text{Cost (saving)} = (\text{TC}_{\text{current practice}} - \text{TC}_{\text{switch mode of dialysis}})$$

$\text{TC}_{\text{current practice}}$	=	the total cost of treatment for the ESKD incident cohort
$\text{TC}_{\text{switch mode of dialysis}}$	=	the total cost of treatment for the ESKD incident cohort assuming the changes in dialysis modality as specified below

The changes in dialysis modality that are modelled in the sensitivity analysis are:

1. Maximising the home HD approach (switching from hospital HD to home HD) (for non-Indigenous patients only)

Assumptions

- Adopt changes in Home HD rates by year 2, with year 1 being half way between current and proposed proportions, and then maintain from year 2 onwards
- The proposed proportion of dialysis patients using home HD is (by age group):
 - 25-44 years = 35%
 - 45-64 years = 25%
 - 65-74 years = 10%
 - 75+ years = 2%

2. Maximising PD approach (switching from hospital HD to PD; for non-Indigenous patients only)

Assumptions

- The proposed proportion of dialysis patients using PD is (by age group):
 - 25-44 years - Y0 = 50%, Y1 = 42.5%, Y2 = 35%, Y3 = 27.5%, Y4 = 20%
 - 45-64 years - Y0 = 50%, Y1 = 50%, Y2 = 42.5%, Y3 = 35%, Y4 = 27.5%
 - 65-74 years - Y0 = 50%, Y1 = 50%, Y2 = 50%, Y3 = 42.5%, Y4 = 35%
 - 75+ years - Y0 = 50%, Y1 = 50%, Y2 = 50%, Y3 = 40%, Y4 = 30%
- The younger cohorts have earlier decay due to preferential transplantation and higher rates of independent home HD among younger and healthier patients
- The older cohorts maintain PD proportions to Y2, then decay mostly due to modality failure

3. A third analysis looked at the combined effect of 1 and 2 (for non-Indigenous patients only) and used the same assumptions

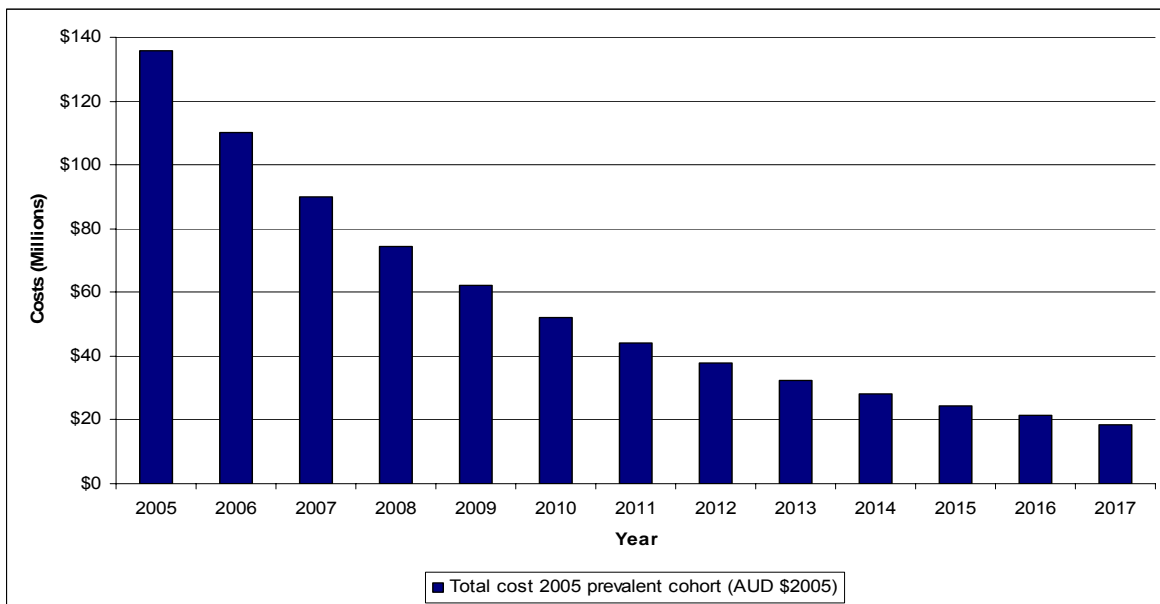
Results

Health sector costs (in present dollar values) of treating current and new cases of ESKD out to 2017

Cost of treating current cases of ESKD

In today’s dollars, the total cost of providing RRT until 2017 for people with ESKD in 2005 is \$732 million. The present value of total annual cost of RRT for current ESKD patients (as at 2005), based on treatment up to and including the year 2017, is summarised in Figure 4. The declining annual cost reflects the diminishing patient cohort due to death. The costs do not include RRT for new cases of ESKD.

Figure 4 The total discounted annual cost of RRT for current ESKD patients

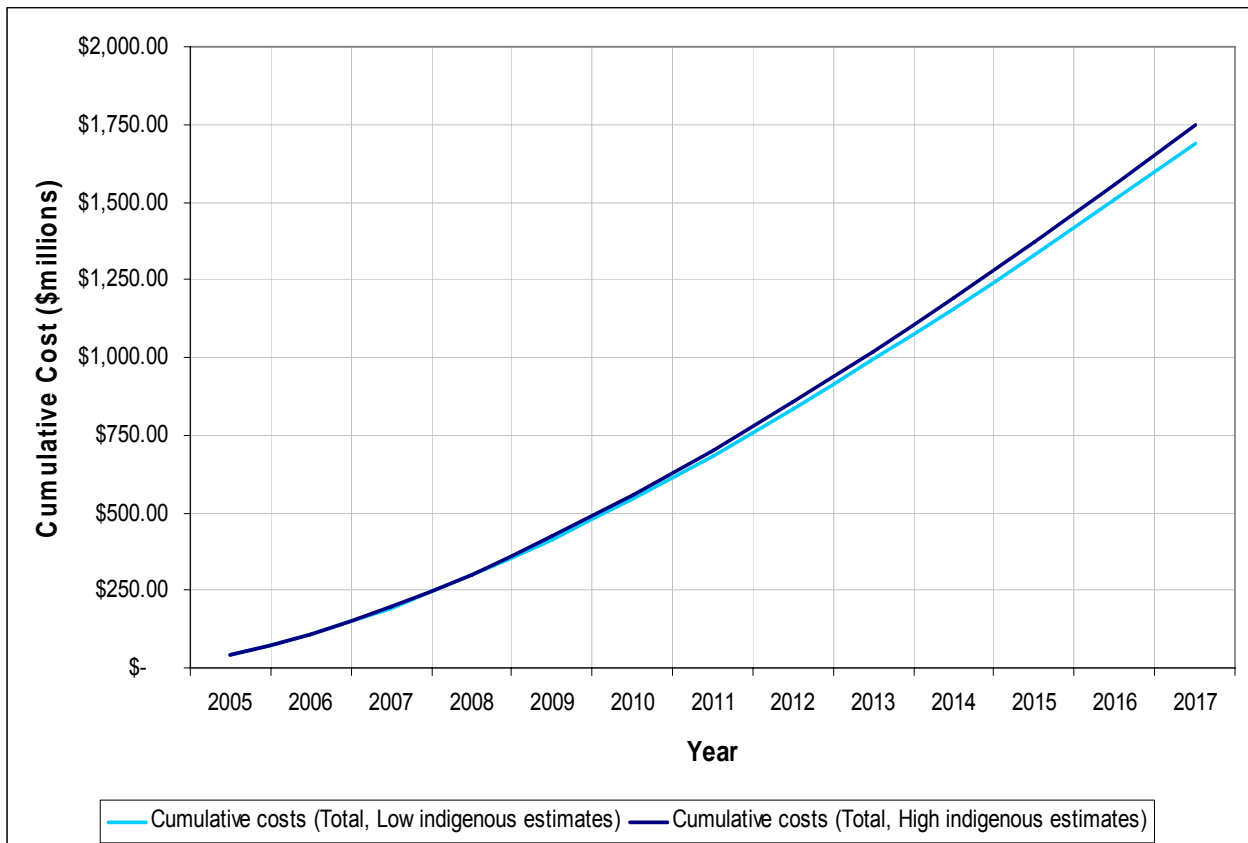


Cost of treating new cases of ESKD out to 2017

The present value cumulative cost of RRT for all new cases of ESKD treated out to 2017, is estimated to fall between \$1.69 billion and \$1.75 billion by the end of 2017 (

Figure 5).

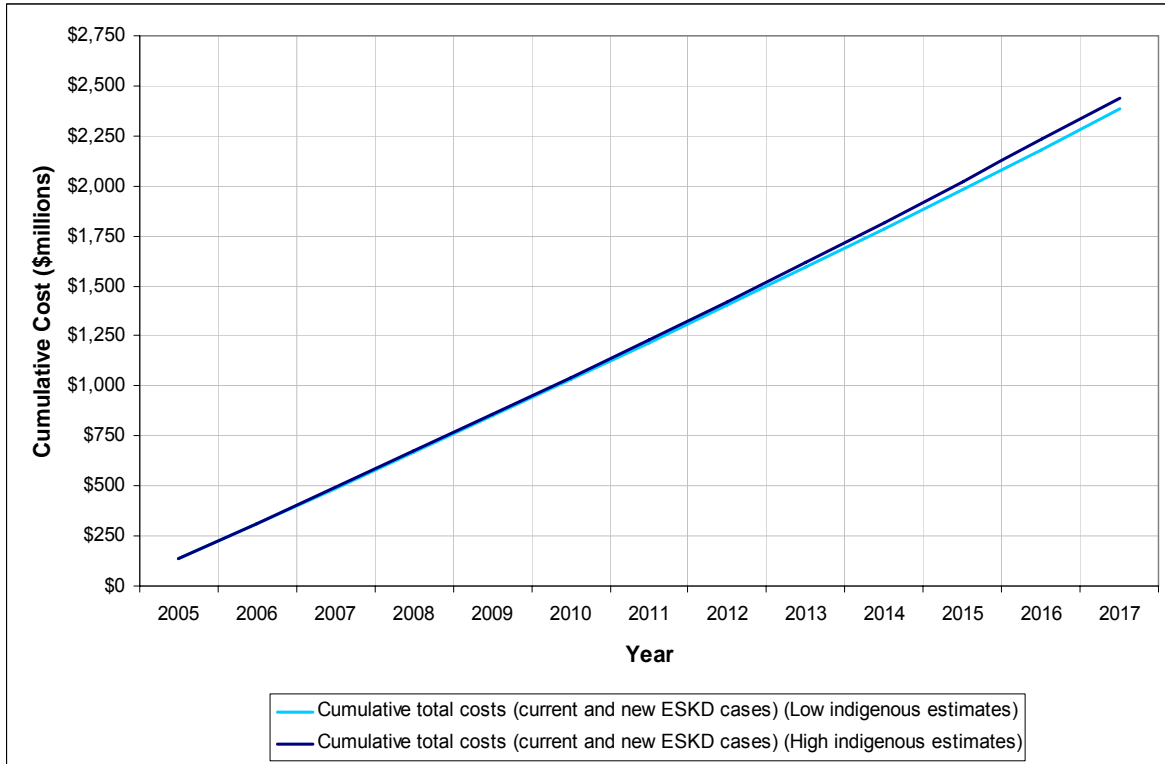
Figure 5 The cumulative present value costs for all new ESKD patients treated out to 2017



Cost of treating current and new cases of ESKD

In today’s dollars the cumulative cost of RRT for all current and new cases of ESKD treated out to 2017, is estimated to fall between \$2.38 billion and \$2.44 billion by the end of 2017. (Figure 6)

Figure 6 The cumulative present value costs for all new and existing ESKD patients treated out to 2017



Projected annual health sector costs of treating all cases of ESKD to 2017

The annual present value cost of RRT is estimated to rise from \$136 million in 2005 to between \$202 and \$211 million in 2017 (Table 16).

2008–17

Table 6 Total present value projected annual health care costs of treating all cases of ESKD for 2005-2017 (\$ millions)

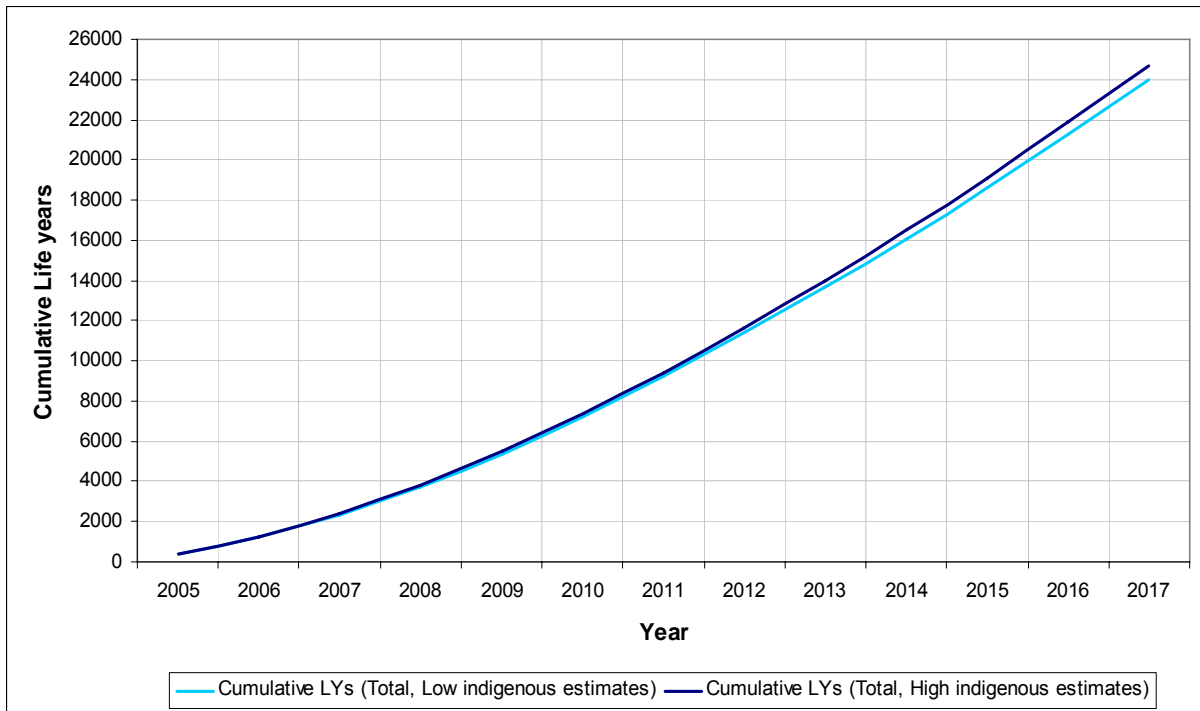
Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Low Indigenous ESKD estimates													
Total annual cost	\$135.8	\$176.1	\$177.9	\$178.7	\$180.2	\$182.2	\$184.5	\$187.2	\$190.2	\$193.3	\$196.4	\$199.4	\$202.3
Cumulative annual total costs	\$135.8	\$311.9	\$489.8	\$668.5	\$848.7	\$1,030.9	\$1,215.4	\$1,402.6	\$1,592.8	\$1,786.1	\$1,982.5	\$2,181.9	\$2,384.2
High Indigenous ESKD estimates													
Total annual cost	\$135.8	\$176.7	\$179.3	\$180.8	\$183.0	\$185.7	\$188.8	\$192.3	\$196.1	\$199.9	\$203.8	\$207.6	\$211.2
Cumulative annual total costs	\$135.8	\$312.5	\$491.8	\$672.6	\$855.6	\$1,041.3	\$1,230.1	\$1,422.4	\$1,618.5	\$1,818.4	\$2,022.2	\$2,229.8	\$2,441.0

Benefits (in life years and quality-adjusted life years) of treating new cases of ESKD (to 2017)

Present value of the benefits of treating all new cases of ESKD

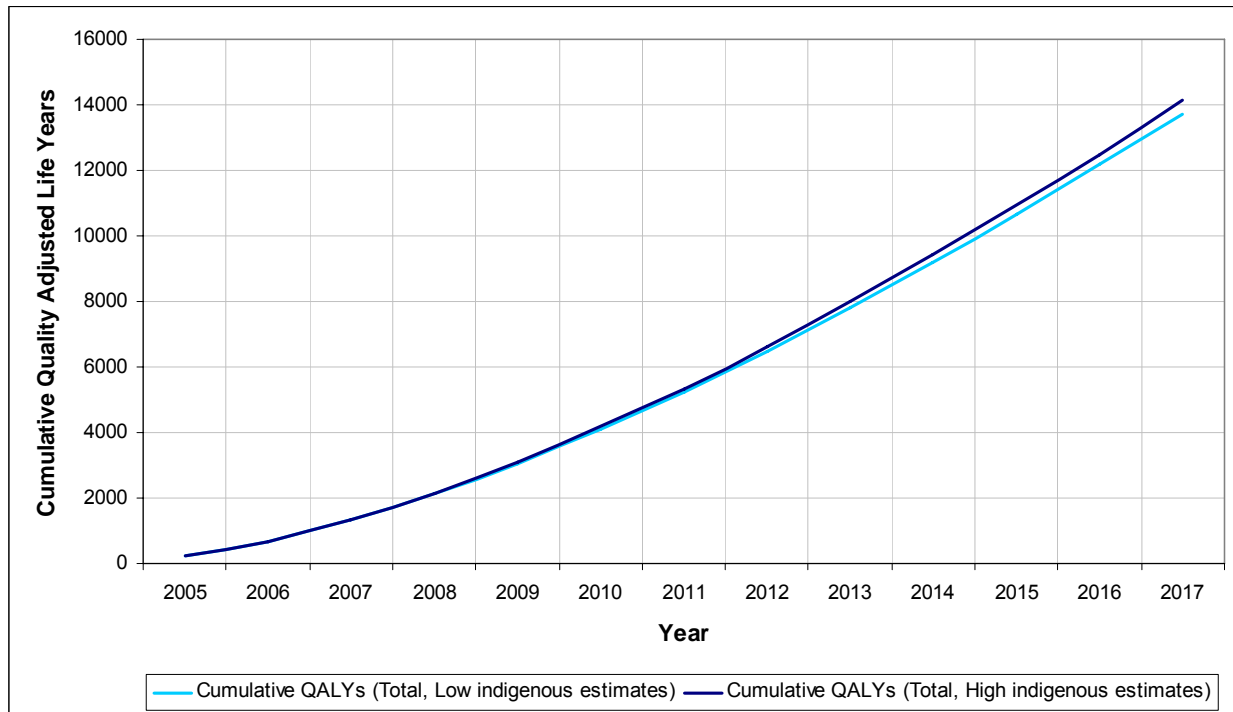
The present value of the benefits of RRT for all new cases of ESKD out to 2017 will approach 25,000 life years by 2017 (Figure 7).

Figure 7 The present value cumulative health benefit (in life years) for all new cases of ESKD (2005-2017)



The present value of the benefits of RRT for all new cases of ESKD (2005-2017) will be approximately 14,000 quality adjusted life years. (Figure 8)

Figure 8 The present value cumulative health benefit (in quality adjusted life years) for all new cases of ESKD (2005-2017)



The cumulative present value of total health benefit for all new cases of ESKD, based on treatment out to 2017 are summarised in Table 7.

2008–17

Table 7 The present value (annual and cumulative) of health benefit (Life years and quality adjusted life years) for all new ESKD cases out to 2017

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Low Indigenous ESKD estimates													
Total annual life years	423	803	1131	1404	1634	1832	2005	2158	2295	2417	2525	2622	2709
Cumulative life years	423	1225	2356	3760	5394	7226	9231	11389	13684	16101	18626	21248	23957
Total annual quality adjusted life years	234	450	639	798	933	1049	1150	1240	1320	1391	1454	1510	1560
Cumulative quality adjusted life years	234	684	1322	2120	3053	4102	5252	6492	7813	9203	10657	12168	13728
High Indigenous ESKD estimates													
Total annual life years	423	810	1147	1429	1668	1876	2058	2222	2369	2501	2621	2728	2825
Cumulative life years	423	1232	2379	3808	5475	7351	9410	11632	14001	16503	19123	21851	24676
Total annual quality adjusted life years	234	453	647	812	951	1073	1180	1275	1361	1438	1506	1568	1624
Cumulative quality adjusted life years	234	688	1335	2147	3098	4171	5351	6626	7987	9424	10931	12499	14123

2008–17

Effect on cost and benefits (out to 2017) of changing patterns of RRT modality for all new ESKD patients

A number of analyses have also been conducted to examine the effect of changing patterns of RRT modality on costs and health outcomes in Queensland. Specific questions address the effect of increasing transplant rates, and the effect of different proportions of patients receiving alternative dialysis modalities.

Additional health care costs and benefits of increasing the number of new ESKD patients who receive a transplant

A cost-effectiveness and cost-utility analysis was conducted to examine the incremental cost effectiveness ratio of increasing transplant rates. Under both models of incidence projection, the incremental cost effectiveness of increasing kidney transplants by 10% is dominant over current practice. That is, increasing the transplant rate is less expensive and more effective than current treatment patterns for ESKD. The incremental cost savings range from \$7.29 million to \$7.38 million out to 2017. Results are shown in Table 8.

Table 8 The present value costs and health benefit (out to 2017) of increasing the current transplant rate in Queensland by 10% by 2010 over current levels

Costs and benefits 2017	Total cost (\$billion)	Incremental cost (\$million)	Total Life Years	Incremental life years	ICER	Total QALYs	Incremental QALYs	ICER
Base Case – Low incidence model	\$1.691		23957.09			13727.81		
Increased transplant rate - Low incidence model	\$1.683	-\$7.293	24021.15	64.07	Dominant	13811.12	83.31	Dominant
Base case – High incidence model	\$1.748		24675.93			14123.27		
Increased transplant rate - High incidence model	\$1.741	-\$7.378	24736.34	60.41	Dominant	14204.58	81.31	Dominant

Similarly, under both models of incidence projection, the incremental cost effectiveness of increasing kidney transplants by 50% is also dominant over current practice. That is, increasing the transplant rate is less expensive and more effective than current treatment patterns for ESKD. The incremental cost savings range from \$33.94 million to \$34.39 million out to 2017. Results are shown in Table 9.

2008–17

Table 9 The present value costs and health benefit (out to 2017) of increasing the current transplant rate in Queensland by 50% by 2010 over current levels

Costs and benefits to 2017	Total cost (\$billion)	Incremental cost (\$million)	Total Life Years	Incremental life years	ICER	Total QALYs	Incremental QALYs	ICER
Base Case – Low incidence model	\$1.691		23957.09			13727.81		
Increased transplant rate - Low incidence model	\$1.657	-\$33.939	24262.02	304.94	Dominant	14127.66	399.85	Dominant
Base case – High incidence model	\$1.748		24675.93			14123.27		
Increased transplant rate - High incidence model	\$1.714	-\$34.385	24961.57	285.64	Dominant	14512.57	389.30	Dominant

Additional health care costs and benefits of increasing the number of dialysis patients receiving home-based or community based, rather than hospital-based dialysis services

The incremental costs and health outcomes of the sensitivity analysis examining switching dialysis modality are summarized in Table 10 to Table 12 below. Increasing the rate of home HD will produce a net saving of \$40.7 million. Increasing the rate of PD will produce a saving of \$111.1 million, and combining an increase in both Home HD and PD utilization will lead to net savings of up to \$145.8 million. Without Australian data on utility-based quality of life on each dialysis modality it is not possible to estimate the incremental benefits of the 'switch modality' scenarios. However, it is reasonable to assume that there would also be a significant improvement in quality of life resulting from these changes.

Table 10 The present value costs and health benefit (out to 2017) of increasing the utilisation of Home HD services in Queensland

Costs and benefits to 2017	Total cost (\$billion)	Incremental cost (\$million)	Total Life Years	Total QALYs
Base Case – Low incidence model	\$1.691		23957.09	13727.81
Increased Home HD utilisation - Low incidence model	\$1.651	-\$40.712	23957.09	13727.81
Base case – High incidence model	\$1.748		24675.93	14123.27
Increased Home HD utilisation - High incidence model	\$1.708	-\$40.712	24675.93	14123.27

2008–17

Table 11 The present value costs and health benefit (out to 2017) of increasing the utilisation of PD services in Queensland

Costs and benefits to 2017	Total cost (\$billion)	Incremental cost (\$million)	Total Years	Life	Total QALYs
Base Case – Low incidence model	\$1.691	-\$111.054	23957.09		13727.81
Increased PD utilisation - Low incidence model	\$1.580		23957.09		13727.81
Base case – High incidence model	\$1.748	-\$111.054	24675.93		14123.27
Increased PS utilisation - High incidence model	\$1.637		24675.93		14123.27

Table 12 The present value costs and health benefit (out to 2017) of increasing the utilisation of both Home HD and PD services in Queensland

Costs and benefits to 2017	Total cost (\$billion)	Incremental cost (\$million)	Total Years	Life	Total QALYs
Base Case – Low incidence model	\$1.691	-\$145.813	23957.09		13727.81
Increased Home HD & PD utilisation - Low incidence model	\$1.545		23957.09		13727.81
Base case – High incidence model	\$1.748	-\$145.813	24675.93		14123.27
Increased Home HD & PD utilisation - High incidence model	\$1.602		24675.93		14123.27

* The savings produced through increasing the utilization of both home haemodialysis (HD) and peritoneal dialysis (PD) services in Table 12 are dependent on achieving the targeted levels of modality utilization, as discussed in Part One: The Way Forward.

2008–17

Appendix B: Details of unit costs

Table 1 Estimated Annual Total cost for each dialysis modality (\$AUD 2005)

Dialysis	Average annual cost per patient	Source
Hospital Haemodialysis – by age group	\$76,602.62	DRG L61Z = \$483 per episode * average # episodes per pt per week * 52 (Qld NHCDC round 10 2005/6)
Other inpatient resource use	\$2,394.61	
Outpatient resource use - consultations & imaging	\$1,082.13	
Outpatient resource use – drugs	\$9,707.02	
Total Annual Hospital HD costs	\$89,786.38	
Initial access (incl temporary access)	\$14,913.95	
Home Haemodialysis – by age group (Nocturnal Home HD, 6 nights out of 7)	\$35,149.52	Agar (Nephrology, 10:555-570, 2005)
Other inpatient resource use	\$2,394.61	
Outpatient resource use - consultations & imaging	\$1,082.13	
Outpatient resource use – drugs	\$9,707.02	
Total Annual Home HD costs	\$48,333.28	
Initial access (incl temporary access)	\$14,913.95	
Satellite Haemodialysis – by age group (low acuity, limited care facility)	\$39,373.09	Agar (Nephrology, 10:555-570, 2005)
Other inpatient resource use	\$2,394.61	
Outpatient resource use - consultations & imaging	\$1,082.13	
Outpatient resource use – drugs	\$9,707.02	
Total Annual Satellite HD costs	\$52,556.85	
Initial access (incl temporary access)	\$14,913.95	
CAPD – by age group	\$41,448.32	Health Department WA 1999 (inflated to 2004 values using AIHW health price index)
Other inpatient resource use	\$5,656.06	
Outpatient resource use - consultations & imaging	\$1,082.13	
Outpatient resource use – drugs	\$9,707.02	
Total Annual CAPD costs	\$57,893.53	
Initial access	\$10,885.03	

2008–17

Table 2 Estimated annual inpatient resource use – dialysis (\$AUD 2005)

In patient resource use (not included in dialysis costs above)	Proportion of patients per year	DRG	Unit cost	Number per year	Average annual cost per patient	Source
Initial access (HD) (all patients, one off cost, only added to year 0 sheets)	1	Sep-weighted L09A/B/C	\$14,549.56		\$14,549.56	Queensland NHCDC round 10 2005/6
Other proc for kidney UT disorders + CCC	0.296703297	L09A	\$30,178.00			
Other proc for kidney UT disorders + SCC	0.208791209	L09B	\$13,331.00			
Other proc for kidney UT disorders no CSCC	0.494505495	L09C	\$5,687.00			
Temporary access for HD	0.58		\$628.25		\$364.39	ANZDATA (utilisation)
Insertion	0.58	MBS 34538	\$231.10			MBS (2005 reimbursement)
VasCath	0.58	estimate	\$350.00			
Xray to check placement	0.58	MBS 59503	\$47.15			(2005 reimbursement)
Total initial access costs HD					\$14,913.95	
Initial access (PD) (all patients, one off cost, only added to Year 0 sheets)	all PD patients	Separation weighted L02A/B	\$10,885.03		\$10,885.03	Queensland NHCDC round 10 2005/6 (unit costs)
	0.383333333	L02A	\$20,822.00			
	0.616666667	L02B	\$4,708.00			
Revision of access (HD) (Surgery)	0.149466667	Sep-weighted L09A/B/C	\$14,549.56		\$2,174.67	ANZDATA (utilisation); Queensland NHCDC round 10 2005/6 (unit cost)
Other proc for kidney UT disorders + CCC	0.296703297	L09A	\$30,178.00			
Other proc for kidney UT disorders + SCC	0.208791209	L09B	\$13,331.00			
Other proc for kidney UT disorders no CSCC	0.494505495	L09C	\$5,687.00			
Revision of access (HD) (angioplasty day stay)	0.027533333	Z64B	\$815.00		\$22.44	ANZDATA (utilisation); Queensland NHCDC round 10 2005/6 (unit cost)
Revision of access (HD) (angioplasty admitted)	0.027533333	F14B	\$7,173.00		\$197.50	ANZDATA (utilisation); Queensland NHCDC round 10 2005/6 (unit cost)

2008–17

Average Inpatient resource use per HD patient					\$2,394.61	
Peritonitis (PD only) (ALOS 11.5days from ANZDATA) (63% PD patients get peritonitis)	0.63					(0.63*
Admitted (67%)	0.67	L09B (ALOS 10.37)	\$13,331.00	0.67	\$8,931.77	ANZDATA (utilisation); Queensland NHCDC round 10 2005/6 (unit costs)
Not admitted (33%)	0.33					
daily visit from Specialist PD nurse for 7 days		MBS 23	\$30.85	7	\$71.26	(2005 reimbursement)
ceftriaxone 1-2 g q 24hr for 7 days		PBS 1785Y x 5 x 2g vials	\$29.62	7	\$68.42	PBS / expert estimate
Total non-admitted peritonitis costs per patient with peritonitis				0.33	\$46.10	
Average Inpatient resource use per PD patients					\$5,656.06	

NB Does not include other hospital admissions other than as specified above due to lack of available data

2008–17

Table 3 Estimated annual outpatient resource use – dialysis (\$AUD 2005)

Outpatient resource use	Proportion of patients per year	DRG	Unit cost	Number per year	Average annual cost per patient	Source
<i>Follow-up: consultations and imaging</i>						
Nephrology review	all	MBS 116	\$64.10	6	\$384.60	Estimate SC
Cardiology consult	0.5	MBS 110	\$128.10	1	\$64.05	
Fistulogram	0.3	MBS 59751	\$139.15	1	\$41.75	
<i>Follow up (only for transplant waiting list)</i>						
Transplant physician consult	0.33249497	MBS 110	\$128.10	1	\$42.59	2644 on waiting list at some time during 2004; 7952 on dialysis (ANZDATA)
Transplant surgeon consult	0.33249497	MBS 104	\$72.60	1	\$24.14	
Thallium or Technetium 99 (sestamibi) stress test (SPECT + planar imaging)	0.33249497	MBS 61307	\$826.65	0.5	\$137.43	
stress ecg	0.33249497	MBS 11712	\$129.05	0.5	\$21.45	
Angiogram	0.33249497	MBS 38218	\$564.55	0.25	\$46.93	
Monthly Cross match bloods	0.33249497		\$960.00	1	\$319.20	
<i>Total average annual cost per pt</i>					<i>\$1,082.13</i>	Tissue Typing Laboratory NSW; National Transplantation Services - ARCBS

2008–17

Table 4 Estimated annual drug costs – dialysis (\$AUD 2005)

Drug	Proportion of patients	PBS code	cost per script	Pack size	dose	duration of pack (days)	script per year	total cost	Average annual cost per patient	Source
Iron	all	2593L	52.38	5 x 100mg	100mg/pt/month	5 months	2.4	\$125.71	\$125.71	Expert estimate
calcitriol	all	2502Q	\$53.74	100	0.25ug	100	3.6525	\$196.29	\$196.29	Estimate
EPO	0.91		Average \$/U or /mcg							
Epoetin alfa	0.455	6204M, 6205N, 6206P, 6207Q, 6251B, 6302Q, 6303R, 6305W, 6339P, 6434P		\$0.01908	11555 u/pt/week			\$11,464.91	\$5,216.53	Estimate
Darbepoetin alfa	0.455	6320P, 63212Q, 6322R, 6323T, 6324W, 6325X, 6438W, 6326Y, 6365B		\$3.81348	46.2 mcg/pt/week			\$9,161.51	\$4,168.49	Estimate
Total drug costs per dialysis patient per year									\$9,707.02	

2008–17

Table 5 Estimated Transplant surgery costs (\$AUD 2005)

	DRG		Unit Cost	Source
Transplant – Live donor (recipient costs)(total)		1	\$26,957.92	separation weighted 2005/6 Queensland hospital morbidity data
Transplant – Live donor (recipient costs) w CSCC	A09A (Renal + pancreas or +CCC)	0.14	\$40,651.00	Separation weighted Queensland NHCDC round 10 2005/6
Transplant – Live donor (recipient costs) w/o CSCC	A09B (renal - pancreas or CCC)	0.86	\$24,707.00	Separation weighted Queensland NHCDC round 10 2005/6
Transplant – Live Donor (donor costs)			\$7,729.04	separation weighted 2004/5 Queensland hospital morbidity data (2005-6 Queensland data not available)
Transplant – Live donor (donor costs) w CSCC	L04A	0.14	\$15,580.00	
Transplant – Live donor (donor costs) w/o CSCC	L04C	0.86	\$6,414.00	
Transplant – Deceased donor (recipient costs)		1	\$26,957.92	separation weighted 2005/6 Queensland hospital morbidity data
Transplant – Deceased donor (recipient costs) w CSCC	A09A (Renal + pancreas or +CCC)	0.14	\$40,651.00	12/12+73 (Qld DRG 05/06)
Transplant – Deceased donor (recipient costs) w/o CSCC	A09B (renal - pancreas or CCC)	0.86	\$24,707.00	73/12+73 (Qld DRG 05/06)
Transplant – Deceased donor (harvest costs)	estimate		\$3,000.00	

2008–17

Table 6 Estimated average annual drug costs post transplant – year of transplant (\$AUD 2005)

Annual cost of immunosuppressive therapy (yr 1)	PBS unit cost	or Initial	1 month	3 months	6 months	Source
CsA + MMF + pred	\$14,612.13	0.5	0.4	0.4	0.36	ANZDATA
Tacrolimus + MMF + pred	\$25,919.28	0.28	0.32	0.36	0.39	ANZDATA
OTHER		0.22	0.28	0.24	0.25	ANZDATA
sirolimus + CsA + pred.	\$17,218.60	0.11	0.14	0.12	0.125	ANZDATA
everolimus + CsA + pred	\$17,955.35	0.11	0.14	0.12	0.125	ANZDATA
Total Proportion and time weighted cost (PBS)	\$19,445.26	\$1,536.05	\$3,177.23	\$4,849.17	\$9,882.81	
Additional immunosuppression (in addition to above)						
OKT3	\$12,000.00	0.025	\$300.00			Estimate
ATG Fresenius	\$15,610.00	0.025	\$390.25			Estimate
Basiliximab	\$6,000.00	0.2	\$1,200.00			Estimate
daclizumab	\$3,650.00	0.2	\$730.00			Estimate
Average additional immunosuppression	\$2620.25					
Average annual cost for other concomitant meds: incl omeprazole; trimethoprim; calcitriol (all for 6mo); valacyclovir or valgancyclovir (80% for 3 mo); antihypertensives (50-70%); statins(50%); hypoglycaemics (10%)	\$9,438.71					
Total drug costs yr 1	\$31,504.22					
Average annual follow up costs (non-drug) Year 1	\$4,729.99					
Total outpatient costs yr 1 (drug + management)	\$36,234.21					

Table 7 Estimated average annual drug costs post transplant – all subsequent years (\$AUD 2005)

Annual cost of immunosuppressive therapy (subsequent yrs)	PBS	regimens at 12 months	Source
CsA + MMF + pred	\$7,213.26	0.27	ANZDATA
Tacrolimus + MMF + pred	\$11,415.18	0.39	ANZDATA
OTHER		0.34	ANZDATA
sirolimus + pred.	\$8,591.25	0.17	ANZDATA
everolimus + pred	\$6,953.85	0.17	ANZDATA
Total (all subsequent years)	\$9,042.17		
Average annual cost for other concomitant medications : incl antihypertensives (50-70%); statins(50%); hypoglycaemics (10%)	\$954.12		
Total drug costs subsequent years	\$9,996.28		
Average annual follow up costs (non-drug) Subsequent years	\$752.53		
Total outpatient costs subsequent yrs (drug + management)	\$10,748.81		

2008–17

Table 8 Annual cost immunosuppressive regimens post transplant – Year of transplant (\$AUD 2005)

Drug	Dose range	Dose used	Total daily dose	Duration of tx in 1 yr (days)	PBS item number (auth)	Cost per mg or g (PBS)	PBS item number (s100)	Cost per mg or g (s100)	Total cost (PBS)
CsA									
CsA loading dose	15 mg/kg	15	1050	1	8657P; 8658Q; 8659R; 8660T; 8661W	\$0.07290	6232B; 6352H; 6353J; 6354K; 6125J	\$0.05852	\$76.54938
CsA (0-14 days)	10-15mg/kg/d	12.5	875	14	8657P; 8658Q; 8659R; 8660T; 8661W	\$0.07290	6232B; 6352H; 6353J; 6354K; 6125J	\$0.05852	\$893.07604
CsA (2wks - onwards)	2-6 mg/kg/d	4	280	351.25	8657P; 8658Q; 8659R; 8660T; 8661W	\$0.07290	6232B; 6352H; 6353J; 6354K; 6125J	\$0.05852	\$7,170.12479
MMF	1 g bd	2000	2000	365.25	8649F; 8650G; 8651H	\$0.00863	6208R; 6209T; 6364Y	\$0.00741	\$6,300.70860
Prednisone	10-100mg/d in divided doses	25	25	365.25	1935W; 1936X	\$0.01880		\$0.01880	\$171.66750
								Total CsA/yr	\$14,612.13
TAC									
TAC 0-1mo	0.26mg/kg/d	0.26	18.2	30.4375	8646C; 8647D; 8648E	\$4.45235	6328C; 6216E; 6217F	\$3.65674	\$2,466.43678
TAC 1-3 mo	0.22 mg/kg.d	0.22	15.4	60.875	8646C; 8647D; 8648E	\$4.45235	6328C; 6216E; 6217F	\$3.65674	\$4,173.96994
TAC 3-12 mo	0.15 mg/kg/d	0.15	10.5	273.9375	8646C; 8647D; 8648E	\$4.45235	6328C; 6216E; 6217F	\$3.65674	\$12,806.49868
MMF	1 g bd	2000	2000	365.25	8649F; 8650G; 8651H	\$0.00863	6208R; 6209T; 6364Y	\$0.00741	\$6,300.70860
Prednisone	10-100mg/d in divided doses	25	25	365.25	1935W; 1936X	\$0.01880		\$0.01880	\$171.66750
								Total TAC/yr	\$25,919.28

2008–17

Drug	Dose range	Dose used	Total daily dose	Duration of tx in 1 yr (days)	PBS item number (auth)	Cost per mg or g (PBS)	PBS item number (s100)	Cost per mg or g (s100)	Total cost (PBS)
SRL									0
SRL loading dose	6mg loading	6	6	1	8724E; 8833X; 8725F	\$7.77785	6436R; 6457W; 6437T	\$6.70000	\$46.66710
SRL (0-3 mo)	2mg/d	2	2	91.3125	8724E; 8833X; 8725F	\$7.77785	6436R; 6457W; 6437T	\$6.70000	\$1,420.42986
SRL (3-12 mo)	6 mg/d	6	6	273.9375	8724E; 8833X; 8725F	\$7.77785	6436R; 6457W; 6437T	\$6.70000	\$12,783.86871
Csa (0-3mo)	2-6 mg/kg/d	6	420	91.3125	8657P; 8658Q; 8659R; 8660T; 8661W	\$0.07290	6232B; 6352H; 6353J; 6354K; 6125J	\$0.05852	\$2,795.96592
prednisone	10-100mg/d in divided doses	25	25	365.25	1935W; 1936X	\$0.01880		\$0.01880	\$171.66750
								Total SRL/yr	\$17,218.60
Everolimus									0
everolimus	0.75mg bd		1.5	365.25	8840G; 8841H; 8842J	\$18.85059	6459Y; 6460B; 6461C	\$16.02000	\$10,327.76842
Csa	2-6 mg/kg/d	4	280	365.25	8657P; 8658Q; 8659R; 8660T; 8661W	\$0.07290	6232B; 6352H; 6353J; 6354K; 6125J	\$0.05852	\$7,455.90913
prednisone	10-100mg/d in divided doses	25	25	365.25	1935W; 1936X	\$0.01880		\$0.01880	\$171.66750
								Total Everolimus/yr	\$17,955.35

Table 9 Annual cost immunosuppressive regimens post transplant – all subsequent years (\$AUD 2005)

Drug	Dose range	Dose used	Total daily dose	Duration of tx in 1 yr (days)	PBS item number (auth)	Cost per mg or g (PBS)	PBS item number (s100)	Cost per mg or g (s100)	Total cost (pbs)
CsA									
CsA	1-2mg/kg/d	2.14	150	365.25	8657P; 8658Q; 8659R; 8660T; 8661W	\$0.07290	6232B; 6352H; 6353J; 6354K; 6125J	\$0.05852	\$3,994.23703
MMF	500mg bd	1000	1000	365.25	8649F; 8650G; 8651H	\$0.00863	6208R; 6209T; 6364Y	\$0.00741	\$3,150.35430
Prednisone	10-100mg/d in divided doses	10	10	365.25	1935W; 1936X	\$0.01880		\$0.01880	\$68.66700
								Total CsA/yr	\$7,213.26
TAC									
TAC	0.05 - 0.1 mg/kg/d	0.072	5.04	365.25	8646C; 8647D; 8648E	\$4.45235	6328C; 6216E; 6217F	\$3.65674	\$8,196.15916
MMF	500mg bd	1000	1000	365.25	8649F; 8650G; 8651H	\$0.00863	6208R; 6209T; 6364Y	\$0.00741	\$3,150.35430
Prednisone	10-100mg/d in divided doses	10	10	365.25	1935W; 1936X	\$0.01880		\$0.01880	\$68.66700
								Total TAC/yr	\$11,415.18
SRL									
SRL	3 mg/d	3	3	365.25	8724E; 8833X; 8725F	\$7.77785	6436R; 6457W; 6437T	\$6.70000	\$8,522.57914
prednisone	10-100mg/d in divided doses	10	10	365.25	1935W; 1936X	\$0.01880		\$0.01880	\$68.66700
								Total SRL/yr	\$8,591.25
Everolimus									
everolimus	0.5mg bd		1	365.25	8840G; 8841H; 8842J	\$18.85059	6459Y; 6460B; 6461C	\$16.02000	\$6,885.17894
prednisone	10-100mg/d in divided doses	10	10	365.25	1935W; 1936X	\$0.01880		\$0.01880	\$68.66700
								Total Everolimus/yr	\$6,953.85

2008–17

Table 10 Regular additional drug costs post transplant (\$AUD 2005)

Drug	Year used	Range	Duration	Dose	Proportion of patients	Cost per script	Pack size	Duration of pack (days)	Script per year	Total cost	PBS code	Cost for proportion of patients	Source
OKT3	Year 1 only	0.05	10-14 days (use 12)	5mg qd	0.025	\$1,000	5mg	1	12	\$12,000.00		\$300.00	Estimate
ATG Fresenius	Year 1 only		7-14 days (use 10)		0.025	\$1,561		1	10	\$15,610.00		\$390.25	Estimate
Anti-CD25 basiliximab (Simulect)	Year 1 only	0.4											Estimate
daclizumab (Zenapax)*	Year 1 only	0.2	2 doses	2 x 20mg doses	0.2	\$3,000	1 dose per pack		2	\$6,000.00		\$1,200.00	Estimate
Omeprazole	Year 1 only	0.2	5 doses	5 doses 1mg/kg	0.2	\$3,650		5	1	\$3,650.00		\$730.00	Estimate
trimethoprim / sulfamethoxazole	Year 1 only	all	6mo	20mg qd	1	\$42.56	30	30	6.0875	\$259.08	8331L	\$259.08	Estimate
calcitriol	Year 1 only	all	6mo	160mg/800mg bd	1	\$8.66	10	5	36.525	\$316.31	2951H	\$316.31	Estimate
valacyclovir (total 80%)	Year 1 only	all	6mo	0.25ug bd	1	\$53.74	100	50	3.6525	\$196.29	2502Q	\$196.29	Estimate
valgancyclovir (total 80%)	Year 1 only	0.4	3mo	2g 4/day	0.4	\$483.63	100	6.25	19.48	\$9,421.11	6280M	\$3,768.44	Estimate
Hypoglycaemics (eg Humulin 30/70; Mixtard 30/70 : 100IU/ml)(HIC utilisation information)	Year 1 only	0.4	3mo	900mg qd	0.4	\$2,245.60	60	30	4.0583	\$9,113.39	6357N	\$3,645.36	Estimate
Simvastatin	All	0.1	ongoing	0.5 - 1 IU/kg/day (use 0.75IU/kg/d)	0.1	\$229.30	100IU/ml, 3ml / vial, 5 vials/script	28	13.044 64286	\$2,991.14	1763T	\$299.11	Estimate
antihypertensives	All	0.5	ongoing	40mg qd	0.5	\$68.33	30	30	12.175	\$831.92	8173E	\$415.96	Estimate
nifedipine	All	0.5-0.7	ongoing										Estimate
enalapril	All		ongoing	20mg bd	0.6	\$22.46	60	30	12.175	\$273.45	1695T	\$164.07	Estimate
irbesartan	All		ongoing	20mg qd	0.6	\$25.89	30	30	12.175	\$315.21	1369C	\$189.13	Estimate
			ongoing	150mg qd	0.6	\$25.32	30	30	12.175	\$308.27	8247C	\$184.96	Estimate
Total cost year 1											\$9,438.71		
Total cost subsequent years											\$954.12		

2008–17

Table 11 Other follow up costs Post transplant – Year of transplant (\$AUD 2005)

Item	Proportion of patients	Frequency	Total per year	MBS item number	Unit cost	Total cost per course	Average annual cost per patient	Source
Year 0 (year of Tx)								
Transplant Surgeon review	all	1/year	1	MBS 104	\$72.60		\$72.60	expert estimate
Transplant physician review (initial)	all	1	1	MBS 110	\$128.05		\$128.05	expert estimate
Transplant physician reviews (subsequent)	all	2/week for first 2 months; 1/week for 1 month, then 1/month	30.66667	MBS 116	\$64.10		\$1,965.73	expert estimate
Dermatology specialist consult (initial)	all	1/yr	1	MBS 110	\$128.05		\$128.05	expert estimate
Dermatology specialist consult (subseq)	all	1/yr	1	MBS 116	\$64.10		\$64.10	expert estimate
Dermatology procedures (removal of skin lesion)	all	1 procedure /yr	0.5	MBS 30195 (benign lesion removal)	\$53.85		\$26.93	expert estimate
			0.5	MBS 30202 (malignant lesion removal by liq nitrogen cryotherapy)	\$41.00		\$20.50	expert estimate
<i>De novo diabetes after Transplant</i>	0.1	Total 4/yr						expert estimate
Diabetes Specialist consult (initial)	0.1	1/yr	1	MBS 110	\$128.05		\$128.05	expert estimate
Diabetes Specialist consult (subsequent)	0.1	3/yr	3	MBS 116	\$64.10		\$192.30	expert estimate
Rejection rate (only data available for rejection within 6 mo) Admitted (50%)	0.23	within yr 0						expert estimate
			0.5	Sep weighted DRG L09A/B	\$13,331		\$1533.07	expert estimate
OKT3	10% of rejection episodes	7-14 days (use 12)	0.05	n.a.	\$1,000	\$12,000.00	\$138.00	expert estimate
ATG	10% of rejection episodes	7-14 days (use 12)	0.05	n.a.	\$1,561	\$18,732.00	\$215.42	expert estimate
Gancyclovir	10% of rejection episodes	IV 5mg/kg bd for 14 days	0.1	6136Y (for 5 vials)	\$280.00	\$1,568.00	\$36.06	expert estimate
valgancyclovir	10% of rejection episodes	900mg qd 1 month	0.1	6357N	\$2,245.60	\$2,245.60	\$51.65	expert estimate
Non-Admitted (50%)			0.5	MBS 166 x 4	\$64.10	\$256.40	\$29.49	expert estimate
			0.5	PBS 8834Y	\$102.47	\$307.41	\$35.35	expert estimate
Total additional follow up management costs (non-drug) Yr0							\$4,729.99	

Table 12 Other follow up costs Post transplant – All subsequent years (\$AUD 2005)

	Proportion of patients	Frequency	Total per year	MBS item number	Unit cost	Total cost per course	Average annual cost per patient	Source
All subsequent years Transplant physician reviews	all	5/year	5	MBS 116	\$64.10		\$320.50	expert estimate
Dermatology specialist consult (subseq)	all	2/yr	2	MBS 116	\$64.10		\$128.20	expert estimate
Dermatology procedures (removal of skin lesion)	all	1 procedure /yr	0.5	MBS 30195 (benign lesion removal)	\$53.85		\$26.93	expert estimate
			0.5	MBS 30202 (malignant lesion removal by liquid nitrogen cryotherapy)	\$41.00		\$20.50	expert estimate
Diabetes Specialist consult (subsequent)	0.1	4/yr	4	MBS 116	\$64.10		\$256.40	expert estimate
Total additional follow up management costs (non-drug) Subsequent years							\$752.53	

Appendix C: Modelling of prevention of End-Stage Kidney Disease

Methods are summarized briefly here, with additional detail on the methods and data having been previously published.²⁶

Following a systematic review of evidence regarding CKD prevalence, risk of disease progression and effectiveness of screening and interventions, the model was developed on the basis of the best available, randomised trial evidence on the effectiveness of the proposed CKD management strategies. Through the Markov model, this evidence is applied to the Australian situation, taking into account CKD prevalence and current management practices. Three key issues which shape the modelling should be noted:

- (1) The strategies chosen were restricted to those for which evidence of an impact on outcomes was available from randomised controlled trials. This enabled modelling of interventions targeting proteinuria, hypertension and diabetes. Other strategies have been proposed to prevent CKD progression in cases of screen-detected low estimated Glomerular Filtration Rate (eGFR), however, no intervention data are available.
- (2) Modelling was restricted to single interventions. Although a multi-level intervention may be appropriate in many cases of CKD, with diabetic nephropathy being a prime example where anti-hypertensive, anti-proteinuric and hypoglycaemic interventions should be employed concurrently, existing clinical trials focus on a single intervention and no good data are available on the interactions between therapies.
- (3) The outcomes and management of CKD, and consequently the costs incurred, are not easily isolated from other chronic diseases. Cardiovascular disease in particular is both a cause and a consequence of CKD. This report has included only those health sector costs which are directly attributable to CKD. Indirect costs, such as lost productivity, have also been excluded from this analysis. Thus, the estimates of total cost attributable to CKD in this report are conservative.

These analyses should therefore be seen as delivering 'preliminary' findings suggesting that the proposed screening and intensive management strategies may be cost-effective.

Specific comparisons

Incremental cost effectiveness ratios were generated for each individual risk factor within the intervention strategy (2) compared to the same risk factor group in the control group (1) and likewise for each individual risk factor within the intervention strategy (3) compared to the same risk factor group in the control group (1). In summary, an ICER is generated for each of the following comparisons:

- a. Intensive treatment of people known to have diabetes (intensive glucose control +/- intensive blood pressure control +/- ACE inhibitor therapy) against current treatment of people with diabetes;
- b. Intensive treatment of people known to have hypertension (intensive blood pressure control) against current treatment of such people;
- c. Opportunistic screening for diabetes and intensive treatment of asymptomatic people found to have diabetes PLUS better treatment of people known to

²⁶ Howard, K, Salkeld, G, White, S, Chadban, S, et al 2006, The Cost-effectiveness of early detection and intervention to prevent the progression of chronic kidney disease in Australia., Kidney Health Australia, Melbourne.

- have diabetes (intensive glucose control +/- intensive blood pressure control +/- ACE inhibitor therapy) against current treatment of people with diabetes;
- d. Opportunistic screening for hypertension and intensive treatment of asymptomatic people found to be hypertensive PLUS intensive treatment of people known to be hypertensive (intensive blood pressure control) against current treatment of people with hypertension; and
 - e. Opportunistic screening for urinary protein and intensive treatment of asymptomatic people found to have urinary protein PLUS intensive treatment of people known to have urinary protein (ACE inhibitor therapy) against current treatment of people with urinary protein.

For each of the cost-effectiveness comparisons listed above, A) to E), the general formula for calculating the ICER is:

$$\text{ICER}_{\text{intervention}} = (\text{TC}_{\text{intervention}} - \text{TC}_{\text{control group}}) \div (\text{TB}_{\text{intervention}} - \text{TB}_{\text{control group}})$$

where:

$\text{TC}_{\text{intervention}}$	=	the total discounted cost of the intervention for the cohort aged ≥ 25 years and older
$\text{TC}_{\text{control group}}$	=	the total discounted cost of treatment for people with CKD risk factors aged ≥ 25 years and older
$\text{TB}_{\text{intervention}}$	=	the total discounted number of quality adjusted life years (QALYs) for the cohort aged ≥ 25 years and older
$\text{TB}_{\text{control group}}$	=	the total discounted number of quality adjusted life years (QALYs) for people with CKD risk factors aged ≥ 25 years and older

Methods

A Markov Monte Carlo simulation model (MARCK-E) was constructed as the basis for estimating the costs and benefits of screening and management strategies, compared to patient cohorts undergoing routine treatment. A Monte Carlo simulation is used to sample a starting age from a) the existing age distribution of known patients with risk factors (from AusDiab) (for the treatment interventions), or b) the existing age distribution of the Australian population > 25 years (for screening interventions). After screening or clinical diagnosis a patient progresses to the appropriate state and follows a series of annual transition probabilities to determine whether they die, have a non-fatal cardiac event, stay in the current state or progress. For the diabetes states, patients progress through diabetes with no albuminuria, to diabetes with microalbuminuria, to diabetes with macroalbuminuria, and eventually to a state of ESKD requiring RRT. For Hypertension and proteinuria states, patients have an annual probability of progressing to a state of ESKD requiring RRT.

A schematic of the models is shown in Figures 10 and 11. Additional detail on methods and structure of the models is provided in a previous Kidney Health Australia report.²⁷

²⁷ Howard, K, Salkeld, G, White, S, Chadban, S, et al 2006, *The Cost-effectiveness of early detection and intervention to prevent the progression of chronic kidney disease in Australia.*, Kidney Health Australia, Melbourne.

2008–17

Figure 1 Better clinical management of existing patients (known)

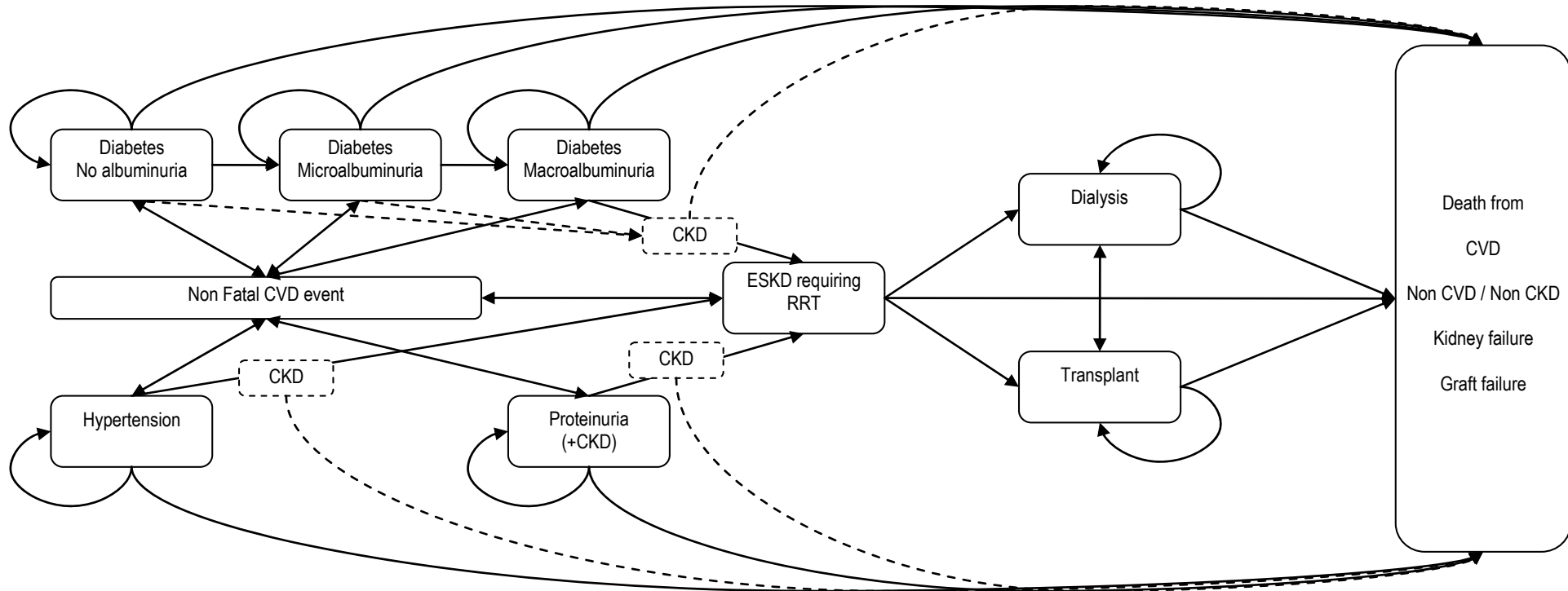
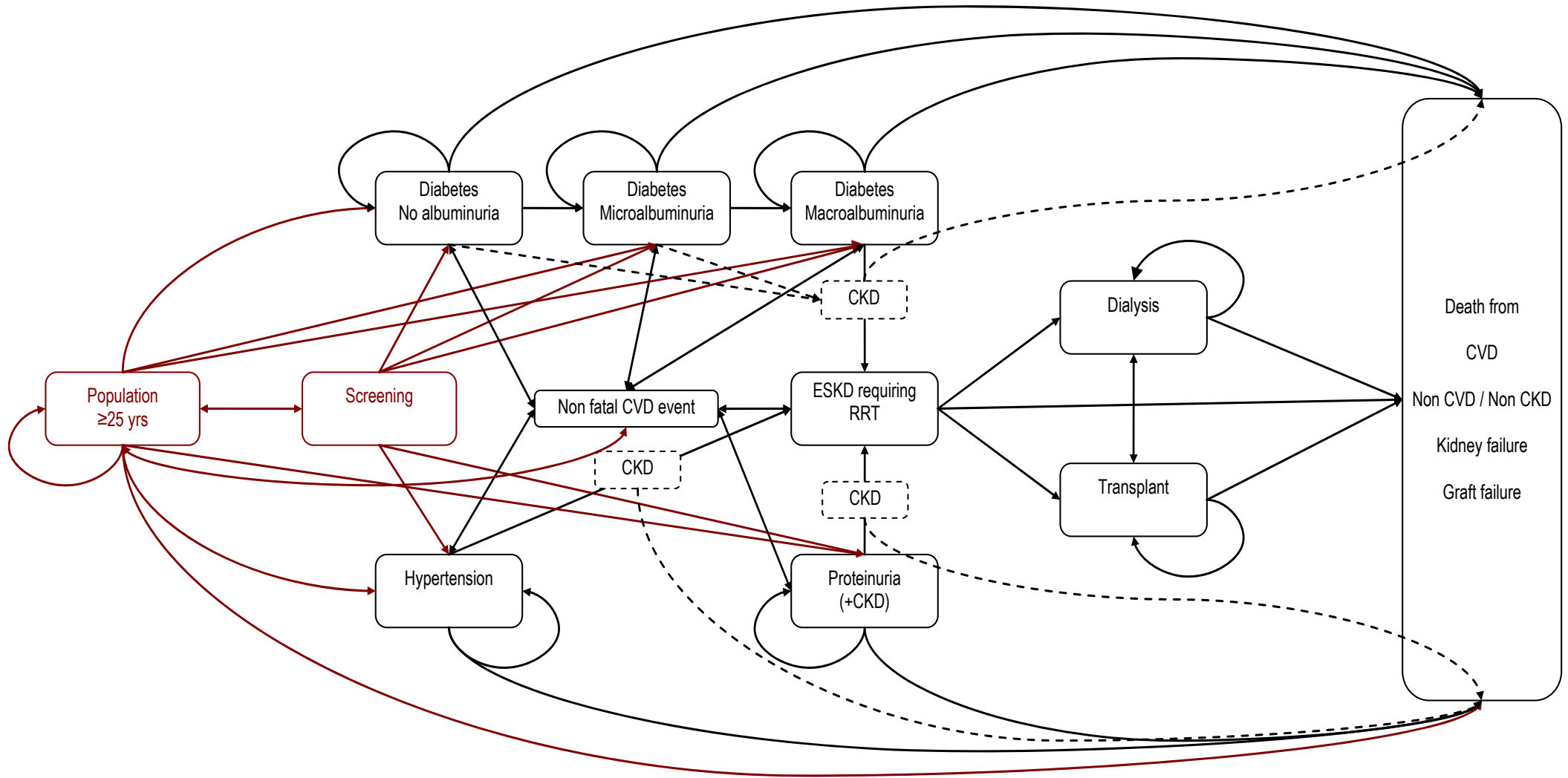


Figure 2 Screening for Chronic Kidney Disease risk factors PLUS better treatment of existing (known and unknown) patients



Results

Costs and benefits of improving the management of existing patients with diabetes and hypertension

Table 1 below provides indicative estimates of the possible cost effectiveness of

- improving glycaemic control (using an intensive regimen) for known diabetes who are currently uncontrolled (based on HbA1c < 7), with health outcomes of Life Years Saved (LYS) and Quality Adjusted Life Years Saved (QALYS). The mean incremental cost-effectiveness estimates are \$24,236/LYS and \$18,514/QALY.
- improving blood pressure control (using an intensive regimen) for known hypertensives (with and without diabetes) who are currently uncontrolled (based on SBP/DBP > 140/90), with health outcomes of life years saved (LYS) and Quality Adjusted Life Years Saved (QALYS). The mean estimates of cost-effectiveness are \$11,812/LYS and \$15,589/QALY.
- the addition of an ACEi for all known diabetic patients, for the health outcomes of life years saved (LYS) and Quality Adjusted Life Years Saved (QALYS). The mean estimates of incremental cost-effectiveness are \$2,761/LYS and \$3,651/QALY.

Table 1 Incremental cost effectiveness ratios for intensive management strategies for existing patients with diabetes and hypertension

Improved management strategy	ICER (\$/LYS)	ICER (\$/QALY)
Intensive glycaemic control in known diabetic patients	\$24,236	\$18,514†
Intensive blood pressure control in known hypertensive patients	\$11,812	\$15,589
Addition of an ACE inhibitor in known diabetic patients	\$2,761	\$3,652

† This model uses AusDiab data for quality of life weights for Australians with controlled and uncontrolled diabetes. In AusDiab, people with controlled diabetes were found to have higher quality of life. As a consequence, the improved glycaemic control strategies that are modelled result in direct improvement in quality of life, unlike the other “Improved Management” strategies. However, improved glycaemic control might not directly cause improvement in quality of life. Within the AusDiab data-set, there may be confounding factors that are unevenly distributed among people with and without good diabetic control. These factors could account for some or all of the observed difference in quality of life.

Costs and benefits of screening and early treatment for risk factors for CKD (diabetes, hypertension and proteinuria) and improving the management of existing patients with diabetes and hypertension

Table 2 below provides indicative estimates of the possible cost effectiveness of

- screening for diabetes, with intensive glycaemic control for all uncontrolled diabetics (known + screen detected), for the health outcomes of life years saved (LYS) and Quality Adjusted Life Years Saved (QALYS). Sensitivity analysis around the screening interval has also been conducted. The base case screening interval is screening from 50-69 years; the upper age limit has been increased to 79 years in sensitivity analyses. The mean incremental cost-effectiveness ratio estimates are \$24,627/LYS and \$29,060/QALY for screening up to age 69. For screening to age 79, the mean cost effectiveness estimates are \$42,307/LYS and \$47,142/QALY.
- screening for hypertension, with intensive blood pressure control for all (known + screen detected) uncontrolled hypertensives (with and without diabetes), for the health outcomes of life years saved (LYS) and Quality Adjusted Life Years Saved (QALYS). Sensitivity analysis around the screening interval has also been conducted. The base case screening interval is screening from 50-69 years; the upper age limit has been increased to 79 years in sensitivity analyses. The mean incremental cost-effectiveness estimates are \$2,347/LYS and \$3,292/QALY for screening up to age 69. For screening to age 79, the mean cost effectiveness estimates are \$3,329/LYS and \$4,738/QALY.
- screening for proteinuria, with addition of an ACEi for all known diabetic patients and for all (known + screen detected) patients with proteinuria (with and without diabetes; with and without hypertension), for the health outcomes of life years saved (LYS) and Quality Adjusted Life Years Saved (QALYS). Sensitivity analysis around the screening interval has also been conducted. The base case screening interval is screening from 50-69 years; the upper age limit has been increased to 79 years in sensitivity analyses. The mean incremental cost-effectiveness estimates are \$3,398/LYS and \$4,269/QALY for screening up to age 69. For screening to age 79, the mean cost effectiveness estimates are \$4,604/LYS and \$5,740/QALY.

Table 2 Incremental cost effectiveness ratios for screening and intensive management strategies

Improved management strategy	ICER (\$/LYS)	ICER (\$/QALY)
Screening (50-69 yrs) for diabetes and intensive glycaemic control in known and screen-detected diabetics	\$24,627	\$29,060
Screening (50-69 yrs) for hypertension and intensive blood pressure control in known and screen-detected hypertensives	\$2,347	\$3,292
Screening (50-69 yrs) for proteinuria and addition of an ACE inhibitor in all known diabetics and screen-detected patients with proteinuria	\$3,398*	\$4,269*

* The cost effectiveness analysis of screening for proteinuria is based on very limited data on the effectiveness of screening. There are no trials that look at this intervention in the relevant patient group: proteinuria with no diabetes and no hypertension. There is a need for randomized trial evidence of ACEi in proteinuric patients with minimal other comorbidities such as diabetes or hypertension. The results presented here should therefore be taken as exploratory only. The results suggest some benefit under optimistic assumptions.

Appendix D: Glossary

Access surgery	See Vascular Access
Analgesic nephropathy	Damage within the internal structures of the kidney, caused by long-term use of compound analgesics.
Australian and New Zealand Dialysis and Transplantation Registry	A disease-specific registry, supported by funding from the Australian Government, which collects data from renal units throughout Australia and New Zealand about patients with End-Stage Kidney Disease.
Automated peritoneal dialysis	(APD) A form of peritoneal dialysis treatment where the patient's blood cycles through their peritoneal membrane (abdomen) via a machine overnight. It offers the patient lifestyle advantages, compared with continuous ambulatory peritoneal dialysis.
Cardiovascular disease	Describes a group of diseases that affect the heart and blood vessels, including coronary artery disease (heart attacks), cerebrovascular disease (strokes) and hypertension (high blood pressure). Also referred to as heart disease.
Chronic kidney disease	The slow and progressive deterioration of kidney function.
Community dialysis	Dialysis that is performed in a modified community facility often with the assistance of a carer.
Continuous ambulatory peritoneal dialysis	(CAPD) A form of peritoneal dialysis where the patient manually cleanses their blood through a 'bag system'. This is performed several times a day.
Coronary artery disease	One of a group of diseases that affect the heart and blood vessels - responsible for heart attacks.
Diabetes	A chronic disease in which the body is unable to regulate blood sugar.
Diabetic nephropathy	A complication of diabetes, characterised by high protein levels in the urine, indicating kidney damage.
Dialysis	A treatment for end-stage kidney disease that removes waste products from the blood by filtering the blood through a special membrane. There are two forms of dialysis—haemodialysis and peritoneal dialysis.
Dialysis modalities	Refers to the different types of dialysis treatments (haemodialysis and

2008–17

	peritoneal dialysis) that vary depending on location of treatment.
Dominant	Dominant is a health economic term referring to a therapy that is more effective and less expensive than the comparator therapy.
Donor	Someone who provides an organ for transplantation. This person can be living (either related or non-related) or deceased.
End-stage kidney disease	The stage of chronic kidney disease where kidney function has been lost to the extent that death is inevitable unless the patient receives life-saving dialysis or transplantation.
Functioning transplant	Describes those individuals living with a functioning kidney transplant.
Glomerular filtration rate	An indirect estimate of kidney function.
Glomerulonephritis	A painless inflammation of the glomerulus in the kidney that can lead to high blood pressure and progressive loss of kidney function.
Haematuria	The presence of blood in the urine.
Haemodialysis	A treatment where blood is pumped from a patient into an artificial kidney machine (called a dialyser) and back.
Home dialysis	Dialysis performed in a patient's home often with assistance of a carer.
Hub	Hubs are centres within a statewide network renal service. They provide full-time nephrological and specialist nursing staff, and may also support a number of spoke services including outreach clinics.
Hypertension	High blood pressure.
Incremental cost	Incremental cost refers to the change in cost associated with introducing a change to current practice.
Incremental cost effectiveness ratio	The ratio of the change in costs as a result of a clinical intervention (compared to an alternative, such as doing nothing or using best available treatments) to the change in effects of the intervention.
In-centre dialysis	Predominately haemodialysis delivered in a tertiary hospital with the assistance of specialised nurses and on-site nephrologist support. Typically used to support patients with no self-care ability and complex care needs.
Incidence	The number of new cases of a condition occurring within a given population,

2008–17

	over a certain period of time.
Indigenous health worker	Indigenous health workers provide primary health care to Aboriginal and Torres Strait Islander individuals, families and communities.
Inpatient	Health services provided to an individual who is admitted (for the day or overnight) to a hospital or health service facility.
Late referral	Those patients who are referred to nephrological care less than three months before commencing renal replacement therapy.
Linear growth	The linear growth model assumes that growth is occurring at absolute increments per year, decade or other unit of time.
Marginal donors	Kidney donations from non heart-beating deceased people or donors with sub-optimal kidney function.
Peripheral vascular disease	Disease that affects the peripheral blood vessels, i.e. those furthest from the heart.
Modality	Refers to the different clinical treatments that may be offered, depending on patient circumstances, clinical need, and availability of health services
Nephrologist	A medical doctor who specialises in kidney function and the treatment of kidney diseases.
Nephrology	Study of the function and diseases of the kidney.
Nurse practitioner	A registered nurse educated to function autonomously and collaboratively in an advanced and expanded clinical role. The nurse practitioner role includes assessment and management of clients using nursing knowledge and skills and may include but is not limited to: <ul style="list-style-type: none"> • the direct referral of clients to other health care professionals • prescribing medications • ordering diagnostic investigations.
Opportunistic screening	Medical testing conducted to detect disease symptoms among high-risk populations or individuals during planned or unplanned interaction with primary care services.
Opportunity costs	What you may forego by choosing one approach rather than another.
Outpatient	A non-admitted health service provided or accessed by an individual at either a hospital or health service facility.

2008–17

Peritoneal dialysis	A treatment where blood cleansing and waste removal occurs internally, using the body's own peritoneal membrane as a filter.
Polycystic kidney disease	An inherited condition where multiple cysts form on the kidneys, causing them to become enlarged.
Pre-emptive transplant	Kidney transplantation that occurs prior to the commencement of dialysis.
Prevalence	The proportion of a population living with a defined condition at a certain period of time.
Primary health care	General health care focused on the point at which an individual makes their first contact with the health system. Usually delivered by general practitioners, nurses and Indigenous health workers.
Primary renal disease	Attributed cause of end stage kidney disease.
Proteinuria	The presence of protein in the urine.
Quality adjusted life years(QALYs)	Quality adjusted life years (QALYs) are a multidimensional outcome measure used in health economics. This economic index of outcome combines patient survival with an adjustment for the quality of life, where adjustment is based on interval scale from 0 (worst health) to 1 (full health).
Reflux nephropathy	A condition in which the kidneys are damaged by the backward flow of urine into the kidney.
Renal	Of the kidneys. Used interchangeably with the words 'kidney' or 'kidneys'.
Renal replacement therapy (RRT)	Encompasses treatments for end-stage kidney disease including dialysis and kidney transplantation.
Satellite dialysis	Haemodialysis provided in a non-tertiary or secondary hospital or health facility. Patients may have some self-care abilities.
Self-care dialysis	Dialysis that is managed by a patient and their carer following extensive training, and with support from a dialysis centre.
Spoke	Services supported by specialised hubs that may provide satellite dialysis, patient education, self-care training and support.

2008–17

Steady-state growth	A condition of constant rates of growth.
Telehealth	Health service delivery where the health service provider and the patient are geographically separated using two-way voice and visual communication (such as by satellite, computer or closed-circuit television).
Transplantation	A surgical procedure whereby a healthy organ from a deceased or living donor is implanted to replace the function of a damaged organ
Vascular access	A necessary surgical procedure that connects an artery and vein in order for dialysis to take place. Access points may be located in the upper or lower arm for haemodialysis, and in the abdomen for peritoneal dialysis.
Vascular disease	Disease of the blood vessels.

2008–17

Appendix E: Acronyms

ABS	Australian Bureau of Statistics
AusDiab	The Australian Diabetes, Obesity and Lifestyle Study
ANZDATA	Australian and New Zealand Dialysis and Transplantation Registry
CKD	chronic kidney disease
CAPD	continuous ambulatory peritoneal dialysis
dpmp	donors per million population
EPO	Erythropoietin
ERP	Estimated Resident Populations
ESKD	End-stage kidney disease
GRF	glomerular filtration rate
HD	haemodialysis
ICER	incremental cost effectiveness ratio
K/DOQI	Kidney Disease Outcomes Quality Initiative
KHA	Kidney Health Australia
MSAC	Medical Services Advisory Committee
NHCDC	National Health Cost Data Collection
PAH	Princess Alexandra Hospital
PBAC	Pharmaceutical Benefits Advisory Committee
PD	peritoneal dialysis
pmp	per million population
ppt	price per treatment
QALY	quality adjusted life years
RRT	renal replacement therapy
SG	standard gamble
TTO	Time trade-off

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