RENINE annual report 2018

T. Hoekstra, F.W. Dekker, K. Cransberg, W.J. Bos, M. van Buren and M.H. Hemmelder

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Dutch Federation for Nephrology

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Nefrovisie
Postbus 830
3500 AV Utrecht
www.nefrovisie.nl
info@nefrovisie.nl

Zicht op nierzorg

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1. Introduction

Renine is the Dutch registry which contains data of patients on chronic renal replacement therapy (RRT). This is defined as either a renal transplant or dialysis for a period of at least 28 days. All dialysis centres in the Netherlands provide data to Renine. Data on patients with a transplant are provided by the 'Nederlandse Transplantatie Stichting' (NTS). With data from Renine the quality of care of renal replacement therapy in the Netherlands can be accurately monitored. Together with stakeholders we want to improve the reporting of the data to advance transparency of renal care.

In 2018 a total of 233 prevalent RRT patients did not provide consent for their data to be included in Renine, whereas 126 incident RRT patients did not provide consent for their data to be included in Renine. This reveals a nationwide coverage of 96% of the prevalent patients and 93% for the incident patients.

In this report we especially want to focus on two patients' groups, i.e. the very young patients (younger than 20 years) and the population of elderly patients (75 years and older). Data from this report are also presented at www.nefrovisie.nl.

The Board of Nefrovisie thanks all of the participating dialysis centres and the NTS for excellent cooperation.

Marc Hemmelder, CEO Nefrovisie

2. Renal replacement therapy: key figures of 2018

Table 1. Characteristics of prevalent renal replacement therapy patients registered in Renine on December 31th 2018 (N=17,672).*

Modality	**N**	**%**
Haemodialysis	5,357	30
Peritoneal dialysis	895	5
Transplant	11,420	65
Sex	**N men**	**% men**
Dialysis patients	3,743	60
Transplant patients	6,936	61
Primary kidney disease	**N**	**%****
Glomerulonephritis/sclerosis	2896	16
Pyelonephritis	1137	6
Polycystic kidney disease	1551	9
Hypertension	2062	12
Renal vascular disease	1100	6
Diabetes type 1	661	4
Diabetes type 2	1697	10
Other	3665	21
Unknown	2903	16
Age (year)	**Mean (SD)**	
Dialysis patients	67.4 (14.5)	
Transplant patients	56.6 (15.0)	
Duration renal replacement therapy (year)	**Mean (SD)**	
Dialysis patients	5.0 (6.4)	
Transplant patients	12.9 (9.6)	

* 233 prevalent RRT patients (not included in this table) did not provide consent for their data to be included in Renine. The coverage in 2018 was 96%. ** The percentages do not add up to 100% due to rounding.

Table 2. Characteristics of incident renal replacement therapy patients registered in Renine in 2018 (N=1,965)*.

Modality at start RRT, at day 1	**N**	**%**
Haemodialysis	1388	71
Peritoneal dialysis	312	16
Transplant	265	13
Sex	**N men**	**% men**
Dialysis patients	1212	61
Transplant patients	753	63
Primary kidney disease	**N**	**%****
Glomerulonephritis/sclerosis	190	10
Pyelonephritis	56	3
Polycystic kidney disease	100	5
Hypertension	298	15
Renal vascular disease	234	12
Diabetes type 1	62	3
Diabetes type 2	312	16
Other	456	23
Unknown	257	13
Age (year)	**Mean (SD)**	
Dialysis patients	64.9 (14.7)	
Transplant patients	54.5 (15.6)	

* 126 incident RRT patients did not provide consent for their data to be included in Renine (7%) **The percentages do not add up to 100% due to rounding.

3. Renal replacement therapy: prevalence and incidence

On December 31th, of 2018 17,672 prevalent patients on renal replacement therapy (RRT) were registered in Renine, which is slightly higher compared to the previous year (N=17,531). Prevalence equals 1,023 patients per million inhabitants of the Netherlands. The number of patients starting chronic renal replacement therapy (incidence) was 1,965 in 2018. This equals 114 patients per million inhabitants. Compared to incidence in 2017 this is an increase of 8%.

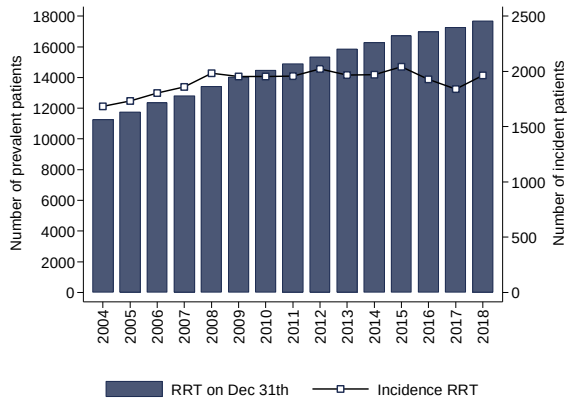


Figure 3.1. Prevalence and incidence of renal replacement therapy.

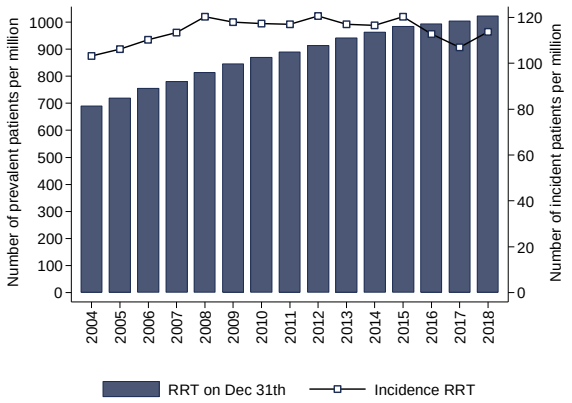


Figure 3.2. Prevalence and incidence of renal replacement therapy expressed per million population.

Both prevalence and incidence of RRT was higher in men than in women. On December 31th 2018 60% of prevalent patients were male. Of the patients starting RRT in 2018 62% was male. Sex specific figures on prevalence and incidence are shown below (Figures 3.3 and 3.4).

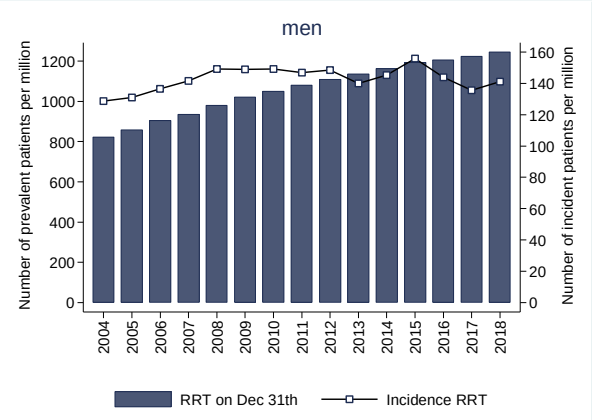


Figure 3.3. Prevalence and incidence of renal replacement therapyper million population in men.

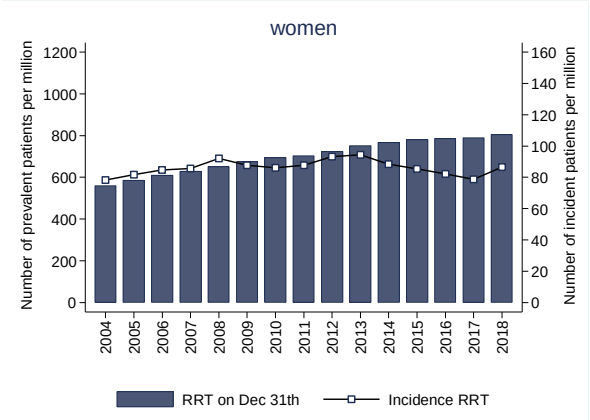


Figure 3.4. Prevalence and incidence of renal replacement therapy per million population in women.

The proportion of elderly patients in the prevalent population is steadily increasing (Figure 3.5). On December 31th 2018 45% of patients on renal replacement therapy were 65 years or older and 19% were 75 years or older.

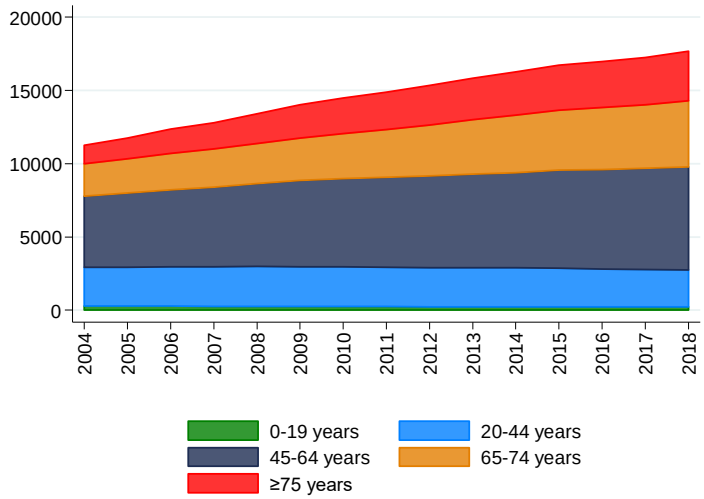


Figure 3.5. Prevalence of renal replacement therapy by age categories.

Figures 3.6 and 3.7 show incidences of renal replacement therapy for different age categories. In absolute numbers incidence in 2018 was highest in the age category 45-64 years (Figure 3.6). However, when expressed per million age-related population incidence was highest in patients 75 years and older (Figure 3.7), i.e. 357 incident patients per million age-related population. Highest incidence per million age-related population in this age category was at its highest in 2009 (i.e. 496 per million age related population) and showed a steady decrease since. This downwards trend however halted in 2018. Incidence was slightly higher compared to 2017.

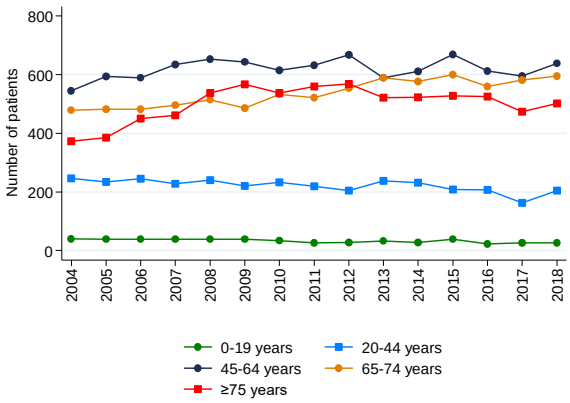


Figure 3.6. Incidence of renal replacement therapy stratified for age categories.

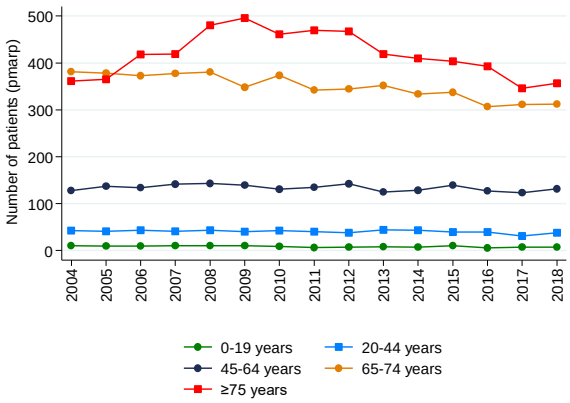


Figure 3.7. Incidence of renal replacement therapy expressed per million age related population stratified for age categories.

Most of the incident RRT patients started treatment by means of haemodialysis in 2018 (71%). In Figure 3.8 the time trends of the different start modalities are shown. The percentage patients starting RRT with a renal transplant stabilized in recent years. In 2018 13% of incident RRT patients received a pre-emptive renal transplant. Figure 3.9 shows trends over time in start modalities stratified for age categories.

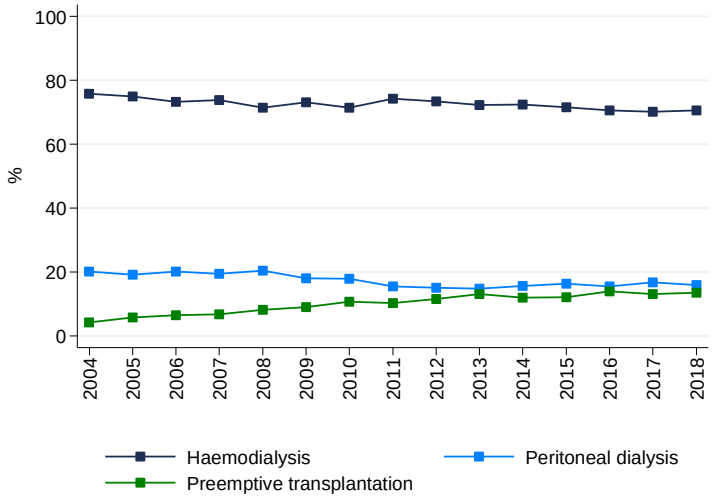


Figure 3.8. Distribution of start modalities in incident RRT patients over time.

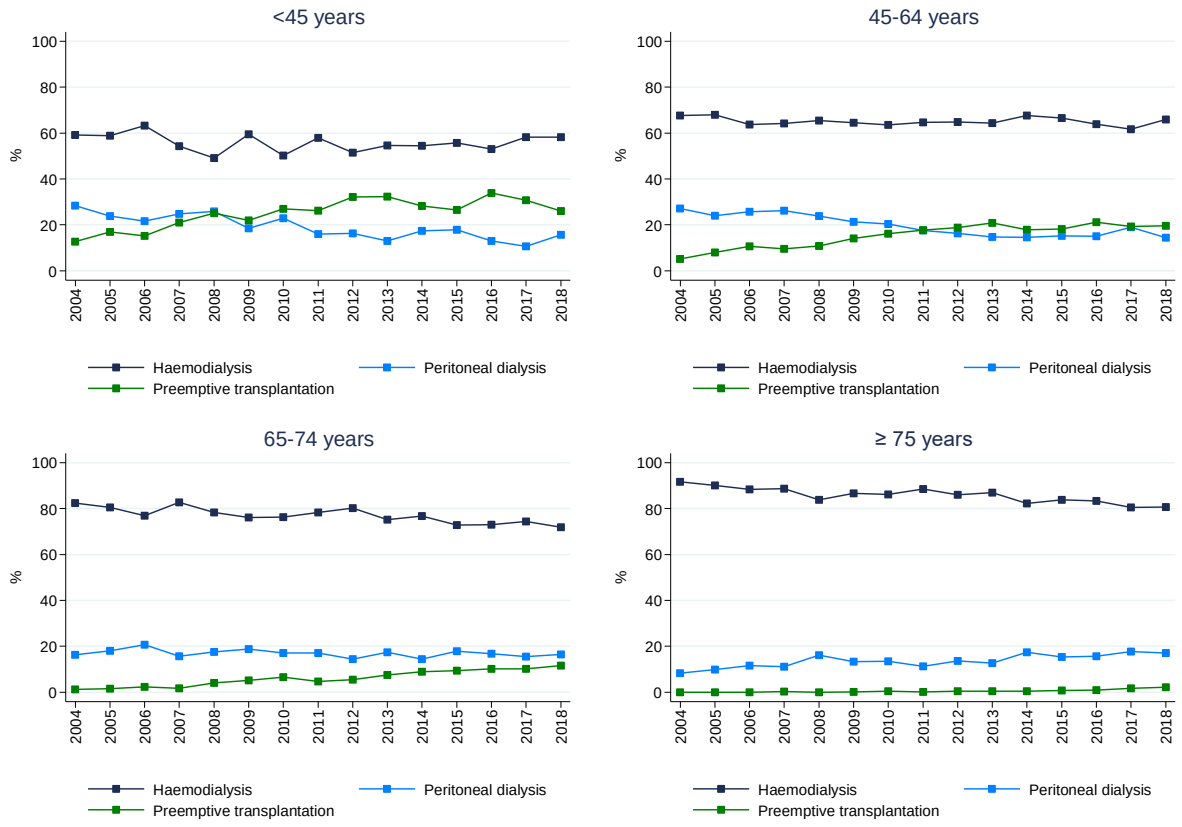
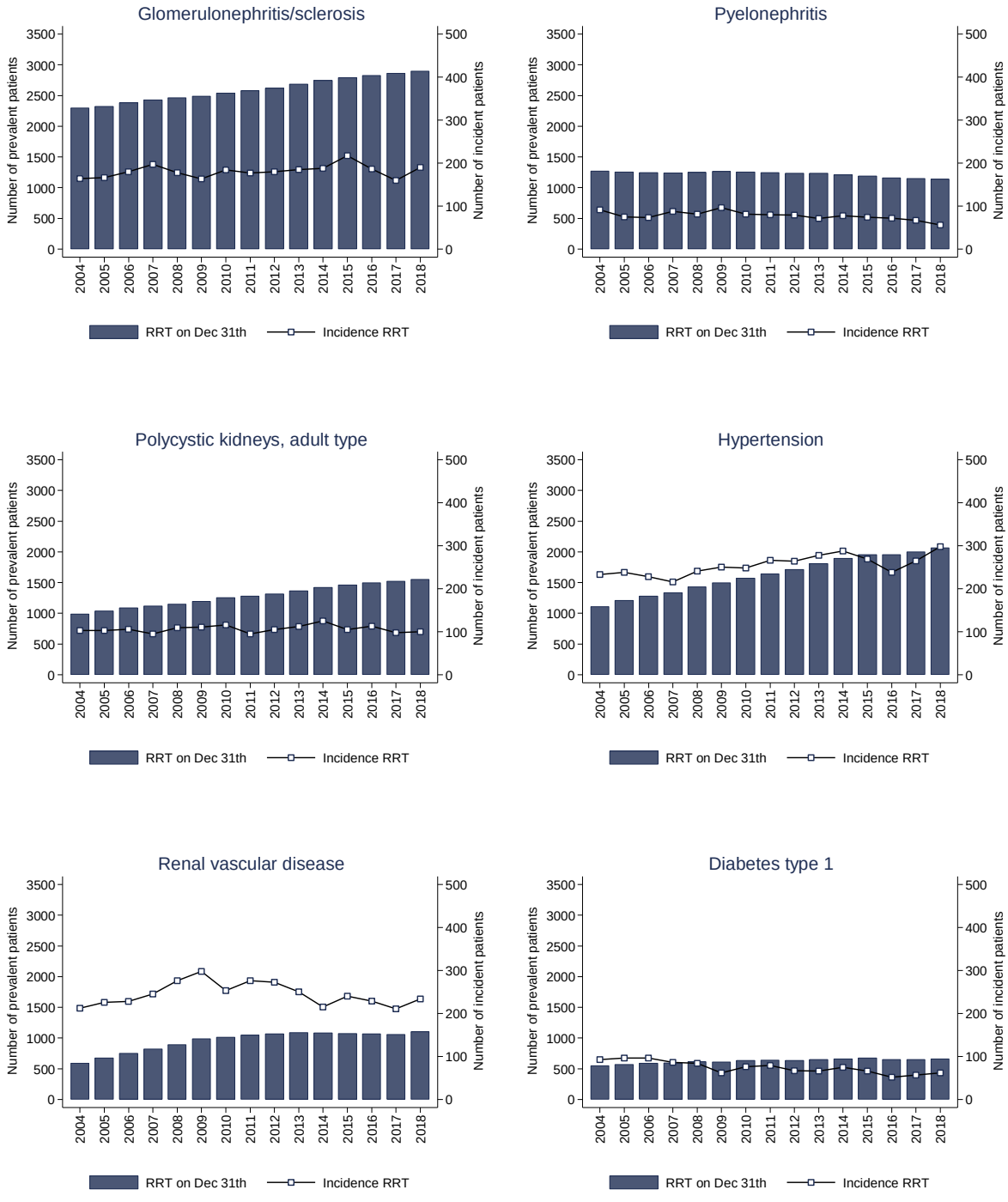


Figure 3.9. Distribution of start modalities in incident RRT patients over time stratified for age categories.

Figure 3.10 shows incidence and prevalence of renal replacement therapy stratified for primary kidney disease categories.



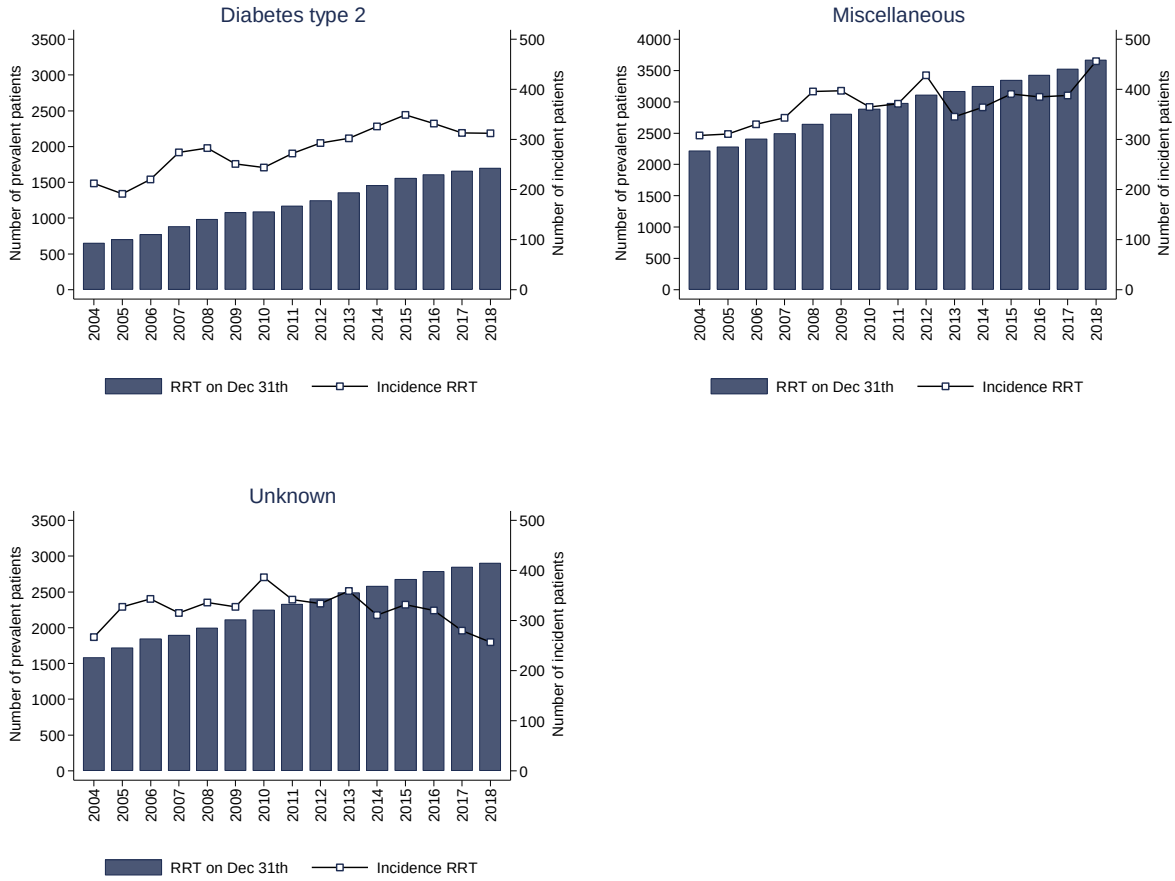


Figure 3.10. Incidence and prevalence of renal replacement therapy stratified for primary kidney disease categories.

4. Dialysis treatment: prevalence and incidence

Prevalence of dialysis remained stable (Figure 4.1). Prevalence includes all patients on dialysis treatment, irrespective of RRT history. On December 31th 2018, 6,252 patients were on dialysis. The age distribution of dialysis patients changed substantially over time with increasing numbers of elderly patients. In 2018 37% of all dialysis patients were 75 years or older.

In 2018 1,967 patients started chronic dialysis therapy. This is an increase of 7% compared to 2017 (Figure 4.2). For the majority of the incident patients this was their first time on chronic dialysis treatment, whilst 235 patients with a history of dialysis restarted dialysis treatment, for example after graft failure. For the remaining of this chapter incidence of dialysis only includes first-time start of chronic dialysis treatment, including after a first pre-emptive transplantation.

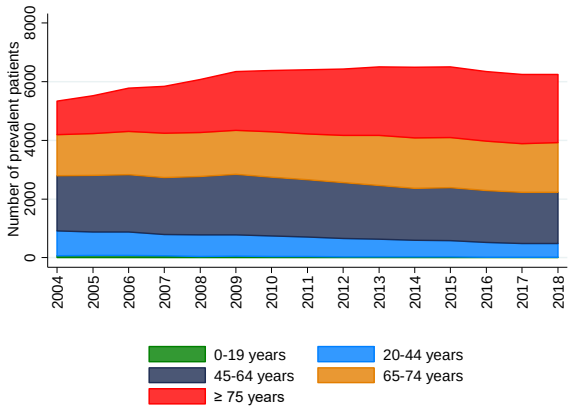


Figure 4.1. Prevalence of dialysis on December 31th by age categories.

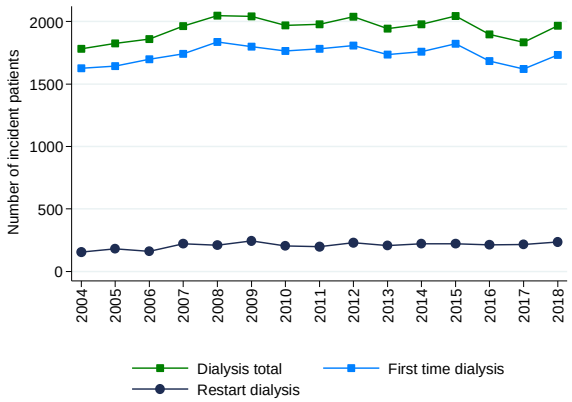


Figure 4.2. Incidence of dialysis per year. A distinction was made between patients receiving chronic dialysis for the first time and patients with dialysis treatment in the past restarting dialysis treatment.

Figures 4.3 and 4.4 show incidence of first-time dialysis stratified for age categories (absolute numbers and expressed per million age related population respectively). Incidence per million age related population was the highest for the group patients of 75 years and older, i.e. 352 new patients per million age related population.

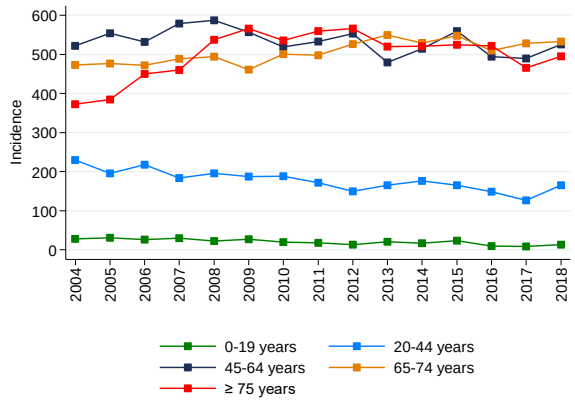


Figure 4.3. Incidence of first-time dialysis (absolute numbers) over time stratified for age categories.

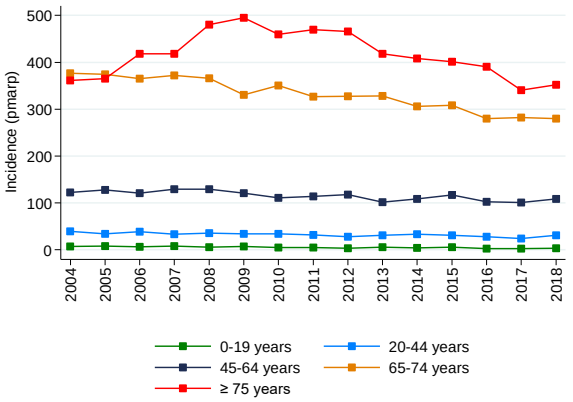


Figure 4.4. Incidence per million age related population of first-time dialysis stratified for age categories.

5. Dialysis modalities

Haemodialysis remained the most performed dialysis modality. In 2018, 14% of prevalent dialysis patients were treated with peritoneal dialysis (Figure 5.1), whereas 18% of the new dialysis patients started with peritoneal dialysis (Figure 5.2). These percentages were more or less stable over the last five years.

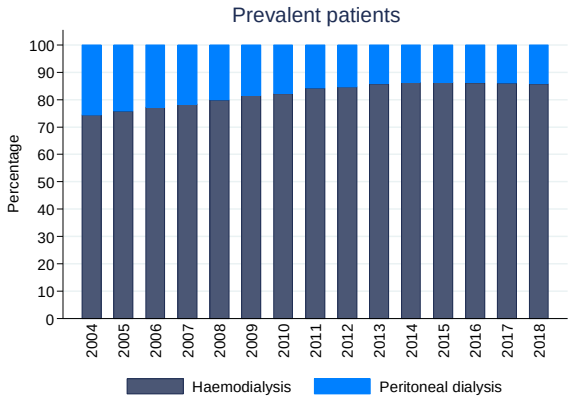


Figure 5.1. Distribution of haemodialysis and peritoneal dialysis in prevalent chronic dialysis patients. (Date: December 31th of each year).

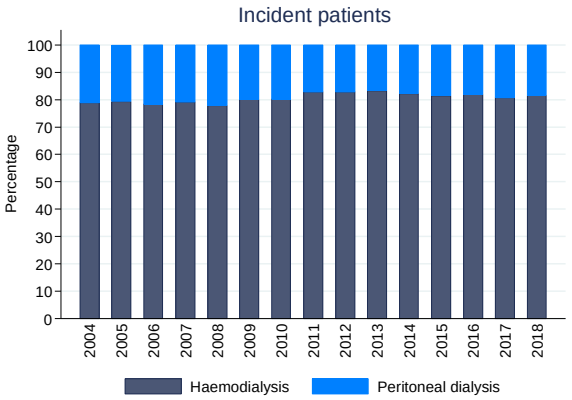


Figure 5.2. Distribution of haemodialysis and peritoneal dialysis in incident chronic dialysis patients per year.

Figures 5.3 and 5.4 show the absolute numbers of prevalent and incident patients on peritoneal dialysis stratified for age categories. Incidence of dialysis only included first-time start of chronic dialysis treatment, including after a first pre-emptive transplantation. Over the years peritoneal dialysis became less common in the younger age categories, whilst the number of peritoneal dialysis patients of 75 years and older increased. The overall number of peritoneal dialysis patients and the age distribution stabilized in recent years.

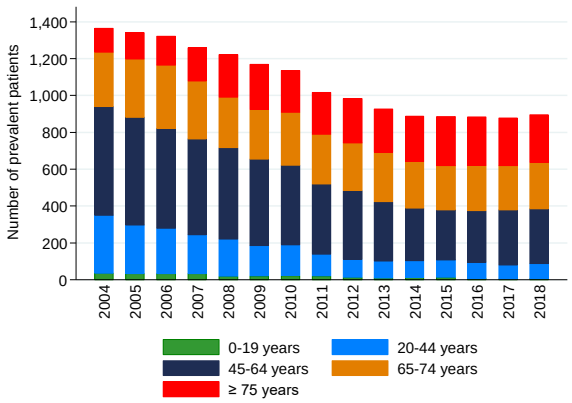


Figure 5.3. Number of prevalent peritoneal dialysis patients in age categories (December 31th).

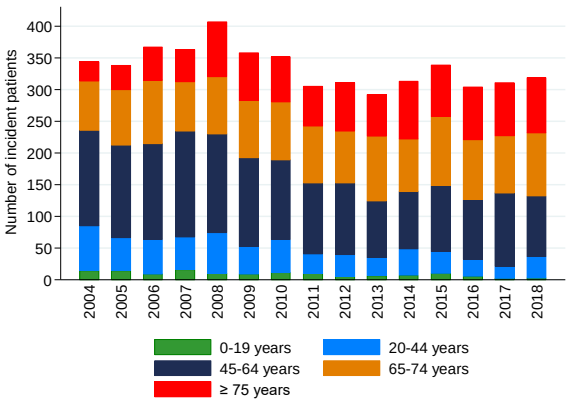


Figure 5.4. Number of incident peritoneal dialysis patients per year in age categories.

Figures 5.5 and 5.6 show the status of patients one year after the start of haemodialysis and peritoneal dialysis as first dialysis modality respectively. Patients who started dialysis in 2018 were not included in this analysis as one year follow-up was not yet available for all these patients. Mortality was higher and transplantation rates were lower in haemodialysis compared to peritoneal dialysis. This is possibly due to differences in case-mix. During the first year of treatment more patients switched from peritoneal to haemodialysis than vice versa. Of the patients that started haemodialysis in 2017 69% were still on haemodialysis treatment one year later, 5% switched to peritoneal dialysis, 8% received a transplant and 18% died. In peritoneal dialysis the percentages that switched to either haemodialysis or received a transplant were somewhat higher, i.e. 13% switched to haemodialysis and 11% had a functioning renal transplant one year after they started peritoneal dialysis. After start of peritoneal dialysis, mortality was 12% in the first year.

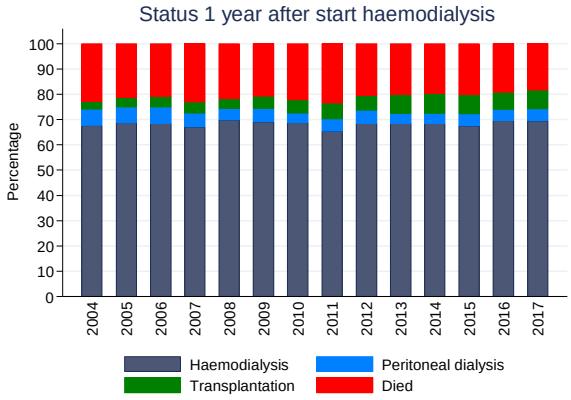


Figure 5.5. Status one year after start HD as percentage. The year represents the year in which HD was started.

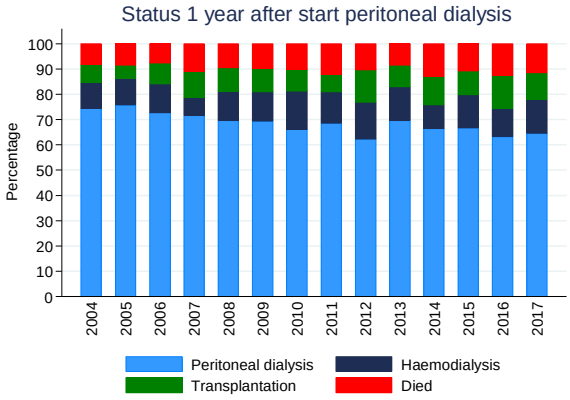


Figure 5.6. Status one year after start PD as percentage. The year represents the year in which PD was started.

Figures 5.7 and 5.8 show centre variation in the percentages switches between modalities during the first year on dialysis in funnel plots. See Appendix A for an explanation on funnel plots. To account for differences in case-mix between dialysis centres adjustments were made for age, sex, socioeconomic status (SES), and categories of primary kidney disease. In these analyses modality at three months after start of dialysis was taken as initial modality. Only patients still on dialysis after one year were included.

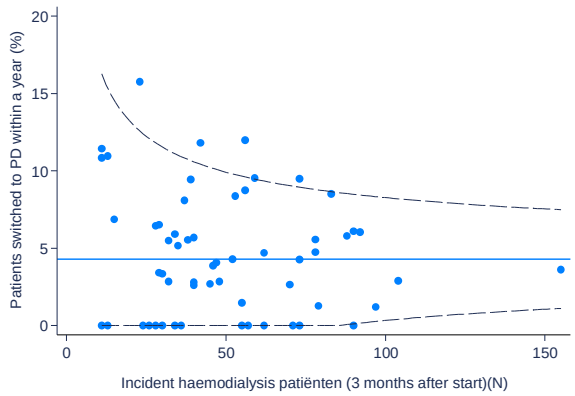


Figure 5.7. Centre variation in switches from HD to PD. Patients were included if on HD 3 months after start dialysis and still on dialysis after one year. Adjustments were performed for age, sex, SES, and primary kidney disease categories.

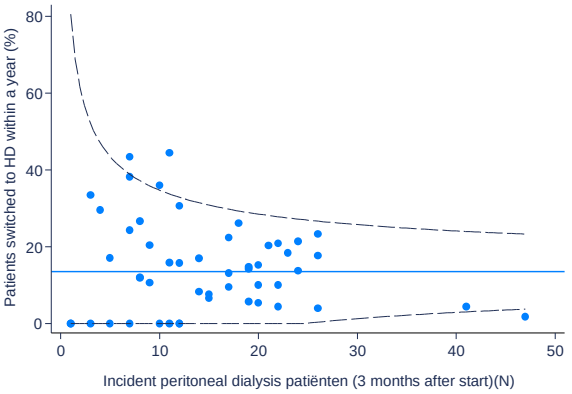


Figure 5.8. Centre variation in switches from PD to HD. Patients were included if on PD 3 months after start dialysis and still on dialysis after one year. Adjustments were performed for age, sex, SES and primary kidney disease categories.

The number of patients treated with home haemodialysis steadily increased from 113 patients in 2004 to almost 300 patients in 2016 (Figure 5.9). These numbers dropped slightly in 2017 and 2018. On December 31th 2018 281 patients were registered on this modality, which equals 4% of all dialysis patients. In total 19% of prevalent patients were treated with a form of home dialysis, i.e. home haemodialysis or peritoneal dialysis (Figure 5.10). This percentage was constant over the last three years.

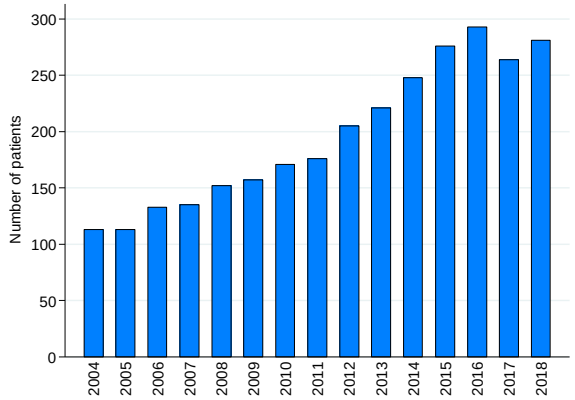


Figure 5.9. Number of prevalent home haemodialysis patients at December 31th of each year.

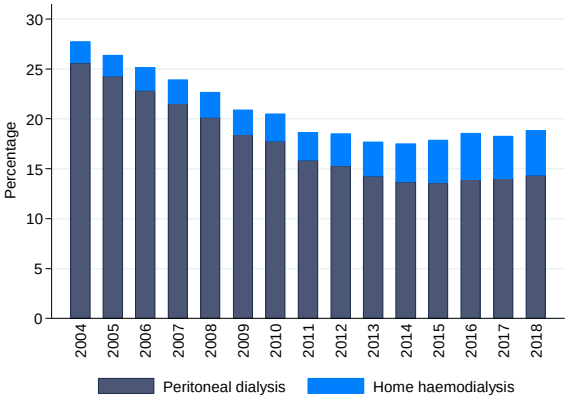


Figure 5.10. Home dialysis (peritoneal dialysis and home haemodialysis) as percentage of total dialysis in prevalent patients.

The proportion of patients treated with home dialysis (home haemodialysis or peritoneal dialysis) shows substantial variation among centres (Figure 5.11). In this analysis we looked at treatment modality 3 months after start of chronic dialysis treatment to account for the time needed to prepare for home (haemo-)dialysis. To account for differences in case-mix between dialysis centres adjustments were made for age, sex, SES, and categories of primary kidney disease).

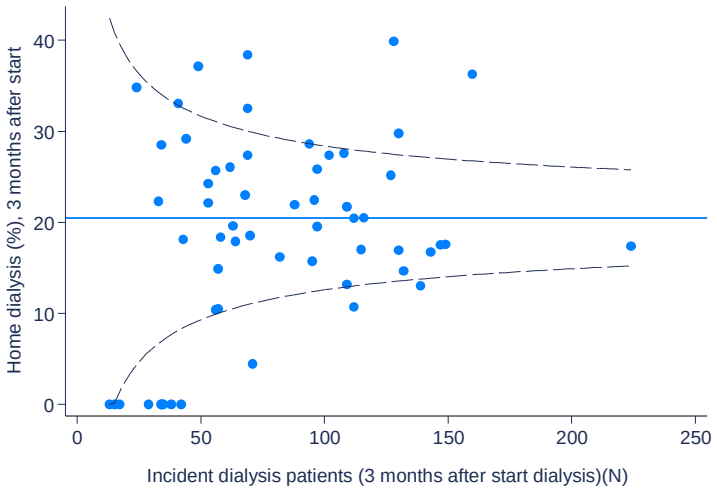


Figure 5.11. Funnel plot showing centre variation in percentage home dialysis at three months after start dialysis. Home dialysis includes peritoneal dialysis and home haemodialysis. Data is adjusted for age, sex, SES, and primary kidney disease categories.

6. Children and adolescents on renal replacement therapy

In the five-year period 2014-2018 140 children and adolescents (<20 years) started renal replacement therapy. Their primary kidney diseases were categorized using categories relevant for this age group. Details are given in Appendix C. A large proportion of patients had a diagnosis belonging to CAKUT (Congenital Abnormalities of Kidneys and Urinary Tract). About half of the patients received a pre-emptive renal transplant and many of these patients had CAKUT as primary kidney disease diagnosis with a slowly progressive course of kidney disease. In contrast, patients with glomerular diseases more often started on dialysis. Glomerular diseases are characterized by a more acute presentation of the disease which does not allow the necessary time to prepare for a renal transplantation.

Table 6.1. Characteristics of incident RRT patients <20 years. Patients who started RRT in the period 2014-2018 were included.

Pre-emptive kidney transplantation	
N	71
Living donor (N (%))	66 (93%)
Male (N (%))	42 (59%)
Mean age at start (years)	12.1
Primary kidney disease (N (%))	
CAKUT*	28 (39%)
Glomerular diseases	6 (8%)
Cystic diseases	9 (13%)
Hereditary diseases	6 (8%)
Other	14 (20%)
Unknown	2 (3%)
Missing	6 (8%)
Start on dialysis	
N	69
Start with peritoneal dialysis (N (%))	25 (36%)
Male (N (%))	38 (55%)
Mean age at start (years)	10.0
Primary kidney disease (N (%))	
CAKUT*	7 (10%)
Glomerular diseases	21 (30%)
Cystic disease	6 (9%)
Hereditary disease	5 (7%)
Other	7 (10%)
Unknown	15 (22%)
Missing	8 (12%)

*Congenital abnormalities of kidneys and urinary tract

Over time both prevalence and incidence of renal replacement therapy show downward trends (Figure 6.1). The majority of patients was male, caused by the high prevalence of boys in the CAKUT category. The sex distribution was comparable to the situation in the adult patient population. Over time incidence decreased for both males and females (Figure 6.2).

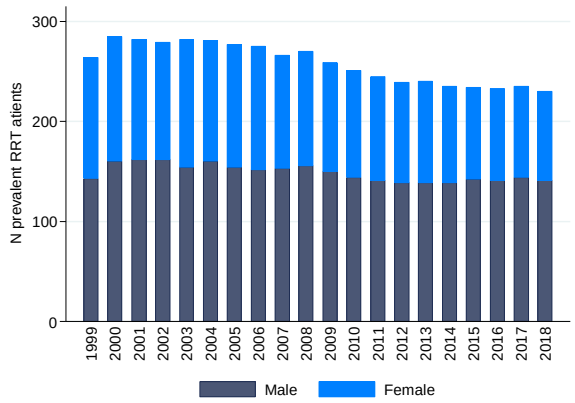


Figure 6.1. Prevalence of renal replacement therapy for male and female patients aged <20 years.

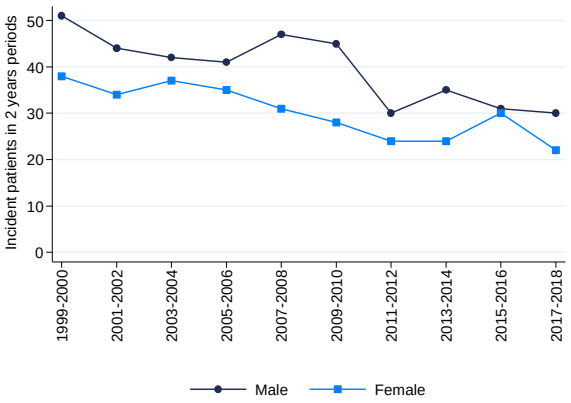


Figure 6.2. Incidence of renal replacement therapy separately for male and female patients aged <20 years. Due to low numbers incidences are over 2 year periods.

Further age categorization shows that the incidence of RRT was highest in patients 15 to 19 years of age. However, a clear downwards trend over time is seen in this age category as well as in patients aged 10 to 14 years of age (Figure 6.3). Improved treatment options for glomerular diseases, for example by monoclonal antibodies, may have contributed to these trends.

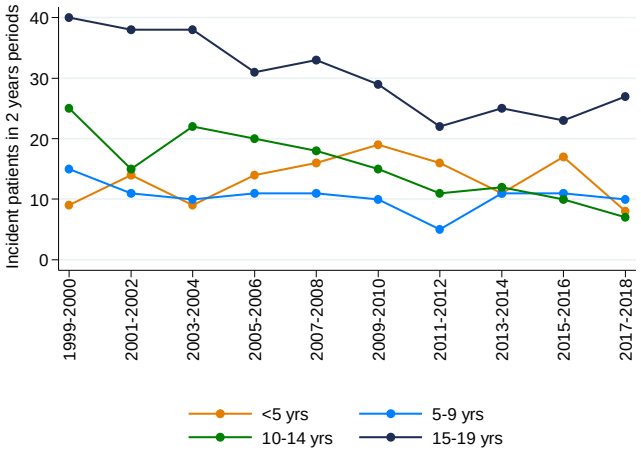


Figure 6.3. Incidence of renal replacement therapy stratified for age categories. Due to low numbers incidences are presented over 2 year periods.

Figure 6.4 shows the number of incident RRT patients over 5 years periods stratified for categories of primary kidney. The decrease over time seems mostly due to lower number of new CAKUT patients. The introduction in 2017 of the standard ultrasound at 20 weeks of pregnancy may have led to more terminations of pregnancies with foetuses diagnosed with severe forms of CAKUT. The decrease of the category glomerular diseases may be associated with better possibilities of treatment of these diseases. However, since the number of children with missing information on primary kidney disease was highest in recent years, these findings should be interpreted with caution.

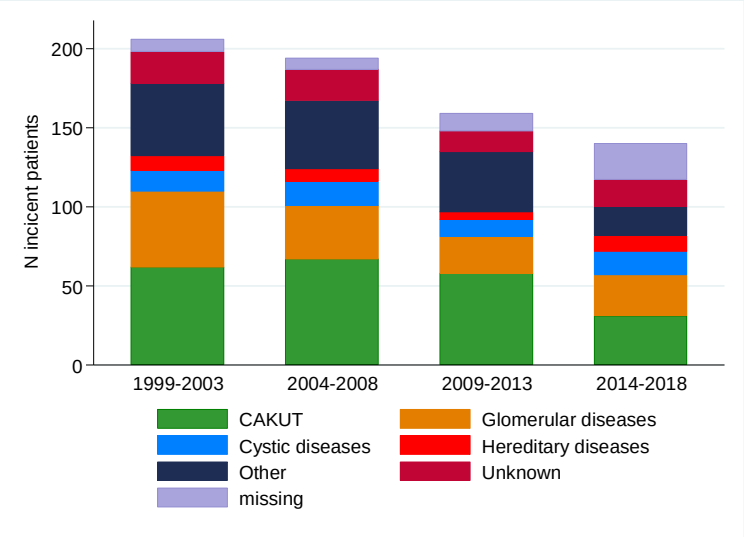


Figure 6.4. Distribution of primary kidney disease categories in incident patients. Due to low numbers incidences are presented over 2 year periods.

Figure 6.5 shows the distribution of prevalent RRT patients aged <20 years over time with a functional renal transplant and on dialysis treatment. The number of prevalent dialysis patients is steadily decreasing due to the higher number of living, pre-emptive transplantations.

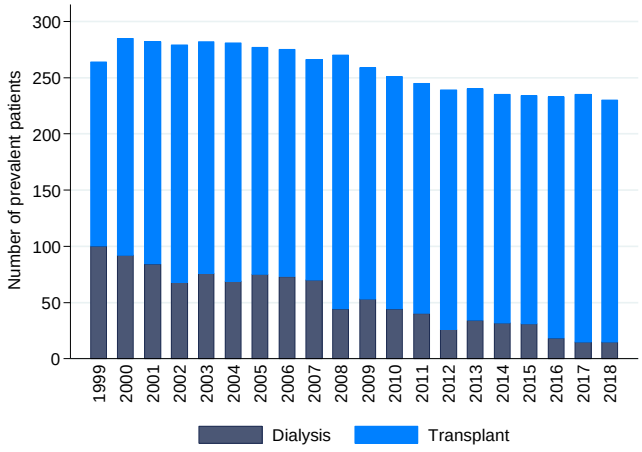


Figure 6.5. Distribution of RRT modalities in prevalent patients aged <20 years.

Figure 6.6 shows the starting modalities. Pre-emptive transplantations show a steep increase over time, whilst the percentage patients starting RRT with peritoneal dialysis decreased from 40% in 1999-2000 to 10% in 2017-2018. Pre-emptive transplantations have increased substantially due to the higher proportion of living donor transplantations. In most cases the donor of a child is one of the parents. In the past very young patients were treated with peritoneal dialysis for long periods of time while waiting for a deceased paediatric donor kidney. Nowadays more and more of these small children receive an adult kidney, enabling both living and preemptive transplantation.

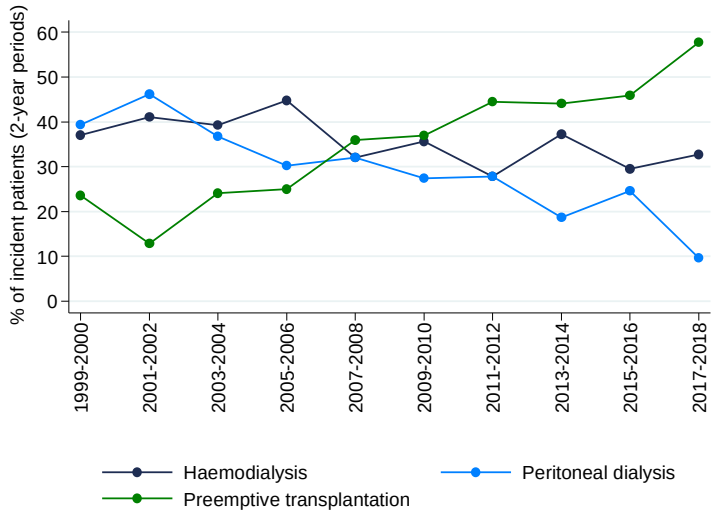


Figure 6.6. Start modalities in incident renal replacement therapy patients aged <20 years. Due to low numbers incident patients are grouped over 2-years periods.

7. Elderly on renal replacement therapy

On December 31th 2018 45% of all patients on renal replacement therapy were 65 years or older. Table 7.1 shows the characteristics of these elderly patients stratified by age group (65-74, 75-79 and ≥80 years). The majority of patients 80 years and older were treated with haemodialysis whilst in the 65-74 and 75-79 categories the proportion patients with a functioning kidney graft was substantially higher. In the oldest patients hypertension was more prevalent as primary kidney disease compared to younger patients.

Table 7.1. Characteristics of prevalent renal replacement therapy patients registered in Renine on December 31th 2018 aged 65 years and above.

	65-74 years	75-79 years	≥80 years
Modality, N (%)			
Haemodialysis	1446 (32%)	888 (50%)	1177 (73%)
Peritoneal dialysis	251 (6%)	136 (8%)	124 (8%)
Transplant	2820 (62%)	738 (42%)	308 (19%)
% men			
Dialysis patients	59%	60%	63%
Transplant patients	61%	63%	58%
Primary kidney disease (%)			
Glomerulonephritis/sclerosis	14%	12%	8%
Pyelonephritis	5%	6%	4%
Polycystic kidney disease	11%	7%	5%
Hypertension	12%	16%	20%
Renal vascular disease	8%	13%	17%
Diabetes type 1	2%	1%	1%
Diabetes type 2	14%	15%	14%
Other	18%	15%	15%
Unknown	15%	16%	15%
Age (year), mean (SD)			
Dialysis patients	70 (3)	77 (1)	84 (3)
Transplant patients	69 (3)	77 (1)	83 (3)
Time on RRT (year), mean (SD)			
Dialysis patients	4.2 (5.8)	3.9 (4.1)	4.6 (3.8)
Transplant patients	12.6 (9.8)	14.1 (10.3)	19.2 (10.9)

In recent years the number of patients starting renal replacement therapy remained more or less stable. Figure 7.1 shows the absolute patient numbers for the three age groups separately for modalities at start of renal replacement therapy. The number of new haemodialysis patients in the category of patients 80 years and older decreased slightly since 2012. However, expressing these numbers per million age related population (Figure 7.2) shows downwards trends in all three age categories. This might be the result of improved prevention or because elderly patients more often decided not to start treatment.

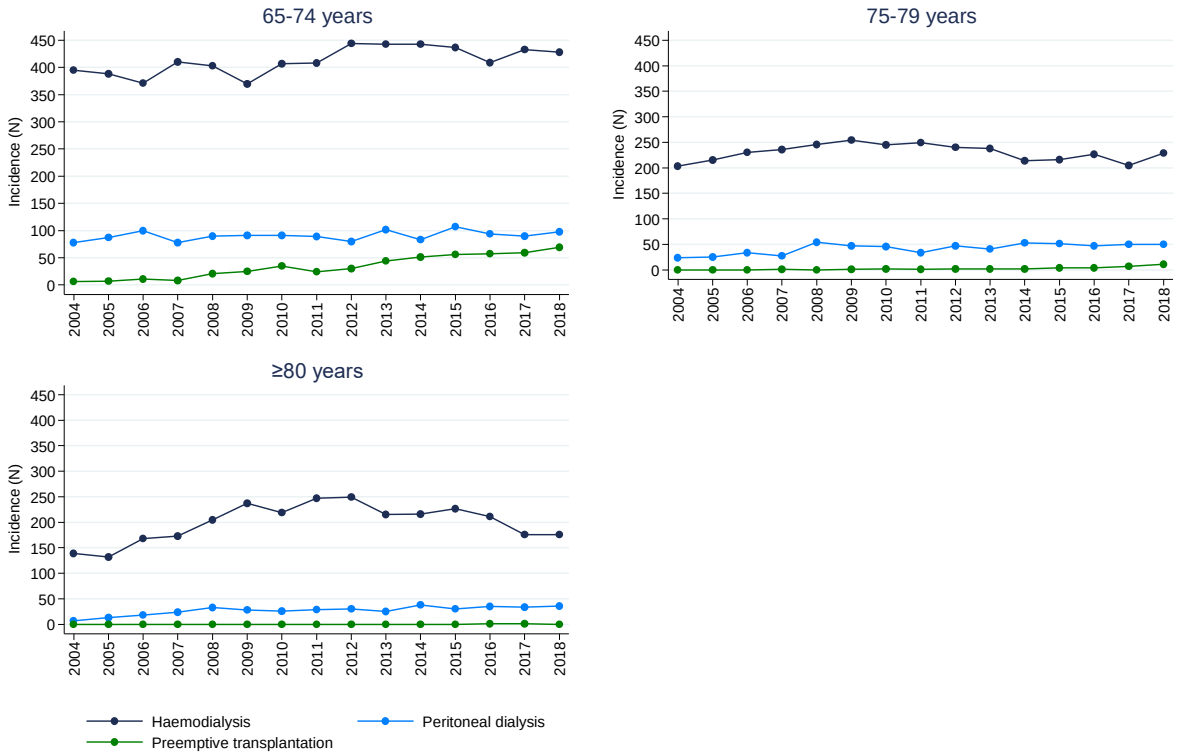


Figure 7.1. Incidence of renal replacement therapy in age categories by different modalities.

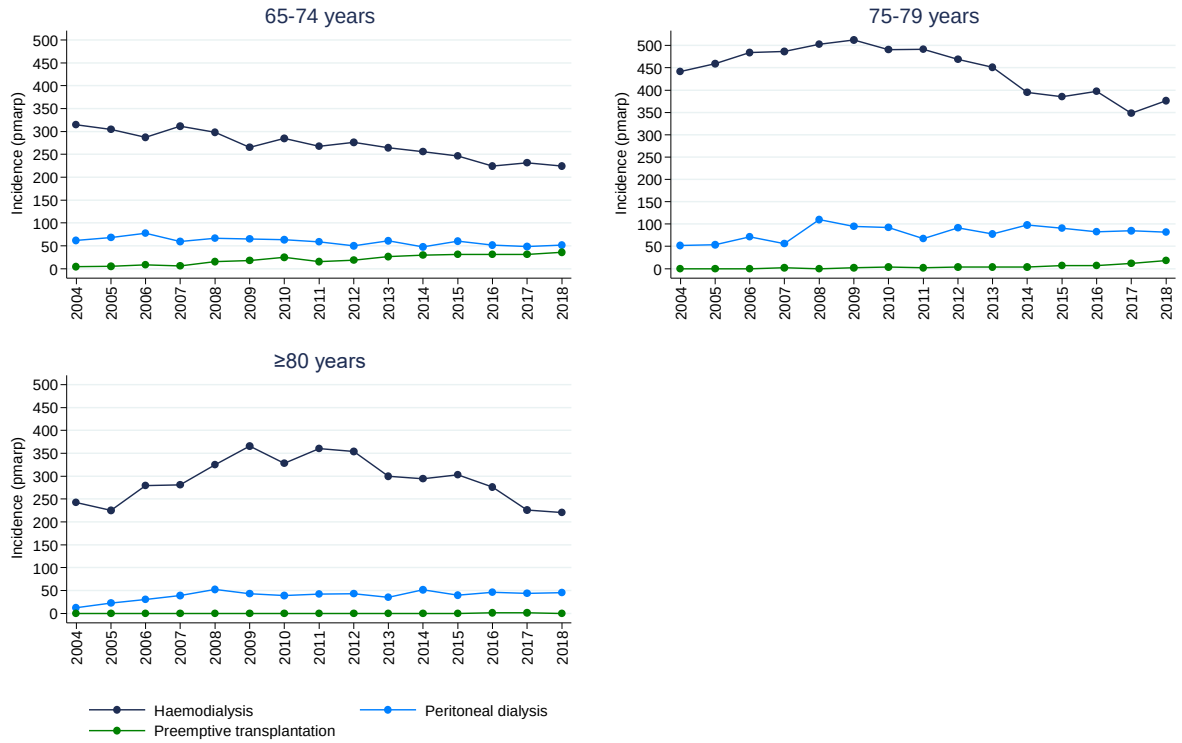


Figure 7.2. Incidence per million age related population of renal replacement therapy in age categories by different modalities.

Time trends in the number of prevalent elderly dialysis patients are provided in absolute numbers (Figure 7.3) and expressed per million age related population (Figure 7.4). In all three age groups currently a decline in prevalene per million is observed. For patients 65-74 years this decline started already around 2007. For the older groups first a steep increase was observed after which the numbers started to decline.

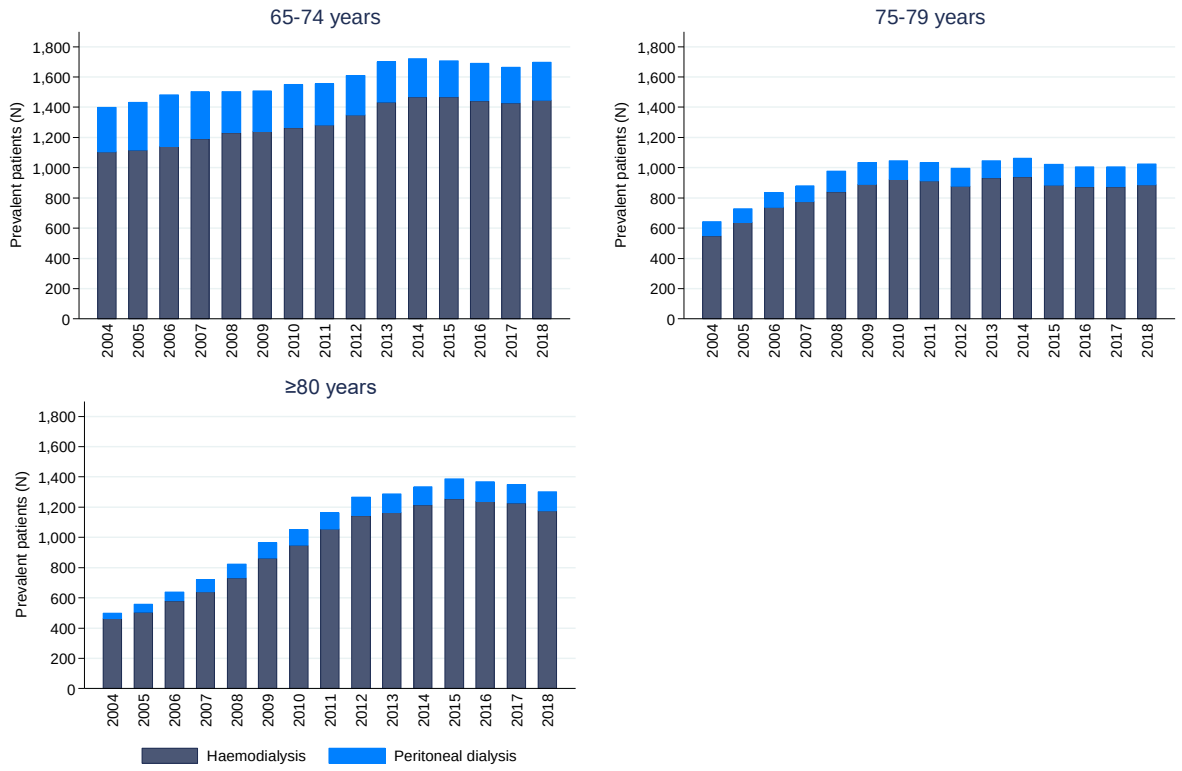


Figure 7.3. Prevalence of haemodialysis and peritoneal dialysis per calendar year in elderly patients by age categories.

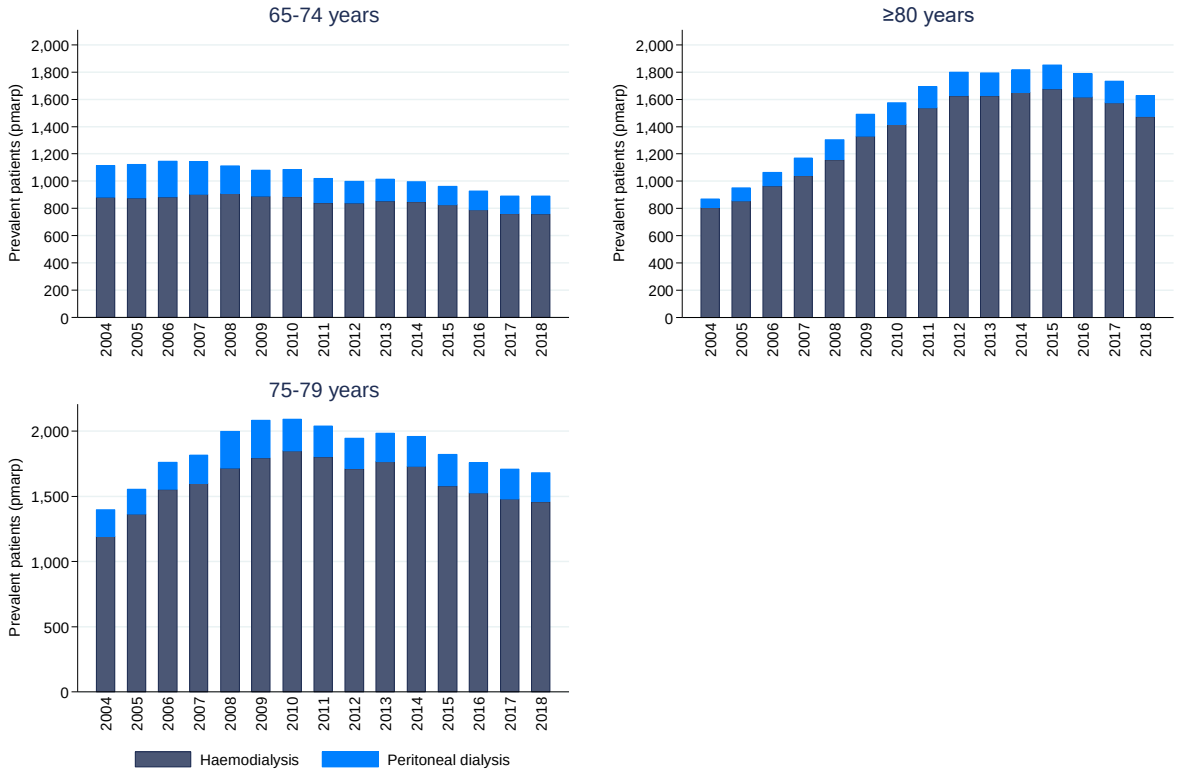


Figure 7.4. Prevalence per million age related population of haemodialysis and peritoneal dialysis per calendar year in elderly patients by age categories.

Considerable variation between centres existed in 2018 in the proportion of dialysis patients of 75 years or older (Figure 7.5). In Figure 7.6 a funnel plot is presented showing between centre variation in the percentage of incident dialysis patients aged 75 years or older.

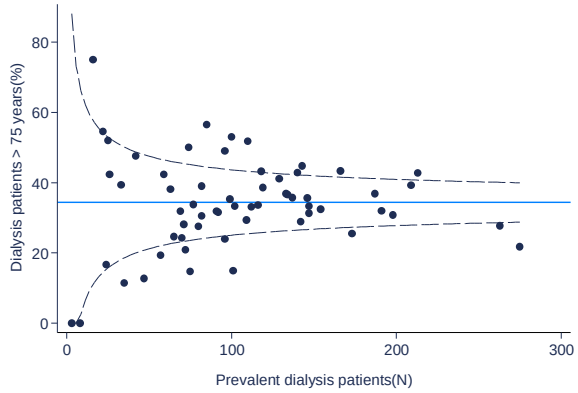


Figure 7.5. Funnel plot showing center variation in percentage of prevalent dialysis patients of 75 years and older.

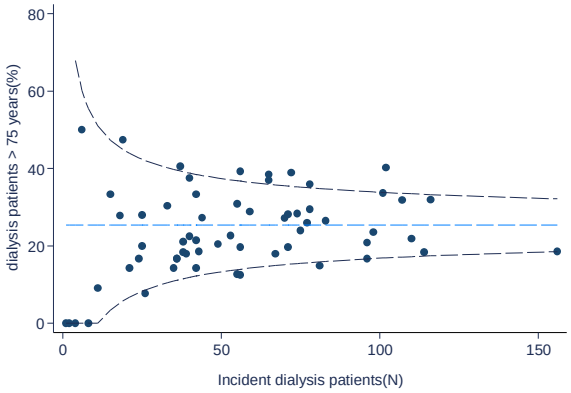


Figure 7.6. Funnel plot showing center variation in percentage of incident dialysis patients of 75 years and older.

Figure 7.7 shows the distribution of vascular access in prevalent haemodialysis patients in 2018. In general, elderly haemodialysis patients had less often a central venous catheter and more often an AV-fistula in comparison to patients younger than 65 years. No major differences were observed within the three elderly age sub groups.

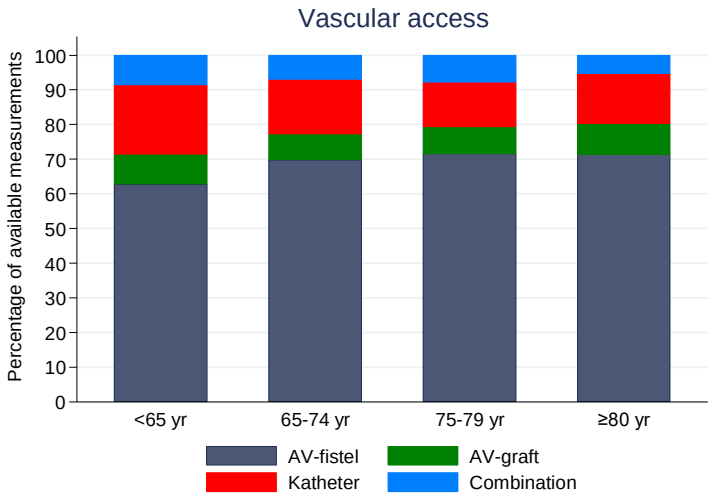


Figure 7.7. Distribution of vascular access categories in prevalent haemodialysis patients.

Over time modest improvements are seen in survival after start of dialysis treatment. Figure 7.8 shows 1-year, 3-year and 5-year survival rates for the three elderly age categories. For one-year survival the curves overlap for the three age groups. Figures 7.9 and 7.10 show absolute and relative causes of death in 2018 for age categories. Especially in patients older than 80 years 'treatment stop' was the most common cause of death. As can be seen in Figure 7.11 over time 'treatment stop' is more often registered as cause of death in all three age categories.

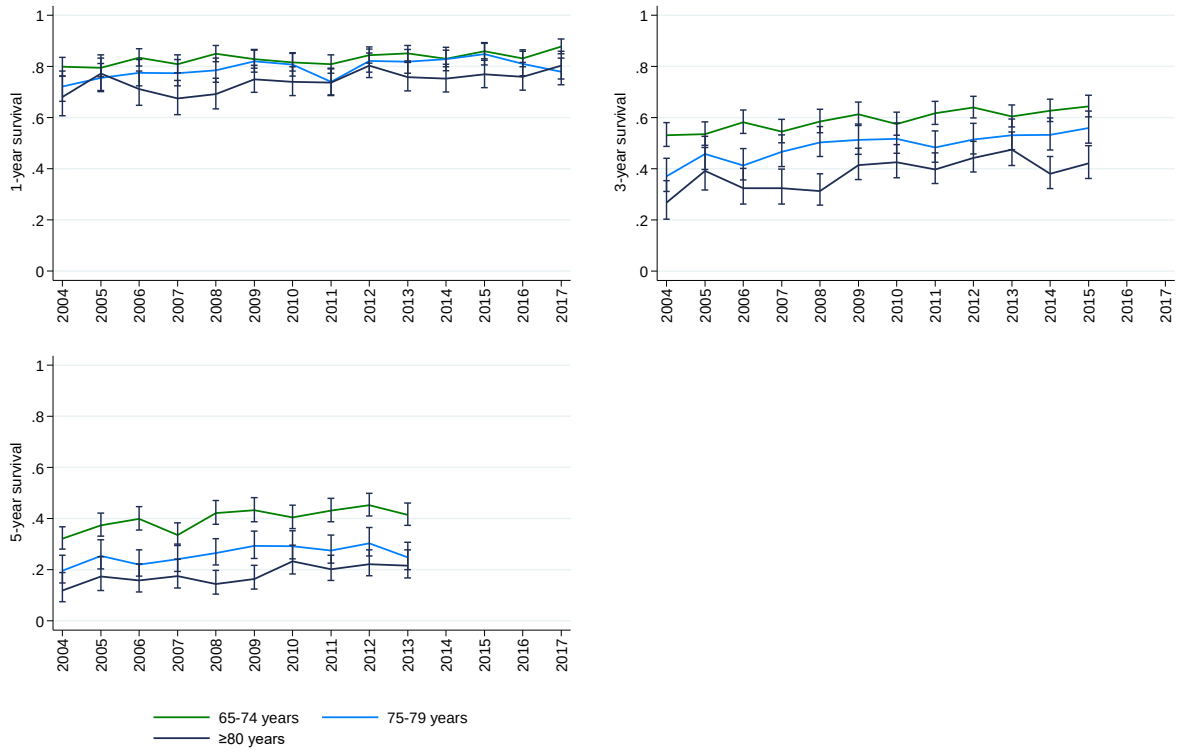


Figure 7.8. 1-year, 3-year and 5-year survival for patients starting dialysis in different calendar years. Survival rates are presented with 95%-confidence intervals and are adjusted for age and sex.

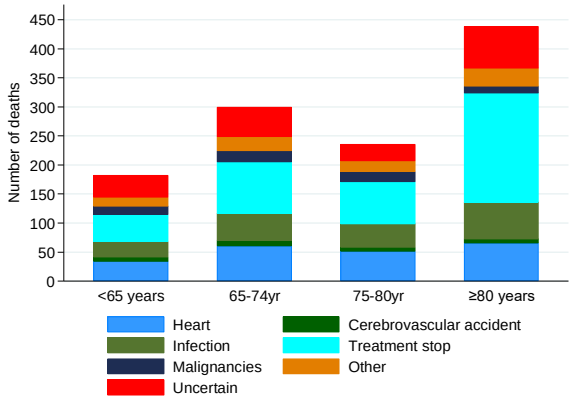


Figure 7.9. Absolute number of deaths in patients on dialysis in 2018 in age categories by cause of death

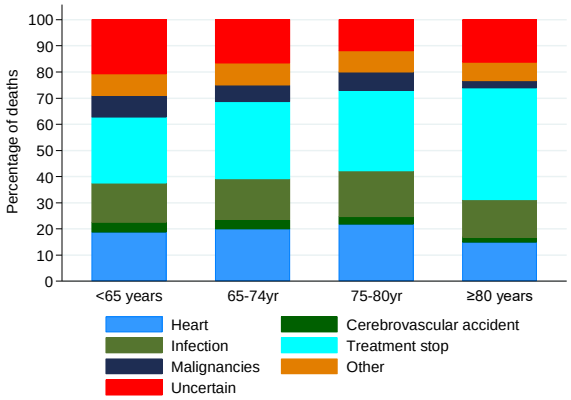


Figure 7.10. Percentages **of** deaths in patients on dialysis in 2018 in age categories by cause of death

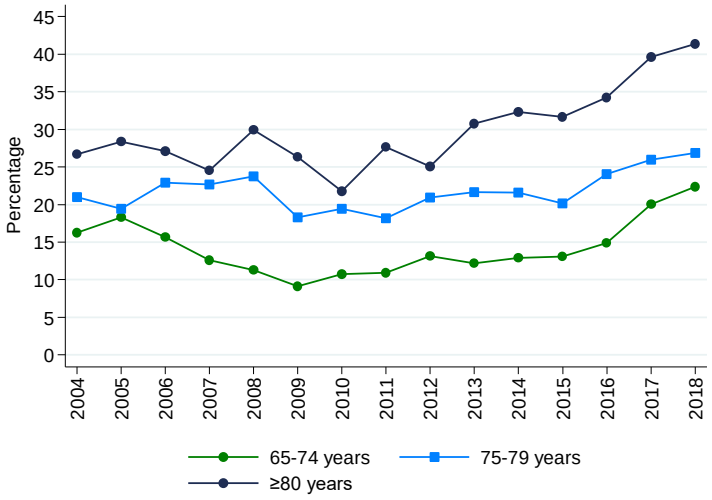


Figure 7.11. Percentages of dialysis patients that died with "treatment stop' as registered cause of death

Time trends in the number of renal transplantations separately for patients 65-74 years and ≥75 years are shown by dialysis history (Figure 7.12) and by donor type (Figure 7.13). Over time more patients in the age group 65-74 years received a renal transplant, mostly after a period of dialysis and from a deceased donor. Numbers in the age group 75 years and older were low but do also show an upwards trend. The number of prevalent patients with a functioning transplant in this age group shows a steep increase over time (Figure 7.14). At the end of 2018 more than 1,000 such patients were registered in Renine. The majority of these patients received their renal transplant before the age of 70 years.

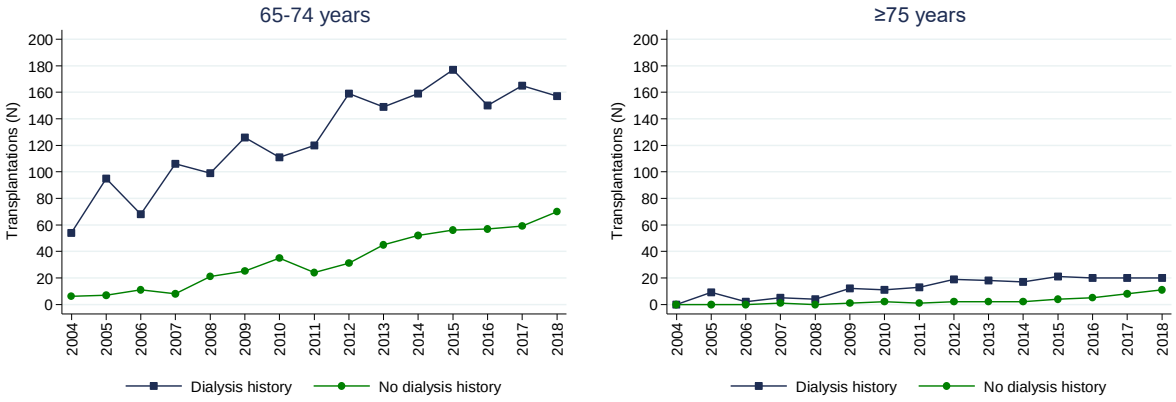


Figure 7.12. Renal transplantations in patients 65-74 years and ≥75 years with and without dialysis history per calendar year.

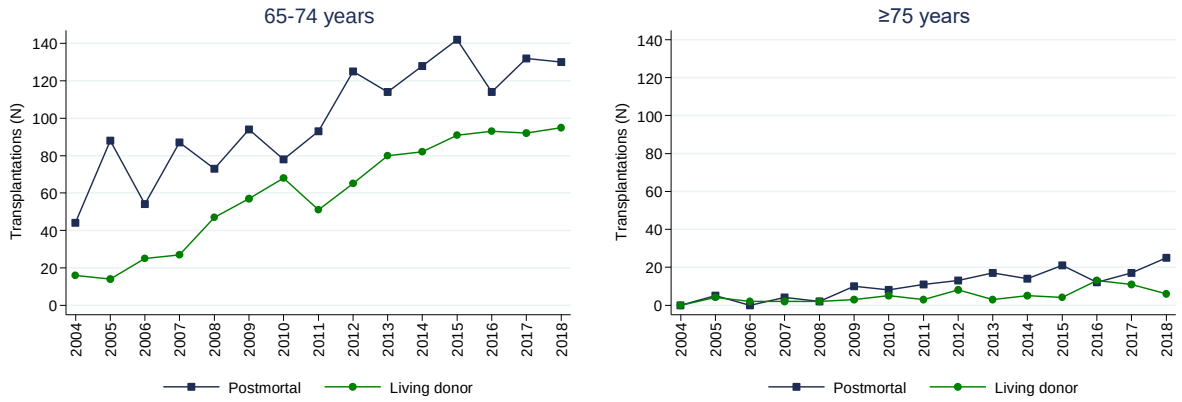


Figure 7.13. Post mortal and living donor renal transplantations in patients 65-74 years and ≥75 years per calendar year.

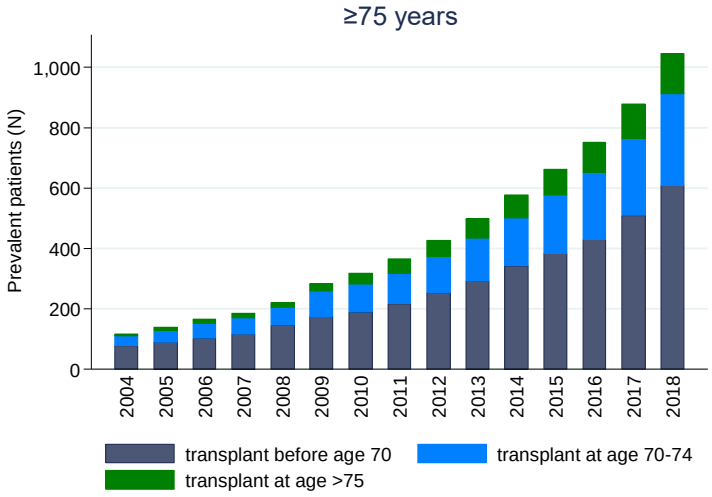


Figure 7.14. Prevalent population of patients of 75 years and older with a functioning transplant by age categories by which they received the renal transplant.

8. Mortality on dialysis

In 2018 1,415 patients died on renal replacement therapy. The majority of deaths (n=1,144) were patients on dialysis therapy. In Figure 8.1 patterns of 5-year mortality is shown stratified for age categories. In these analyses transplantation was treated as a competing event.

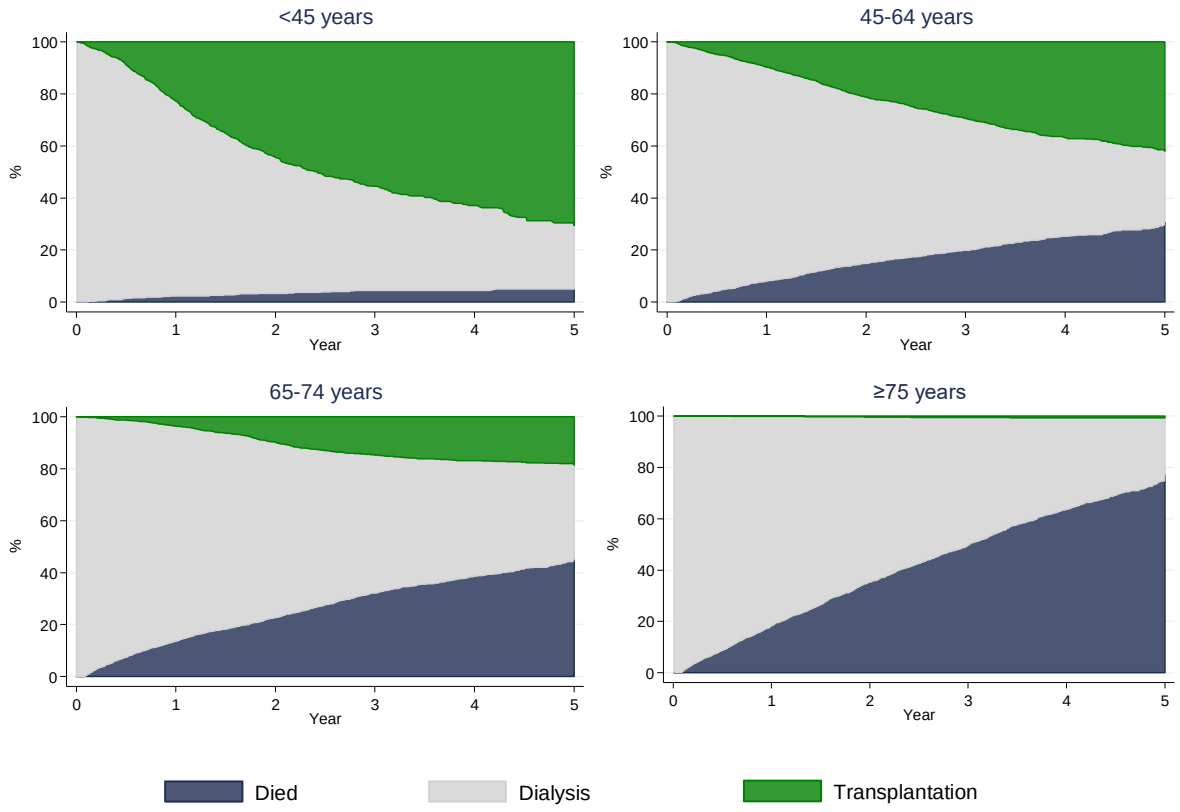


Figure 8.1. Survival and transplantations in incident dialysis patients separately for age categories. Inclusion period 2012-2018. Competing risk analyses were performed (Fine and Gray method). Adjustment was done using fixed values of age, sex and primary kidney disease categories.

In Figures 8.2 and 8.3 centre variation is shown for 1-year and 3-year mortality in incident dialysis patients. The data was adjusted for age, sex, SES, and primary kidney disease categories. However, other important factors affecting prognosis such as comorbidities are not available. Results should therefore be interpreted with caution.

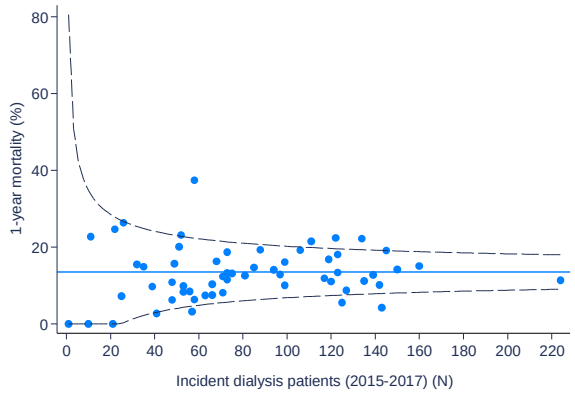


Figure 8.2. Centre variation in 1-year mortality in incident patients. Inclusion period 2015-2017. Adjustments were performed for age, sex, SES, and primary kidney disease categories

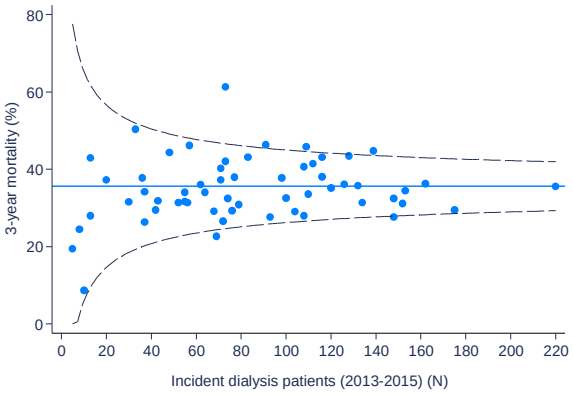


Figure 8.3. Centre variation in 3-year mortality in incident dialysis patients. Inclusion period 2013-2015. Adjustments were performed for age, sex, SES, and primary kidney disease categories

Causes of death were coded according to the ERA-EDTA coding system and categorized according to the categorization as applied by the UKRR (Appendix D). In Figures 8.4 and 8.5 absolute and relative numbers of causes of death are shown for patients who died on dialysis therapy. As in previous years “treatment stop” was the most dominant cause of death.

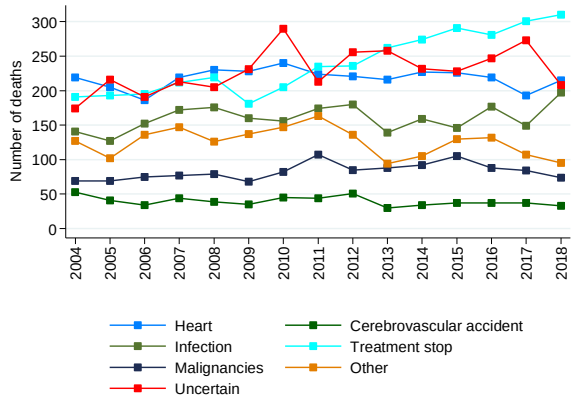


Figure 8.4. Causes of death over time.

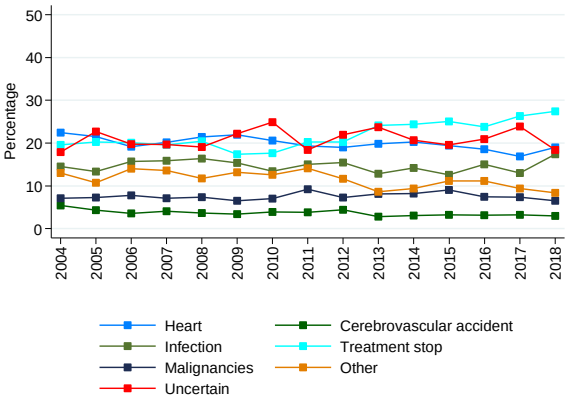


Figure 8.5. Causes of death expressed as percentage of total over time.

9. Renal transplantations

The population of patients living with a function renal transplant is steadily increasing. On December 31th 2018 11,420 prevalent patients living with a renal transplant were registered in Renine. This is 65% of all patients on renal replacement therapy. Figures 9.1 and 9.2 show time trends of prevalence of renal transplantation according to the preceding modality. At present 24% of all patients with a functioning renal transplant were never treated with chronic dialysis.

Figure 9.3 and 9.4 show the same data for post-mortal and living donor transplantations. The proportion patients living with a functioning transplant from a living donor was 51% on December 31th 2018.

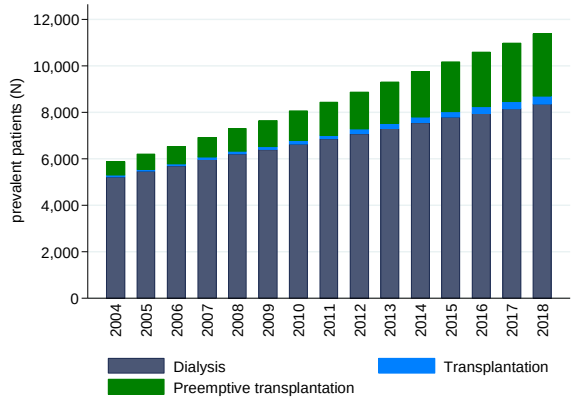


Figure 9.1. Number of prevalent transplant patients by preceding modalities.

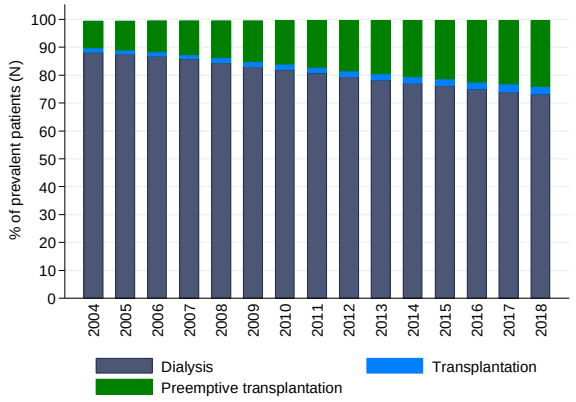


Figure 9.2. Percentage of prevalent transplant patients by preceding modalities.

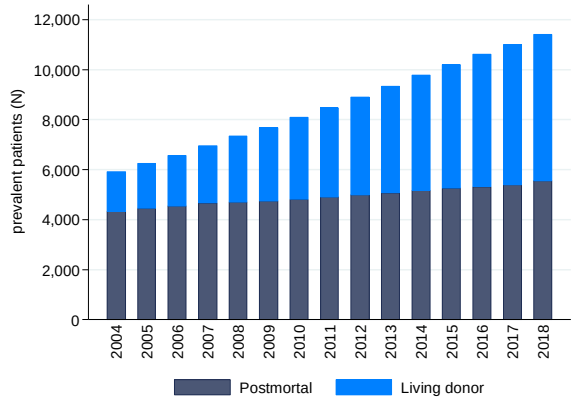


Figure 9.3. Number of prevalent transplant patients according to donor type.

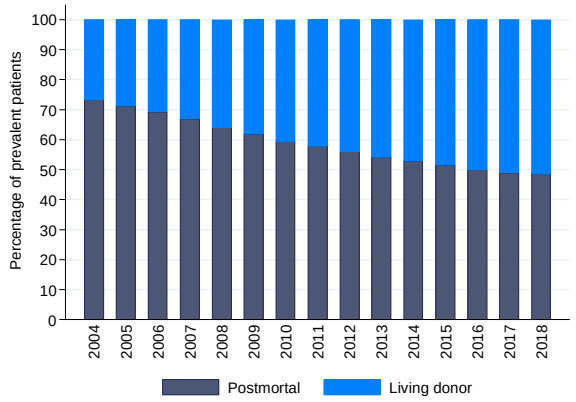


Figure 9.4. Percentage of prevalent transplant patients according to donor type.

In Figure 9.5 and 9.6 prevalent transplant patients are categorized into four groups according to previous treatment with chronic dialysis and donor type (post-mortal/living donor). Most of the young patients were being transplanted with a living donor transplant (Figure 9.6).

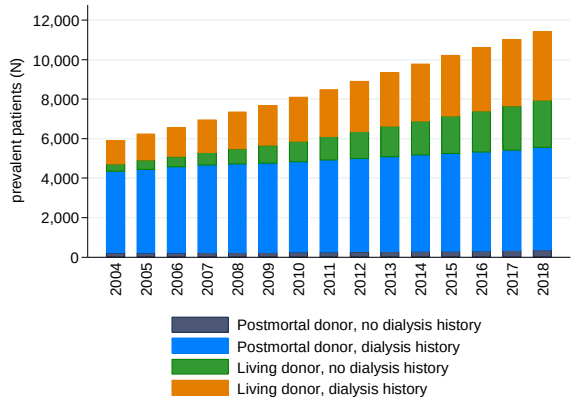


Figure 9.5. Distribution of transplant types in prevalent transplant patients over time.

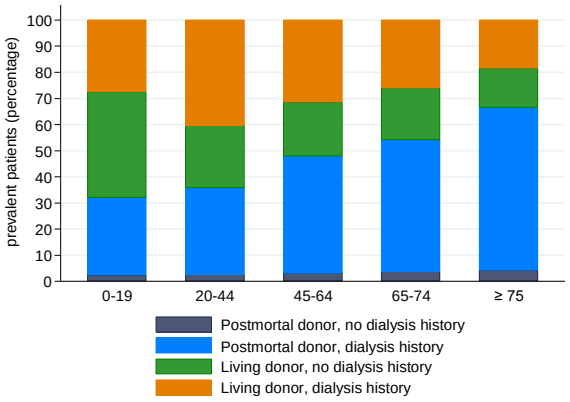


Figure 9.6. Distribution of transplant types in age categories in prevalent transplant patients (December 31th 2018).

In 2018 944 renal transplantations were registered in Renine. Most of the renal transplants were from post-mortal donors and performed in patients with chronic dialysis treatment in their history (Figure 9.7). This number has been more or less stable over the last 15 years. Pre-emptive living-donor transplantations increased until 2013 but have been stable afterwards.

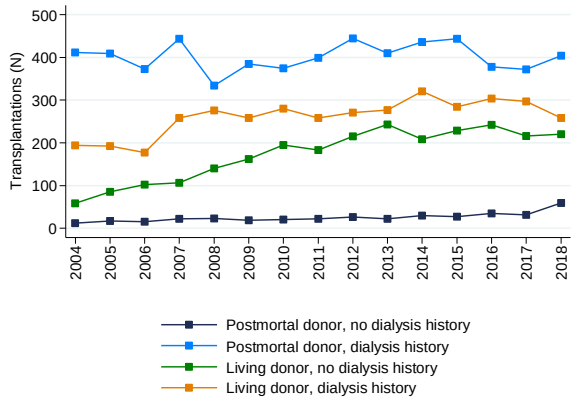


Figure 9.7. Number of different types of renal transplantations over time.

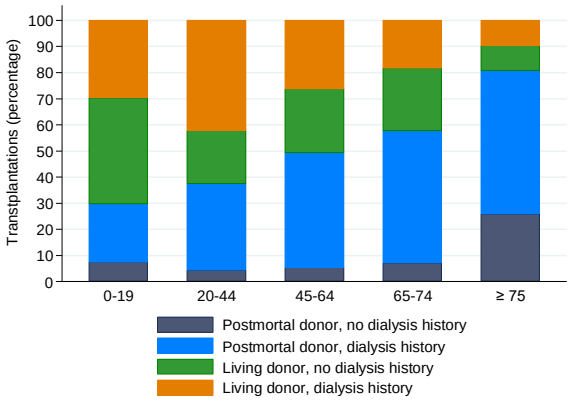


Figure 9.8. Distribution of different types of renal transplantations in age categories in the year 2018.

Substantial variation between centre variation exists regarding the proportion of incident patients starting RRT therapy by means of a pre-emptive renal transplant (Figure 9.9). Figure 9.10 shows centre variation in the percentage of prevalent patients that received a renal transplant in 2018. In these analyses patients were included aged 18-75 years. The analyses were adjusted for age, sex, SES, and primary kidney disease categories.

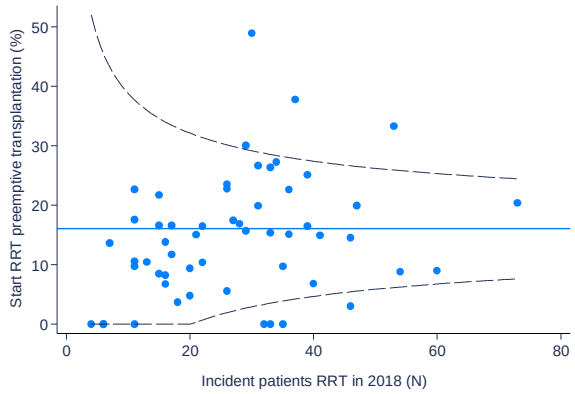


Figure 9.9. Centre variation in percentage pre-emptive transplantation in incident RRT patients in 2018. Adjustments were performed for age, sex, SES, and primary kidney disease categories.

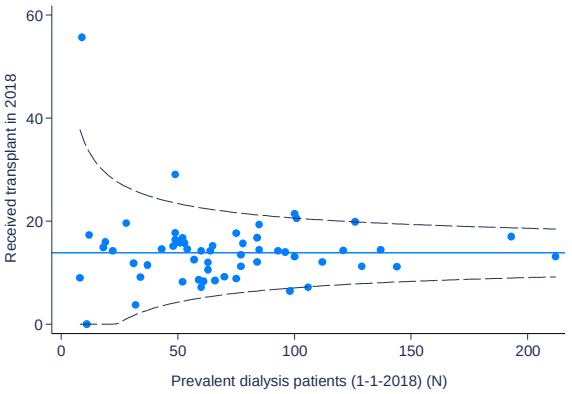


Figure 9.10. Centre variation in percentage of prevalent patients on January 1 that received a transplant in 2018. Adjustments were performed for age, sex, SES, primary kidney disease categories and dialysis vintage.

10. Clinical variables

Clinical variables such as laboratory measurements, details of dialysis treatment and vascular access data of dialysis patients are being registered four times per year. Since 2016 registration of clinical variables is a mandatory component of the Renine registry. This resulted in a steep increase in availability of data in that year. For 2018 completeness of the data was 79% for phosphate levels (Figure 10.1) and 81% for vascular access in haemodialysis patients (Figure 10.2). This is a minimal improvement compared to 2017.

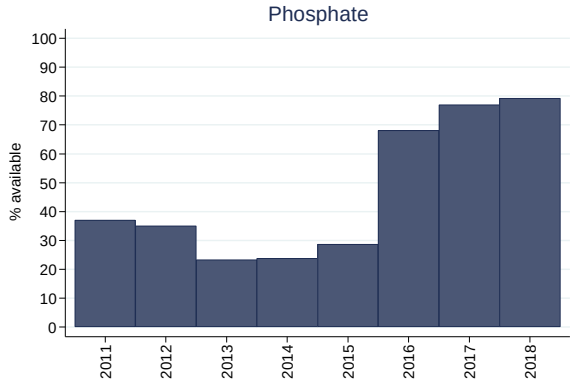


Figure 10.1. Availability of phosphate measurements per year expressed as percentage of the total number of potential measurements.

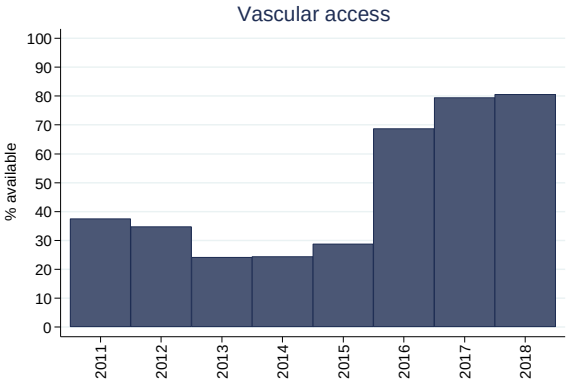


Figure 10.2. Availability of vascular access data per year as percentage of the total number of potential measurements.

Figure 10.3. shows categories of clinical indicators stratified for age categories. Substantial variation in observed mean values was observed across different centres as is shown in the funnel plots (Figure 10.4). Adjustments were performed for differences in case-mix (age, sex, SES, and primary kidney disease categories.

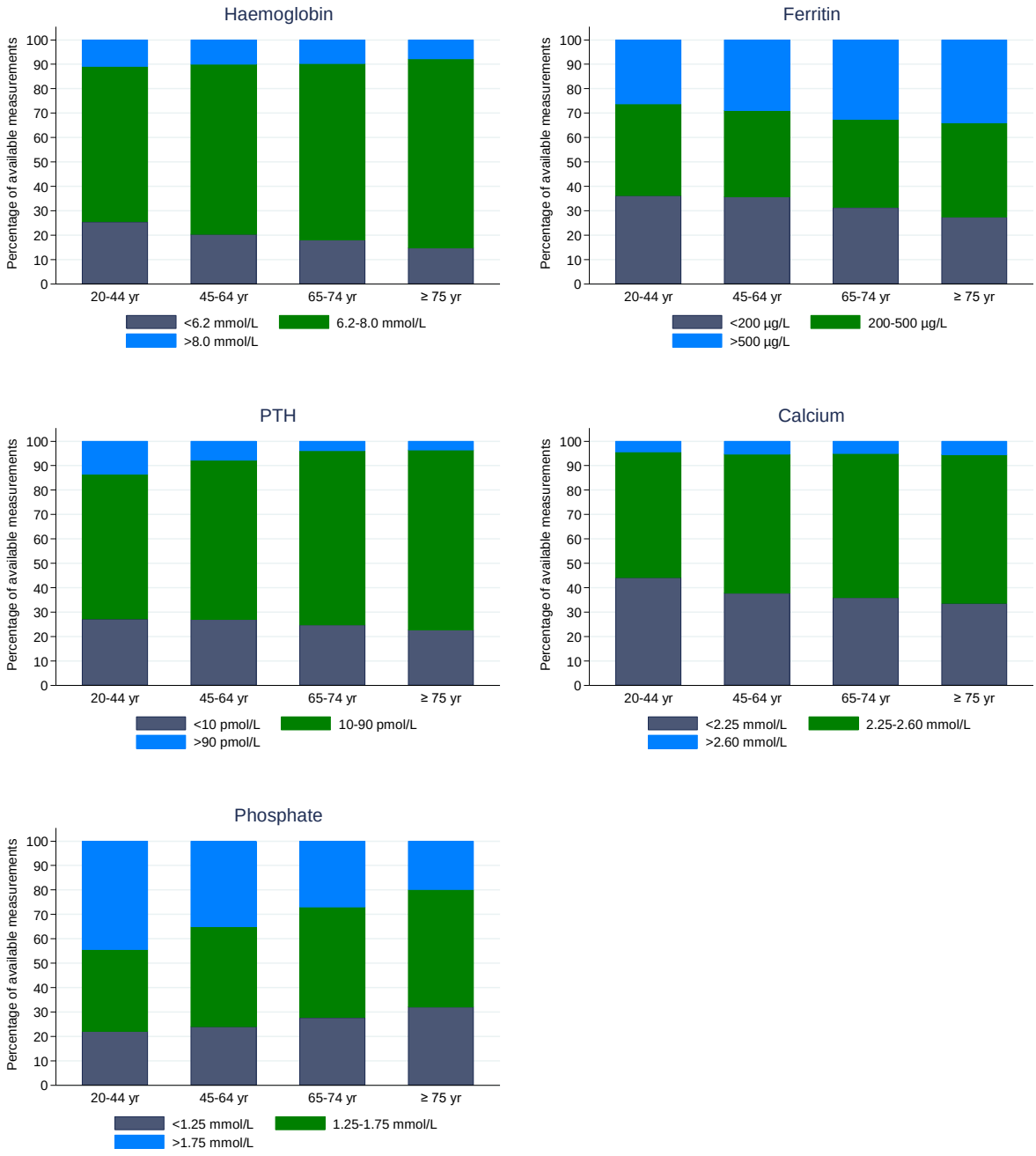


Figure 10.3. Categories of clinical variables stratified for age categories

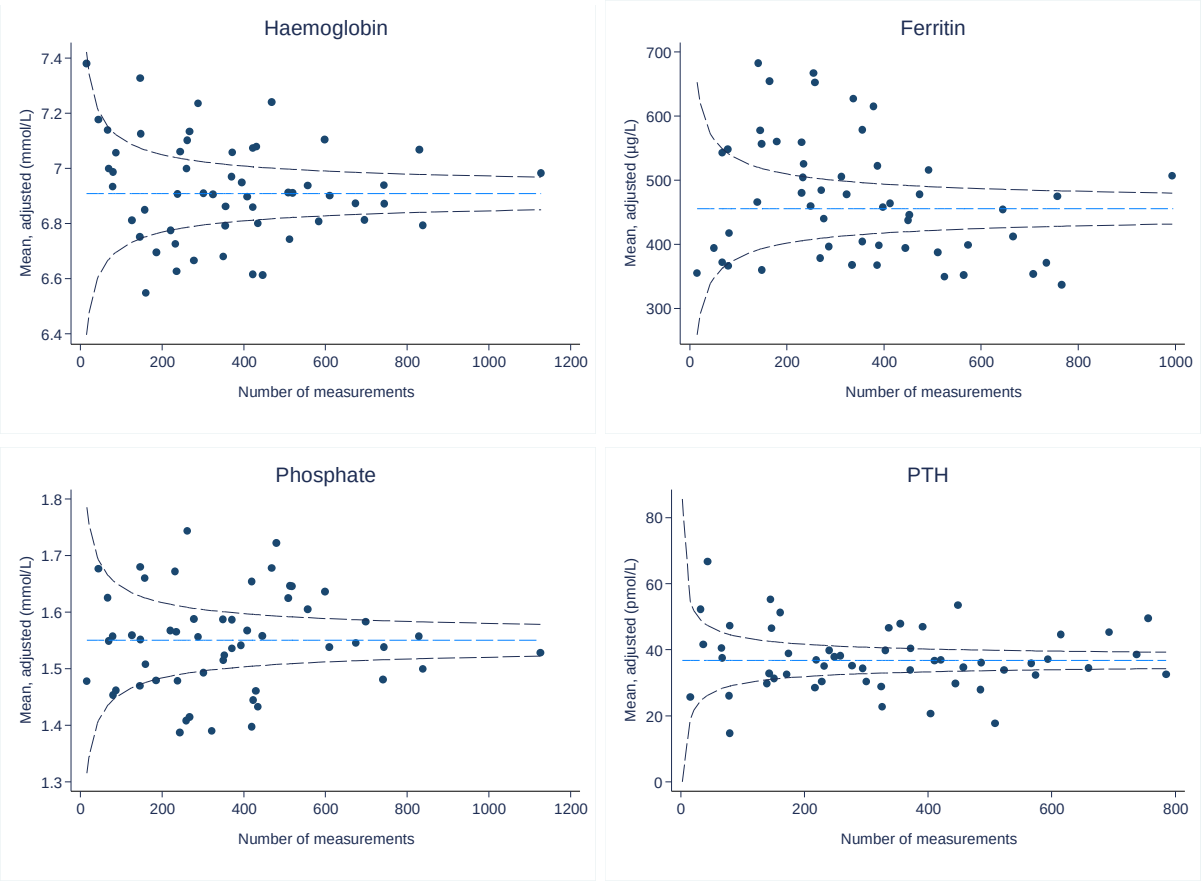


Figure 10.4. Funnel plots showing centre variation of mean values of clinical variables. The funnels were adjusted for differences in case-mix (age, gender, SES, and primary kidney disease categories).

In Figures 10.5 and 10.6 centre variation in the percentages patients with a central venous catheter is shown for prevalent and incident haemodialysis patients respectively.

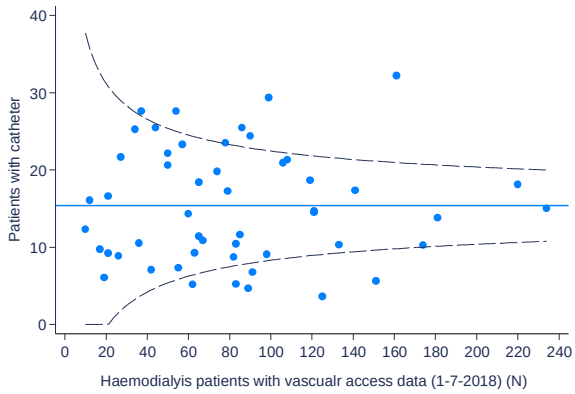


Figure 10.5. Centre variation in catheter use in prevalent haemodialysis patients. Adjustments were performed for age, sex, SES, and primary kidney disease categories.

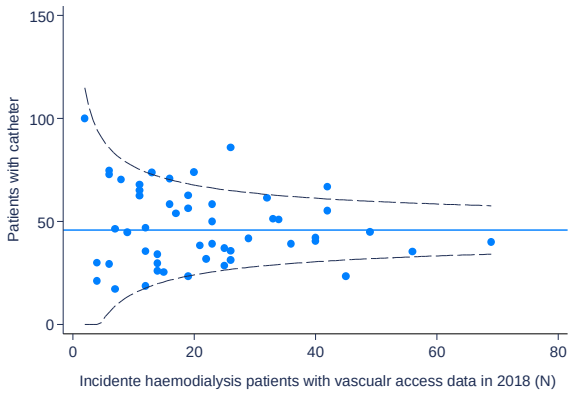


Figure 10.6. Centre variation in catheter use in incident patients. Adjustments were performed for age, sex, SES, and primary kidney disease categories.

11. Conclusions

This annual report concerning renal replacement therapy in the Netherlands in 2018 shows stable incidence and increased prevalence of RRT patients over the last ten years. The slightly decreased incidence in 2017 has not been sustained. Thirteen percent of incident RRT patients received a pre-emptive renal transplant. The increase of prevalence is the consequence of an increased number of patients with a functioning kidney transplant.

Over the years peritoneal dialysis became less common in the younger age categories, whilst the number of peritoneal dialysis patients of 75 years and older increased. During the first year of treatment more patients switch from peritoneal to haemodialysis than vice versa. The decline of home dialysis in previous years has been stopped, but all efforts to stimulate home dialysis did not result in an increased number of prevalent home dialysis patients. Nineteen percent of the prevalent dialysis patients were treated with peritoneal dialysis or home haemodialysis. The proportion of patients treated with peritoneal dialysis or home haemodialysis showed substantial variation among centres.

In the present report, we focused on the population of children and adolescents younger than 20 years and the older population of 65 years and older. In the period 2014-2018, 140 children started renal replacement therapy; about 50% with kidney transplantation and 50% with dialysis. Congenital abnormalities of kidneys and urinary tract is the predominant primary diagnosis category. Most patients with glomerular diseases start on dialysis due to a more frequent acute presentation of the disease which does not allow necessary time to prepare for a kidney transplantation. Over time both incidence and prevalence of renal replacement therapy in the younger age population decreased gradually. This is associated with a lower number of new CAKUT patients and better treatment options with glomerular disease.

Forty-five percent of the prevalent patients on RRT were older than 65 years. The number of incident elderly renal replacement therapy patients remained stable. Over time more patients older than 65 years received a kidney transplant, mostly after a period of dialysis and from a deceased donor. Prevalence per million age related population of haemodialysis and peritoneal dialysis per calendar year decreased in the three elderly age categories. Elderly haemodialysis patients have less often a central venous catheter in comparison to patients younger than 65 years. In dialysis patients older than 80 years treatment withdrawal was the most reported cause of death with an increased frequency over the years.

The completeness of the clinical data was 79% for phosphate levels and 81% for vascular access in haemodialysis patients. This is a minimal improvement compared to 2017. We aim to have a complete dataset in the next years by improving data availability by electronic registration from primary data sources. The coming years the registry Renine will be extended with data on the population with chronic kidney disease stage G4-5 before the start of RRT. In the next annual report 2019 we will focus on patient reported outcomes in the dialysis population.

Appendix A Methods and definitions

Incidence
An incident population is defined as the population starting renal replacement therapy or a specific treatment modality in a calendar year. Unless otherwise stated this only includes first-time start of renal replacement therapy or a specific dialysis treatment modality.

Prevalence
Prevalence is defined as the population on renal replacement therapy or a specific treatment modality on December 31th of a calendar year.

Per million population (pmp)
The incidence or prevalence pmp is the observed incident or prevalent count divided by the general population in that year and multiplies by one million.

Per million age-related population (pmarp)
The incidence or prevalence pmarp is the observed incident or prevalent count for a specific age group divided by the general population of that age group and multiplied by one million.

Coding
Renal diseases and causes of death were defined according to the ERA-EDTA coding systems and classified into groups. See Appendix B and C for details.

Survival analysis
Cumulative incidence curves were plotted using the Fine and Gray method for competing events. Subjects were censored in case of recovery of renal function, loss to follow-up or end of follow-up time (December 31th 2018). Survival was analysed from day 1 of chronic dialysis treatment. The cumulative incidence curves were adjusted for fixed values of age (50 years for the age category <65 years and 70 years for the age category ≥65 years), sex (63% men) and primary kidney disease categories (24% Diabetes; 19% Hypertension/renal vascular disease; 11% Glomerulonephritis; 46% Other causes).

Funnel plots
Centre variations in the year 2018 are presented by funnel plots. In these plots a centre-specific mean or percentage is plotted against a variable indicating centre size. For binary and continuous outcomes 95%-confidence intervals were plotted based on the binomial and normal distribution respectively. Funnels are plotted around the average estimate over all centres. Any centres which fall outside the 95%-confidence intervals of the funnels are significantly different from the average. The funnel shape of the limits reflects the fact that for smaller centres a greater observed difference from the average is required for it to be statistically significantly different. To account for differences in case-mix a number of adjustments were performed. For binary outcomes a logistic model with age, sex, SES, and primary kidney disease as independent variables was used to derive a probability of the event for every individual patient. These probabilities were summed over the patients within a centre to give an expected number of events (E). A standardized percentage is calculated by multiplying the ratio of observed and expected events (O/E) by the overall percentage over all centres. For continuous outcomes expected outcomes were estimated using linear regression models. An adjusted mean was calculated by adding the difference between the observed and expected mean (O-E) to the overall mean value.

Appendix B Categories of primary kidney disease

Category	ERA-EDTA code	Primary renal disease
Glomerulonephritis/sclerosis	10	Glomerulonephritis, histologically NOT examined
	11	Severe nephrotic syndrome with focal sclerosis (paediatric patients only)
	12	IgA nephropathy (proven by immunofluorescence, not code 85)
	13	Dense deposit disease membrano-proliferative GN, type II (proven by immunofluorescence and/or electron microscopy)
	14	Membranous nephropathy
	15	Membrano-proliferative GN, type I (proven by immunofluorescence and/orelectron microscopy - not code 84 or 89)
	16	Rapidly progressive GN without systemic disease (crescentic, histologically confirmed, not coded elsewhere)
	19	Glomerulonephritis, histologically examined
	17	Focal segmental glomerusclerosis with nephrotic syndrome in adults
Pyelonephritis	20	Pyelonephritis/Interstitial nephritis-cause not specified
	21	Pyelonephritis/Interstitial nephritis associated with neurogenic bladder
	22	Pyelonephritis/Interstitial nephritis due to congenital obstructive uropathy with or without vesico-ureteric reflux
	23	Pyelonephritis/Interstitial nephritis due to acquired obstructive uropathy
	24	Pyelonephritis/Interstitial nephritis due to vesico-ureteric reflux without obstruction
	25	Pyelonephritis/Interstitial nephritis due to urolithiasis
	29	Pyelonephritis/Interstitial nephritis due to other cause
Polycystic kidneys, adult type	41	Polycystic kidneys, adult type (dominant)
Hypertension	71	Renal vascular disease due to malignant hypertension (NO primary renal disease)
	72	Renal vascular disease due to hypertension (NO primary renal disease)

Category	ERA-EDTA code	Primary renal disease
Renal vascular disease	70	Renal vascular disease-type unspecified
	79	Renal vascular disease-classified
Diabetes, type 1	80	Type I Diabetes Mellitus
Diabetes, type 2	81	Type II Diabetes Mellitus
Miscellaneous	30	Tubulo interstitial nephritis (not pyelonephritis)
	31	Nephropathy due to analgesic drugs
	32	Nephropathy due to cis-platinum
	33	Nephropathy due to cyclosporin A
	39	Nephropathy caused by other specific drug
	40	Cystic kidney disease-type unspecified
	42	Polycystic kidneys, infantile (recessive)
	43	Medullary cystic disease, including nephronophthisis
	49	Cystic kidney disease-other specified type
	50	Hereditary/Familial nephropathy-type unspecified
	51	Hereditary nephritis with nerve deafness (Alport's Syndrome)
	52	Cystinosis
	53	Primary oxalosis
	54	Fabry’s disease
	59	Hereditary nephropathy-other
	60	Congenital renal hypoplasia-type unspecified
	61	Oligomeganephronic hypoplasia
	63	Congenital renal dysplasia with or without urinary tract malformation
	66	Syndrome of agenesis of abdominal muscles (Prune Belly Syndrome)
	73	Renal vascular disease due to polyarteritis
	74	Wegener’s granulomatosis

Category	ERA-EDTA code	Primary renal disease
	82	Myelomatosis/light chain deposit disease
	83	Amyloid
	84	Lupus erythematosus
	85	Henoch-Schoenlein purpura
	86	Goodpasture's Syndrome
	87	Systemic sclerosis (scleroderma)
	88	Haemolytic Uraemic Syndrome including Moschcowitz Syndrome
	89	Multi-system disease-other
	90	Cortical or tubular necrosis
	91	Tuberculosis
	92	Gout
	93	Nephrocalcinosis and hypercalcaemic nephropathy
	94	Balkan nephropathy
	95	Kidney tumour
	96	Traumatic or surgical loss of kidney
	99	Other identified renal disorders
	34	Lead induced interstitial nephropathy
	75	Ischaemic renal disease / cholesterol embolisation
	76	Glomerulonephritis related to liver cirrhosis
	78	Cryglobulinaemic glomerulonephritis
Unknown	0	Chronic renal failure, aetiology uncertain

Appendix C. Categories of primary kidney disease in children and adolescents

Category	ERA-EDTA code	Primary renal disease
Congenital abnormalities of kidneys and urinary tract (CAKUT)	20	Pyelonephritis; cause not specified
	21	Pyelonephritis associated with neurogenic bladder
	22	Pyelonephritis due to congenital obstructive uropathy with/without vesico-ureteric reflux
	23	Pyelonephritis due to acquired obstructive uropathy
	24	Pyelonephritis due to vesico-ureteric reflux without obstruction
	25	Pyelonephritis due to urolithiasis
	29	Pyelonephritis due to other cause
	60	Renal hypoplasia (congenital) - type unspecified
	61	Oligomeganephronic hypoplasia
	63	Congenital renal dysplasia with or without urinary tract malformation
	66	Syndrome of agenesis of abdominal muscles (Prune Belly)
Glomerular diseases	10	Glomerulonephritis; histologically NOT examined
	11	Focal segmental glomerulosclerosis with nephrotic syndrome in children
	12	IgA nephropathy (proven by immunofluorescence, not code 76 or 85)
	13	Dense deposit disease; membrano-proliferative GN; type II (proven by immunofluorescence/ electron microscopy)
	14	Membranous nephropathy
	15	Membrano-proliferative GN; type I (proven by immunofluorescence / electron microscopy, not code 84 or 89)
	16	Crescentic (extracapillary) glomerulonephritis (type I, II, III)
	17	Focal segmental glomerulosclerosis with nephrotic syndrome in adults
	19	Glomerulonephritis; histologically examined, not given above
	76	Glomerulonephritis related to liver cirrhosis
	78	Cryoglobulinaemic glomerulonephritis

Category	ERA-EDTA code	Primary renal disease
	85	Henoch-Schoenlein purpura
	88	Haemolytic Uraemic Syndrome (including Moschcowitz Syndrome)
Cystic diseases	40	Cystic kidney disease - type unspecified
	41	Polycystic kidneys; adult type (dominant)
	42	Polycystic kidneys; infantile (recessive)
	43	Medullary cystic disease; including nephronophthisis
	49	Cystic kidney disease - other specified type
Metabolic diseases	52	Cystinosis
	53	Primary oxalosis
	54	Fabry's disease
	80	Diabetes glomerulosclerosis or diabetic nephropathy - Type I
	81	Diabetes glomerulosclerosis or diabetic nephropathy - Type II
	92	Gout
	93	Nephrocalcinosis and hypercalcaemic nephropathy
Hereditary diseases	50	Hereditary / Familial nephropathy - type unspecified
	51	Hereditary nephritis with nerve deafness (Alport's Syndrome)
	59	Hereditary nephropathy - other specified type
Systemic diseases	73	Renal vascular disease due to polyarteritis
	74	Wegener's granulomatosis
	84	Lupus erythematosus
	86	Goodpasture's Syndrome
	87	Systemic sclerosis (scleroderma)
	89	Multi-system disease - other (not mentioned above)

Category	ERA-EDTA code	Primary renal disease
Vascular diseases	70	Renal vascular disease - type unspecified
	71	Renal vascular disease due to malignant hypertension
	72	Renal vascular disease due to hypertension
	79	Renal vascular disease - due to other cause (not given above and not code 84-88)
Other	30	Interstitial nephritis (not pyelonephritis) due to other cause, or unspecified (not mentioned above)
	31	Nephropathy (interstitial) due to analgesic drugs
	32	Nephropathy (interstitial) due to cis-platinum
	33	Nephropathy (interstitial) due to cyclosporin A
	34	Lead induced nephropathy (interstitial)
	39	Drug induced nephropathy (interstitial) not mentioned above
	75	Ischaemic renal disease/cholesterol embolism (1998 prd code)
	82	Myelomatosis / light chain deposit disease
	83	Amyloid
	90	Tubular necrosis (irreversible) or cortical necrosis (different from 88)
	91	Tuberculosis
	94	Balkan nephropathy
	95	Kidney tumour
	96	Traumatic or surgical loss of kidney
	99	Other identified renal disorders
Unknown	0	Chronic renal failure, aetiology uncertain

Appendix D. Categories of causes of death

Category	ERA-EDTA code	Cause of death
Heart	11	Myocardial ischaemia and infarction
	14	Other causes of cardiac failure
	15	Cardiac arrest / sudden death; other cause or unknown
	16	Hypertensive cardiac failure
	18	Fluid overload / pulmonary oedema
Cerebrovascular accident	22	Cerebro-vascular accident, other cause or unspecified
Infection	30	Infection
	31	Pulmonary infection (bacterial - not code 73)
	32	Pulmonary infection (viral)
	33	Pulmonary infection (fungal or protozoal; parasitic)
	34	Infections elsewhere except virus hepatitis
	35	Septicaemia
	36	Tuberculosis (lung)
	37	Tuberculosis (elsewhere)
	38	Generalized viral infection
	39	Peritonitis (all causes except for Peritoneal Dialysis)
	100	Peritonitis (bacterial, with peritoneal dialysis)
	101	Peritonitis (fungal, with peritoneal dialysis)
	102	Peritonitis (due to other cause, with peritoneal dialysis)
Treatment stop	51	Patient refused further treatment for ESRF
	54	ESRF treatment withdrawn for medical reasons
	61	Uremia caused by graft failure
	53	ESRF treatment ceased for any other reason
Malignancy	66	Malignant disease, possibly induced by immunosuppressive therapy
	67	Malignant disease: solid tumors except those of 66

Category	ERA-EDTA code	Cause of death
	68	Malignant disease: lymphoproliferative disorders except those of 66
Other	12	Hyperkalaemia
	13	Haemorrhagic pericarditis
	17	Hypokalaemia
	21	Pulmonary embolus
	23	Gastro-intestinal haemorrhage
	24	Haemorrhage from graft site
	25	Haemorrhage from vascular access or dialysis circuit
	26	Haemorrhage from ruptured vascular aneurysm (not code 22 or 23)
	27	Haemorrhage from surgery (not code 23, 24 or 26)
	28	Other haemorrhage (not codes 23-27)
	29	Mesenteric infarction
	41	Liver disease due to hepatitis B virus
	42	Liver disease due to other viral hepatitis
	43	Liver disease due to drug toxicity
	44	Cirrhosis - not viral
	45	Cystic liver disease
	46	Liver failure - cause unknown
	52	Suicide
	62	Pancreatitis
	63	Bone marrow depression
	64	Cachexia
	69	Dementia
	70	Peritonitis (sclerosing, with peritoneal dialysis)
	71	Perforation of peptic ulcer
	72	Perforation of colon
	73	Chronic obstructive airways disease
	80	Accident (all causes)

Category	ERA-EDTA code	Cause of death
	81	Accident related to ESRF treatment (not code 25)
	82	Accident unrelated to ESRF treatment
	90	Gastro-intestinal - other
	99	Other identified cause of death
Uncertain	0	Cause of death uncertain / not determined