



# Cause of death for living kidney donors and people with end stage kidney disease, in Australia and New Zealand; a data linkage study (the CELESTIAL study)

## **Acknowledgements and Disclaimers**

The analysis presented in this report was undertaken by the CELESTIAL team. The interpretation is theirs alone.

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This research was led by Professor Angela Webster

The projects within the CELESTIAL study were undertaken by: Nicole L De La Mata, Brenda M Rosales, Emma O'Lone, Melanie Wyld and Victor Zhou.

Collaborators on projects within CELESTIAL were: Philip Clayton, Jonathan Craig, Steve Chadban, Patrick J Kelly, Stephen MacDonald, Philip Masson, Rachael Morton, Maria Alfaro-Ramirez, Rustam Al-Shahi Salman, Claire Vajdic, and Kate Wyburn.

This report was written by Nicole L De La Mata, Patrick J Kelly, Pinika Patel and Angela C Webster.

### **Funding:**

The CI Professor Angela Webster received a \$46,000 Kidney Health Australia Project Grant in the 2014 round, for a project entitled "Death from stroke and heart disease in people with end-stage kidney disease". This funding contributed to the data linkage endeavour, which formed the basis of the subsequent expansion into the CELESTIAL study.

# **Cause of death for living kidney donors and people with end stage kidney disease, in Australia and New Zealand; a data linkage study (the CELESTIAL study)**

Ethics approval for this project was granted by the University of Sydney Human Research Ethics Committee.

**HREC reference number:** 2014/917

**Date received:** 31 October 2014

## **Study Details:**

A cohort study using data linkage to compare people with end stage kidney disease (ESKD) and living kidney donors versus the general population. The datasets of people with ESKD, living kidney donors in Australia and New Zealand, and the Australians and New Zealand population were linked to investigate cause of death in these three study populations. These datasets included those managed by the Australia and New Zealand Dialysis and Transplant Registry (ANZDATA), The Australian Institute for Health and Welfare (AIHW) and the NZ Ministry of Health.

The study aimed to compare the death rates from;

- stroke and specific types of strokes (ischaemic, haemorrhagic and all-cause stroke)
- heart disease and specific causes of heart disease (ischaemic heart disease, cardiomyopathies and arrhythmias)
- cancers and specific types of cancers (breast, lung, bowel, prostate, melanoma and haematological malignancies)
- all other causes,

between people with ESKD and the general population and between living kidney donors and the general population in Australia and New Zealand. We were also interested in how having a kidney transplant affected the risk of death by these causes, compared to patients on dialysis. Once underway we expanded the questions of interest to include how people who withdraw from treatment (dialysis or transplant) have their deaths recorded.

## CELESTIAL PROJECTS

### 1. Absolute risk and risk factors for stroke mortality in patients with end stage kidney disease (ESKD): retrospective population-based cohort using data linkage

**Investigators:** Nicole De La Mata, Angela Webster, Patrick Kelly, Maria Alfaro-Ramirez, Rustam Al-Shahi Salman

#### Summary

This study aimed to evaluate risk factors associated with stroke mortality in people with ESKD in Australia and New Zealand. One of the main findings of this study was that women with ESKD were 41% more likely to die from a stroke death compared with men with ESKD. Additionally, ESKD patients with a history of cerebrovascular disease were more than twice as likely to die of stroke compared with those without cerebrovascular disease. Other factors associated with higher risk of stroke death were older age, with hypertensive/renovascular or polycystic kidney disease causing ESKD, with earlier year of ESKD treatment and receiving dialysis. We concluded that these groups may benefit from targeted stroke prevention interventions.

#### Dissemination/Awards

This study was presented at the following conferences:

- Australian and New Zealand Society of Nephrology (ANZSN) Annual Scientific Meeting, September 2017 in Darwin, Australia and presented by Nicole De La Mata:  
*De La Mata NL, Alfaro-Ramirez M, Masson P, Al-Shahi Salman R, Kelly PJ, Webster AC. Absolute risk and risk factors for stroke mortality in patients with end-stage kidney disease (ESKD): population-based cohort study using data linkage. Nephrology, 2017. 22(S3): 19.*

#### Publication arising:

De La Mata NL, Alfaro-Ramirez M, Kelly PJ, Masson P, Al-Shahi Salman R, Webster AC. Absolute risk and risk factors for stroke mortality in patients with end-stage kidney disease (ESKD): population-based cohort study using data linkage. *BMJ open*. 2019 Feb 1;9(2): e026263.

**Link/access:** <https://bmjopen.bmj.com/content/9/2/e026263.long>

## 2. Death from stroke in the ESKD population: A cohort linkage study in Australia and New Zealand, 1980-2013

**Investigators:** Nicole De La Mata, Philip Masson, Rustam Al-Shahi Salman, Patrick Kelly, Angela Webster.

### Summary

This study looked at the stroke death in people with ESKD compared with the general population in Australia and New Zealand over a 30-year period. The study found that all cause stroke deaths were more than three times higher in the ESKD population compared to people in the general population, mainly from haemorrhagic stroke. Younger people and women with ESKD had a higher rate of stroke mortality, when compared with age and sex matched people in the general population. Although over time the rates of stroke death in people with ESKD decreased, it was still double that of the general population at the end of the 30-years period.

### Dissemination/Awards

This study was presented at the following conferences:

- Australian and New Zealand Society of Nephrology (ANZSN) Annual Scientific Meeting, September 2017 in Darwin, Australia and presented by Nicole De La Mata:

*Masson P, De La Mata NL, Al-Shahi Salman R, Kelly PJ, Webster AC. Death from Stroke in the ESKD Population: A Cohort Study in Australia and New Zealand, 1980-2013. Nephrology, 2017. 22(S3): 54-54.*

### Publication arising:

De La Mata NL, Masson P, Al-Shahi Salman R, Kelly PJ, Webster AC. Death from stroke in end stage kidney disease: a population-based study using data linkage. *Stroke*. 2019;50(2):487-490

**Link/access:** <https://www.ahajournals.org/doi/10.1161/STROKEAHA.118.023644>

### 3. Cancer mortality in kidney transplant recipients: an Australian and New Zealand population-based cohort study, 1980-2013

**Investigators:** Brenda Rosales, Nicole De La Mata, Claire Vajdic, Patrick Kelly, Kate Wyburn, Angela Webster

#### Summary

This study compared death rates from cancer between kidney transplant recipients and the general population in Australia and New Zealand. The study showed cancer mortality in kidney transplant recipients was higher than expected in the general population, over the 30-year period. The magnitude of excess mortality varied by cancer site, age and sex. Cancers with the highest relative mortality risk were viral associated including, lymphoma (associated with Epstein Barr Virus infection) and cancers thought to be associated with impaired immune surveillance such as non-melanoma and melanoma skin cancers. Conversely, the relative risk of death for cancers with high mortality burden in the general population including, breast cancer in females and prostate in males were not increased in our cohort. We concluded that the relative cancer mortality risk in kidney transplant recipients has not changed, despite improvements in cancer diagnosis and treatments decreasing cancer mortality in the general population.

#### Dissemination/Awards

This study was presented at the following conferences:

- The Transplantation Society of Australia and New Zealand (TSANZ) Annual Scientific Meeting, 2018 in Melbourne, Australia and presented by Brenda Rosales, awarded **Early Career Researcher Award**:  
*Rosales B, De La Mata NL, Kelly P, Webster AC. "Cancer Mortality In People On Dialysis In Australia And New Zealand: A National Cohort Study From 1980 To 2013." Nephrology 23.s3 (2018): 24–24.*
- The Transplantation Society (TTS) 27<sup>th</sup> International Congress, June 2019 in Madrid, Spain and presented by Brenda Rosales, awarded **Young Investigators Award**:  
*Rosales B, De La Mata NL, Kelly P, Webster AC. "Cancer Mortality in Transplant Recipients in Australia and New Zealand: A National Cohort Study from 1980 to 2013." Transplantation 102 Suppl 7S-1 (2018): S11–S12.*

#### Publication arising:

Rosales B, de la Mata N, Vajdic C, Kelly PJ, Wyburn K, Webster AC. Cancer mortality in kidney transplant recipients: an Australian and New Zealand population-based cohort study, 1980-2013. *International Journal of Cancer*. 2020 May 15;146(10):2703-11

**Link/access:** <https://www.ncbi.nlm.nih.gov/pubmed/31340063>

#### 4. Stroke mortality in kidney transplant recipients: A retrospective population-based cohort study using data linkage

**Investigators:** Nicole De La Mata, Philip Masson, Rustam Al-Shahi Salman, Patrick Kelly, Angela Webster.

##### **Summary**

This study compared death rates from stroke between kidney transplant recipients and the general population in Australia and New Zealand. The findings over a 30 year period showed that stroke mortality was higher among kidney transplant recipients when compared to the general population, particularly for young people and females. A higher risk of stroke death was associated with older age at transplant, earlier year of transplant and cerebrovascular disease. Previous duration of dialysis prior to transplant was associated with an increased risk of non-stroke mortality only. We concluded that interventions to control cardiovascular risk factor have helped reduce stroke mortality in the general population, but their effectiveness in kidney transplant recipients is less clear.

##### **Dissemination/Awards**

This study was presented at the following conferences:

- 27th International Congress of The Transplantation Society, July 2018 in Madrid, Spain and presented by Nicole De La Mata (**awarded Young Investigator prize**): *De La Mata NL, Masson P, Salman RA, Kelly PJ, Webster AC. Stroke Mortality in Kidney Transplant Recipients: A Retrospective Population-Based Cohort Study using Data Linkage. Transplantation, 2018. 102: S423-S424.*
- The Transplantation Society of Australia and New Zealand (TSANZ) Annual Scientific Meeting, April 2018 in Melbourne, Australia and presented by Angela Webster:  
*De La Mata NL, Masson P, Al-Shahi Salman R, Kelly P, Webster AC. Stroke mortality in kidney transplant recipients: A population-based cohort study using data linkage. Transplantation Direct, 2018. 4(S8): S32.*

##### **Publication arising:**

De La Mata N, Masson P, Salman RA, Kelly P, Webster AC. Stroke Mortality in Kidney Transplant Recipients: A Retrospective Population-Based Cohort Study using Data Linkage. *Transplantation*. 2018 Jul 1;102:S423-4.

##### **Link/access:**

[https://journals.lww.com/transplantjournal/Abstract/2018/07001/Stroke\\_Mortality\\_in\\_Kidney\\_Transplant\\_Recipients\\_.671.aspx](https://journals.lww.com/transplantjournal/Abstract/2018/07001/Stroke_Mortality_in_Kidney_Transplant_Recipients_.671.aspx)

## 5. Cardiac mortality in kidney transplant recipients: A Population-Based Cohort Study 1988-2013 In Australia and New Zealand.

**Investigators:** Melanie Wyld, Nicole De La Mata, Philip Masson, Emma O'Lone, Patrick Kelly, Angela Webster.

### Summary

This study compared cardiac death rates between kidney transplant recipients and the general population in Australia and New Zealand. The study found that kidney transplant recipients had greater than five times the burden of cardiac deaths compared to the general population, and that female transplant recipients had a greater burden of cardiac deaths compared to male recipients. The findings over the 33 years period showed that cardiac death rates in transplant recipients, while remaining high compared to the general population have fallen significantly over time. Also, while men have higher absolute rates of cardiac death in comparison to the general population, women disproportionately bear the burden of excess cardiac mortality following transplantation. Despite the widespread use of cardiac screening both prior to transplant listing and while on the waitlist, those with pre-existing coronary artery disease have significantly higher rates of cardiac death than those without coronary artery disease prior to transplant. Women, particularly young women, have the greatest excess of cardiac deaths, suggesting cardiac risks may be under-recognized in this population and/or prevention efforts are less effective or more harmful. We concluded that targeted cardiac risk reduction programs, particularly those focused on younger women, could substantially improve graft and patient outcomes.

### Dissemination/Awards

This study was presented at the following conferences:

- American Transplant Congress, June 2019 in Boston, United States, presented by Melanie Wyld  
*Wyld M, De La Mata NL, Masson P, O'lon E, Webster AC. Cardiovascular mortality in transplant patients; A population-based cohort study 1988-2013 in Australia and New Zealand. American Journal of Transplantation, 2019. 19: 456.*
- Transplant Society of Australia and New Zealand, 2019, presented by Melanie Wyld (**awarded Early Career Researcher Award**):  
*Wyld M, De La Mata N, Masson P, O'Lone E, Webster A. Cardiovascular Mortality in Transplant Patients: A Population Based Cohort Study 1988-2013 in Australia and New Zealand. American Journal of Transplantation. 19:456.*

### Publication arising:

Wyld M, De La Mata N, Masson P, O'Lone E, Kelly P, Webster AC. Cardiac mortality in kidney transplant patients; a population-based cohort study 1988-2013 in Australia and New Zealand. *Transplantation* 2020 Mar 10 doi: 10.1097/TP.0000000000003224. [Epub ahead of print]

**Link/access:** <https://www.ncbi.nlm.nih.gov/pubmed/32168042>



## 6. Survival rates in living kidney donors: An Australian and New Zealand cohort study using data linkage

**Investigators:** Nicole De La Mata, Phillip Clayton, Patrick Kelly, Stephen McDonald, Steve Chadban, Kevan Polkinghorne, Angela Webster.

### Summary

This study compared mortality in living kidney donors with the general population in Australia and New Zealand. We hypothesised that living donors should have much better survival given they are a highly selected population. The study found that the living kidney donor population had about one-third of the deaths compared with the general population of the same age, sex, and calendar year. The survival probability of living donors was also similar or even greater than the general population. About half the deaths in the living kidney donor population were due to cancer. In conclusion, the study found that living kidney donors experienced fewer deaths and higher than expected survival post donation in Australia and New Zealand.

### Dissemination/Awards

This study was presented at the following conferences:

- Australian and New Zealand Society of Nephrology (ANZSN) Annual Scientific Meeting, September 2018 in Sydney, Australia, presented by Angela Webster: *De La Mata NL, Clayton P, McDonald S, Chadban S, Polkinghorne K, Webster AC. Mortality in Living Kidney Donors: An Australian and New Zealand Cohort Study Using Data Linkage. Nephrology, 2018. 23(S3): 65-66.*
- The Transplantation Society of Australia and New Zealand (TSANZ) Annual Scientific Meeting, April 2018 in Melbourne, Australia, presented by Angela Webster: *De La Mata NL, Clayton P, McDonald S, Chadban S, Polkinghorne K, Webster AC. Mortality rates in living kidney donors: An Australian and New Zealand cohort study using data linkage. Transplantation Direct, 2018. 4(S8): S11.*

### Publication arising:

De La Mata NL, Clayton PA, Kelly PJ, McDonald S, Chadban S, Polkinghorne KR, Webster AC. Survival in living kidney donors: An Australian and New Zealand cohort study using data linkage. *Transplantation Direct* 2020 Mar;6(3)

**Link/access:** <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7056283/>

## 7. Cause of death for people with ESKD withdrawing from treatment: a population-based cohort study from Australian and New Zealand

**Investigators:** Victor Zhou, Nicole De La Mata, Patrick Kelly, Rachael Morton, Angela Webster

### Summary

This study aimed to describe deaths after treatment withdrawal and their legal (certified) causes of death in the Australia and New Zealand ESKD population. We found that treatment withdrawal deaths were underrepresented in official death registries, despite representing approximately one quarter of all ESKD deaths. Treatment withdrawal deaths also occurred more often in women, at older ages, and in those with co-morbidities. A third of all treatment withdrawal deaths were in patients who had experienced a treatment modality change in the preceding 12 months. In conclusion, national death registers tend to underestimate treatment withdrawal deaths and may not be useful for service provision planning for advance care planning and palliative care. A better understanding of the precursors to treatment withdrawal may provide opportunities for end-of-life discussions and improve service delivery in this population.

### Dissemination/Awards

This study was presented at the following conferences:

- Australian and New Zealand Society of Nephrology (ANZSN) Annual Scientific Meeting, September 2018 in Sydney, Australia and presented by Victor Khou: *Khou V, De La Mata NL, Morton RL, Webster AC. Examining Legal Cause of Death in National Registries for People Who Withdraw from Renal Replacement Therapy: An Australian and New Zealand Population-Based Cohort Study. Nephrology, 2018. 23(S3): 41.*

### Publication arising:

Khou V, De La Mata NL, Morton RL, Kelly PJ, Webster AC. Cause of death for people with end-stage kidney disease withdrawing from treatment in Australia and New Zealand. *Nephrology Dialysis Transplantation*, 2020 [in press].

## 8. Cardiac mortality rates in ESKD and transplant recipients

**Investigators:** Nicole De La Mata, Patrick Kelly, Angela Webster

### Summary

This study aimed to estimate cardiovascular mortality rates and graft failure rates by pre-existing cardiovascular disease in the ESKD population in Australia and New Zealand. We found that pre-existing cardiovascular disease was common among the ESKD population, affecting approximately one third. Among dialysis patients, cardiovascular mortality was nearly double in those with pre-existing cardiovascular disease compared to those without. However, in kidney transplant recipient's mortality rates and graft failure were similar between those with or without pre-existing cardiovascular disease. These estimates informed the NHMRC funded CARSK trial economic model (see <https://www.sciencedirect.com/science/article/abs/pii/S027263861931056X>) and were subsequently contributed to the "Natural history of cardiac and peripheral vascular death in ESKD" study (see project 10 below).

### Dissemination/Awards

This study was presented at the following conferences:

- Australian and New Zealand Society of Nephrology (ANZSN) Annual Scientific Meeting, September 2018 in Sydney, Australia and presented by Nicole De La Mata:  
*De La Mata NL, Kelly P, Webster AC. Cardiovascular Mortality Rates in People with End-Stage Kidney Disease with Pre-Existing Cardiovascular Disease. Nephrology, 2018. 23(S3): 43.*

## 9. Cardiac mortality in people with end stage kidney disease; a two-nation cohort study

**Investigators:** Emma O'Lone, Nicole De La Mata, Patrick Kelly, Brenda Rosales, Philip Masson, Angela Webster.

### Summary

This study aimed to evaluate absolute and relative rates of cardiac death in the ESKD population compared to the general population. We found females with ESKD had more excess deaths than males with ESKD, in particular in younger people. Overall, females had 8 times expected deaths and males had nearly 6 times. Once stratifying by age, females aged <30 years had 60 times the expected deaths while males only had 18 times. However, there have been improvements over time with fewer excess deaths in more recent years, most notable in women.

### Dissemination/Awards

This study was presented at the following conferences:

- Australian and New Zealand Society of Nephrology (ANZSN) Annual Scientific Meeting, September 2017 in Darwin, Australia and presented by Emma O'lonc: *O'Lone E, De La Mata NL, Kelly PJ, Rosales B, Masson P, Webster AC. Ischaemic Heart Disease Mortality in People with End Stage Kidney Disease in Australia and New Zealand: A Cohort Study from 1980 to 2013. Nephrology, 2017. 22(S3): 47.*
- American Society of Nephrology (ASN) Kidney Week Meeting, November 2019 in Washington DC, United States and presented by Emma O'Lone; *O'Lone, E, De La Mata N, Rosales B, Kelly P, Webster AC. Cardiac Mortality In People With End Stage Kidney Disease In Australia And New Zealand; A Cohort Study From 1980 To 2013. Kidney International Reports (2019) 4, S1–S437*

### Publication arising:

O'Lone E, De La Mata NL, Kelly PJ, Rosales B, Masson P, Webster AC. Cardiac mortality in people with end stage kidney disease; a two-nation cohort study. *European Heart Journal*, 2020 [in submission].

There are currently five further projects arising from the CELESTIAL study that are yet to be published. We anticipate they will be in press by the end of 2020.

Continuing Work includes:

### 10. Natural history of cardiac and peripheral vascular death in ESKD: an Australian and New Zealand cohort-based study

**Investigators:** Victor Khou, Nicole De La Mata, Patrick Kelly, Philip Masson, Emma O'Lone, Rachael Morton, Angela Webster

#### Summary

This study aimed to describe cardiac and vascular deaths across the lifespan of people with ESKD. We aimed to model the natural history of ESKD, in particular to understand the effect multimorbidity and transitions between dialysis and transplant had on cumulative cardiovascular disease burden. We found that cardiac/vascular mortality varied since initiation of renal replacement therapy, where rates typically peaked in the first few months before declining and gradually increasing thereafter. However, improvements have occurred overtime with the lower rates and risk of cardiac/vascular deaths in the most recent era. Cardiac/vascular deaths were lower among those who received a transplant with the probability of cardiac/vascular deaths reaching 2.0% after 15 years in those with a transplant and 13.6% in those without. These findings highlight the opportunity for cardiovascular management in advanced CKD and at the time of commencing renal replacement therapy.

### 11. Sex differences in mortality among the ESKD population

**Investigators:** Nicole De La Mata, Grace MacLeod, Patrick Kelly, Brenda Rosales, Philip Masson, Rachael Morton, Angela Webster

#### Summary

This study aimed to evaluate sex differences in mortality among the ESKD population in Australia and New Zealand. We found that sex differences in mortality comparing women and men within the ESKD population were minor, but were starkly apparent once compared to the general population. Females with ESKD had greater excess deaths, worse relative survival and greater life years lost compared to male ESKD patients. Females had nearly 12 times the expected deaths and males had nearly 7 times the expected. Overall, survival was consistently lower among females with ESKD with an adjusted excess mortality 9% higher in females compared to males. The average life years lost was also 4-5 years greater in females with ESKD compared to their male counterparts. However, kidney transplantation did attenuate these sex differences in survival.

#### Dissemination/Awards

This study was presented at the following conferences:

- 57<sup>th</sup> European Renal Association-European Dialysis and Transplant Association (ERA-EDTA) Congress, June 2020 in Milan, Italy (fully virtual congress due to

COVID-19) and will be presented by Nicole De La Mata (**awarded best abstract by a Young Investigator**):

*De La Mata NL, MacLeod G, Kelly PJ, Rosales B, Masson P, Morton R, Webster AC. Sex differences in mortality among the ESKD population. Nephrology Dialysis Transplantation, 2020 [in press].*

## 12. Mortality among the Paediatric population with end-stage kidney disease (ESKD)

**Investigators:** Melanie Wyld, Nicole De La Mata, Siah Kim, Patrick Kelly, Philip Masson, Angela Webster

### Summary

This study aimed to estimate mortality rates and life expectancy in the paediatric ESKD population compared to the general population. We found mortality rates were higher among those of younger age and during the first few months after renal replacement therapy. Over calendar era, there was substantial excess deaths between 20 to 40 times that expected in the general population, with some indication of decline in recent years. Death was most likely during periods on dialysis rather than during periods of functioning transplant, reaching 17% at 15 years follow-up. Life expectancy estimates were 30-40 years lower than the general population. Life expectancy did increase with age at ESKD, but the older the age at ESKD, the more time was spent on dialysis rather than with a working transplant.

## 13. Cancer mortality in people on dialysis in Australia and New Zealand: A National cohort study from 1980 to 2013.

**Investigators:** Brenda Rosales, Nicole De La Mata, Patrick Kelly, Angela Webster

### Summary

This study aimed to compare all-site and site-specific cancer mortality between people on dialysis and the general population in Australia and New Zealand. Overall, cancer represented 10% of all deaths in the dialysis population. Cancer mortality rates were higher in men and increased with age. However, once compared to the general population females on dialysis had 2.5 times excess deaths while males only had 2.0 times and a greater excess of deaths were in those of younger age.

### Dissemination/Awards

This study was presented at the following conferences:

- Australian and New Zealand Society of Nephrology (ANZSN) Annual Scientific Meeting, September 2018 in Sydney, Australia and presented by Brenda Rosales: *Rosales B, De La Mata NL, Kelly P, Webster AC. Cancer Mortality in People on Dialysis in Australia and New Zealand: A National Cohort Study from 1980 to 2013. Nephrology, 2018. 23(S3): 24*

## 14. Melanoma and keratinocyte cancer mortality in people with end-stage kidney disease in Australia: A National cohort study from 1980 to 2013.

**Investigators:** Brenda Rosales, Nicole De La Mata, Patrick Kelly, Angela Webster

### **Summary**

This study aimed to compare melanoma and keratinocyte cancer mortality between people with end-stage kidney disease and the general population in Australia and investigate differences based on treatment modality. We found, skin cancer deaths represented 3% of deaths in people on dialysis and 21% in kidney transplant recipients. The death rate from melanoma in people on dialysis was similar to the general population of the same age, sex and during the same period. Relative to the general population, kidney transplant recipients had 5 times the risk of melanoma death. The relative risk of keratinocyte cancer death was 51 times higher in kidney transplant recipients and 2 times higher in people on dialysis compared the general population. Female kidney transplant recipients, aged 50-55, had the highest relative risk of skin cancer death. The relative risk of skin cancer death in people with end-stage kidney disease, compared to the general population, has remained unchanged between 1980-2013.