Australian Government
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Projections of the prevalence of treated end-stage kidney disease in Australia 2012–2020

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Authoritative information and statistics to promote better health and wellbeing

Projections of the prevalence of treated end-stage kidney disease in Australia

2012–2020

Australian Institute of Health and Welfare
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Contents

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Summary

End-stage kidney disease (ESKD), the most severe form of chronic kidney disease, results in a high health and economic burden for patients, families and communities. It usually requires kidney replacement therapy (KRT) in the form of dialysis or kidney transplantation for patients to survive. The number of people receiving KRT treatment for ESKD has tripled between 1991 and 2011.

This report examines whether the number of people with treated-ESKD (prevalence) will continue to increase up until 2020. This information is important for health service planning and resource allocation in the future. It is important to note that projections are not intended to function as exact forecasts, but to give an indication of what might be expected if the stated assumptions were to apply over the projection time frame and so should be interpreted with this in mind.

The projected treated-ESKD prevalence estimates were derived from a series of models, to provide a range of projection results. The report also examines the influence of diabetes on future treated-ESKD prevalence growth.

Prevalence of treated-ESKD is increasing

- The number of people receiving KRT for their ESKD is projected to increase over the next decade. The 'base' model predicts that the prevalence will rise by 60%—from 19,780 cases in 2011 to 31,589 cases in 2020. This is despite the Australian population only increasing 13% over this period (ABS 2013a).
- The projected increase in treated-ESKD is expected to occur across all age groups, with the largest increase occurring for people who start treatment when they are over 75, where the prevalence is projected to double from 2,013 to 4,130 cases.
- When the rate of new cases of treated-ESKD is held constant, the prevalence of treated-ESKD is projected to increase by 45% (rising to 28,756 cases). Where dialysis survival is expected to improve over the projections years, the prevalence is expected to increase by 64% (rising to 32,437 cases).

Diabetes to continue to contribute to increases in treated-ESKD

- The prevalence of treated-ESKD with diabetes as a primary cause is projected to double between 2011 and 2020 (from 4,392 to 9,677 cases). By contrast, the prevalence of treated-ESKD without diabetes as the primary cause is projected to increase by 47% (from 15,388 to 22,960 cases).

Dialysis- and transplant-treated-ESKD cases are projected to increase

- The number of dialysis-treated ESKD patients is projected to increase by 49%—from 10,998 cases in 2011 to 16,362 cases in 2020, while the number of transplant-treated patients is projected to rise by 73%—from 8,782 cases in 2011 to 15,227 cases in 2020.
- In 2020, almost half (48%) of all treated-ESKD patients are predicted to have a functioning kidney transplant. This compares with 44% in 2011.

1 Introduction

Chronic kidney disease (CKD) is a common chronic disease in Australia, with around 1 in 10 Australians showing biomedical signs of CKD (ABS 2013b). CKD refers to all kidney conditions where a person has evidence of kidney damage and/or reduced kidney function, lasting at least 3 months. Many people do not know that they have kidney disease as up to 90% of kidney function can be lost before symptoms appear. Clinically, CKD is classified into five stages, from kidney damage with no loss of kidney function to severe loss of kidney function. However, it is often not until kidney function has deteriorated into the fifth and most severe stage, known as end-stage kidney disease (ESKD), that a diagnosis is made.

For people with ESKD, kidney function has deteriorated to such an extent it is no longer sufficient to sustain life. Kidney replacement therapy (KRT) is required for the patient to survive, either in the form of kidney transplantation (in which a kidney from either a living or recently deceased donor is implanted in a patient), or by dialysis (an artificial way of removing waste substances from the blood provided largely in hospitals or satellite dialysis units, but also in a home setting [Kidney Health Australia 2007]). However, not all patients with ESKD receive KRT. Prognosis, anticipated quality of life (with or without KRT), treatment burden on the patient, and patient preference all play a part in the decision for or against KRT (Murtagh et al. 2007). See Appendix A for more information on the treatment of ESKD.

The health and economic burden of ESKD on individual patients, carers and the community is high. At the end of 2011, there were around 19,800 people receiving KRT for their ESKD (referred to as treated-ESKD hereafter) and over 2,500 new cases of treated-ESKD in 2011 (ANZDATA 2013). Rates of treated-ESKD are high among certain groups of the population, including older Australians (rates are 6 times as high among those aged 70 years and over compared with those under 50 years) and among Aboriginal and Torres Strait Islander people (where rates of treated-ESKD are 6 times the rate of non-Indigenous Australians). CKD is also a costly disease, accounting for around 1.7% of total allocated health care expenditure in 2004–05, with KRT responsible for most (85%) of that expenditure. The cost of dialysis treatment is high, ranging from $101,189 per patient per year for in-centre treatment to $54,017 per patient year for community/home self-care haemodialysis, according to a costing study funded by NSW Health (New South Wales Government 2009).

ESKD places a considerable health, time and cost burden on patients and families (Low et al. 2008), including reduced life expectancy (Turin et al. 2012), reduced quality of life (Dobbels et al. 2007; Lew & Piraino 2005), and significant out-of-pocket expenses (New South Wales Government 2009). Further, the need to adhere to strict treatment protocols and the need for frequent treatment for dialysis patients—normally 4–5 hour sessions 3 times per week for in-centre dialysis—often impacts on education, employment and family responsibilities, and often results in the need to relocate to access dialysis (Preston-Thomas et al. 2007).

However, ESKD is largely a preventable chronic condition, as many of its risk factors are modifiable, including high blood pressure, tobacco smoking, physical inactivity, poor nutrition, and obesity. Many of the risk factors for CKD also apply to other chronic diseases such as cardiovascular disease and diabetes which, in turn, are risk factors for ESKD. Diabetes is the leading cause of treated-ESKD in Australia, accounting for one-in-three new cases in 2011. Cardiovascular disease, especially hypertension, is also one of the major causes of treated-ESKD (ANZDATA 2013).

The number of people receiving KRT treatment for ESKD has tripled over the last two decades, increasing from around 6,600 to 19,800 between 1991 and 2011. This increase is in part attributed to increases in diabetes prevalence (see Box 1.1) that have led to increases in diabetic nephropathy and consequently ESKD; increases in the prevalence of high blood pressure; better survival rates for patients on KRT; and a reduction in the number of people dying from cardiovascular diseases (McDonald et al. 2005; Stewart et al. 2004). Over the past few decades progressively greater numbers of older people are also being treated for ESKD (AIHW 2009), meaning that previously untreated-ESKD cases are now contributing to higher treated-ESKD prevalence counts.

It is anticipated that the prevalence of treated-ESKD will continue to increase in Australia over the next decade, due in part to the ageing population and increasing rates of diabetes; a finding that has been predicted by other studies (Cass et al. 2010). Not all ESKD patients are treated with KRT, so it is important to note that the prevalence of treated-ESKD is not only determined by the prevalence of the disease itself, but is also influenced by patient choice, and by KRT acceptance policies. It is possible that changes in either treatment availability or acceptance policies over the next decade may influence future treated-ESKD prevalence rates.

This report is a follow-on report from a previous AIHW project that presented projections of the incidence of treated-ESKD (AIHW 2011b). This report explores the future burden of ESKD in Australia by presenting projections of the prevalence of ESKD for patients who receive KRT for the period 2012 to 2020, based on data from the Australian and New Zealand Dialysis and Transplant (ANZDATA) Registry.

Projections are, by their nature, estimates about what might reasonably be expected in the future. Predicting the future prevalence and incidence (see Box 1.1) of treated-ESKD is important for dialysis and kidney transplant-related health service planning and resource allocation purposes.

Box 1.1 Definitions of incidence and prevalence

Incidence refers to the number of new cases (of an illness, disease or event) occurring during a given period. Treated-ESKD patients are only classified as being 'incident' once.

Prevalence refers to the number or proportion of cases or instances present in a population at a given time. The prevalence of treated-ESKD is related to both the incidence of the disease and how long people live while receiving KRT (survival). The prevalence is also influenced by factors not related to ESKD itself, for example, patient choice regarding KRT.

2 Methods

This chapter describes the data sources used in the prevalence projections, and the range of models used for projecting the prevalence of ESKD. It describes the construction of the 'base' treated-ESKD prevalence projections model to 2020, as well as the assumptions of the various models and data challenges and limitations. The need for alternative projection models and a description of these alternative models is also provided.

Data sources

Australia and New Zealand Dialysis and Transplant (ANZDATA) Registry

The data used in projecting the prevalence of ESKD were based on Australian and New Zealand Dialysis and Transplant (ANZDATA) Registry data. This registry collects information from all dialysis and transplant units in Australia and New Zealand as at 31 December each year, and these data are published annually (see <www.anzdata.org.au>).

The ANZDATA Registry includes the number of people for whom the intention to treat is long-term; those who start dialysis or transplant treatment for ESKD (incident treated-ESKD cases; that is, new cases of treated-ESKD) during each calendar year; and the total number of (prevalent) treated-ESKD cases at the end of each calendar year. ANZDATA also records other information such as age, sex, treatment type, comorbidities, and Indigenous status. All relevant hospitals and related dialysis units participate. While patients have the option of opting-out of having part or all of their data recorded, this rarely happens. ANZDATA incidence and prevalence data were both required for projecting the prevalence of treated-ESKD.

The interpretation and reporting of ANZDATA Registry information in this report have been undertaken by the AIHW, and do not represent ANZDATA Registry policy or interpretation.

Information about the data quality of ANZDATA can be found in the 35th Annual ANZDATA Report 2012 <http://www.anzdata.org.au/v1/report_2012.html>.

Population data

The latest ABS population projection series (ABS 2013a) were used in projecting the number of future incident cases of treated-ESKD for each year over the projection period 2012 to 2020. These incident counts were inputs for the prevalence projections models. The ABS population projections reveal the size, structure and distribution of the future population under various assumptions on future levels of fertility, mortality and migration. These assumptions are based on long- and short-term trends and future scenarios dictated by research in Australia and elsewhere (ABS 2013a). After each census, the ABS produce three series of projections (Series A, B and C), which provide a range of projections for analysis and discussion. Series B—the medium-variant projection—is the one used for the incidence-projections component in the prevalence model.

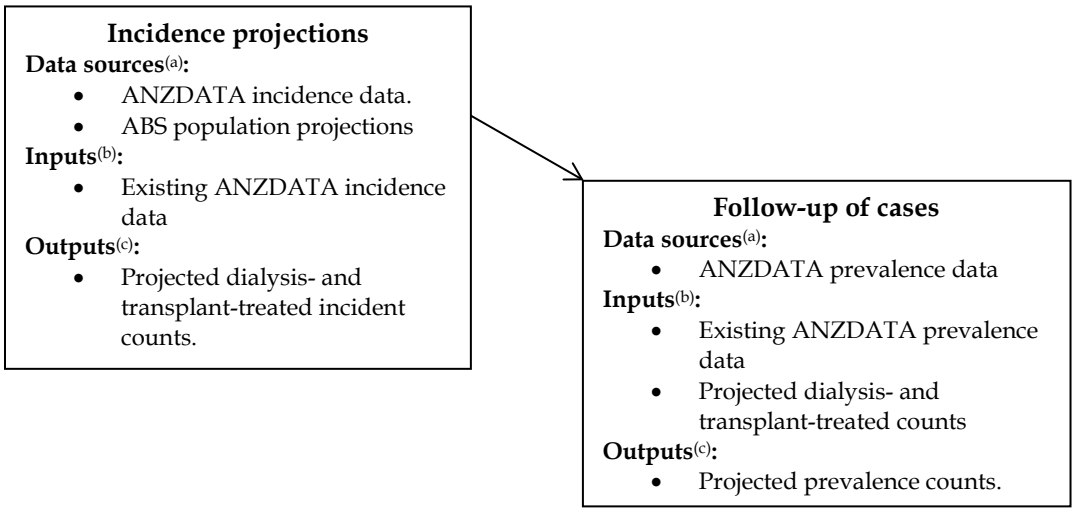
Construction of 'base' prevalence projections model

The construction of 'base' prevalence projections model involved two broad stages:

- projection of the incidence of dialysis- and transplant-treated-ESKD cases based on ANZDATA Registry data from 1996 to 2011.
- follow-up of these projected incident cases and existing prevalent cases to 2020.

Similar modelling techniques were used in other treated-ESKD prevalence projections (Cass et al. 2010; Cass et al. 2006; Department of Health and Ageing (DoHA) 2011). (See Appendix B and D for more detailed information on the construction of the prevalence models.)

A flow chart of the different elements of the 'base' prevalence projections overall model, and of the data making up these components, is shown in Figure 2.1.



Note: The prevalence projections methodology is explained in detail in Appendix B.

(a) Data sources used in model construction.

(b) Inputs for prevalence projections model component.

(c) Output for prevalence projections model component.

Figure 2.1: Prevalence projection model components, data sources, inputs and outputs

Incidence projections

The incidence projections used in the 'base' prevalence projections model were based on existing ANZDATA registry trends in the incidence of treated-ESKD in Australia. The number of incident dialysis- and transplant-treated-ESKD cases were projected using the log-linear Poisson regression methodology that was previously used by the AIHW for projecting the incidence of treated-ESKD (AIHW 2011b).

The incidence projections model used in this report extrapolates existing treated-ESKD incidence rates into the projection years; applies these rates to the ABS Series B population projections (ABS 2013a) to calculate incident counts; and then estimates incident dialysis- and transplant-treated-ESKD incident counts from these numbers (see Appendix B). Incidence projections were stratified by sex, and these projection counts were summed together to create person-level counts. Incidence projections were created for 5 age groups

(0–29, 30–49, 50–64, 65–74 and 75-and-above). Projected incident counts from 2012 to 2020 are listed in tables E1 and E2.

Follow-up of projected incident cases and existing prevalent cases

The 'base' prevalence projection model in this report expands on the previous AIHW treated-ESKD incidence projections model by using Markov modelling techniques to follow up existing prevalent cases and projected incident cases to predict the future prevalence of treated-ESKD.

Markov models are capable of modelling clinical conditions when risk is continuous over time. Markov models assume that a patient is always in one of a finite number of states (referred to as Markov states). All events of interest are modelled as transitions from one state to another (Sonnenberg & Beck 1993); for example, from dialysis to death or from transplant to dialysis.

The Markov model component of the 'base' prevalence projection model (to be referred to as the 'base' model) was stratified by the following factors:

- treatment length
- treatment modality (dialysis or transplant)
- incident age.

Existing prevalent cases and projected incident cases were followed through the projection years using a 'base' model that consisted of 5 separate Markov models. These Markov models had the same overall structure, although they had different incident age cases feeding into them (age groups 0–29, 30–49, 50–64, 65–74 and 75-and-above). The 'base' model was based on incident age, rather than current age, as the projection methods used in this report do not allow for patients to move between the 5 Markov models as the age over the projection period.

These models incorporated transfers between dialysis, transplant and death; that is, 3 possible states, and 6 possible transitions between these states: dialysis to death; transplant to death; transplant to dialysis; dialysis to transplant; remaining on dialysis; or remaining with a functioning transplant (see Figure B1).

The likelihood of transitioning between treatment states depends on transition probabilities. The transition probabilities for the 5 different Markov cycles in each incident age group model were based on the latest trends in KRT treatment outcomes. The latest treatment trends were assessed by following a cohort of patients who were prevalent in 2009–2011 and calculating average transition probabilities for this period. (See 'Prevalence model construction' in Appendix B for more detailed information on the prevalence projections model structure and construction.)

The influence of diabetes on future prevalence counts

The 'base' model was also altered to assess the influence of diabetes on future treated-ESKD prevalence counts. This involved separately projecting the prevalence of treated-ESKD for patients with, and without, diabetes as a primary cause of their treated-ESKD.

Projection assumptions

The accuracy of prevalence projections depends on the accuracy of the available historical data; the suitability of the model used as a representation of the underlying trends; and the assumptions underpinning the model. The assumptions for the 'base' projections model are best conceptualised by looking separately at the two main components of the model: incidence projections; and the follow-up of cases. (Note that some assumptions cross over between these two components.)

Incidence projections

The incidence projections were based on the following assumptions:

- recent historical trends (1996–2011) in the incidence of treated-ESKD will continue in the projection years
- the proportion of incident cases that receive a transplant before starting dialysis treatment (pre-emptive transplantation) will remain constant over the projection years
- the population will grow and age according to the Series B ABS population (medium variant) projections for the next decade (see 'Population data' on page 3)
- treatment options, patient choices, and availability of services will remain unchanged in the projection years.

The follow-up cases over the projection period

The follow-up of prevalent cases over the projection period was based on the following assumptions:

- transplant outcomes do not vary by transplant type (donations from deceased versus living donors) or by transplant number (first transplant, second transplant, and so forth)
- dialysis treatment outcomes do not vary by dialysis modality (peritoneal dialysis versus haemodialysis) or by dialysis location (home, hospital or satellite dialysis unit) (see Appendix A for a discussion of these terms)
- transition probabilities in each incident age treatment length group will remain constant over the projection years. For example, the likelihood of receiving a transplant while on dialysis (dialysis to transplant transition) remains constant across the projection years
- only a patient's current treatment state (dialysis or transplant), their incident age and their KRT treatment length influence their transition probabilities
- transition probabilities remain constant after 5 years of treatment. For example, over the projection years, all patients in a given incident age group who have received KRT for over 5 years have the same likelihood of receiving a transplant
- the average treatment patterns (in the form of transition probabilities) that occurred in 2009–2011 will continue throughout the projection years. (For example, for patients with a given treatment length and incident age group, the likelihood of remaining on dialysis, or of receiving a transplant, remains constant over the projection years)
- patients can only transition once between Markov states (dialysis, transplant or death) during a Markov cycle (1 year)
- treatment options, patient choices, and availability of services will remain unchanged in the projection years.

Variables controlled for in 'base' prevalence projections model

Numerous variables are likely to influence the future prevalence of treated-ESKD.

The 'base' prevalence projections model used in this report controlled for some of these factors, including:

- the age profile and size of the future Australian population
  - The incidence of treated-ESKD is related to age. An ageing population is likely to contribute to an increase in incidence of treated-ESKD, which in turn will lead to an increase in the prevalence of treated-ESKD (assuming survival rates do not worsen). The incidence component of the prevalence projections used ABS population projections to account for likely changes in prevalence counts due to changes to the population size and age structure.
- sex-related differences in incidence rates
  - Males have higher incidence and prevalence rates of treated-ESKD. Projections of the incidence of treated-ESKD were carried out separately for males and females, with these results summed to create person counts for each age group for each projection year.
- select KRT treatment states
  - Transplant-treated-ESKD patients tend to have improved survival relative to dialysis-treated patients. The Markov-model-based component of the 'base' model controlled for differences in survival between dialysis- and transplant-treated cases.
- age and treatment duration related effects
  - Age and KRT treatment duration also influence transition probabilities. For example, older dialysis patients are less likely to receive a transplant (dialysis-to-transplant transition) during a Markov cycle (1 year). The Markov model controlled for age and KRT treatment duration by having separate Markov models based on incident age and separate cycles within these.

Data limitations

Projections are, by nature, estimates about what might reasonably be expected in the future. A number of statistical modelling approaches have been developed and widely applied in recent decades. The choice of a good modelling approach, based on historical trends and other available information, can generate the best estimates. However, there is no guarantee of their realisation in the future.

As noted above, the prevalence model used in this report is made up of two main components: projecting the incidence of treated-ESKD, and the follow-up of new and existing treated-ESKD cases. Both these components involve several assumptions and both have potential sources of error.

In developing these assumptions, a balance needed to be achieved between realistic model assumptions, model complexity, model stability and data availability and reliability.

Variables not controlled for in the projections model

Several factors were not controlled for in the projections model that may influence future prevalence rates of treated-ESKD. These factors include: comorbid conditions (excluding diabetes as a primary cause); KRT treatment history; transplant type (living versus deceased donor source); dialysis type; and ethnicity. KRT treatment policies are also likely to influence future prevalence of treated-ESKD.

Some of these factors are potentially able to be factored into the 'base' prevalence projections, but these were not controlled for in the model (see Projection Assumptions, above). When controlling for factors in the model, there is a need to balance having realistic projection assumptions with model complexity and stability. Stratifying the projections model too finely is likely to lead to unstable and potentially inaccurate projection results. For example, although treatment patterns (transition probabilities) do vary slightly by sex, the Markov model component of the projections model was not stratified by sex, as this would have led to less stable transition probabilities and therefore less stable projection results.

Indigenous projections

The prevalence of treated-ESKD is high among Aboriginal and Torres Strait Islander people—at the end of 2011, almost 8% of people with treated-ESKD commencing KRT identified as Indigenous, despite making up only 3% of the total Australian population. Furthermore, Indigenous Australians with ESKD were far less likely than their non-Indigenous counterparts to be treated with a functioning kidney transplant in 2011 (13% compared with 47%, respectively) (ANZDATA 2013).

Unfortunately the projections model was not able to control for Indigenous status, due to the relatively small numbers of Indigenous Australians with treated-ESKD in the ANZDATA Registry for stable Markov modelling. These small cell sizes impact on the reliability and robustness of the Indigenous-specific transition probabilities, meaning that other aspects of the projections model would need to be altered to calculate stable transition probabilities (for example, the model would have to be stratified by fewer incident age groups).

At the time of preparing this publication, there was also a lack of up-to-date Indigenous population projection data: the latest Indigenous population projections are based on the 2006 Census, rather than the 2011 Census-based Series B total population estimates, which were used in the 'base' prevalence projections model.

Alternative models

Appendix C contains an assessment of the accuracy of the two main components of the 'base' prevalence projections model: the incidence model and the Markov model for following up cases over the projection period. Following this assessment, two alternative prevalence models were constructed that involve slightly different projection assumptions to the 'base' model. (See Appendix D for more detailed information on these alternative models.) A summary of the 3 models used in this report is also listed in Table 2.1.

‘Stable incidence’ model

The incidence model-fit analysis, presented in Figures C1–6 in Appendix C, appears to suggest that the incidence model component of the ‘base’ prevalence projections model may overestimate the incidence of treated-ESKD, particularly for older patients (the 75-and-over incident age group). This overestimation in future incident counts is likely to be due to the incidence model not controlling for the recent (2008–2011) stabilisation of treated-ESKD incidence trends (see Figure E1).

The ‘stable incidence’ model was created to control for any potential overestimation of the future incidence (and prevalence) of treated-ESKD due to a possible sustained (2012–2020) levelling off of future treated-ESKD incidence trends. The model assumes that the 2008–2011 trends in the incidence of treated-ESKD (see Figure E1) remain constant over the projection years. All other aspects of the model remained the same as the ‘base’ projections model. The ‘stable incidence’ model is a more conservative estimate of future prevalence counts.

‘Improving dialysis treatment outcomes’ model

Markov model-fit analysis (Figure C7) suggests that the Markov model component of the projections model may underestimate prevalence for older incident age patients (age groups 65–74 and 75-and-above).

These results suggest that the assumptions underpinning the ‘base’ model for following up existing prevalent cases lead to an underestimation in projection results in older incident age groups (ages 65–74 and 75-and-above), assuming that similar treatment and incidence trends that occurred from 2003 to 2011 also occur from 2012 to 2020.

For older patients, the assumption most likely to be disproven is that treatment outcomes (transition probabilities) remain constant over the projection years. In particular, over the last decade there has been an improvement in dialysis survival for older patients (that is, a decrease in dialysis-death transition probabilities) (see Figure C8).

The ‘improving dialysis treatment outcomes’ model attempted to factor in improving dialysis treatment outcomes for older patients by altering the dialysis-death and dialysis-dialysis transition probabilities in the ‘base’ model for older patients (age groups 65–74 and 75-and-above) over the projection years. This involved using the previous trends in dialysis survival (dialysis-death transition probabilities) to predict improvements in dialysis survival over the projection years. All other aspects of the model remained the same as for the ‘base’ projections model.

Table 2.1: Summary of prevalence projections models

Model name	Description	Chapter
'Base' model	• Assumes that the 1996 to 2011 trend in treated-ESKD incidence will continue over the projection years • Uses Markov modelling techniques to follow treated-ESKD patients over the projection years • Assumes that recent KRT treatment outcomes (2009–2011) will continue over the projection years.	Chapter 3
Diabetes projections	• 'Base' model stratified by treated-ESKD cases with and without diabetes as a primary cause of treated-ESKD.	End of Chapter 3
'Stable incidence' model	• Assumes the 2008–2011 ('stable') trends in the incidence of treated-ESKD will remain constant over the projection years • All other aspects of the model remained the same as the 'base' projections model • Produces conservative estimates of the future prevalence relative to the 'base' model.	Chapter 4
'Improving dialysis treatment outcomes' model	• Assumes recent improvements in dialysis survival for older patients (incident age groups 65–74 and 75-and-above) will continue over the projection years • All other aspects of the model remained the same as the 'base' projections model • Gives a less conservative estimate of the future prevalence relative to the 'base' model.	Chapter 4

3 Base prevalence projections model

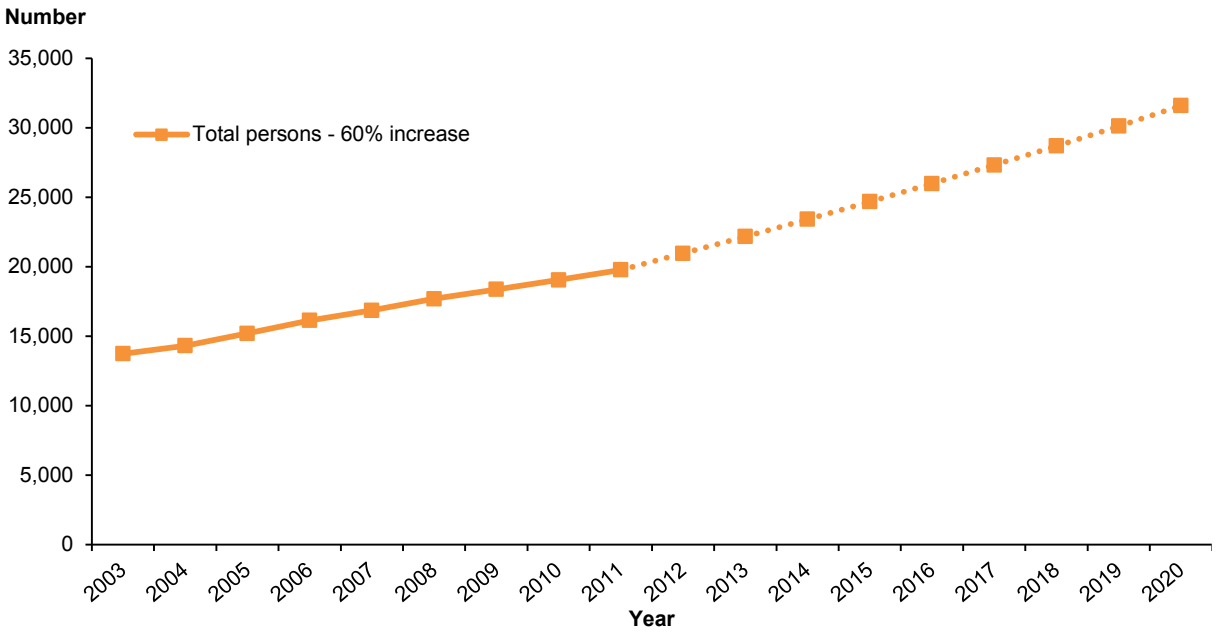
This chapter presents the results of the 'base' prevalence projections model to determine whether the recent increase in treated-ESKD prevalence is likely to continue in the future. It also examines prevalence projections for dialysis and transplantation separately, and the influence of diabetes on the future prevalence of treated-ESKD.

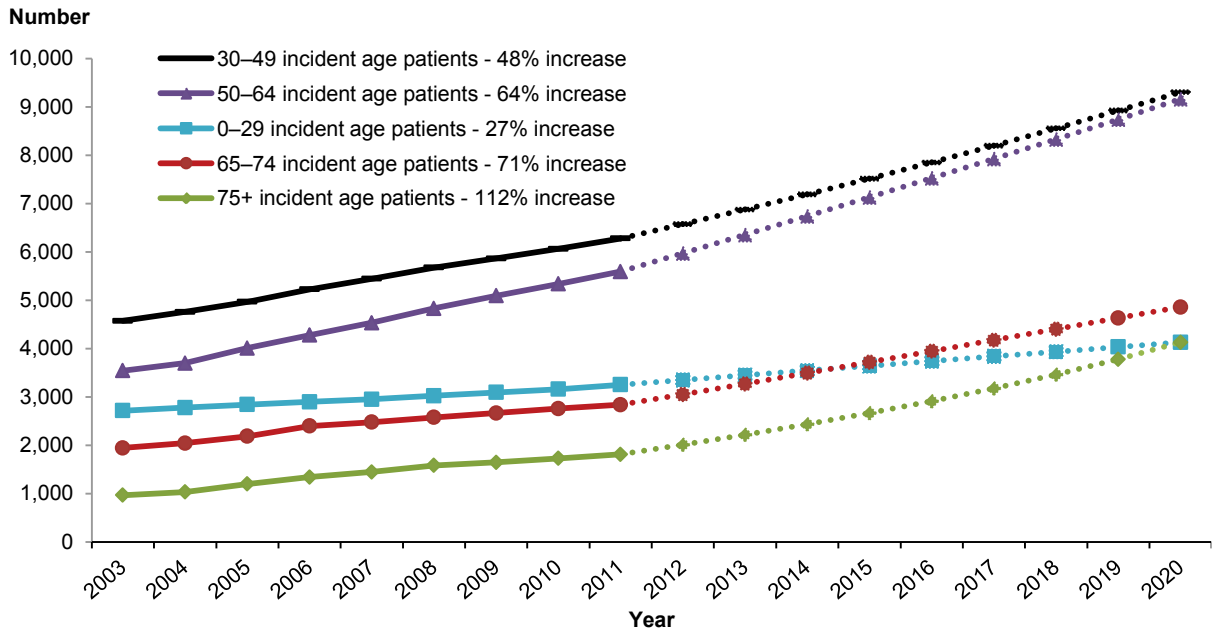
Overall

The 'base' model shows a continued increase in the prevalence of treated-ESKD, increasing 60% from 19,780 cases in 2011 to 31,589 cases in 2020 (Figure 3.1). This is consistent with the existing trend for treated-ESKD prevalence both in Australia and internationally (U.S. Renal Data System 2013).

The increase in treated-ESKD prevalence is projected to occur across all incident age groups, with larger increases occurring in the older age groups. The prevalence of treated-ESKD among those aged 75 years and over is expected to more than double between 2011 to 2020 (increasing from 2,013 to 4,130), while among the 0–29 incident age group the rate of increase was considerably slower and is projected to increase by 27% over this period (Figure 3.1). This pattern is consistent with the rapid increase observed in the prevalence and incidence of ESKD in the 75-and-over age group over the last 20 years, due partly to an increasing trend to treat older patients (AIHW 2011b).

There are a number of likely contributing factors for the projected increase in the prevalence of treated-ESKD, including increases in the population size and the ageing of the population; improved survival rates for patients with treated-ESKD; and increasing incidence rates for treated-ESKD—in part due to the increasing prevalence of diabetes in Australia (see Figure 3.3).





Notes

1. The solid lines represent existing registry data while the dotted lines are for projected prevalent cases.
2. The percentage increases from 2011 to 2020 for each age group and for total cases are listed in the legends.

Source: AIHW analysis of ANZDATA Registry data.

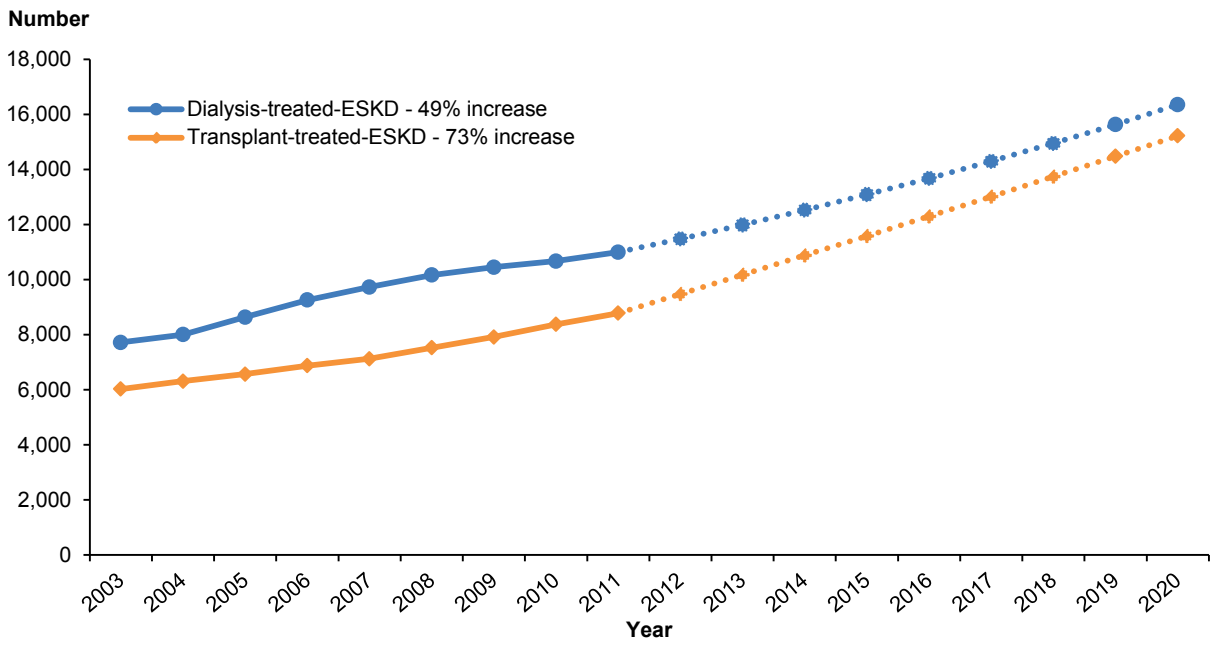
Figure 3.1: Prevalence of registered and projected treated-ESKD, for all patients and by incident age, 2003–2020

Kidney replacement therapy (KRT) treatment trends

Examining dialysis and transplant cases separately over the projection years allows for a better prediction of future service-delivery needs, assuming the prevalence projection assumptions are accurate over the projection years and that treatment modalities do not change considerably over this period.

Both dialysis- and transplant-treated-ESKD prevalence counts are predicted to increase steadily over the projection period. The number of patients treated with dialysis is predicted to increase by 49% from 10,988 in 2011 to 16,382 in 2020, while the number of patients with a functioning kidney transplant is predicted to increase by 73%, from 8,782 in 2011 to 15,227 in 2020 (Figure 3.2).

While the number of patients with a functioning kidney transplant is predicted to increase faster than for those receiving dialysis, in 2020 dialysis patients are still likely to account for a higher proportion of treated-ESKD patients: 52% of treated-ESKD cases are predicted to receive dialysis treatment for their ESKD in 2020 with the remaining 48% predicted to have a functioning kidney transplant. In 2011, the corresponding proportions were 56% and 44%, respectively. This is consistent with prevalence data from 2007 to 2011, which show an increase in the proportion of treated-ESKD patients with a functioning kidney transplant, from 42% to 44%, respectively.



Notes

1. The solid lines represent existing registry data while the dotted lines are for projected prevalent cases.
2. The percentage increases from 2011 to 2020 for dialysis- and transplant-treated-ESKD cases are listed in the legend.

Source: AIHW analysis of ANZDATA Registry data.

Figure 3.2: Prevalence of registered and projected treated-ESKD, by treatment type, 2003–2020

Influence of diabetes

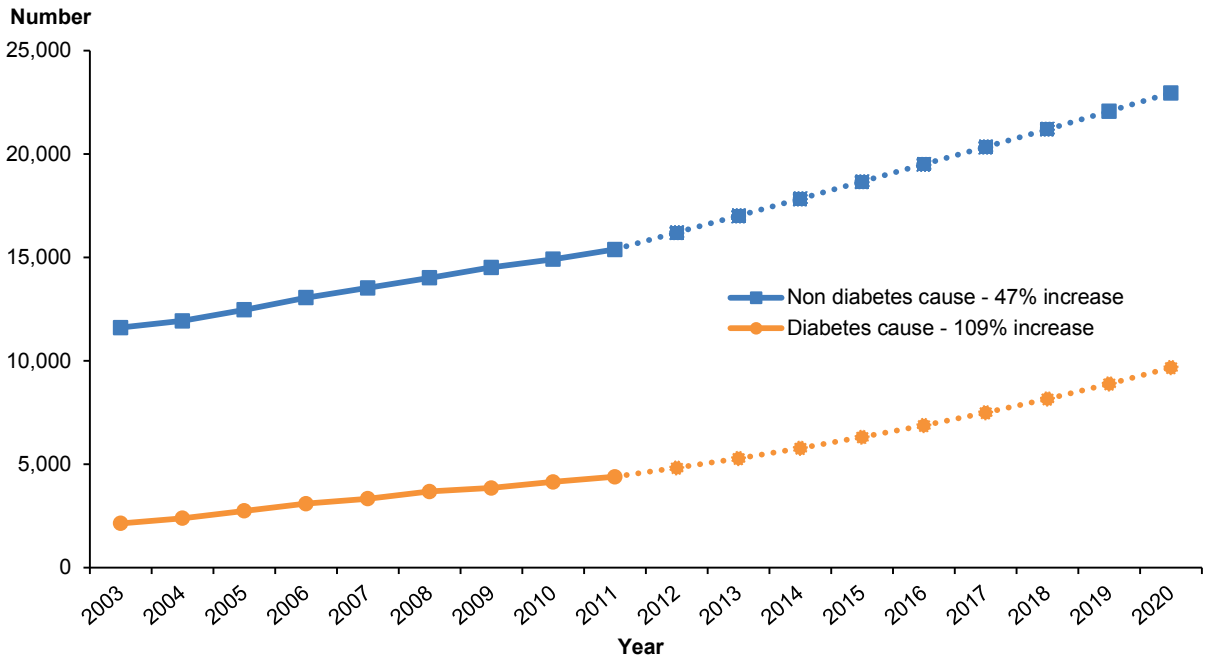
Over the last decade the prevalence of self-reported diabetes in Australia has more than doubled, increasing from 1.5% to 4.2% between 1989–90 and 2011–12 (AIHW 2013). This increasing prevalence of diabetes is a major contributor to the increase in CKD and treated-ESKD in Australia, with diabetes now the leading primary cause of new cases of treated-ESKD (ANZDATA 2013). In 2011, diabetes was the underlying cause in one-in-three new cases of treated-ESKD in Australia, compared with 13% in 1991 (ANZDATA 2013).

To assess the influence of diabetes on future treated-ESKD prevalence counts, the same methodology as for the 'base' model was used to create separate models for treated-ESKD with and without a primary cause of diabetes. It is important to note that the projected sum of non-diabetes and diabetes-related treated-ESKD prevalent cases does not equal the 'base' model-derived results. This is because of differences in the historical trends for treated-ESKD patients with and without diabetes as a primary cause, and different transition probabilities used in the 'base' model.

As shown in Figure 3.3, the prevalence of treated-ESKD is projected to increase faster for cases with diabetes listed as the primary cause than for patients without diabetes. The prevalence of treated-ESKD with diabetes as the primary cause is projected to more than double between 2011 and 2020 (from 4,392 in 2011 to 9,677 in 2020). This compares to a 47% projected increase (from 15,388 to 22,960 cases over this period) when diabetes is not the primary cause.

The proportion of prevalent treated-ESKD cases with an underlying cause of diabetes is also projected to increase over this period. In 1996, 10% of prevalent cases had diabetes as the primary cause; this increased to 22% in 2011 and is projected to increase to 30% in 2020.

These projection results indicate that the increasing burden of diabetes in Australia will continue to make a significant contribution to the increase in prevalence of treated-ESKD over the next decade.



Notes

1. The solid lines represent existing registry data while the dotted lines are for projected prevalent cases.
2. The projected sum of non-diabetes and diabetes-related treated-ESKD prevalent cases does not equal the 'base' model sum (see page 14).
3. The percentage increase from 2011 to 2020 for both models is listed in the legend.

Source: AIHW analysis of ANZDATA Registry data.

Figure 3.3: Prevalence of registered and projected treated-ESKD, by primary cause of treated-ESKD (diabetes versus non-diabetes), 2003–2020

4 Alternative models

This chapter compares results from alternative models to those from the 'base' model. These alternative models were created based on the results of model-fit analyses that assessed the incidence and Markov-model components of the 'base' prevalence projections model (see Appendix C). The aim of presenting results from these models is to provide a range of projection results, based on altering select assumptions underpinning the 'base' projections model.

Two alternative models to the 'base' model were constructed: a more conservative 'stable incidence' model and a less conservative 'improving dialysis treatment outcomes' model. Further information on the construction of these models is discussed in the Methods chapter and Appendix D.

'Stable incidence' model

Model-fit analysis comparing incidence projection data for the incidence model base years to the existing incidence data from the ANZDATA Registry (1996 to 2011) suggests that the 'base' prevalence projections model may overestimate the incidence of treated-ESKD (Figure C1). The main source of this potential overestimation is incidence data from older age groups (ages 65–74 and 75-and-above) in the projections model (see Figures C5 and C6). The 'stable incidence' model acts as a 'conservative estimate' model by assuming that the 2008–2011 ('stable') trend in incidence rates remains constant over the projection period. Other aspects of the model were the same as for the 'base' model.

According to the 'stable incidence' model, the prevalence of treated-ESKD is projected to increase by 45% from 19,780 in 2011 to 28,756 in 2020 (compared to a predicted 60% increase to 31,589 cases in 2020 in the 'base' prevalence projections model) (Figure 4.1).

The greatest relative difference between 'base' model and 'stable incidence' model results occurred in the 75-and-above incident age group (Table E4). In this age group, the 'stable incidence' model predicted 37% growth in prevalence of treated-ESKD from 2011 to 2020 (with 2,499 cases in 2020), compared to 112% growth in the 'base' model (with 4,130 cases in 2020).

This analysis has shown that when incidence rates are held constant across the projection years (a conservative estimate of future incident counts), the prevalence of treated-ESKD still increases substantially. These results suggest that increasing incidence rates are not the only factor driving future growth in treated-ESKD prevalence.

'Improving dialysis treatment outcomes' model

Model-fit analyses of the Markov model component of the prevalence projections model (see Appendix C) appear to indicate that the 'base' model may underestimate the prevalence of treated-ESKD in older incident age patients (age groups 65–74 and 75-and-above) (Figure C7). This is most likely due to the model not controlling for improving dialysis treatment outcomes for older patients (age groups 65–74 and 75-and-above) over the projection years. The 'improving dialysis treatment outcomes' model attempts to factor in improving dialysis treatment outcomes for older patients by altering the dialysis-death and dialysis-dialysis

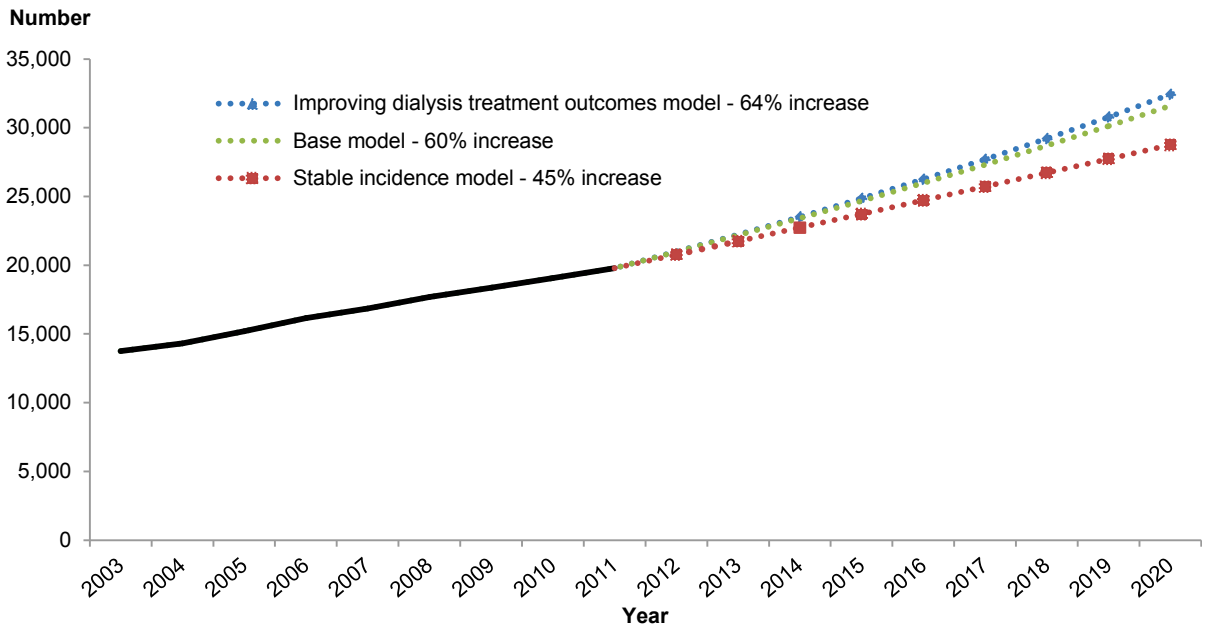
transition probabilities for older patients (age groups 65–74 and 75-and-above) over the projection years. Other aspects of the model were the same as for the 'base' model.

According to the 'improving dialysis treatment outcomes' model, the prevalence of treated-ESKD is projected to increase by 64% from 19,780 cases in 2011 to 32,437 in 2020. This compares to a predicted 60% increase to 31,589 cases in 2020 in the 'base' prevalence projections model (Figure 4.1).

In the 65–74 incidence age group, the 'improving dialysis treatment outcomes' model predicted a 83% growth in the prevalence of treated-ESKD from 2011 to 2020 (with 5,179 cases in 2020), compared with a 72% increase in the 'base' model (to 4,858 cases in 2020).

In the 75-and-above incident age group, the 'improving dialysis treatment outcomes' model predicted 155% growth in the prevalence of treated-ESKD from 2011 to 2020 (with 4,658 cases in 2020), compared with a 112% increase in the 'base' model (with 4,130 cases in 2020) (see Table E4).

This analysis has shown that when potential improvements in dialysis survival are factored into the projections model, the prevalence of treated-ESKD still increases at a similar rate to that in the 'base' model.



Notes

1. The solid lines represent existing registry data while the dotted lines are for projected prevalent cases.
2. The percentage increases from 2011 to 2020 for the models are listed in the legend.
3. Detailed projection results for all models are presented in Table E3 and by incident age group in Table E4.

The solid line represents existing registry data while the dotted lines are for projected prevalent cases.

Source: AIHW analysis of ANZDATA Registry data.

Figure 4.1: Comparison of treated-ESKD prevalence projection results using the various models, 2003–2020

5 Discussion

This report has highlighted that the prevalence of treated-ESKD is predicted to increase rapidly and considerably over the next decade. In 2011, there were just under 20,000 cases of treated-ESKD in Australia, with all three models—'base', 'stable incidence' and 'improving dialysis treatment outcomes'—predicting that this number is projected to increase to between 29,000 and 32,000 by 2020. All models predict at least a 45% growth in the prevalence of treated-ESKD between 2011 and 2020, with the 'base' and 'improving dialysis treatment outcomes' models predicting a growth in treated-ESKD prevalence of at least 60%. This is despite the Australian population only increasing 13% over this period (ABS 2013a).

The increasing prevalence predicted by the 'stable incidence' model (45% growth), and the relatively small (13%) population increase predicted over the projection years, suggest that there are other factors driving the predicted increase in the prevalence of treated-ESKD. Other likely contributing factors for future prevalence growth include: the ageing population; changes in propensity to treat ESKD with KRT; and improvements in survival for KRT patients. While it would be useful to detail the exact contribution of these factors on future prevalence growth, the projections methodology used in this report does not allow for such analysis. Some of these factors, such as propensity to treat, are also not able to be predicted.

Dialysis- and transplant-treated-ESKD prevalence counts are both predicted to increase steadily over the projection period. The number of patients treated with dialysis is predicted to increase 49% from 10,988 in 2011 to 16,382 in 2020, while the number of patients with a functioning kidney transplant is predicted to increase by 73%, from 8,782 in 2011 to 15,227 in 2020. The proportion of treated-ESKD patients with a functioning kidney transplant is estimated to increase to 48% in 2020 (compared with 44% in 2011).

Diabetes-specific projection results also suggest that the burden of diabetes-related treated-ESKD will continue to influence the increase in the prevalence of treated-ESKD over the next decade. The prevalence of treated-ESKD cases with diabetes as the primary cause is projected to increase 109% between 2011 and 2020, compared to a 47% increase for cases where diabetes is not the primary cause.

The projection results presented in this report are based on the projection assumptions outlined in Chapter 2, including the assumption that recent (2009 to 2011) KRT treatment patterns will continue over the projection years.

Implications of projections

The projected increase in the prevalence of treated-ESKD has significant implications for health service planning and resource allocation in the future, including the probable increasing need for dialysis services and kidney transplants. However, these results also highlight the ongoing need to prevent CKD and the progression of CKD to ESKD, by eliminating or reducing modifiable risk factors such as high blood pressure, tobacco smoking and obesity. The projection results also suggest that diabetes will continue to be a major driver of increases in treated-ESKD prevalence, and will continue to be an important area for further prevention activities. Such activity could include increased and early CKD screening in people with diabetes and other at-risk groups, as many interventions to slow progressive CKD are more successful the earlier they are initiated (Thomas 2007).

The issue of untreated-ESKD

The projection estimates presented in this report are based on data for patients already receiving KRT for their ESKD, and do not include those that are not receiving KRT. Previous AIHW analysis has shown that in 2003–2007, for every new ESKD patient who received KRT, there was one who did not (AIHW 2011b). The vast majority (more than 80%) of the new ESKD patients who did not receive KRT were aged over 70 years. The reasons for some patients not receiving KRT are not fully understood: prognosis; anticipated quality of life (with or without KRT); treatment burden on the patient; and patient preference all play a part in the decision for or against KRT (Murtagh et al. 2007). As a considerable number of new ESKD patients are not receiving KRT, this is also likely to be the case for prevalent treated-ESKD cases. This suggests that the treated-ESKD prevalence estimates presented in this report may be an underestimate of the true prevalence of future ESKD cases.

If the propensity for people to receive KRT changes over the projection years, it is possible that there could be a greater increase in the incidence of treated-ESKD and an increase in the number of people starting KRT treatment for their ESKD. This increase would likely lead to higher prevalence estimates than those presented in this report.

Future projections work

The prevalence projections models presented in this report provide a useful foundation for further testing the influence of certain drivers for the likely future increase in the prevalence of treated-ESKD. Such work is essential for better targeting of ESKD prevention strategies. For example, the model could be altered to assess the impact of further diabetes scenarios, such as the impact of possible reductions in new diabetes-related treated-ESKD cases.

The 'base' prevalence projections model could also be further altered to assess the impact of future changes in KRT treatment patterns on treated-ESKD prevalence and survival. For example, the effect of increasing kidney transplant rates to levels seen in other countries could be assessed, as well as the extent of any possible gains, in terms of increased survival, for such a scenario. Recent projections work undertaken for Kidney Health Australia indicates that increasing the rate of kidney transplantation by 50%, to match rates currently achieved in the United States and numerous European countries, would be associated with cost savings and greater health benefits (Cass et al. 2010).

Appendix A: Treatment options for end-stage kidney disease (ESKD)

Kidney replacement therapy (KRT)

KRT refers to procedures which temporarily or permanently remedy insufficient cleansing of body fluids by the kidneys. There are two forms of KRT: dialysis and kidney transplantation.

Dialysis

Dialysis is an artificial method of removing waste substances from the blood and regulating levels of circulating chemicals – functions normally performed by the kidneys. There are two main types of dialysis: peritoneal and haemodialysis.

Which form is used depends on the patient's health, age and lifestyle, and is influenced by the availability of local resources.

Haemodialysis is a form of dialysis where a machine is connected to a person's bloodstream to filter the blood externally to the body. This type of dialysis can be done at home, in hospital, or in satellite dialysis units. The main advantage of haemodialysis is that it generally takes a shorter amount of time and is done on fewer days each week than peritoneal dialysis. Its limitations are that patients need to plan their activities around their dialysis sessions; the need for special equipment limits a patient's ability to travel; and a patient's diet and the amount of fluid they can consume are limited (NHS 2013).

Peritoneal dialysis is a form of dialysis where a solution is pumped into the abdominal cavity where the body's own peritoneum membrane acts as a dialysis filter to remove waste products and water. Peritoneal dialysis can either be performed by the patient during the day (continuous ambulatory dialysis), usually 3 or 4 times a day, or automatically by a machine at night for around 8–10 hours while patient sleeps (automated peritoneal dialysis). The advantages of peritoneal dialysis include not having to make regular visits to a dialysis centre or have bulky equipment installed in the home; greater capacity for travel as the equipment required for peritoneal dialysis is portable; and fewer restrictions on diet and fluid intake. The limitations on peritoneal dialysis include that it needs to be carried out every day, and it increases the risk of developing inflammation of the abdominal lining (peritonitis) (NHS 2013).

Kidney transplantation

Transplantation is considered the preferred option for KRT by patients and health-care professionals (Mathew et al. 2005). Advantages of transplantation over dialysis include increased life expectancy and quality of life, and lower costs (Karnellis 2008). Drawbacks include taking ongoing medications to prevent rejection of the kidney, as these medications may cause complications (CIHI 2013). Donated kidneys come from either deceased or living donors (Kidney Health Australia 2007).

A number of factors can prevent people from being considered for kidney transplantation, including age; other health conditions; lifestyle factors such as obesity; smoking, drug and alcohol abuse; and an inability to comply with complex medical therapy (TSANZ 2011).

Transplantation can occur without a patient starting dialysis first, and in 2011 11% of all transplants in Australia were for patients receiving their first transplant without prior dialysis treatment (pre-emptive transplants) (ANZDATA 2013). This has advantages as the length of time spent on dialysis before transplantation is related to increased risk of mortality and decreased survival rates of the donated kidney (Karnellis 2008).

Transplants from living donors are considered to have several advantages over deceased-donor kidneys. These include avoidance of lengthy dependence on dialysis while waiting for a transplanted kidney from a deceased donor; the possibility of receiving a better matched kidney from a relative; the period that the kidney is without blood supply and 'on ice' is shorter, which means that the transplanted kidney usually works immediately; the transplant can be scheduled at a time suitable for the donor, the recipient and the transplant team; and live-donor kidneys work better and last longer than kidney transplants from deceased donors (Renal Resource Centre 2010). In 2011, 31% of kidney transplants came from living donors (ANZDATA 2013).

Non-KRT treated-ESKD

Non-KRT medical management of ESKD is another treatment choice and involves a shift from efforts to prolong life to focusing on care, quality of life and symptom control (Chandna et al. 2011). Prognosis; anticipated quality of life (with or without dialysis); treatment burden (if dialysis is undertaken); and patient preferences all play a part in the decision for or against KRT (Murtagh et al. 2007). Medications, diet and other therapies may be used to lessen symptoms. It is generally older patients that do not receive KRT to treat their ESKD (AIHW 2011a), due to factors such as comorbidities, length of lifespan, and quality of life (Murtagh et al. 2007).

Appendix B – Statistical methods

Time-series analysis

Time-series analyses presented throughout this report have used linear regression analysis to determine whether there have been significant increases or decreases in the observed rates for the period. In this report, comments have been made on significant increases or decreases only.

Percentage increases over the projection years were calculated using the last available registry data point (2011) as a base year. Using linear regression analysis means that all points within the analysis period are factored in when calculating total percentage changes, therefore limiting the influence of potential outliers.

Time-series data in this report are generally presented for the 18-year period from 2003 to 2020. The first 9 years of the period (2003 to 2011) consist of existing ANZDATA registry data while the remaining 9 years are projection results (2012 to 2020).

Prevalence model construction

The construction of the prevalence model involved two stages: projection of the incidence of dialysis- and transplant-treated-ESKD cases, and follow-up of these projected incident cases and existing prevalent cases to 2020.

Estimating the incidence of dialysis-treated- and transplant-treated-ESKD

Incident dialysis- and transplant-treated-ESKD counts needed to be projected for each year of the 2012 to 2020 projection period, as these were inputs into the projection model.

The first step in projecting the number of new transplant and dialysis cases required projecting the overall incidence of treated-ESKD. Incident transplant and dialysis cases were then estimated based on these numbers.

Projecting the incidence of treated-ESKD

The incidence of treated-ESKD was projected using the log-linear Poisson regression technique that was previously used by the AIHW for projecting the incidence of treated-ESKD (AIHW 2011b).

Projection of the incidence of treated-ESKD involved firstly summarising historical trends in the incidence rates reported by the ANZDATA Registry; identifying the most recent trend by examining existing data and using Joinpoint regression; and extrapolating it into the future (AIHW 2011b). The second step is the projection of incidence rates using the latest ABS population series B population projections (ABS 2013a).

Like other projections of disease incidence, the most important assumption in this report is that the most recent historical trend will continue into the future. An age-period modelling approach, which assumes disease incidence is a function of age (in age group) and period (in calendar year) effects, was applied to describe and extrapolate the historical trends of the incidence of treated-ESKD. The advantage of this approach is that the age and period effects

are treated as a proxy for the underlying causes of the disease's incidence (Dyba et al. 1997), involving minimal subjective judgement. The incidence model was also stratified by sex.

The age-period model used in this analysis is a log-linear Poisson regression mode (Kuh & Ben-Shlomo 2004). This model assumes the incidence of treated-ESKD, as a rare disease, followed a Poisson distribution. The model also assumes that the logarithmic transformed incident cases (with the population as an offset) is a function of age and period effects. The extrapolated incidence rates display an exponential growth trend.

The incidence model in this report used 5 age groupings (0–29, 30–49, 50–64, 65–74 and 75-and-above) and had 2 years of base data additional to those previously published AIHW projections work (1996 to 2011, instead of 1996 to 2009) (AIHW 2011b).

Projected incident treated-ESKD cases for each age group were estimated by applying projected incidence rates to the latest ABS population series B population projections (ABS 2013a).

Estimating dialysis and transplant counts

It is rare to start KRT with kidney transplantation (pre-emptive transplant); particularly in older age groups. This made it unsuitable to project pre-emptive transplant counts using a similar log-linear Poisson regression to the one used to project overall incident treated-ESKD cases. The projected numbers of pre-emptive transplants in each age group model were estimated using the latest trends in pre-emptive transplant rates. These counts were estimated by applying the average proportion of incident cases in 2008 to 2011 that were first treated with a (pre-emptive) transplant to the overall projected treated-ESKD incident count for each projection year. For example, for each year in the 0–29 incident age model, the estimated number of transplants was 21% of all projected incident cases for that age group.

The number of incident dialysis cases for each projection year was estimated as the number of remaining cases after applying the transplant proportion. For example, the estimated number of incident dialysis cases for each year of the 0–29 incident age model was 79% of the projected total treated-ESKD count each year.

Over the last decade there has been a slight increase in the proportion of younger (0–29, 30–49 and 50–64) incident treated-ESKD cases that received a pre-emptive transplant. This potentially means that the method used to estimate pre-emptive transplants may lead to an overall underestimation in the projected prevalence of treated-ESKD for younger age groups (as transplant patients tend to have better survival compared to dialysis cases).

Follow-up of projected incident cases and existing prevalent patients

Existing prevalent patients and projected incident patients were followed through the projection years using the 'base' prevalence projections model, consisting of 5 separate Markov models. These Markov models differed based on the incident age of the patients feeding into them (age groups 0–29, 30–49, 50–64, 65–74 and 75-and-above).

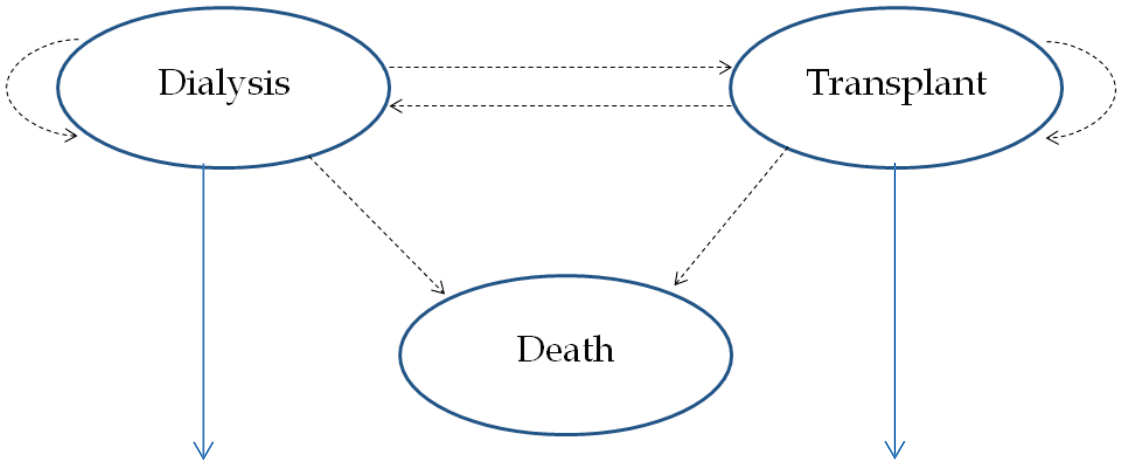
The 'base' model was based on incident age, rather than current age, as the projections methodology used did not allow for patients to move between the 5 Markov models as they aged during the projection period.

Markov models

Markov models are capable of modelling clinical conditions when risk is continuous over time. Markov models assume that a patient is always in one of a finite number of states referred to as Markov states. All events of interest are modelled as transitions from one state to another (Sonnenberg & Beck 1993); for example, from dialysis to death or from transplant to dialysis.

The Markov models used in the base prevalence model were divided into equal increments of time called Markov cycles. During each cycle, a patient may transition from one state to another or remain in the same state. It is assumed that a patient in a given state can only make a single state transition during a cycle (see 'Projection Assumptions' in Chapter 2). Often the choice of a cycle time will be determined by the available probability data, but a 1-year cycle is generally appropriate for relatively rare events, such as ESKD (Sonnenberg & Beck 1993). ANZDATA Registry records are also provided on a yearly basis, meaning that a 1-year cycle is the shortest cycle possible.

The prevalence of treated-ESKD was projected from 2012 to 2020, using a series of 5 Markov models. These models incorporated transfers between dialysis, transplant and death: that is, 3 Markov states (see Figure B1). There are 6 possible transitions between these states: dialysis to death; transplant to death; transplant to dialysis; dialysis to transplant; remaining on dialysis; or remaining with a functioning transplant.



Notes

1. The dotted lines represent the possible transitions within a Markov cycle.
2. Solid lines represent the outputs for the cycle after the cycle period (1 year) ends. These cases were inputs into the next projection year's cycle (see Figure B2).
3. Only one transition can occur during each Markov cycle (1 year).

Figure B1: Markov states and possible transitions during a Markov cycle (1 year) in the five Markov models making up the 'base' treated-ESKD prevalence projections model

Controlling for the effect of treatment length and incident age on Markov-state transition probabilities

The probabilities associated with transitioning between the 3 Markov states (transition probabilities) in Figure B1 depend on a number of factors, including patient age and the duration of their KRT treatment. Other factors, such as comorbid conditions, KRT treatment history and ethnicity also influence transition probabilities but these were not controlled for in the model (see Methods chapter).

Age-related differences in treatment outcomes (transition probabilities) were controlled for in the 'base' projections model by having different transition probabilities in the 5 incident age group Markov models used in the 'base' model (see Table B1).

The influence of treatment length was controlled for within each of the 5 Markov models by having 5 parallel Markov cycles (see Figure B2) in each projection year for patients of differing KRT treatment duration. The 5 Markov cycles included in each year of each Markov model were for patients during their:

- incident year, that is, first year of treatment (1 year)
- second year of treatment year (2 year)
- third year of treatment (3 year)
- fourth year of treatment (4 year)
- fifth or subsequent year of treatment (5 year).

Within each age group Markov model, each of these treatment-length Markov cycles had different transition probabilities, although these probabilities remained constant over the projection years. For example, the probability of transitioning from dialysis to transplant during the second year of treatment in the 50–64 incident age model was the same in every projection year.

Controlling for age and treatment length in the projections model resulted in 25 Markov cycles occurring in each projection year – 5 treatment-length cycles x 5 incident-age models.

Calculating transition probabilities

Transition probabilities for the 5 different Markov cycles in each incident age group model were based on the latest trends in treatment outcomes for treated-ESKD patients. The latest treatment trends were assessed by calculating the average transition probabilities for prevalent ANZDATA-registered patients during 2009–2011. Three years' worth of transition data were required due to small cell sizes for some of the transitions.

Table B1: Transition probabilities used to follow up existing prevalent patients and projected incident patients in the projection of the prevalence of treated-ESKD

Transition	Treatment length	Transition probabilities by incident age group				
		0–29	30–49	50–64	65–74	75+
Dialysis – Dialysis	1 year	0.855	0.914	0.926	0.904	0.876
Dialysis – Transplant	1 year	0.104	0.054	0.024	0.005	0.000
Dialysis – Death	1 year	0.041	0.032	0.050	0.092	0.124
Transplant – Dialysis	1 year	0.016	0.013	0.006	0.000	0.000
Transplant – Transplant	1 year	0.984	0.974	0.977	0.963	0.000
Transplant – Death	1 year	0.000	0.013	0.018	0.037	0.000
Dialysis – Dialysis	2 years	0.652	0.806	0.828	0.860	0.805
Dialysis – Transplant	2 years	0.311	0.124	0.072	0.013	0.000
Dialysis – Death	2 years	0.038	0.070	0.100	0.127	0.195
Transplant – Dialysis	2 years	0.017	0.000	0.006	0.000	0.000
Transplant – Transplant	2 years	0.949	1.000	0.970	1.000	0.000
Transplant – Death	2 years	0.034	0.000	0.024	0.000	0.000
Dialysis – Dialysis	3 years	0.735	0.826	0.817	0.828	0.780
Dialysis – Transplant	3 years	0.242	0.116	0.085	0.020	0.000
Dialysis – Death	3 years	0.024	0.057	0.098	0.152	0.220
Transplant – Dialysis	3 years	0.033	0.012	0.000	0.000	0.000
Transplant – Transplant	3 years	0.962	0.982	0.974	1.000	0.000
Transplant – Death	3 years	0.005	0.006	0.026	0.000	0.000
Dialysis – Dialysis	4 years	0.792	0.822	0.829	0.829	0.786
Dialysis – Transplant	4 years	0.188	0.113	0.072	0.015	0.001
Dialysis – Death	4 years	0.021	0.064	0.098	0.156	0.213
Transplant – Dialysis	4 years	0.028	0.002	0.003	0.017	0.000
Transplant – Transplant	4 years	0.967	0.989	0.978	0.950	0.000
Transplant – Death	4 years	0.005	0.009	0.020	0.033	0.000
Dialysis – Dialysis	5 years and above	0.849	0.822	0.812	0.816	0.761
Dialysis – Transplant	5 years and above	0.134	0.109	0.076	0.014	0.000
Dialysis – Death	5 years and above	0.017	0.069	0.112	0.170	0.239
Transplant – Dialysis	5 years and above	0.023	0.004	0.008	0.017	0.000
Transplant – Transplant	5 years and above	0.972	0.989	0.977	0.948	0.000
Transplant – Death	5 years and above	0.005	0.008	0.015	0.034	0.000

Notes

1. The above transition probabilities were used in the construction of 5 Markov models in the 'base' model and 'stable incidence' model – see Prevalence model construction (Appendix B).
2. Transition probabilities were calculated by following a cohort of treated-ESKD patients during 2009–2011.
3. Five-year transition probabilities were used for treated patients who had received treatment for 5 years or longer.
4. The prevalence model assumed that only a patient's current treatment modality, incident age and treatment length influenced transition probabilities.

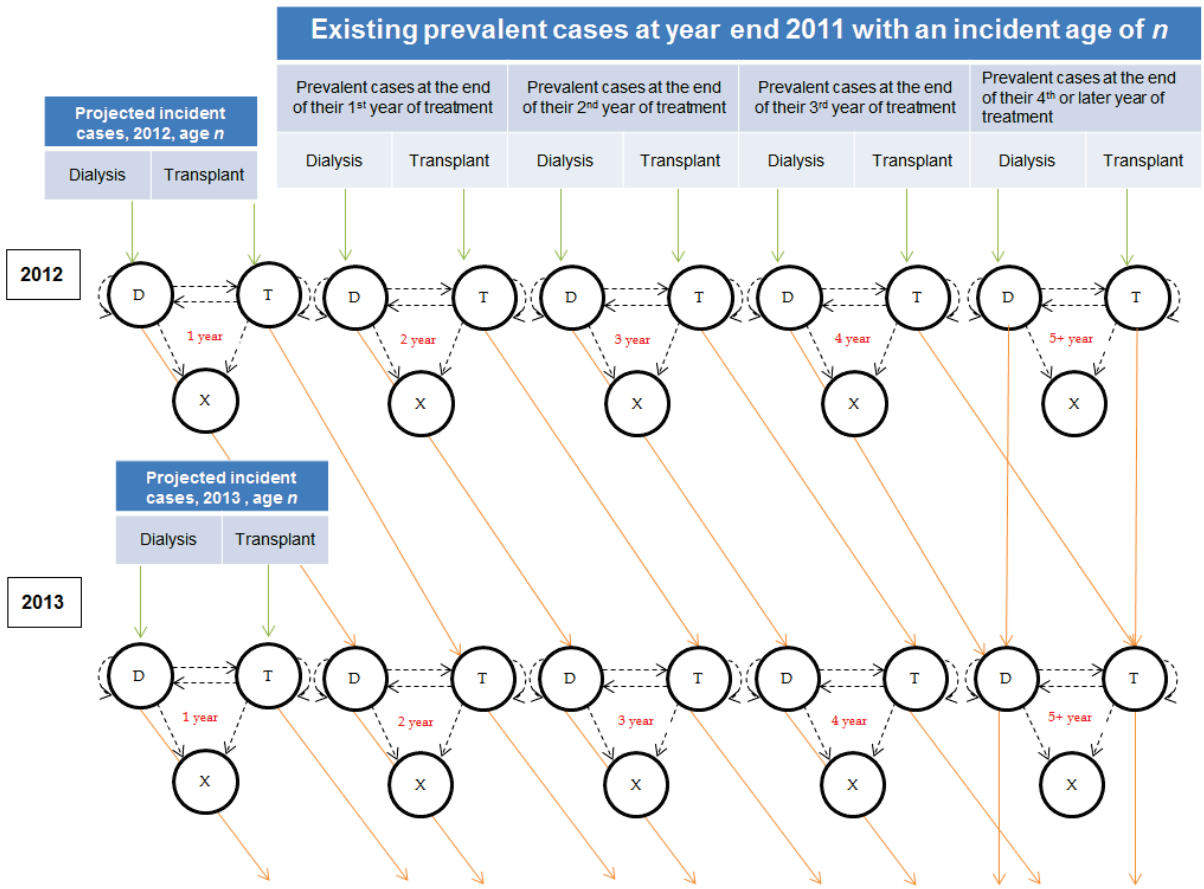
Source: AIHW analysis of ANZDATA Registry data.

Inputs for Markov models

For all projection years, in each incident age group model, estimated incident dialysis- and transplant-treated patients acted as the inputs for the 1-year cycles (see arrows entering the 1-year cycle in Figure B2).

In the first projection year, existing 2011 prevalent patients who started treatment at the same age as the incident patients feeding into the year 1 cycle (that is, had the same incident age) were the inputs for the 2-, 3- and 4-year and 5-years-and-above cycles (see 2012 cycle in Figure B2). During each projection year, patients could undergo one of 6 possible transitions (see dotted lines). If patients died during a projection year they dropped out of the model, while the surviving patients acted as inputs for the 2-, 3- and 4-year and the 5-years-and-above cycles of the subsequent year (see inputs into these cycles in 2013 in Figure B2). For example, the dialysis and transplant patients remaining at the end of the 2 year cycle in 2011 acted as inputs for 3 year cycle in 2012.

Patients remained in the same Markov model throughout the entire projection period, as each model was based on incident age, not current age. Current age could not be factored into the model as Markov modelling techniques are cohort-based.



Notes

1. The 'base' prevalence model had 5 separate parallel Markov models, with the same structure as above, for patients of differing incident ages (age groups 0–29, 30–49, 50–64, 65–74 and 75-and-above).
2. The 5 Markov cycles within each Markov cycle for each projection year were for patients of differing treatment length. Each cycle had three possible states (D – Dialysis, T – Transplant, X – Death), resulting in six possible transitions during each cycle (D-D, D-T, D-X, T-T, T-D and T-X).
3. The dotted lines represent the possible transitions within each Markov cycle.
4. Solid lines represent the outputs for the cycle after the cycle period.
5. Existing prevalent patients in the same incident age group acted as inputs for the 2–5+ year cycles in 2012.
6. The inputs and output pattern of the model from 2013 onwards remained the same; that is, incidence data acted as the input for the 1 year model and the outputs from the previous year's model acted as the input for the other cycles.
7. See Table B1 for the transition probabilities used in each Markov model.

Figure B2: Markov model component used in projection of the prevalence of treated-ESKD

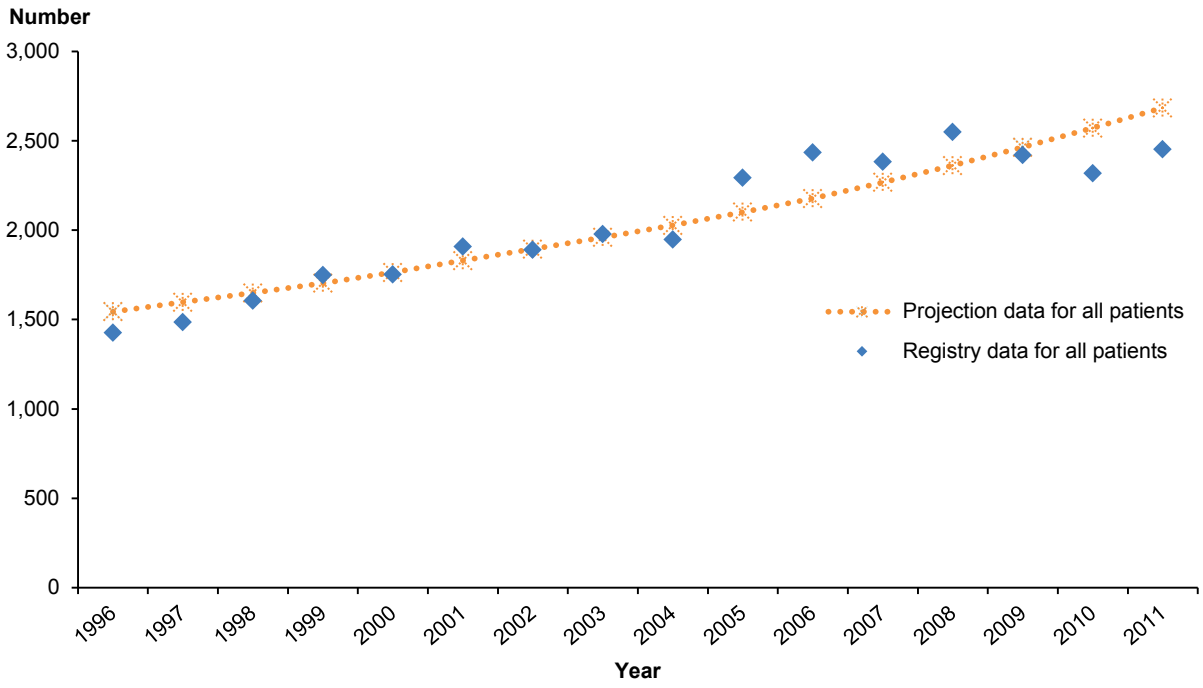
Appendix C – Model accuracy

Appendix C aims to independently assess the accuracy of the two components of the 'base' prevalence projections model: the incidence component and the follow-up component.

Incidence model accuracy

The analysis below assesses the model-fit of the incidence model by fitting the incidence projection data for incidence model base years to the existing incidence data from the ANZDATA Registry (1996 to 2011). A similar approach was taken in previous AIHW treated-ESKD incidence projection work (AIHW 2011b).

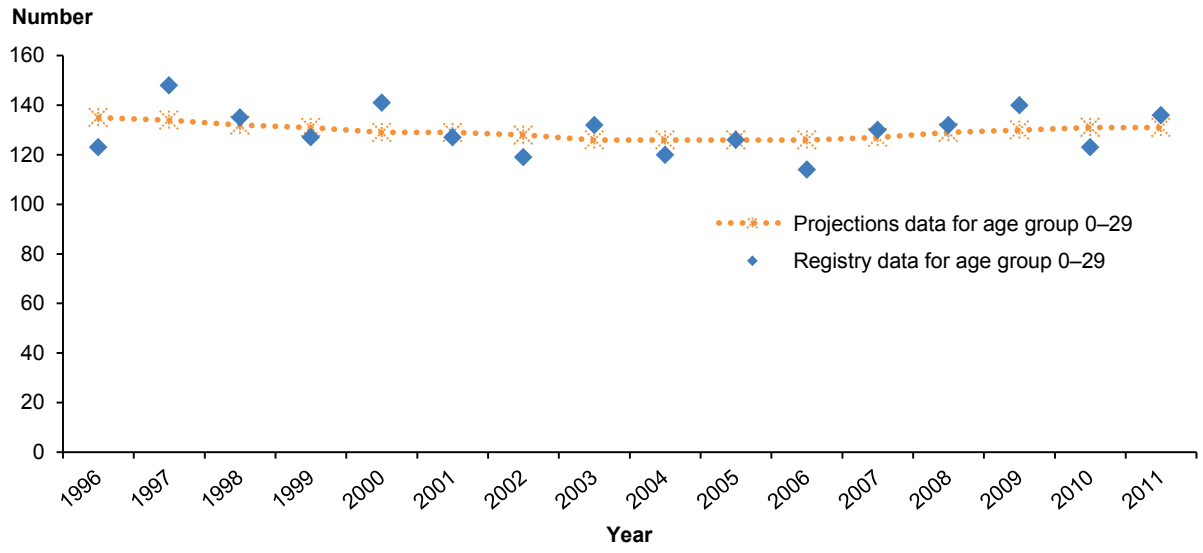
The overall incidence model fits existing incidence data well (see Figures C1–C6). However, the model appears to possibly overestimate the incidence of treated-ESKD in the 65–74 and 75-and-above age groups (Figure C5 and C6). This is most likely to be due to flattening in the incidence of treated-ESKD over the last 3 to 4 years for all (incident) age groups used in the prevalence projection model (see Figures C.1–C6). These findings appear to suggest that recent historical trends (1996–2011) in the incidence of treated-ESKD may not continue in the prevalence projection years (2012–2020), which is one of the key assumptions underpinning the 'base' projections model (see Chapter 2: Methods). As a result of this analysis, a prevalence projections model was constructed based on the assumption that incidence rates will remain constant over the projection years (see Chapter 4 and Appendix D).



Note: The squares represent existing registry data while the dotted line is for projected prevalent patients.

Source: AIHW analysis of ANZDATA Registry data.

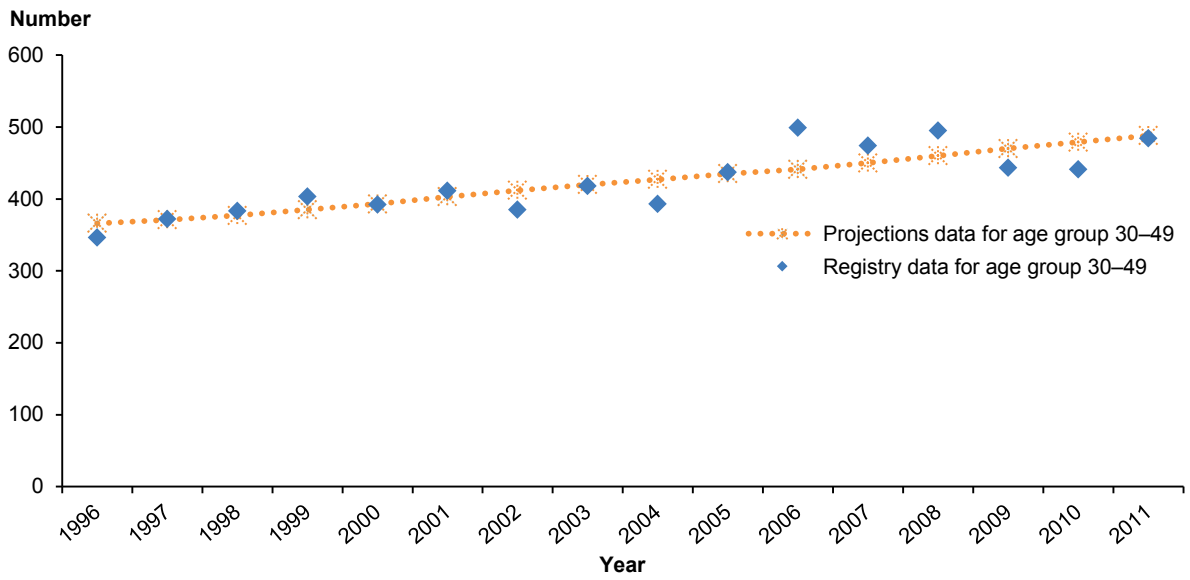
Figure C1: Annual incident counts of registered and projected treated-ESKD patients, 1996–2011



Note: The squares represent existing registry data while the dotted line is for projected prevalent patients.

Source: AIHW analysis of ANZDATA Registry data.

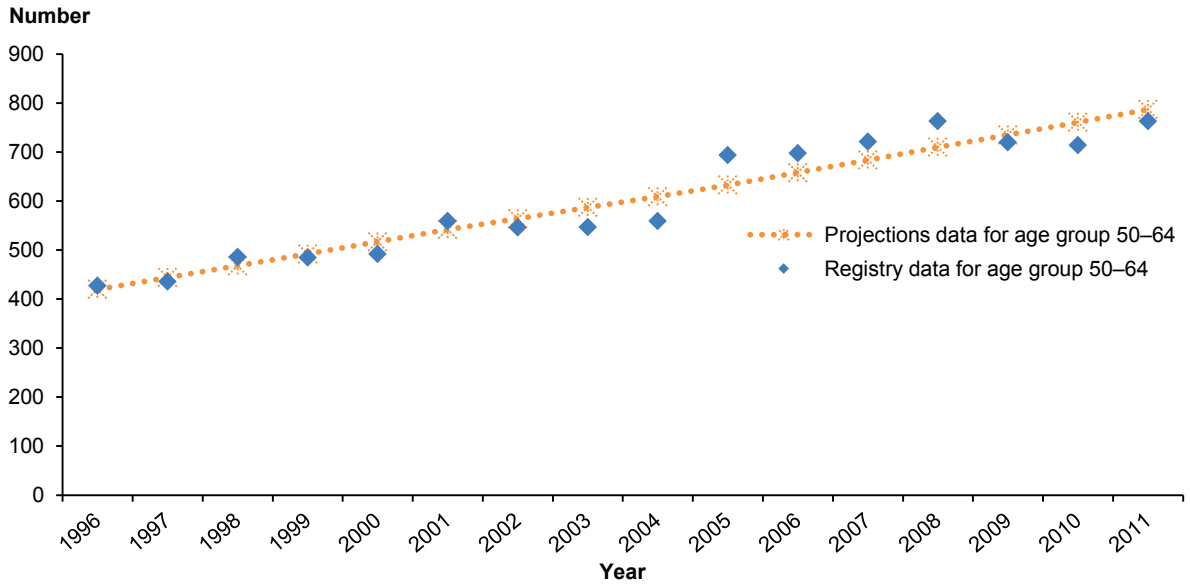
Figure C2: Annual incident counts of registered and projected treated-ESKD patients, 0–29 age group, 1996–2011



Note: The squares represent existing registry data while the dotted line is for projected prevalent patients.

Source: AIHW analysis of ANZDATA Registry data.

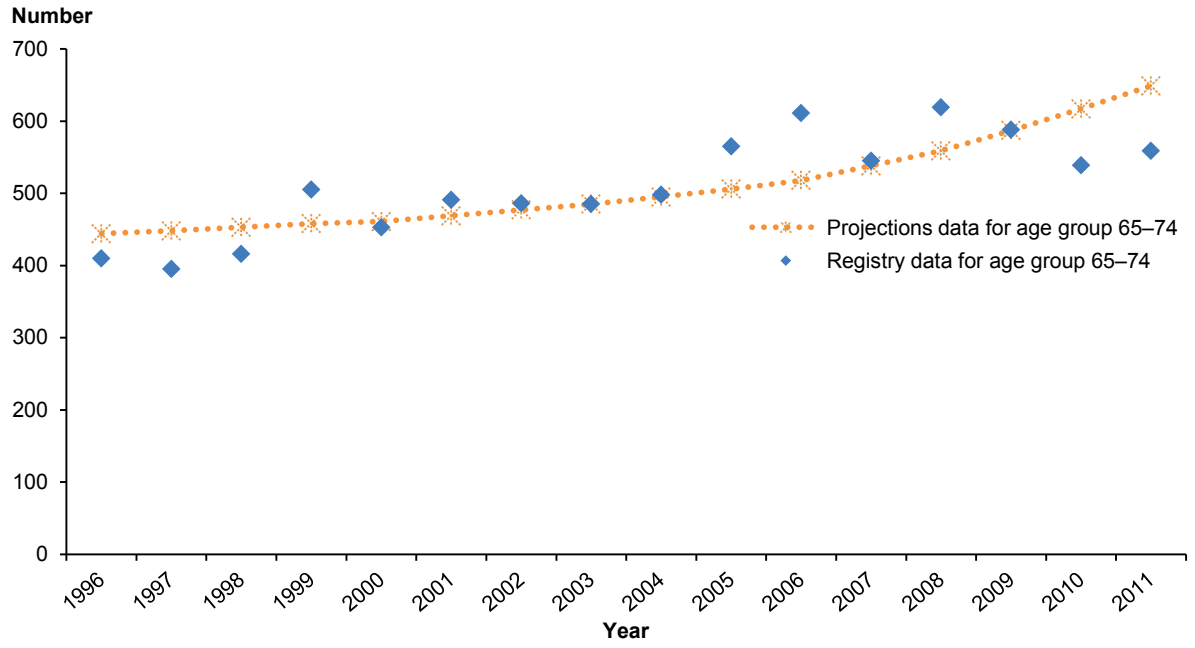
Figure C3: Annual incident counts of registered and projected treated-ESKD patients, 30−49 age group, 1996−2011



Note: The squares represent existing registry data while the dotted line is for projected prevalent patients.

Source: AIHW analysis of ANZDATA Registry data.

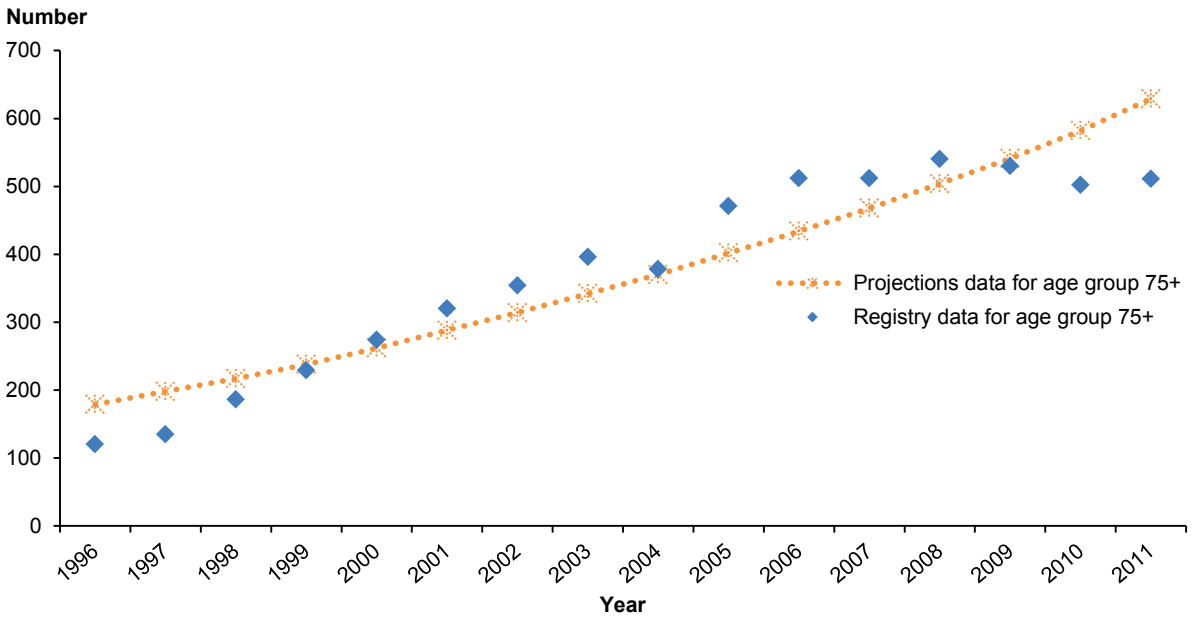
Figure C4: Annual incident counts of registered and projected treated-ESKD patients, 50−64 age group, 1996−2011



Note: The squares represent existing registry data while the dotted line is for projected prevalent patients.

Source: AIHW analysis of ANZDATA Registry data.

Figure C5: Annual incident counts of registered and projected treated-ESKD patients, 65–74 age group, 1996–2011



Note: The squares represent existing registry data while the dotted line is for projected prevalent patients.

Source: AIHW analysis of ANZDATA Registry data.

Figure C6: Annual incident counts of registered and projected treated-ESKD patients, 75+ age group, 1996–2011

Follow-up of patients over the projection period

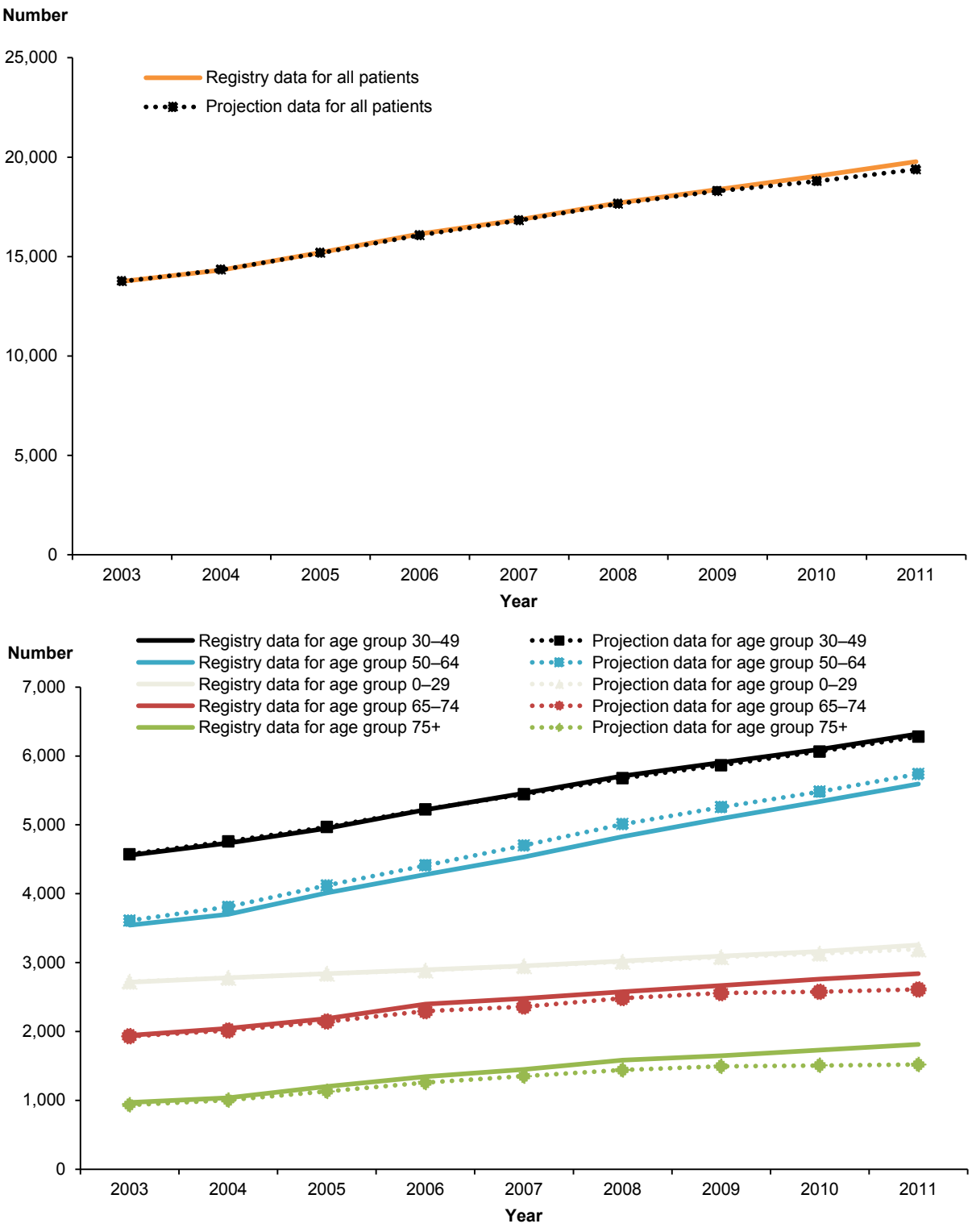
This section assesses the accuracy of the Markov model-based method for following up existing prevalent patients and projected new patients (incident patients) over the projection period.

Model accuracy was assessed by projecting the prevalence of treated-ESKD from 2003 to 2011 (the same number of projection years as for the 'base' model), using the same overall methods for following up patients, as discussed in Appendix B. These results were then compared to existing ANZDATA Registry data from the same period to assess model-fit.

Transition probabilities in the 2003 to 2011 model were calculated by following a cohort of patients who started KRT treatment in 2001 to 2003 (the same cohort length as the 'base' model). Actual incidence data were the inputs for the model, rather than projected patients, so accuracy of the Markov model methodology could be assessed separately to the projected incidence results feeding into this model.

Similar incidence and follow-up model-fit analyses have been carried out in other Markov modelling work (Gilbertson et al. 2005; Schaubel et al. 1998), but not for Australian-based ESKD prevalence projections work.

Generally, the prevalence of treated-ESKD was quite similar for registry data and projection data (Figure C7), with the Markov model component of the projections model slightly (2.0%) underestimating true prevalence counts. Only small differences occurred between registry data and projection data for most incident age groups; however, the models for age groups 65–74 (8.1%) and 75-and-above (16.1%) underestimated true prevalence counts.



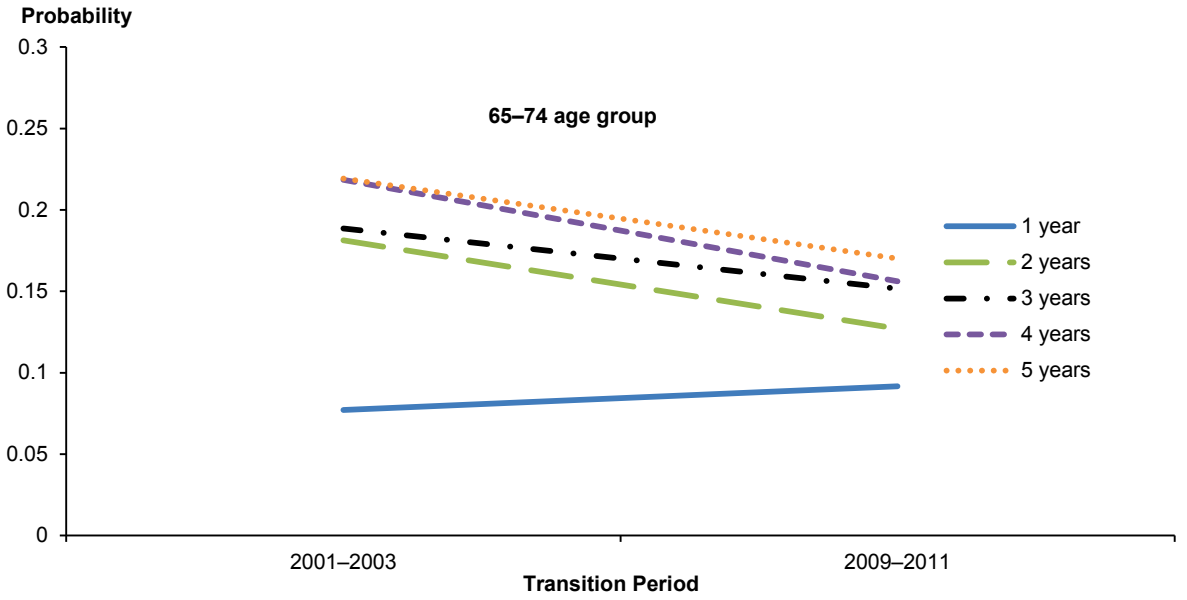
Note: The solid lines represent existing registry data while the dotted lines are for projected prevalent patients.

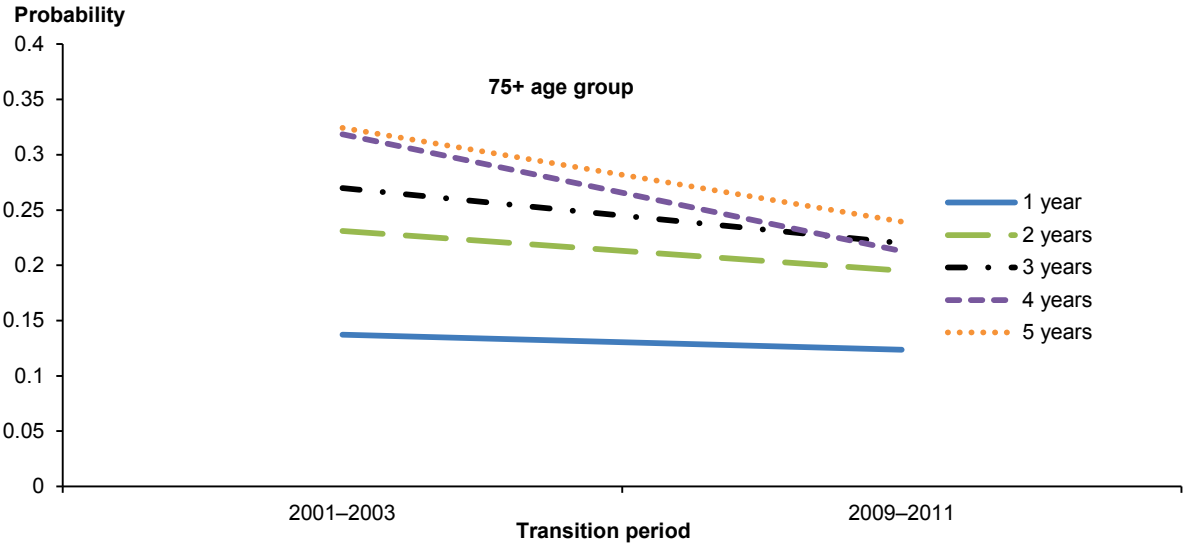
Source: AIHW analysis of ANZDATA Registry data.

Figure C7: Prevalence of registered and projected treated-ESKD, for all patients and by incident age, 2003–2011

These results suggest that the assumptions underpinning the 'base' model for following up existing prevalent patients lead to a underestimation in projection results in older incident age groups (ages 65–74 and 75-and-above), assuming similar treatment and incidence trends that occurred from 2003 to 2011 also occur from 2012 to 2020.

For older patients, the assumption most likely to be disproven is that treatment outcomes (transition probabilities) remain constant over the projection years. In particular, over the last decade there has been an improvement in dialysis survival for older patients (that is, a decrease in dialysis-death transition probabilities). Figure C8 shows the change in dialysis-death transition probabilities between the base years used to calculate the model-fit probabilities (1999–2001) and the base years used in the 'base' model (2009–2011). All transitions in the 75-and-above model, and all in the 65–74 age group model (except the 1 year cycle) show an improvement in dialysis treatment outcomes over time (Figure C8).





Notes

1. Time period refers to KRT treatment length for prevalent cohort.
2. Probability refers to the likelihood of dying while on dialysis (Dialysis – Death transition).
3. Decreases in transition probabilities over time indicate improved dialysis survival.

Source: AIHW analysis of ANZDATA Registry data.

Figure C8: Dialysis survival (likelihood of dying while on dialysis) for patients during 2001–2003 and 2009–2011, by treatment length and age.

As a result of improving dialysis treatment outcomes in older incident dialysis patients, a prevalence-projections model was constructed based on the assumption that similar improvements in survival will occur over the prevalence projection years (see Chapter 4 and Appendix D).

Appendix D – Alternative models

The model-accuracy analyses in Appendix C appear to indicate that the two following 'base' projection model assumptions might not hold over the projection years:

- **Assumption 1**: Recent historical trends in the incidence of dialysis- and transplant treated-ESKD will continue in the projection years.
- **Assumption 2:** Transition probabilities in each age group Markov model will remain constant over the projection years.

As a result of these model-accuracy analyses, two alternative models were constructed and compared to the 'base' model results, to give a range of prevalence results based on different projection scenarios. These results are presented in Chapter 4.

'Stable incidence' model

The potential for overestimation of future incidence rates was addressed in the 'stable incidence' model, which acts as a 'conservative estimate' model. The model assumes that the 2008–2011 ('stable') trend in incidence rates remains constant over the projection years. In this model, the average yearly incidence rate from 2008–2011, for each age group, was applied to the projection year populations to calculate estimated incident counts over the projection years. Incident dialysis and transplant patients were estimated from these ('stable') incidence counts using the same method as for the 'base' model (see Appendix B). All other aspects of the model remained the same as the 'base' projections model.

'Improving dialysis treatment outcomes' model

Model-fit analyses of the Markov model component of the prevalence-projections model (see Appendix C) appear to indicate that the 'base' model may underestimate the prevalence of treated-ESKD in older incident age patients (age groups 65–74 and 75-and-above) (Figure C7). This is most likely to be due to the model not controlling for improving dialysis treatment outcomes for older patients (age groups 65–74 and 75-and-above) over the projection years.

The 'improving dialysis treatment outcomes' model attempted to factor in improving dialysis treatment outcomes for older patients by altering the dialysis-death and dialysis-dialysis transition probabilities for older patients (age groups 65–74 and 75-and-above) over the projection years. The first step in the process was to use linear regression to calculate the annual rate (%) of change in dialysis-deaths transition probabilities over the 8 years (2003–2011) preceding the 8-year projection period (2012–2020) for the 5 treatment-length groups in the 2 older incident-age groups. This analysis resulted in 10 annual rates of change figures (5 for each incident age group).

The relevant annual-rate-of-change value was then applied over the projection years to the dialysis-death transitions, and the difference in probability as a result of this was added to the dialysis-dialysis (that is, dialysis survival) transitions. Any improvements in survival (in terms of reduction in dialysis-death transition probability) were applied to the dialysis-dialysis transitions, rather than to the dialysis-transplant transition probabilities, because the likelihood of transplantation is low in the 65–74 and 75-and-above incident age groups. (See Table D1 for a full list of the revised dialysis-dialysis and dialysis-death transitions

probabilities used in the 'improving dialysis treatment outcomes' model.) All other aspects of the 'improving dialysis treatment outcomes' model were the same as for the 'base' model.

Table D1: Transition probabilities used to follow-up existing prevalent patients and projected incident patients in the 'improving dialysis treatment outcomes' model

		Transition probabilities by incident age group and transition			
		65–74 age group		75+ age group	
Treatment length	Projection year	Dialysis–Dialysis	Dialysis–Death	Dialysis–Dialysis	Dialysis–Death
1 year	2012	0.899	0.095	0.878	0.122
1 year	2013	0.894	0.100	0.878	0.122
1 year	2014	0.889	0.105	0.879	0.121
1 year	2015	0.884	0.110	0.879	0.121
1 year	2016	0.878	0.116	0.879	0.121
1 year	2017	0.872	0.122	0.879	0.121
1 year	2018	0.866	0.128	0.879	0.121
1 year	2019	0.860	0.134	0.879	0.121
1 year	2020	0.853	0.141	0.879	0.121
2 years	2012	0.863	0.123	0.808	0.192
2 years	2013	0.867	0.119	0.811	0.189
2 years	2014	0.871	0.116	0.815	0.185
2 years	2015	0.875	0.112	0.818	0.182
2 years	2016	0.878	0.109	0.821	0.179
2 years	2017	0.881	0.105	0.824	0.176
2 years	2018	0.885	0.102	0.827	0.173
2 years	2019	0.888	0.099	0.830	0.170
2 years	2020	0.891	0.096	0.833	0.167
3 years	2012	0.831	0.149	0.787	0.213
3 years	2013	0.834	0.146	0.793	0.207
3 years	2014	0.838	0.142	0.799	0.201
3 years	2015	0.843	0.137	0.805	0.195
3 years	2016	0.847	0.133	0.811	0.189
3 years	2017	0.851	0.129	0.816	0.184
3 years	2018	0.855	0.125	0.822	0.178
3 years	2019	0.859	0.121	0.827	0.173
3 years	2020	0.863	0.117	0.832	0.168

Table D1 (continued): Transition probabilities used to follow-up existing prevalent patients and projected incident patients in the 'improving dialysis treatment outcomes' model

		Transition probabilities by incident age group and transition			
		65–74 age group		75+ age group	
Treatment length	Projection year	Dialysis–Dialysis	Dialysis–Death	Dialysis–Dialysis	Dialysis–Death
4 years	2012	0.834	0.152	0.795	0.204
4 years	2013	0.838	0.148	0.803	0.195
4 years	2014	0.841	0.144	0.812	0.187
4 years	2015	0.845	0.140	0.819	0.179
4 years	2016	0.849	0.136	0.827	0.172
4 years	2017	0.853	0.133	0.834	0.165
4 years	2018	0.856	0.129	0.841	0.158
4 years	2019	0.860	0.126	0.848	0.151
4 years	2020	0.863	0.123	0.854	0.145
5 years and above	2012	0.821	0.165	0.768	0.232
5 years and above	2013	0.826	0.161	0.774	0.226
5 years and above	2014	0.830	0.156	0.781	0.219
5 years and above	2015	0.834	0.152	0.788	0.212
5 years and above	2016	0.839	0.148	0.794	0.206
5 years and above	2017	0.843	0.144	0.800	0.200
5 years and above	2018	0.847	0.140	0.806	0.194
5 years and above	2019	0.851	0.136	0.812	0.188
5 years and above	2019	0.854	0.132	0.817	0.183

Notes

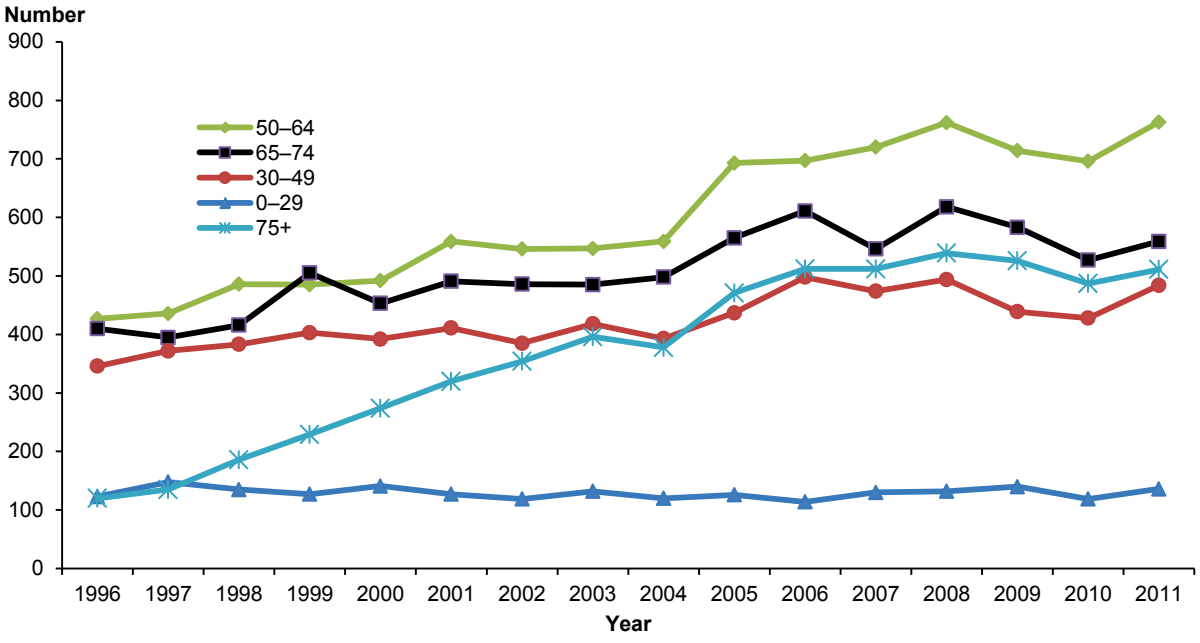
1. The transition probabilities in this table were used in the construction of the 65–74 and 75+ Markov models in the 'improving dialysis treatment outcomes' model.
2. Transplant transition probabilities (transplant-death, transplant-transplant, dialysis-transplant) and transition probabilities in the ages 0–29, 30–49, 50–64 models were the same as for the 'base' model.

Source: AIHW analysis of ANZDATA Registry data.

Appendix E – Detailed data

Existing treated-ESKD incidence trends

Figure E1 below illustrates the recent stabilising of the incidence of treated-ESKD. The 'stable incidence' model controls for this trend and is explained in the 'stable incidence' model section of the Methods chapter.



Source: AIHW analysis of ANZDATA Registry data.

Figure E1: New treated-ESKD patients, by incident age, 1996 to 2011

Incidence projection results

Table E1: Projected dialysis-treated and transplant-treated incident ESKD counts from the 'base' model, 2012–2020

Year	Incident dialysis patients	Incident transplant patients	Total incident patients
2012	2,699	111	2,810
2013	2,826	114	2,940
2014	2,960	117	3,077
2015	3,099	119	3,218
2016	3,243	122	3,365
2017	3,398	125	3,523
2018	3,562	128	3,690
2019	3,737	131	3,868
2020	3,928	134	4,062

Source: AIHW analysis of ANZDATA Registry data.

Table E2: Projected dialysis-treated and transplant-treated incident ESKD counts from the 'base' model, by age group, 2012–2020

Year	Age group	Incident dialysis patients	Incident transplant patients	Total incident patients
2012	0–29	109	22	131
2013	0–29	109	22	131
2014	0–29	109	23	132
2015	0–29	110	23	133
2016	0–29	110	23	133
2017	0–29	111	23	134
2018	0–29	111	23	134
2019	0–29	111	23	134
2020	0–29	111	23	134
2012	30–49	455	44	499
2013	30–49	467	45	512
2014	30–49	481	46	527
2015	30–49	494	48	542
2016	30–49	509	49	558
2017	30–49	525	51	576
2018	30–49	541	52	593
2019	30–49	556	54	610
2020	30–49	572	55	627
2012	50–64	769	39	808
2013	50–64	791	40	831
2014	50–64	813	41	854
2015	50–64	834	42	876
2016	50–64	855	43	898
2017	50–64	875	44	919
2018	50–64	897	45	942
2019	50–64	921	46	967
2020	50–64	946	48	994
2012	65–74	686	6	692
2013	65–74	723	6	729
2014	65–74	757	7	764
2015	65–74	792	7	799
2016	65–74	827	7	834
2017	65–74	859	8	867
2018	65–74	896	8	904
2019	65–74	927	8	935
2020	65–74	959	8	967
2012	75+	680	0	680
2013	75+	737	0	737
2014	75+	800	0	800
2015	75+	868	0	868
2016	75+	942	0	942
2017	75+	1,027	0	1,027
2018	75+	1,117	0	1,117
2019	75+	1,222	0	1,222
2020	75+	1,340	0	1,340

Source: AIHW analysis of ANZDATA Registry data.

Prevalence projection results

Table E3: Projected prevalence counts from the 'base' model, the 'stable incidence' model and the 'improving dialysis treatment outcomes' model, total persons, 2012–2020

Year	Incident age group	'Base' model	'Stable incidence' model	'Improving dialysis treatment outcomes' model
2012	Total	20,968	20,769	20,987
2013	Total	22,174	21,750	22,230
2014	Total	23,412	22,735	23,523
2015	Total	24,682	23,726	24,867
2016	Total	25,983	24,720	26,259
2017	Total	27,320	25,719	27,708
2018	Total	28,696	26,724	29,216
2019	Total	30,117	27,736	30,789
2020	Total	31,589	28,756	32,437
Percentage Increase[(a)]		**59.6%**	**45.3%**	**63.8%**

(a) Percentage increases over the projection years were calculated using the last available registry data point (2011) as a base year.

Source: AIHW analysis of ANZDATA Registry data.

Table E4: Projected prevalent counts from 'base' model, 'stable incidence' model and 'improving dialysis treatment outcomes' model by incident age group, 2012–2020

Year	Incident age group	'Base' model	'Stable incidence' model	'Improving dialysis treatment outcomes' model
2012	0–29	3,352	3,358	3,352
2013	0–29	3,449	3,462	3,449
2014	0–29	3,546	3,567	3,546
2015	0–29	3,644	3,673	3,644
2016	0–29	3,741	3,781	3,741
2017	0–29	3,839	3,889	3,839
2018	0–29	3,936	3,999	3,936
2019	0–29	4,033	4,110	4,033
2020	0–29	4,129	4,222	4,129
2011–2020 percentage increase[(a)]		**26.9%**	**29.7%**	**26.9%**
2012	30–49	6,576	6,555	6,576
2013	30–49	6,878	6,831	6,878
2014	30–49	7,192	7,112	7,192
2015	30–49	7,516	7,400	7,516
2016	30–49	7,851	7,695	7,851
2017	30–49	8,199	7,996	8,199
2018	30–49	8,558	8,302	8,558
2019	30–49	8,928	8,613	8,928
2020	30–49	9,307	8,928	9,307
2011–2020 percentage increase[(a)]		**48.2%**	**42.2%**	**48.2%**
2012	50–64	5,974	5,945	5,974
2013	50–64	6,355	6,289	6,355
2014	50–64	6,742	6,634	6,742
2015	50–64	7,133	6,976	7,133
2016	50–64	7,529	7,315	7,529
2017	50–64	7,928	7,652	7,928
2018	50–64	8,333	7,986	8,333
2019	50–64	8,744	8,320	8,744
2020	50–64	9,164	8,654	9,164
2011–2020 percentage increase[(a)]		**63.7%**	**54.6%**	**63.7%**
2012	65–74	3,053	3,013	3,061
2013	65–74	3,273	3,192	3,296
2014	65–74	3,497	3,373	3,542
2015	65–74	3,722	3,556	3,797
2016	65–74	3,949	3,739	4,060
2017	65–74	4,176	3,920	4,329
2018	65–74	4,405	4,102	4,608
2019	65–74	4,632	4,279	4,891
2020	65–74	4,858	4,454	5,179
2011–2020 percentage increase[(a)]		**71.4%**	**57.2%**	**82.7%**
2012	75+	2,013	1,899	2,024
2013	75+	2,219	1,976	2,252
2014	75+	2,436	2,049	2,502
2015	75+	2,667	2,120	2,777
2016	75+	2,911	2,190	3,077
2017	75+	3,177	2,262	3,412
2018	75+	3,464	2,335	3,780
2019	75+	3,780	2,414	4,193
2020	75+	4,130	2,499	4,658
2011–2020 percentage increase[(a)]		**111.8%**	**37.0%**	**154.9%**

(a) Percentage increases over the projection years were calculated using linear registration with the last available registry data point (2011) as a base year.

Source: AIHW analysis of ANZDATA Registry data.

Glossary

chronic kidney disease (CKD)	Refers to all kidney conditions where a person has evidence of kidney damage and/or reduced kidney function, lasting at least 3 months, regardless of the specific diagnosis of the disease or condition causing the disease.
comorbidity	When a person has 2 or more health problems at the same time.
diabetes (diabetes mellitus)	A chronic condition in which the body cannot properly use its main energy source, the sugar glucose. This is due to a relative or absolute deficiency in insulin, a hormone that is produced by the pancreas and helps glucose enter the body's cells from the bloodstream and then be processed by them. Diabetes is marked by an abnormal build-up of glucose in the blood, and it can have serious short- and long-term effects.
diabetic nephropathy	Disease of the capillaries of the glomeruli (a component of the basic filtering unit in the kidney) caused by **diabetes**.
dialysis	An artificial method of removing waste substances from the blood and regulating levels of circulating chemicals—functions usually performed by the kidneys.
end-stage kidney disease (ESKD)	The most severe stage of **chronic kidney disease**. It occurs when kidney function has deteriorated so much that it is no longer sufficient to sustain life, and kidney replacement therapy (KRT) in the form of **dialysis** or **kidney transplantation** is required for the patient to survive.
haemodialysis	A form of **dialysis** where a machine is connected to a person's bloodstream and then filters the blood externally to the body, removing water, excess substances and waste from the blood as well as regulating the levels of circulating chemicals. In doing this the machine takes on the role normally played by the kidneys. Haemodialysis is provided largely in hospitals or **satellite dialysis units**.

incidence	The number of new cases (of an illness, disease or event) occurring during a given period. Compare with **prevalence**.
incident patient	A new (treated-ESKD) patient. Compare with **prevalent patient**.
kidney replacement therapy (KRT)	Having a functional **kidney transplant** or receiving regular **dialysis**.
kidney transplant	A healthy kidney is taken from one person and surgically placed into someone with ESKD. The kidney can come from a live or deceased donor.
Markov states	Possible states (dialysis, transplant, death) in the Markov-model-based projection models used in this report.
peritoneal dialysis	A form of **dialysis** where a solution is pumped into the abdominal cavity, where the body's own peritoneum — the lining of that cavity— acts as a dialysis filter to remove waste products and water.
pre-emptive transplant	A transplant performed on a patient without prior **dialysis** treatment.
prevalence	The number or proportion (of cases, instances) present in a population at a given time. Compare with **incidence**.
prevalent patient	An existing (treated-ESKD) patient. Compare with **incident patient**.
satellite dialysis unit	A dialysis unit to provide **dialysis** away from a hospital.
transition probability	The likelihood of transitioning between Markov states, or remaining in the same state. For example, the likelihood of transitioning from **dialysis** treatment to death.

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List of figures

End-stage kidney disease (ESKD) is the most severe form of chronic kidney disease with patients usually requiring kidney replacement therapy in the form of dialysis or kidney transplantation to survive.

Projections of the prevalence of treated end-stage kidney disease in Australia presents national level projections of the number of people receiving kidney replacement therapy for their ESKD for the period 2012 to 2020. This information is important for predicting the future burden of ESKD in Australia.