Effect of comorbidities on survival in patients > 80 years of age at onset of renal replacement therapy: data from the ERA-EDTA Registry

Helve, J; Kramer, A; Diez, JMA; Areste-Fosalba, N; Arici, M ...

2021-04
Oxford University Press
http://hdl.handle.net/10138/344014
Helve, J, Kramer, A, Diez, JMA, Areste-Fosalba, N, Arici, M, Cases, A, Collart, F, Heaf, J, De Meester, J, Nordio, M, Palsson, R, Pobes, A, Rydell, H, Reisaeter, AV, Massy, ZA, Jager, KJ & Finne, P 2021, 'Effect of comorbidities on survival in patients > 80 years of age at onset of renal replacement therapy: data from the ERA-EDTA Registry', Nephrology Dialysis Transplantation, vol. 36, no. 4, pp. 688-694. https://doi.org/10.1093/ndt/gfaa278

33. Wu TT, Chang CY, Hsu WM *et al.* Nutritional status of vegetarians on maintenance haemodialysis. *Nephrology (Carlton)* 2011; 16: 582–587
34. Kandouz S, Mohamed AS, Zheng Y *et al.* Reduced protein bound uraemic toxins in vegetarian kidney failure patients treated by haemodiafiltration. *Hemodial Int* 2016; 20: 610–617
35. Tseng CY, Wu TT, Lai CW *et al.* Vegetarian diet may ameliorate uremic pruritus in hemodialysis patients. *Ren Fail* 2018; 40: 514–519
36. Chan M, Kelly J, Tapsell L. Dietary modeling of foods for advanced CKD based on general healthy eating guidelines: what should be on the plate? *Am J Kidney Dis* 2017; 69: 436–450
37. Millward DJ. Identifying recommended dietary allowances for protein and amino acids: a critique of the 2007 WHO/FAO/UNU report. *Br J Nutr* 2012; 108(Suppl 2): S3–S21
38. Rand WM, Pellett PL, Young VR. Meta-analysis of nitrogen balance studies for estimating protein requirements in healthy adults. *Am J Clin Nutr* 2003; 77: 109–127
39. Millward DJ. The nutritional value of plant-based diets in relation to human amino acid and protein requirements. *Proc Nutr Soc* 1999; 58: 249–260
40. Young VR, Pellett PL. Plant proteins in relation to human protein and amino acid nutrition. *Am J Clin Nutr* 1994; 59: 1203S–1212S
41. Joshi S, Shah S, Kalantar-Zadeh K. Adequacy of plant-based proteins in chronic kidney disease. *J Ren Nutr* 2019; 29: 112–117
42. Saglimbene VM, Wong G, Craig JC *et al.* The association of Mediterranean and DASH diets with mortality in adults on hemodialysis: the DIET-HD multinational cohort study. *J Am Soc Nephrol* 2018; 29: 1741–1751
43. Saglimbene VM, Wong G, Teixeira-Pinto A *et al.* Dietary patterns and mortality in a multinational cohort of adults receiving hemodialysis. *Am J Kidney Dis* 2019; 75: 361–372

Received: 15.4.2020; Editorial decision: 24.6.2020

Nephrol Dial Transplant (2021) 36: 688–694
doi: 10.1093/ndt/gfaa278
Advance Access publication 4 February 2021

Effect of comorbidities on survival in patients >80 years of age at onset of renal replacement therapy: data from the ERA-EDTA Registry

Jaakko Helve[1,2], Anneke Kramer [3], Jose Maria Abad Diez[4], Nuria Aresté-Fosalba[5,6], Mustafa Arici[7], Aleix Cases [8,9], Frederic Collart[10], James Heaf[11], Johan De Meester[12], Maurizio Nordio[13,14], Runolfur Palsson[15,16], Alfonso Pobes[17], Helena Rydell[18,19], Anna Varberg Reisæter[20], Ziad A. Massy[21,22], Kitty J. Jager[3] and Patrik Finne[1,2]

[1]Finnish Registry for Kidney Diseases, Helsinki, Finland, [2]Abdominal Center Nephrology, University of Helsinki, Helsinki University Hospital, Helsinki, Finland, [3]Department of Medical Informatics, ERA-EDTA Registry, Academic Medical Center, University of Amsterdam, Amsterdam Public Health Research Institute, Amsterdam, The Netherlands, [4]Renal Registry of Aragon, Aragon Health Service, Zaragoza, Spain, [5]Department of Nephrology, University Hospital Virgen Macarena, Seville, Spain, [6]Information System of the Autonomic Transplant Coordination of Andalucía (SICATA), Andalucía, Spain, [7]Department of Nephrology, Faculty of Medicine, Hacettepe University, Ankara, Turkey, [8]Department of Nephrology, Hospital Clinic, Universitat de Barcelona, IDIBAPS, Barcelona, Spain, [9]Registre de Malalts Renals de Catalunya, Barcelona, Spain[10]French-Belgian ESRD Registry (GNFB), Brussels, Belgium, [11]Department of Medicine, Zealand University Hospital, Roskilde, Denmark, [12]Department of Nephrology, Dialysis and Hypertension, Dutch-speaking Belgian Renal Registry (NBVN), Sint-Niklaas, Belgium, [13]Veneto Dialysis and Transplantation Registry, Regional Epidemiology System, Padua, Italy, [14]Nephrology Dialysis Unit, Padua, Italy, [15]Division of Nephrology, Landspitali-The National University Hospital of Iceland, Reykjavik, Iceland, [16]Faculty of Medicine, School of Health Sciences, University of Iceland, Reykjavik, Iceland, [17]Area Gestation Clinica Nefrología VII-VIII Asturias, Spain, [18]Department of Clinical Sciences Intervention and Technology, Karolinska Institutet, Huddinge, Sweden, [19]Department of Internal Medicine, Swedish Renal Registry, Ryhoy County Hospital, Jönköping, Sweden, [20]Department of Transplantation Medicine, Oslo University Hospital, Rikshospitalet, Oslo, Norway, [21]Division of Nephrology, Amboise Paré University Hospital, APHP, Boulogne-Billancourt, Paris, France and [22]Institut National de la Santé et de la Recherche Médicale (INSERM) Unit 1018 team5, Research Centre in Epidemiology and Population Health (CESP), University of Paris Ouest-Versailles-St Quentin-en-Yveline, Villejuif, France

Correspondence to: Jaakko Helve; E-mail: Jaakko.Helve@Helsinki.fi; Twitter handle: @EraEdtaRegistry

ABSTRACT

Background. The number of elderly patients on renal replacement therapy (RRT) is increasing. The survival and quality of life of these patients may be lower if they have multiple comorbidities at the onset of RRT. The aim of this study was to explore whether the effect of comorbidities on survival is similar in elderly RRT patients compared with younger ones.

Methods. Included were 9333 patients ≥80 years of age and 48 352 patients 20–79 years of age starting RRT between 2010 and 2015 from 15 national or regional registries submitting data to the European Renal Association–European Dialysis and Transplantation Association Registry. Patients were followed until death or the end of 2016. Survival was assessed by Kaplan–Meier curves and the relative risk of death associated with comorbidities was assessed by Cox regression analysis.

Results. Patients ≥80 years of age had a greater comorbidity burden than younger patients. However, relative risks of death associated with all studied comorbidities (diabetes, ischaemic heart disease, chronic heart failure, cerebrovascular disease, peripheral vascular disease and malignancy) were significantly lower in elderly patients compared with younger patients. Also, the increase in absolute mortality rates associated with an increasing number of comorbidities was smaller in elderly patients.

Conclusions. Comorbidities are common in elderly patients who enter RRT, but the risk of death associated with comorbidities is less than in younger patients. This should be taken into account when assessing the prognosis of elderly RRT patients.

Keywords: comorbidity, elderly, ESKD, renal replacement therapy, survival

INTRODUCTION

In Europe, the proportion of patients ≥75 years of age on renal replacement therapy (RRT) increased from 16% in 2006 to 21% in 2016 [1, 2]. The increasing life expectancy of the general population [3] is expected to lead to a further expansion of elderly patients on RRT. Although kidney transplantation rates are increasing, most elderly RRT patients do not receive a transplant and the selection of in-centre haemodialysis as an RRT modality is more common than among younger patients [2]. In addition, the survival of elderly patients on RRT is worse compared with younger patients [2, 4]. In particular, elderly patients with comorbidities may not have a survival benefit or improved health-related quality of life on dialysis compared with conservative treatment of end-stage kidney disease (ESKD) [5–8].

In general, comorbidities have been associated with worse survival on RRT [9, 10], also among elderly patients [11]. Models that have been developed to predict the prognosis of RRT patients include information on age and comorbidities [12–16]. However, all those models assume that the relative risk of death associated with comorbidity is the same regardless of the patient's age. In patients ≥80 years of age, estimates of remaining survival time may have more impact on treatment decisions than in younger patients and reliable prognostic tools are needed. Still, knowledge of potential variation in the effect of comorbidity on mortality across age groups is scarce or non-existent. Therefore our aim was to quantify the prognostic effect of comorbidity at the initiation of RRT in patients ≥80 years of age compared with younger patients.

KEY LEARNING POINTS

What is already known about this subject?

- Comorbidities associate with worse survival on renal replacement therapy (RRT).
- Elderly patients on RRT have more comorbidities compared with younger patients.

What this study adds?

- Comorbidities do not have such a substantial effect on the risk of death in patients ≥80 years of age compared with younger patients.

What impact this may have on practice or policy?

- Variance in effect of comorbidities on survival according to age should be considered when the prognosis of these patients is estimated and prognostic indices are built.

MATERIALS AND METHODS

Cohort

This cohort study consisted of incident patients ≥80 years of age at the start of RRT from 1 January 2010 to 31 December 2015, retrieved from the European Renal Association–European Dialysis and Transplantation Association (ERA-EDTA) Registry. Patients 20–79 years of age from the same national and regional registries were selected for comparison. Furthermore, sensitivity analyses were made using three age groups (patients 20–64, 65–79 and ≥80 years of age). Individual patient-level data were obtained from seven national (Austria, Bosnia and Herzegovina, Denmark, Finland, Iceland, Norway and Sweden) and eight regional (Dutch- and French-speaking Belgium and Spanish regions of Andalusia, Aragon, Asturias, Catalonia, Galicia and Valencia) renal registries providing additional data on the following comorbidities at initiation of RRT: diabetes, ischaemic heart disease, chronic heart failure, cerebrovascular disease, peripheral vascular disease and malignancy. The data also included date of birth, date of RRT onset, sex, primary renal disease, initial treatment modality and date and cause of death.

Data acquisition

Information on studied comorbidities was available for the majority of patients and ranged between 95.0% for ischaemic heart disease to 96.5% for malignancies, except for data on chronic heart failure, which was only available for 62% of the patients, because not all registries provide this information. Diabetes was recorded as a comorbidity, both when it was the primary renal disease and when it was a separate comorbid condition. Body mass index (BMI) was available for 42% of the patients. We divided patients into four groups of primary renal disease: diabetes, renovascular disease (including hypertension), glomerulonephritis (primary)

and other or unknown diagnoses. The list of diagnosis codes belonging to each group is presented in the ERA-EDTA annual report [1].

Multivariable models were made separately for both age groups. Chronic heart failure was not included in the models when assessing the association of other comorbidities with mortality to avoid exclusion of patients with missing data. BMI was not included in the multivariable models and analyses on the number of comorbidities due to a large number of patients with missing data. Patients who received or did not receive kidney transplantation were not analysed separately due to the small number of transplantations among elderly patients.

Statistical analysis

When comparing distributions of variables between age groups, the chi-square test was used for categorical variables and the Mann–Whitney U-test for continuous variables. Survival probability was assessed using the Kaplan–Meier method, while the relative risk of death associated with comorbidities within each age group was estimated using Cox proportional hazards regression. The survival time was calculated from the first day of RRT (dialysis or pre-emptive kidney transplantation) and patients ≥80 years of age were followed until death (65.4%), censoring at loss to follow-up (0.5%), recovery of renal function (3.3%) or end of the follow-up period on 31 December 2016 (30.6%). For patients 20–79 years of age, the corresponding proportions were 34.3, 0.5, 3.7 and 60.8%, respectively. Patients were not censored upon kidney transplantation. The patient's age was introduced as a continuous variable in the model. In order to test whether the effect of comorbidity on survival differed significantly between age groups, the interaction between age and comorbidity was assessed by including interaction terms in the Cox regression models. Two-sided P-values <0.05 were considered statistically significant. Statistical analyses were performed using SPSS Statistics version 25 (IBM, Armonk, NY, USA).

RESULTS

Patient characteristics

During the study period, 9333 patients ≥80 years of age and 48 352 patients 20–79 years of age started RRT. The median follow-up times were 1.74 and 2.65 years, respectively. Renovascular disease was a more common cause of ESKD in patients ≥80 years of age than in younger patients, whereas diabetes and glomerulonephritis were less common among elderly patients (Table 1). The median BMI was lower among the elderly than the younger patients (25.2 kg/m^2 versus 26.3 kg/m^2; $P < 0.001$). Haemodialysis was more often the initial treatment modality in elderly patients than in younger patients. Of the patients ≥80 years of age, only 0.2% received a kidney transplant during the follow-up period compared with 26.7% of younger patients.

Comorbidities

Comorbid conditions were more common among patients ≥80 years of age (Table 1). Elderly patients more frequently

Table 1. Baseline characteristics of the patients

Variable	Patients age 20–79 years	Patients age ≥80 years	P-value
Number of patients	48 352	9333	
Male gender, *n* (%)	31 855 (65.9)	5715 (61.2)	<0.001
Deaths during follow-up, *n* (%)	16 571 (34.3)	6100 (65.4)	<0.001
Age at RRT onset (years), median (IQR)	65.0 (19.2)	83.3 (4.1)	
BMI (kg/m^2), %			<0.001
20–30	66.9	76.4	
<20	6.9	7.3	
>30	26.2	16.3	
Primary renal disease, %			<0.001
Diabetes	25.3	15.8	
Renovascular disease	15.1	30.1	
Glomerulonephritis	12.7	4.9	
Other or unknown	46.9	49.2	
Initial treatment modality, %			<0.001
Haemodialysis	77.8	89.3	
Peritoneal dialysis	17.6	10.6	
Kidney transplantation	4.6	0.0	
Comorbidity, %			
Diabetes	39.8	33.8	<0.001
Ischaemic heart disease	23.2	33.9	<0.001
Chronic heart failure	21.7	37.0	<0.001
Cerebrovascular disease	12.9	17.8	<0.001
Peripheral vascular disease	16.1	20.8	<0.001
Malignancy	13.5	20.8	<0.001
Number of comorbidities, %			
No comorbidity	37.8	25.6	<0.001
Presence of one comorbidity	28.8	29.9	
Presence of two comorbidities	17.8	22.8	
Presence of three or more comorbidities	15.5	21.7	

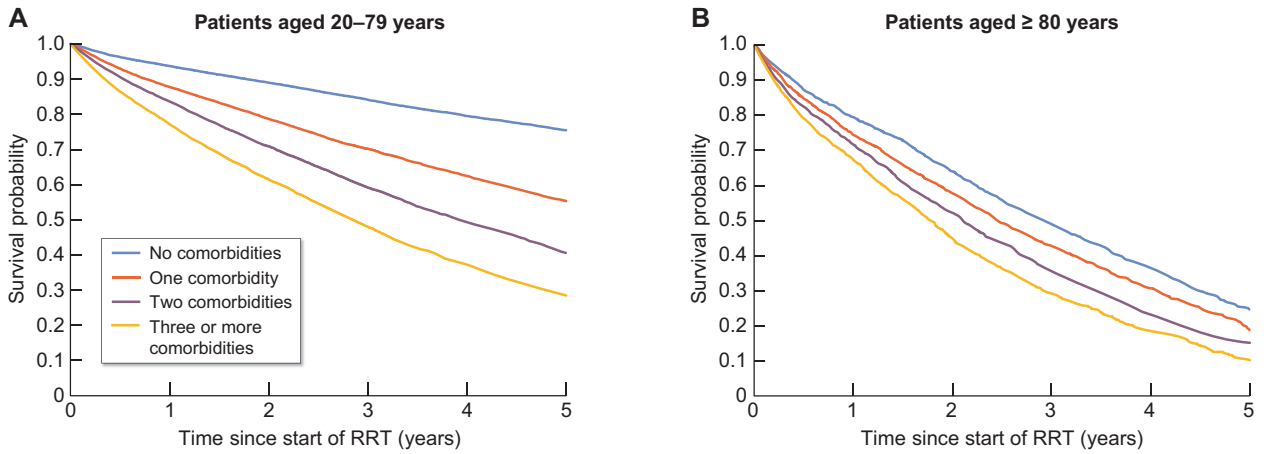

FIGURE 1: Cumulative survival probability of RRT patients according to number of comorbidities.

Table 2. Relative risk of death according to the type of comorbidity

Comorbidity	Patients age 20–79 years, HR (95% CI)			Patients age ≥80 years, HR (95%CI)[a]		
	Crude	Age- and sex-adjusted	Multivariable adjustment[a,b]	Crude	Age- and sex-adjusted	Multivariable adjustment[a,b]
Diabetes[c]	1.67 (1.62–1.72)	1.43 (1.38–1.47)	1.35 (1.29–1.41)	1.09 (1.03–1.15)	1.13 (1.07–1.19)	1.12 (1.04–1.21)
Ischaemic heart disease	2.12 (2.06–2.19)	1.57 (1.51–1.62)	133 (1.28–1.38)	1.31 (1.24–1.38)	1.30 (1.23–1.37)	1.16 (1.10–1.23)
Chronic heart failure	2.35 (2.25–2.45)	1.72 (1.65–1.80)	1.53 (1.47–1.61)	1.51 (1.41–1.61)	1.49 (1.40–1.59)	1.44 (1.35–1.55)
Cerebrovascular disease	1.87 (1.80–1.95)	1.48 (1.42–1.54)	1.22 (1.17–1.27)	1.30 (1.22–1.39)	1.30 (1.22–1.39)	1.19 (1.12–1.28)
Peripheral vascular disease	2.03 (1.96–2.10)	1.55 (1.50–1.16)	1.33 (1.28–1.38)	1.27 (1.20–1.35)	1.27 (1.20–1.35)	1.20 (1.12–1.28)
Malignancy	2.06 (1.98–2.14)	1.52 (1.46–1.58)	1.51 (1.45–1.57)	1.22 (1.14–1.29)	1.19 (1.11–1.26)	1.14 (1.07–1.22)

[a]Interaction term was significant ($P < 0.05$) in all analyses between age groups.
[b]Adjusted for age at RRT onset, sex, initial treatment modality, primary renal disease, other comorbidities and reporting registry.
[c]Ischaemic heart disease, cerebrovascular disease and peripheral vascular disease were excluded from the multivariable adjustment as these conditions may be involved in the causal pathway between diabetes and death.
HR: hazard ratio; CI: confidence interval.

had ischaemic heart disease, chronic heart failure, cerebrovascular disease, peripheral vascular disease and malignancies than younger patients. Only diabetes was more common among younger patients. Comorbid conditions and pre-emptive kidney transplantation of the patients by registry are presented in Supplementary data, Table S1.

Survival

During follow-up, 6100 patients ≥80 years of age and 16 571 patients 20–79 years of age died. Cardiac disease was the most common cause of death in both age groups. Unadjusted survival of patients ≥80 years of age at RRT onset was inferior to that of the younger patients. During the first year on RRT, the risk of death among patients ≥80 years of age without any comorbid conditions was 21%, while it was 33% for patients with three or more comorbidities. In patients 20–79 years of age, the risk of death increased from 6% when no comorbidity was present to 23% when the number of comorbidities was three or greater (Figure 1). In general, the difference in absolute risk of death between patients without comorbidity and those with three or more comorbidities during 5 years after the onset of RRT was smaller in patients ≥80 years of age compared with younger patients.

Relative risk of death

All individual comorbid conditions as well as an increase in the number of comorbidities were associated with a greater risk of death in both age groups. When analysed without adjustment, relative risks of death associated with all the studied comorbidities were lower in patients ≥80 years of age compared with patients 20–79 years of age (Table 2). Adjustment for age and sex or further multivariable adjustment did not substantially change the results in patients ≥80 years of age, while relative risks of death decreased in patients 20–79 years of age due to wider age distribution in the latter group and strong association between age and mortality, as well as age and number of comorbidities. However, the increase in mortality associated with comorbidity was higher in younger patients, also after adjustment for confounding factors. When examining the relationship between the number of comorbidities and relative risk of death, the results were similar, showing a smaller effect of an increasing number of comorbidities on survival in elderly patients (Figure 2). Interaction analyses confirmed that all differences between the age groups in the effect of the individual comorbid conditions as well as the number of comorbidities on survival were statistically significant. In sensitivity analyses, relative risks of death were assessed according to the time from

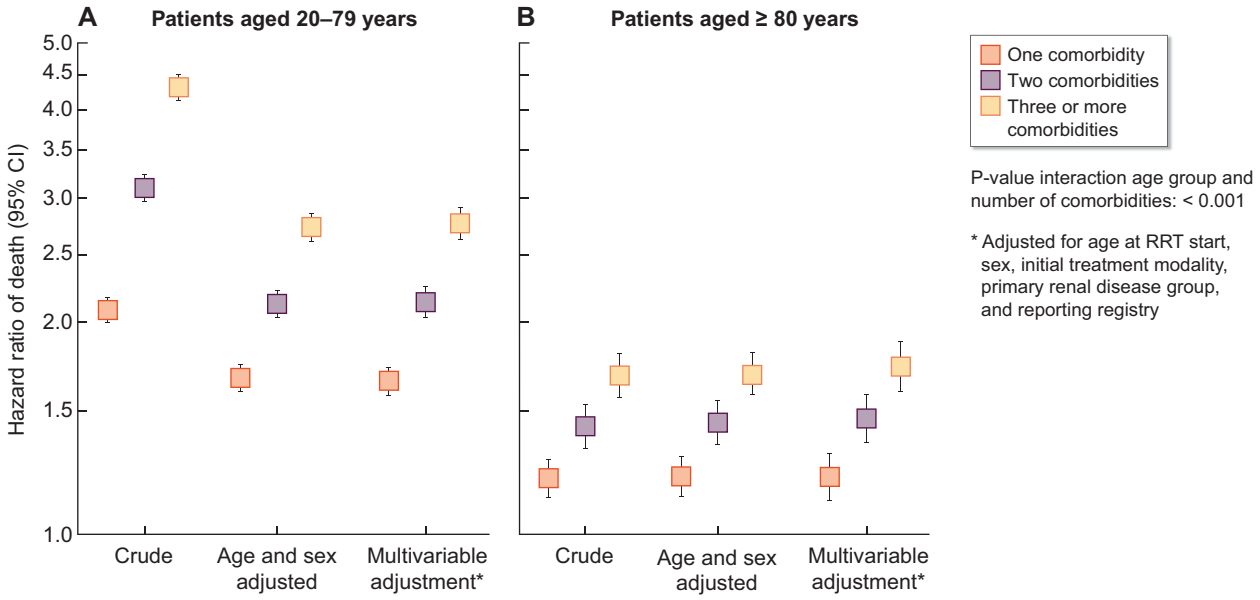

FIGURE 2: Relative risk of death among RRT patients according to the number of comorbidities.

onset of RRT and to different age groups. The results were similar within and after the first 2 years on RRT. When relative risks of death were analysed for three age groups (20–64, 65–79 and ≥80 years), the relative risk of death associated with all individual comorbidities as well as the number of comorbidities decreased gradually with age.

DISCUSSION

This study extends our knowledge on the absolute and relative effects of comorbidities on survival of elderly patients starting RRT, showing that comorbidities affect survival less in elderly than in younger patients. In addition, our study confirms that elderly patients have more comorbidities and a higher risk of death on RRT than younger patients.

To our knowledge, this is the first study to investigate how the effect of comorbidity on survival among patients on RRT varies according to age. This new insight helps us to assess how we should take comorbidities into account when estimating the prognosis of elderly patients at RRT onset. The strength of this study is the large cohort from 15 renal registries across Europe with comprehensive data on comorbidities at the onset of RRT, age, sex, primary renal disease, initial treatment modality and survival. The potential limitation is the fact that information on the severity of the comorbidities was not available. Younger RRT patients may have more severe comorbidities because elderly patients with severe comorbid conditions might have died before the onset of RRT or conservative treatment was chosen. Definitions of comorbid conditions were not homogeneous between the registries [17]. However, as comorbidities were collected in a similar manner within each registry, regardless of the patients' age, it should not cause significant bias to our results, and the results were consistent when analysed by country. There was also a lack of information on frailty, cognitive impairment, functional status and socio-economic factors, which have remarkable importance in this setting. In elderly patients, problems with these factors or heavy comorbidity burden may have led to avoidance of the initiation of dialysis, whereas this would be unlikely in younger patients. This may have resulted in the selection of relatively well-preserved elderly patients with less severe comorbid conditions, thereby underestimating the effect of comorbidities on survival in this group.

When considering initiation of dialysis for patients with impaired physical or cognitive function, a major question is whether the treatment is likely to be beneficial [18, 19]. While the variable incidence of RRT among elderly people is remarkable in Europe, this finding could not be explained by differences in patient characteristics, excluding patient age or country economics [20]. Studies comparing survival between frail elderly patients on dialysis and ESKD patients receiving conservative treatment have suggested that dialysis confers little survival advantage and improvement in quality of life in those with a severe comorbidity burden [5–7, 21–24]. As our study included only the patients who initiated RRT, we do not know how the investigated comorbidities would affect patients' survival on conservative treatment. However, our study indicates that among elderly patients considered fit enough to start RRT, comorbidities are less relevant to the prognosis than in younger patients.

It is widely acknowledged that we need better tools to predict the survival of elderly patients with ESKD in order to assist in making informed treatment decisions [25]. Various comorbidity indices have shown potential usefulness in estimating the risk of death after the onset of RRT [12, 13, 26]. Several prognostic models have included other factors in addition to comorbidities [14–16, 27–32]. However, nearly all these studies have been based on significantly younger patients with a median age ~20–25 years lower than in our study. Therefore these

prediction models may not be applicable for patients of advanced age. Our study suggests that we should not use the same effect estimates of death associated with comorbidities in young and elderly patients, because doing so may overestimate the risk of death in patients ≥80 years of age. A recent systematic review and meta-analysis explored 32 prognostic indices predicting mortality at the start of dialysis, but none of these took into account variance according to the patient's age in the risk of death associated with comorbidity [33]. Notably, studies from France, Canada and the USA have presented stratification algorithms that include data on comorbidities to predict early mortality in elderly patients when initiating dialysis [31, 32, 34, 35] and showed that these models could identify elderly patients with high risk of early mortality. Although factors that affect the survival of elderly RRT patients are complex, our data imply that comorbid conditions may have a smaller effect on the relative risk of death among elderly patients compared with younger age groups, and this should be considered when the prognosis of these patients is estimated.

CONCLUSION

The results of this multinational European study suggest that once patients have been selected for RRT, comorbidities do not have such a substantial effect on the risk of death in patients ≥80 years of age compared with younger patients. Reasons for the smaller effect of comorbidities on the risk of death in the elderly may be their higher baseline risk caused by several age-related factors and differences in the severity of comorbidities. Nevertheless, it is important to critically assess whether an elderly patient with multiple comorbidities is likely to benefit from RRT. Therefore shared decision-making should be employed when RRT initiation is considered in elderly patients. To this end, better prognostic tools tailored to elderly ESKD patients are needed.

SUPPLEMENTARY DATA

Supplementary data are available at ndt online.

ACKNOWLEDGEMENTS

We would like to thank the patients and the staff of the dialysis and transplant units for contributing the data via their national and regional renal registries. Furthermore, we gratefully acknowledge the following registries and persons for their contribution of data: Austrian Dialysis and Transplant Registry (OEDTR): R. Kramar; Dutch-speaking Belgian Society of Nephrology (NBVN): M. Couttenye and F. Schroven; French-speaking Belgian Society of Nephrology (GNFB): J.M. des Grottes; Renal Registry Bosnia and Herzegovina: H. Resić, B. Jakovljevic and M. Tomić; Danish Nephrology Registry (DNS); Finnish Registry for Kidney Diseases: P.H. Groop; Icelandic End-Stage Renal Disease Registry; Norwegian Renal Registry: A. Åsberg; Swedish Renal Registry (SRR): K.G. Prütz, M. Stendahl, M. Evans, S. Schön, T. Lundgren and M. Segelmark; and the regional registries of Andalusia (SICATA): P. Castro de la Nuez (on behalf of all users of SICATA); Aragon: F. Arribas Monzón and J.I. Sanchez Miret; Asturias: P. Beltrán, J.R. Quirós and RERCA Working Group; Catalonia (RMRC): E. Arcos, J. Comas and J. Tort; Galicia: E. Bouzas-Caamaño; and Valencian region (REMRENAL): M. Ferrer Alamar, N. Fuster Camarena and J. Pérez Penadés; and the other ERA-EDTA registry committee members not mentioned above for their advice in the analysis and drafting of this article: C. Zoccali, P. Ambühl, J. Harambat, L. Mercadal, M. Nordio, S.S. Sørensen and E. Vidal; and R. Boenink in the AMC Registry office for data collection and management. This article was written by Jaakko Helve, Anneke Kramer, Jose Maria Abad Diez, Nuria Aresté-Fosalba, Mustafa Arici, Aleix Cases, Frederic Collart, James Heaf, Johan De Meester, Maurizio Nordio, Runolfur Palsson, Alfonso Pobes, Helena Rydell, Anna Varberg Reisæter, Ziad A. Massy, Kitty J. Jager and Patrik Finne on behalf of the ERA-EDTA Registry, which is an official body of the ERA-EDTA.

FUNDING

J.H. was funded by Munuaissäätiö and the Finnish Medical Foundation. The ERA-EDTA Registry is funded by the ERA-EDTA.

AUTHORS' CONTRIBUTIONS

J.H., A.K. and P.F. contributed to the literature search, study design, data collection, data analysis, data interpretation and writing. All co-authors contributed to the study design, data collection, data interpretation and writing. All authors have seen and approved the final version of the article.

CONFLICT OF INTEREST STATEMENT

M.A. reports personal fees from Alexion, Amgen, AstraZeneca, Bayer, Boehringer Ingelheim and Menarini, outside the submitted work. J.D.M. reports personal fees from Menarini, outside the submitted work. K.J.J. reports grants from the ERA-EDTA during the conduct of the study and personal fees from Fresenius, outside the submitted work. The other authors have nothing to disclose.

REFERENCES

1. *ERA-EDTA. ERA-EDTA Registry Annual Report 2016.* Amsterdam: Academic Medical Center, Department of Medical Informatics, 2018: 69
2. *ERA-EDTA. ERA-EDTA Registry Annual Report 2006.* Amsterdam: Academic Medical Center, Department of Medical Informatics, 2008: 33
3. Eurostat. *Table: Healthy Life Years and Life Expectancy at Age 65 by Sex.* https://ec.europa.eu/eurostat/tgm/table.do? tab=table&plugin=1&language=en&pcode=tepsr_sp320
4. U.S. Renal Data System. *2018 USRDS Annual Data Report: Epidemiology of Kidney Disease in the United States.* Bethesda, MD: National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, 2018
5. Verberne WR, Geers AB, Jellema WT *et al.* Comparative survival among older adults with advanced kidney disease managed conservatively versus with dialysis. *Clin J Am Soc Nephrol* 2016; 11: 633–640
6. Seow YY, Cheung YB, Qu LM *et al.* Trajectory of quality of life for poor prognosis stage 5D chronic kidney disease with and without dialysis. *Am J Nephrol* 2013; 37: 231–238

7. Chandna SM, Da Silva-Gane M, Marshall C *et al.* Survival of elderly patients with stage 5 CKD: comparison of conservative management and renal replacement therapy. *Nephrol Dial Transplant* 2011; 26: 1608–1614
8. Brown MA, Collett GK, Josland EA *et al.* CKD in elderly patients managed without dialysis: survival, symptoms, and quality of life. *Clin J Am Soc Nephrol* 2015; 10: 260–268
9. Kotwal S, Webster AC, Cass A *et al.* Comorbidity recording and predictive power of comorbidities in the Australian and New Zealand dialysis and transplant registry compared with administrative data: 2000–2010. *Nephrology* 2016; 21: 930–937
10. Goodkin DA, Bragg-Gresham JL, Koenig KG *et al.* Association of comorbid conditions and mortality in hemodialysis patients in Europe, Japan, and the United States: the Dialysis Outcomes and Practice Patterns Study (DOPPS). *J Am Soc Nephrol* 2003; 14: 3270–3277
11. Malberti F, Conte F, Limido A *et al.* Ten years experience of renal replacement treatment in the elderly. *Geriatr Nephrol Urol* 1997; 7: 1–10
12. Miskulin DC, Meyer KB, Martin AA *et al.* Comorbidity and its change predict survival in incident dialysis patients. *Am J Kidney Dis* 2003; 41: 149–161
13. van Manen JG, Korevaar JC, Dekker FW *et al.* How to adjust for comorbidity in survival studies in ESRD patients: a comparison of different indices. *Am J Kidney Dis* 2002; 40: 82–89
14. Wagner M, Ansell D, Kent DM *et al.* Predicting mortality in incident dialysis patients: an analysis of the United Kingdom Renal Registry. *Am J Kidney Dis* 2011; 57: 894–902
15. Liu J, Huang Z, Gilbertson DT *et al.* An improved comorbidity index for outcome analyses among dialysis patients. *Kidney Int* 2010; 77: 141–151
16. Haapio M, Helve J, Grönhagen-Riska C *et al.* One- and 2-year mortality prediction for patients starting chronic dialysis. *Kidney Int Rep* 2017; 2: 1176–1185
17. Ceretta ML, Noordzij M, Luxardo R *et al.* Changes in comorbidity pattern in patients starting renal replacement therapy in Europe – data from the ERA-EDTA Registry. *Nephrol Dial Transplant* 2018; 33: 1794–1804
18. Kallenberg MH, Kleinveld HA, Dekker FW *et al.* Functional and cognitive impairment, frailty, and adverse health outcomes in older patients reaching ESRD-A systematic review. *Clin J Am Soc Nephrol* 2016; 11: 1624–1639
19. Hole B, Tonkin-Crine S, Caskey FJ *et al.* Treatment of end-stage kidney failure without renal replacement therapy. *Semin Dial* 2016; 29: 491–506
20. Helve J, Kramer A, Abad-Diez JM *et al.* Factors associating with differences in the incidence of renal replacement therapy among elderly: data from the ERA-EDTA registry. *Nephrol Dial Transplant* 2018; 33: 1428–1435
21. Kurella Tamura M, Covinsky KE, Chertow GM *et al.* Functional status of elderly adults before and after initiation of dialysis. *N Engl J Med* 2009; 361: 1539–1547
22. Hussain JA, Mooney A, Russon L. Comparison of survival analysis and palliative care involvement in patients aged over 70 years choosing conservative management or renal replacement therapy in advanced chronic kidney disease. *Palliat Med* 2013; 27: 829–839
23. Murtagh FE, Marsh JE, Donohoe P *et al.* Dialysis or not? A comparative survival study of patients over 75 years with chronic kidney disease stage 5. *Nephrol Dial Transplant* 2007; 22: 1955–1962
24. Shum CK, Tam KF, Chak WL *et al.* Outcomes in older adults with stage 5 chronic kidney disease: comparison of peritoneal dialysis and conservative management. *J Gerontol A Biol Sci Med Sci* 2014; 69A: 308–314
25. van der Veer SN, van Biesen W, Bernaert P *et al.* Priority topics for European multidisciplinary guidelines on the management of chronic kidney disease in older adults. *Int Urol Nephrol* 2016; 48: 859–869
26. Geddes CC, van Dijk PC, McArthur S *et al.* The ERA-EDTA cohort study—comparison of methods to predict survival on renal replacement therapy. *Nephrol Dial Transplant* 2006; 21: 945–956
27. Cohen LM, Ruthazer R, Moss AH *et al.* Predicting six-month mortality for patients who are on maintenance hemodialysis. *Clin J Am Soc Nephrol* 2010; 5: 72–79
28. Merkus MP, Jager KJ, Dekker FW *et al.* Predictors of poor outcome in chronic dialysis patients: the Netherlands cooperative study on the adequacy of dialysis. *Am J Kidney Dis* 2000; 35: 69–79
29. Mauri JM, Cleries M, Vela E *et al.* Design and validation of a model to predict early mortality in hemodialysis patients. *Nephrol Dial Transplant* 2008; 23: 1690–1696
30. Peeters P, Van Biesen W, Veys N *et al.* External validation of a risk stratification model to assist shared decision making for patients starting renal replacement therapy. *BMC Nephrol* 2016; 17: 41
31. Couchoud C, Labeeuw M, Moranne O *et al.* A clinical score to predict 6-month prognosis in elderly patients starting dialysis for end-stage renal disease. *Nephrol Dial Transplant* 2009; 24: 1553–1561.
32. Couchoud CG, Beuscart JB, Aldigier JC *et al.* Development of a risk stratification algorithm to improve patient-centered care and decision making for incident elderly patients with end-stage renal disease. *Kidney Int* 2015; 88: 1178–1186
33. Anderson RT, Cleek H, Pajouhi AS *et al.* Prediction of risk of death for patients starting dialysis: a sistematic review and meta-analysis. *Clin J Am Soc Nephrol* 2019; 14: 1213–1227
34. Thamer M, Kaufman JS, Zhang Y *et al.* Predicting early death among elderly dialysis patients: development and validation of a risk score to assist shared decision making for dialysis initiation. *Am J Kidney Dis* 2015; 66: 1024–1032
35. Wick JP, Turin TC, Faris PD *et al.* A clinical risk prediction tool for 6-month mortality after dialysis initiation among older adults. *Am J Kidney Dis* 2017; 69: 568–575

Received: 29.1.2020; Editorial decision: 15.9.2020